Syllabus Effective for students who are enrolled in the year 2022-23, 2023-24 & 24-25

U.G. (Honours)
(VII and VIII semester)

Subject: Biotechnology

Course Type	Semester-VII				Semester-VIII			
	Subject/Title	No. of paper	Credits T	Credits P	Subject /Title	No. of paper	Credits T	Credits P
Major Subject (One)	**Core Major-I (CBT-7)** Biochemistry and Metabolism	1	5	-	**Core Major-I (CBT-10)** Bio-Analytical Techniques	1	5	-
	Core Major-II (CBT-8) Advanced Molecular Biology	1	5	-	**Core Major-II (CBT-11)** Immunology	1	5	-
	Core Major-III (CBT-9) Microbes and Microbial Technology	1	5	-	**Core Major-III (CBT-12)** Genetic Engineering and Applications	1	5	-
	Major Practical [CBT-7(P)] Lab Course based on CBT-7, CBT-8 and CBT-9	1	-	5	**Major Practical [CBT-8(P)]** (Lab Course based on CBT-10, CBT-11 and CBT-12)	1	-	5
	Core Major Elective (CBTE-1a) Genomics and Proteomics **Or** **(CBTE-1b)** Biofuels and Biopolymers **Elective Practical [CBTE-1(P)]** Lab Course based on CBTE-1a **Or** CBTE-1b	1	2	2	**Core Major Elective (CBTE-2a)** Nanobiotechnology Or **(CBTE-2b)** Epigenetics and Cancer Biology **Elective Practical [CBTE-2(P)]** Lab Course based on CBTE-2a **Or** CBTE-2b	1	2	2
Minor (One)	**Minor-I (MIBT-1)** General Biochemistry **Or** Swayam course on Marine Biotechnology (https://onlinecourses.swayam2.ac.in/cec24_bt14/preview)	1	4		**Minor-II (MIBT-2)** Basics of Genetic Engineering **Or** Swayam course on Food Preservation Technology (https://onlinecourses.swayam2.ac.in/cec25_ag04/preview)	1	4	
Total		**6**	**21**	**7**		**6**	**21**	**7**
Student on exit after successfully completing four years (i.e., securing minimum required 176 credits along with securing additional 2 credits under SSD course work) will be awarded "Four years Bachelor's Degree (Honours)".								

Effective for students who are enrolled in the year 2022-23, 2023-24 & 24-25

U.G. (Honours with Research)
(VII and VIII semester)

Subject: Biotechnology

Course Type	Semester-VII				Semester-VIII			
	Subject/Title	No. of paper	Credits		Subject /Title	No. of paper	Credits	
			T	P			T	P
Major Subject (One)	**Core Major-I [CBT(R)-7]** Biochemistry and Metabolism	**1**	**5**	**-**	**Core Major-I [CBT(R)-10]** Genetic Engineering and Applications	**1**	**5**	**-**
	Core Major-II [CBT(R)-8] Advanced Molecular Biology	**1**	**5**	**-**				
	Major Practical [CBT(R)-7(P)] (Lab Course based on CBT(R)-7 and CBT(R)-8)	**1**	**-**	**5**	**Major Practical [CBT(R)-8(P)]** (Lab Course based on CBT (R)-10	**1**	**-**	**3**
	Core Major Elective [CBTE(R)-1a] Genomics and Proteomics **Or** **[CBTE(R)-1b]** Biofuels and Biopolymers **Elective Practical [CBTE(R)-1(P)]** (Lab Course based on [CBTE(R)-1a) **Or** [CBTE(R)-1b]	**1**	**2**	**2**	**Core Major Elective [CBTE(R)-2a]** Nanobiotechnology **Or** **[CBTE(R)-2b]** Epigenetics and Cancer Biology **Elective Practical [CBTE(R)-2(P)]** (Lab Course based on [CBTE(R)-2a] **Or** CBTE(R)-2b	**1**	**2**	**2**
	CBT(R)-9 Research Methodology	**1**	**5**		**[CBTE(R)-3(P)]** Dissertation	**1**	**-**	**12**
Minor (one)	**Minor-I [MIBT(R)-1]** General Biochemistry **Or** Swayam course on Marine Biotechnology (https://onlinecourses.swayam2.ac.in/cec24_bt14/preview)	**1**	**4**		**Minor-II [MIBT(R)-2]** Basics of Genetic Engineering **Or** Swayam course on Food Preservation Technology (https://onlinecourses.swayam2.ac.in/cec25_ag04/preview)	**1**	**4**	
Total		**6**	**21**	**7**		**6**	**11**	**17**
Student on exit after successfully completing four years (i.e., securing minimum required 176 credits along with securing additional 2 credits under SSD coursework) will be awarded "Four years Bachelor's Degree "Honours with Research", in related field/discipline/subject								

The Departments offering a 4-year UG Degree (Honours with Research) must have the required infrastructure such as the library, access to journals, computer lab and software, laboratory facilities to carry out experimental research work, and at least two permanent faculty members who are recognized as Ph.D. supervisors. The Departments already recognized for conducting the Ph.D. programme may conduct a 4-year UG Degree (Honours with Research) without obtaining any approval from the affiliating University.

Syllabus (NEP-2020)- HNBGU
B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Core Major-I: Biochemistry and Metabolism
(Course code: CBT-7) No. of Credits: 5

UNIT-I (Cr- 1)

Carbohydrates: Classification, structure, and functions.
Carbohydrate metabolism I: Pathway and regulation of glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis.
Carbohydrate metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway, and its regulation.

UNIT- II (Cr-1.25)

Fatty acids: Classification and structure.
Fatty acid metabolism: Fatty acid oxidation and regulation, β-oxidation, oxidation of unsaturated fatty acids and odd chain fatty acids, β-oxidation in peroxisomes, ketone bodies and their overproduction.
Fatty acid biosynthesis and regulation: Reactions of fatty acid synthase, synthesis of triglycerols, cholesterol biosynthesis, and regulation.

UNIT- III (Cr-1)

Nucleic acids: Structure and functions.
Nucleic acid metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis, and its regulation, formation of deoxyribonucleotides, Salvage pathway for purine and pyrimidine nucleotides, degradation of purines and pyrimidines.

UNIT-IV (Cr-1.25)

Amino acids: Structure and functional group properties, peptides and covalent structure of proteins, primary and higher-order structures, and Ramachandran plot.
Protein: Classification, structure, and functions.
Amino acid metabolism: overview of amino-acid biosynthesis and degradation, urea cycle (Linkage between urea cycle and citric acid cycle) and its regulation, and conversion of nitrogen to ammonia by microorganisms.

UNIT-V (Cr-0.5)

Enzymes: Introduction and classification, concept of E-S complex, binding sites, active site, specificity, lock and key hypothesis, induced-fit hypothesis, zymogens, Michaelis-Menten equation, enzyme inhibition.

Recommended Books:

1. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
2. Berg J.M., Tymoczko J.L., Gatto G.J.Jr., Stryer L. Biochemistry. 2023. 10th ed. Macmillan Learning.
3. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry: Life at the Molecular Level. 2023. 6th ed. John Wiley & Sons.
4. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
5. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Core Major-II: Advanced Molecular Biology
(Course code: CBT-8) No. of Credits: 5

UNIT-I (Cr- 1)

Chemical and physical properties of nucleic acids: Structure and types of RNA and DNA, Watson-Crick model, different forms of DNA, topological properties of DNA, and DNA renaturation kinetics and DNA as genetic material

UNIT- II (Cr-1)

DNA replication and mechanism: Enzymes and proteins involved in DNA replication, mechanism of DNA replication in prokaryotes and eukaryotes, molecular mechanism of the regulation process of DNA replication in prokaryotes and eukaryotes.
DNA damage: Types and repair mechanisms.

UNIT- III (Cr-1)

Mechanism of transcription: Promoter, *cis* and *trans* elements, and consensus sequences, mechanism of transcription in prokaryotes and eukaryotes, reverse transcription.
Post-transcriptional processing of RNA: Capping, polyadenylation, splicing, and RNA editing.

UNIT-IV (Cr-1)

Mechanism of translation in prokaryotes and eukaryotes: Genetic code, wobble hypothesis, Aminoacyl-t RNA synthetase and its role, steps of initiation, elongation and termination of translation process and the proteins and enzymes involved. Post-translational modifications and its relevance.

UNIT-V (Cr-1)

Regulation of gene expression in prokaryotes and eukaryotes: Positive and negative regulation, *lac* operon, and *trp* operon, regulatory proteins and DNA binding, chromatin modifications associated with gene expression, and regulatory modules for eukaryotic promoters.

Recommended Books:

1. Brown T.A. Genomes 5. 2023. 5th ed. CRC Press.
2. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's Genes XII. 2018. 12th ed. Jones & Bartlett Learning.
4. Watson J.E. Molecular Biology of the Gene. 2014. 7thed. Pearson Publishers.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Core Major-III: Microbes and Microbial Technology
(Course code: CBT-9) No. of Credits: 5

UNIT-I (Cr- 1.5)

Microorganisms: General structure, characteristic features and classification of bacteria, fungi and viruses.
Laboratory culture and methods to study microbes: Concept of pure culture, aseptic conditions, sterilization and staining methods. microbial culture media and its types.

UNIT– II (Cr- 0.5)

Bacterial growth: Monoauxic, diauxic, and synchronous growth, growth phases, and growth curve. Factors affecting bacterial growth, modes of bacterial nutrition, methods to control microbial growth.

UNIT– III (Cr- 1)

Microbial applications in food & health: Microbial processes and their application in food and healthcare industries, food processing and food preservation, Single cell proteins (*Spirulina*, and Yeast), and microbial production of organic acids, vitamins, and amino acids.

UNIT–IV (Cr- 1)

Microbial cell factories: Definition and concept, advantages over traditional chemical synthesis, and applications.
Plant growth promoting bacteria: Types and their applications.
Microbial production of nanoparticles.

UNIT–V (Cr- 1)

Metagenomics: Definition and concept, applications in studying unculturable microorganisms, metagenomic library construction and functional screening in suitable hosts, amplicon and genome sequencing to study microbial diversity and functions, general overview of bioinformatics methods for studying metagenomics sequence data.

Recommended Books:

1. Wood D., Joanne W., Sandman K. Prescott's Microbiology. 2023. 10th ed. New York, McGraw-Hill Education.
2. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M., Stahl D.A. Brock Biology of Microorganisms. 2021. 16th ed. Pearson Education Ltd.
3. Tortora G.J., Funke B.R., Case C.L. Microbiology: An Introduction. 2019. 13th ed. Chicago, Pearson.
4. Pelczar M.J., Chan E.C.S., Krieg N.R. 2001. Microbiology, McGraw-Hill Education.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Major Practical: Lab Course based on CBT-7, CBT-8, and CBT-9
Course code: CBT-7(P) No. of Credits: 5

Practicals based on CBT-7 (Biochemistry and Metabolism)

1. Quantitative estimation of protein.
2. Quantitative estimation of carbohydrate.
3. Quantitative estimation of cholesterol.
4. Determination of the acid value of fats.
5. Determination of the saponification value of fat or oil.

Practicals based on CBT-8 (Advanced Molecular Biology)

1. Isolation of genomic DNA.
2. Qualitative and quantitative estimation of DNA.
3. Determination of the melting temperature of DNA.
4. Preparation of the absorption spectra of DNA.
5. Preparation of the absorption spectra of DNA

Practicals based on CBT-9 (Microbes and Microbial Technology)

1. Enumeration of microorganisms.
2. Preparation of pure culture of microorganisms.
3. Staining of microbial cells.
4. Preparation of agar slant and glycerol stock for microbial culture preservation.
5. Preparation of agar slant and glycerol stock for microbial culture preservation.

Any other practical based on the facility.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Core Major Elective: Genomics and Proteomics
(Course code: CBTE-1a) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction to genomics: Fundamentals of genomics and proteomics, a brief overview of prokaryotic and eukaryotic genome organization.
Extra-chromosomal DNA: Bacterial plasmids, mitochondria, and chloroplast.

UNIT-II (Cr- 0.5)

Genomic mapping: Importance and characteristics, genetic and physical maps, methods and techniques used for gene mapping, and linkage analysis.

UNIT-III (Cr- 0.5)

Proteomics: Aims, strategies, and challenges in proteomics.
Proteomics technologies: Protein sequencing techniques, 2D gel electrophoresis, MALDI-TOF, and mass spectrometry.

UNIT-IV (Cr- 0.5)

DNA-protein interactions: DNA binding motifs, methods for detecting DNA-protein interactions, protein motifs and domains, protein chips, clinical and biomedical applications of proteomics.

Recommended Books:

1. Rastogi S.C., Rastogi P., Mendiratta N. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. 2022. 5th ed. PHI.
2. Rudolph M. Genomics and Proteomics: Functional and Computational Aspects. 2019. 1st ed. Syrawood Publishing House.
3. Keerthikumar S., Mathivanan S. Proteome Bioinformatics. 2017. 1st ed. Springer, Humana, New York.
4. Kussmann M., Stover P.J. Nutragenomics and Proteomics in Health and Disease. 2017. 2nd ed. John Wiley & Sons Ltd.
5. Campbell A.M., Heyer L.J. Discovering Genomics, Proteomics, and Bioinformatics. 2007. 2nd ed. San Francisco, CSHL Pearsons/Benjamin Cummings.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Core Major Elective: Biofuels and Biopolymers
(Course code: CBTE-1b) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction to biofuels: Generation of biofuels (first, second, third and fourth generations) and their historical development.

UNIT-II (Cr- 0.5)

Microbial metabolism to produce biofuels: Producers of key biofuels such as biohydrogen, biomethane, biomethanol, bioethanol, biodiesel, and biobutanol, and their metabolism.

UNIT-III (Cr- 0.5)

Natural biopolymers: Types of natural biopolymers and their benefits over synthetic plastics. Polyhydroxyalkanoates (PHA): Microbial biodiversity of PHA-producers and PHA production.

UNIT-IV (Cr- 0.5)

PHA application: Biotechnological advancement in application of PHA as biocontrol agents, drug carriers, medical implants, and tissue engineering.

Recommended Books:

1. Soccol C.R., Brar S.K., Permaul K., Pakshirajan K., de Carvalho J.C. Biohydrogen - Advances and Processes. 2024. 1st ed. Springer Cham.
2. Rena Kumar S. Biofuels – Technologies, Policies and Opportunities. 2023. 1st ed. CRC Press.
3. Koller M. The Handbook of Polyhydroxyalkanoates. 2023. 1st ed. CRC Press.
4. Sahay S. Handbook of Biofuels. 2021.1st ed. Academic Press.
5. Kalia V.C. Biotechnological Applications of Polyhydroxyalkanoates. 2019. 1st ed. Springer Singapore

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Elective Practical: Lab Course based on CBTE-1a or CBTE-1b
(Course code: CBTE-1(P) No. of Credits: 2

Practicals based on CBTE-1a (Genomics and Proteomics)

1. Multiple sequence alignment using CLUSTALW.
2. Phylogenetic analysis of bacteria and fungi based on rRNA gene.
3. Prediction of subcellular localization of given protein sequences.

Any other practical based on the facility.

Practicals based on CBTE-1b (Biofuels and Biopolymers)

1. Determination of the composition of biowaste(s).
2. Demonstration of dark fermentative biohydrogen production.
3. Determination of dry cell mass of bacterial culture.

Any other practical based on the facility.

B.Sc. (Honours)
Subject: Biotechnology

Seventh Semester
Minor -1 **General Biochemistry**
(Course code: MIBT-1) **No. of Credits: 4**

UNIT-I (Cr- 1)

Carbohydrate: Classification, structure, and functions,
Carbohydrate Metabolism: Pathway and Regulation of Glycolysis, Gluconeogenesis, Citric acid cycle and its regulation, Electron transport Chain and Oxidative phosphorylation.

UNIT-II (Cr- 1)

Amino acids: Structure and functional group properties, peptides and covalent structure of proteins, primary and higher order structures.
Protein: Classification, structure, and functions.
Enzymes: Classification.
Enzyme substrate complex: Lock and Key Hypothesis and Induced-Fit Hypothesis.

UNIT-III (Cr- 1)

Fatty acids: Classification and structure.
Fatty acid metabolism: Fatty acid oxidation and regulation, β-oxidation, Fatty acid biosynthesis and regulation, and reactions of fatty acid synthase.

UNIT-IV (Cr- 1)

Nucleic acid: Structure and functions.
Nucleic acid metabolism: Purine biosynthesis and its regulation, Pyrimidine biosynthesis and its regulation.
Formation of deoxyribonucleotides: Salvage pathway for Purine and Pyrimidine nucleotides.

Recommended Books:

1. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
2. Berg J.M., Tymoczko J.L., Gatto G.J.Jr., Stryer L. Biochemistry. 2023. 10th ed. Macmillan Learning.
3. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry: Life at the Molecular Level. 2023. 6th ed. John Wiley & Sons.
4. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
5. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Core Major-I: Bio-Analytical Techniques
(Course code: CBT-10) No. of Credits: 5

UNIT- II (Cr- 1)
Chromatography: General principles and applications of chromatography, paper chromatography, thin layer chromatography, gel filtration chromatography, ion exchange chromatography, affinity chromatography, gas chromatography and HPLC.

UNIT- II (Cr- 1)
Electrophoresis: General principle and applications, paper electrophoresis, moving boundary method, gel electrophoresis (Native, denaturing & reducing), isoelectric focusing (IEF), and isotachophoresis.

UNIT- III (Cr- 1)
Centrifugation: Basic principles and applications, types of rotors, common centrifuges used in laboratory, clinical, high speed & ultracentrifuges. Differential centrifugation, density gradient centrifugation-zonal and isopycnic.

UNIT–IV (Cr- 1)
Basic knowledge of the principles and applications of microscopy: Light, phase contrast, fluorescence microscopy, confocal laser scanning microscopy, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy.

UNIT-V (Cr- 1)
Spectroscopic methods: Principle and applications of UV-visible, IR and fluorescence spectroscopy. Introduction to FTIR, NMR and X-ray crystallography and applications.

Recommended Books:

1. Alberts B., Heald R., Johnson A., Morgan D., Raff M., Roberts K., Walter P. Molecular Biology of the Cell. 2022. 7th ed. WW Norton & Co.
2. Egbuna C., Patrick-Iwuanyanwu K.C., Shah M.A., Ifemeje J.C., Rasul A. Analytical Techniques in Biosiences: From Basics to Applications. 2021. 1st ed. Academic Press.
3. Ghosal S., Avasthi A.S. Fundamentals of Bioanalytical Techniques and Instrumentation. 2018. 2nd ed. PHI.
4. Hofmann A., Clokie S. Wilson & Walker's: Principles and Techniques of Biochemistry and Molecular Biology. 2018. 8th ed. Cambridge Univ. Press.
5. Jayaraman J. Laboratory Manual in Biochemistry. 2011. 1st ed. New Age International Private Ltd.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Core Major-II: Immunology
(Course code: CBT-11) No. of Credits: 5

UNIT-I (Cr- 1)

Historical development in Immunology.
Overview of the immune system: Innate and adaptive immunity, Cells and organs of the immune system, Hematopoiesis,
Antigens, antigenicity and immunogenicity, haptens & epitopes.
Immunoglobulins: Structure and function.

UNIT- II (Cr- 1)

Organization & expression of immunoglobulin genes: Multigene organization of genes, variable-region gene rearrangements, generation of antibody diversity, class switching among constant-region genes, expression of Ig genes.
Major histocompatibility complex, Antigen processing and presentation.

UNIT- III (Cr- 1)

Structure and functions of BCR & TCR.
Cytokines: Properties, general physiology, interferons, application of cytokine for therapy.
Complement system.
Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis, Ab-dependent cell mediated cytotoxicity (ADCC).

UNIT–IV (Cr- 1)

Hypersensitivity: Types of hypersensitivity
Autoimmunity and their types.
Organ transplantation: Introduction, types and challenges, and graft rejection.
Vaccines: Types & applications, Active and passive Immunization.

UNIT-V (Cr- 1)

Monoclonal antibodies: Overview of monoclonal antibodies and hybridoma technology.
Types of antigen-antibody interactions: Precipitation reaction, agglutination reactions, RIA, ELISA, western blotting, immuno-precipitation, and immuno-fluorescence.

Recommended Books:

1. Stranford S., Owen J.A., Punt J., Jones P. Kuby: Immunology. 2022. 8th ed. W.H. Freeman.
2. Male D., Peebles R.S.Jr., Male V. Immunology. 2020. 9th ed. Elsevier.
3. Hofmann A., Clokie S. Wilson & Walker's: Principles and Techniques of Biochemistry and Molecular Biology. 2018. 8th ed. Cambridge Univ. Press.
4. Elgert K.D. Immunology: Understanding the Immune System. 2009. 2nd ed. Wiley-Blackwell.
5. Hay F.C., Westwood O.M.R. Practical Immunology. 2002. 1st ed. Wiley-Blackwell.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Core Major-III: Genetic Engineering and Applications
(Course code: CBT-12) No. of Credits: 5

UNIT-I (Cr- 1)

Recombinant DNA technology: Introduction to Recombinant DNA technology and applications.
Nucleic acid modification: Nucleic acid modifying enzymes, and restriction endonucleases.
Cloning vectors: Plasmid and phage based vectors, cosmid, phagemid, yeast cloning vectors, animal and plant viruses as vectors. BAC, PAC & YAC.

UNIT- II (Cr- 1)

Nucleic acid isolation: Isolation of nucleic acid from plant, animal & bacteria.
Basic steps of gene cloning and heterologous expression: Cloning strategies, genomic library, selection of rDNA clones and their expression products, cDNA and cDNA library, expression of cloned genes in heterologous hosts.

UNIT- III (Cr- 1)

DNA sequencing: Chemical and enzymatic methods, NGS.
PCR: Types and applications, and real-time PCR,
Nucleic acid analysis techniques: Gel retardation assay, DNA foot-printing, and DNA finger-printing.

UNIT–IV (Cr- 1)

Probe labeling, and hybridization.
Blotting techniques: Southern, northern, and western blotting (Methodologies and applications).
Site directed mutagenesis.

UNIT-V (Cr- 1)

Transgenic technology: Types, approaches & applications (plants & animals).
Gene therapy: Types and applications.
Genome editing technologies: Principles and applications, and CRISPR technology.

Recommended Books:

1. Glick B.R., Pasternak C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. 2022. 6th ed. Wiley-Blackwell.
2. Grover D.M. Gene Cloning and DNA Analysis. 2021. 8th ed. John Wiley & Sons Ltd.
3. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley-Blackwell.
4. Williamson R. Genetic Engineering 3. 2012. 2nd ed. Springer.
5. Watson J.D., Caudy A.A., Myers R., Witkowski J.A. Recombinant DNA. 2007. 3rd ed. W H Freeman & Company.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Major Practical: Lab Course based on CBT-10, CBT-11, and CBT-12
(Course code: CBT-8(P) No. of Credits: 5

Practical Based on CBT-10 (Bio-Analytical Techniques)
1. Separation of compounds through paper chromatography.
2. Separation of cells from a suspension/biological sample by centrifugation.
3. Protein separation by SDS-PAGE.
4. Preparation of standard curve and determination of the concentration of unknown compound using UV-Visible spectroscopy.
5. Thin Layer Chromatography.

Practical Based on CBT-11 (Immunology)
1. Study of blood cells through permanent slides
2. Blood group detection.
3. Precipitation test and ouidin tube test.
4. Outcherlony double diffusion test.
5. Dot-ELISA test for detection of antigen.

Practical Based on CBT-12 (Genetic Engineering and Applications)
1. Genomic DNA isolation from bacteria or other organisms
2. Restriction digestion of DNA sample
3. Ligation of fragmented DNA
4. Competent cell preparation and transformation analysis.
5. Demonstration of PCR.

Any other practical based on the facility.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Core Major Elective Paper: Nanobiotechnology
(Course code: CBTE-2a) No. of Credits: 2

UNIT-I (Cr- 0.5)

Nanoparticles and nanotechnology: History, origin, and principles,
Introduction to nanobiotechnology: Concepts, historical perspectives, various applications and uses of nanomaterials.

UNIT-II (Cr- 0.5)

Synthesis of nanoparticles: Top-Down" and "Bottom-Up" approaches of nanomaterial synthesis, physical, chemical, and biological approaches of nanoparticle synthesis, limitations of physical and chemical approaches, and advantages of using the green synthesis approach.

UNIT-III (Cr- 0.5)

Nanomedicine: Nanoparticles within a biological environment, nanoparticle dynamics in biological media, and Nanoparticles for therapy.

UNIT-IV (Cr- 0.5)

Environmental impact of nanomaterials: Exposure and risk assessment, and toxicological impacts of nanomaterials.

Recommended Books:

1. Visakh P.M., Bayraktar O. Recent Progress in Nanobiotechnology: Modern Techniques in Biomedical Applications. 2024. 1st ed. Springer, Singapore.
2. Tomar R.S., Jyoti A., Kausik S.K. Nanobiotechnology. 2020. 1st ed. Apple Academic Press Inc.
3. Hermanson G.T. Bioconjugate Techniques. 2013. 3rd ed. Elsevier.
4. Summers H.D. Nanomedicine. 2013. 1st ed. Elsevier.
5. Decher G., Schlenoff J.B. Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials. 2012. 2nd ed. Wiley-VCH Verlag GmbH.
6. Ramsden J.J. Nanotechnology: An Introduction. 2011. 1st ed. Elsevier.
7. Malsch N.H. Biomedical Nanotechnology. 2005. 1st ed. CRC Press.
8. Goodsell D.S. Bionanotechnology: Lessons from Nature. 2004. 1st ed. Wiley-LISS.
9. Niemeyer C.M., Mirkin C.A. Nanobiotechnology: Concepts, Applications and Perspectives. 2004. 1st ed. Wiley-VCH Verlag GmbH.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Core Major Elective : Epigenetics and Cancer Biology
(Course code: CBTE-2b) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction: Basic characteristics of cancer cells, morphological and ultrastructural properties of various types of cancer cells,
Types of growth: Hyperplasia, dysplasia, and differential characteristics of benign and malignant tumors.

UNIT-II (Cr- 0.5)

Cancer biology and biochemistry: Aberrant metabolism in cancer development, para-neoplastic syndromes, tumor markers, cellular proto-oncogenes, and their activation mechanism.

UNIT-III (Cr- 0.5)

Epigenetics: Role of DNA methylation in gene silencing, and epigenetic silencing of tumor-suppressor genes.
Apoptosis in cancer: Cell death by apoptosis, and the role of caspases.
Death signaling pathways: Mitochondrial and death receptor pathways.

UNIT-IV (Cr- 0.5)

Cancer detection methods and therapy: Introduction to the methods of cancer detection. Basic concepts of chemotherapy, radiation therapy, and immunotherapy.

Recommended Books:

1. Kumar D.U. An Introduction to Epigenetics of Cancer. 2025. 1st ed. B P International.
2. Kalkan R. Cancer Epigenetics. 2024. 1st ed. Springer Cham.
3. Gray S.G. Epigenetic Cancer Therapy. 2023. 2nd ed. Academic Press.
4. Qazi A.S., Tariq K. Therapeutic Approaches in Cancer Treatment. 2023. 1st ed. Springer Cham.
5. Tollefsbol T.O. Cancer Epigenetics. 2019. 1st ed. CRC Press.
6. Sarkar F.H. Epigenetics and Cancer. 2013. 1st ed. Springer Dordrecht.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Elective Practical: Lab Course based on CBTE-2a or CBTE-2b
(Course code: CBTE-2 (P) No. of Credits: 2

Practical Based on CBTE-2a (Nanobiotechnology)
1. Preparation of plant extract for nanoparticle synthesis
2. Green synthesis of nanoparticles using plant extract.
3. Characterization of nanoparticles.

Practical Based on CBTE-2b (Epigenetics and Cancer Biology)
1. Protein sequence analysis of cancer related genes.
2. Homology search for cancer related genes.
3. *In silico* determination of physicochemical properties and 3-D structure analysis of a cancer related protein.

Any other practical based on the facility.

B.Sc. (Honours)
Subject: Biotechnology

Eighth Semester
Minor -II: Basics of Genetic Engineering
(Course code: MIBT-2) No. of Credits: 4

UNIT-I (Cr- 1)

Recombinant DNA technology: Introduction to Recombinant DNA technology and applications.

Nucleic acid modification: Nucleic acid modifying enzymes and restriction endonucleases.

Cloning vectors: Different types of cloning vectors and their applications.

UNIT-II (Cr- 1)

Basic steps of gene cloning: Cloning strategies.
Genomic library, cDNA, and cDNA library.
Methods for screening rDNA clones.

UNIT-III (Cr- 1)

DNA sequencing: Chemical and enzymatic methods, and NGS.
PCR: Types and applications, and real-time PCR.

UNIT-IV (Cr- 1)

Blotting techniques: Southern, Northern, and Western blotting (Methodologies and applications).
Introduction to transgenic and genome editing technologies, and gene therapy.

Recommended Books:

1. Glick B.R., Pasternak C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. 2022. 6th ed. Wiley-Blackwell.
2. Grover D.M. Gene Cloning and DNA Analysis. 2021. 8th ed. John Wiley & Sons Ltd.
3. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley-Blackwell.
4. Williamson, R. Genetic Engineering 3. 2012. 2nd ed. Springer.
5. Watson J.D., Caudy A.A., Myers R., Witkowski J.A. Recombinant DNA. 2007. 3rd ed. W H Freeman & Company.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Core Major-I: Biochemistry and Metabolism
(Course code: CBT(R)-7) No. of Credits: 5

UNIT-I (Cr- 1)

Carbohydrates: Classification, structure, and functions.
Carbohydrate metabolism I: Pathway and regulation of glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis.
Carbohydrate metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway, and its regulation.

UNIT- II (Cr-1.25)

Fatty acids: Classification and structure.
Fatty acid metabolism: Fatty acid oxidation and regulation, β-oxidation, oxidation of unsaturated fatty acids and odd chain fatty acids, β-oxidation in peroxisomes, ketone bodies and their overproduction.
Fatty acid biosynthesis and regulation: Reactions of fatty acid synthase, synthesis of triglycerols, cholesterol biosynthesis, and regulation.

UNIT- III (Cr-1)

Nucleic acids: Structure and functions.
Nucleic acid metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis, and its regulation, formation of deoxyribonucleotides, Salvage pathway for purine and pyrimidine nucleotides, degradation of purines and pyrimidines.

UNIT-IV (Cr-1.25)

Amino acids: Structure and functional group properties, peptides and covalent structure of proteins, primary and higher-order structures, and Ramachandran plot.
Protein: Classification, structure, and functions.
Amino acid metabolism: overview of amino-acid biosynthesis and degradation, urea cycle (Linkage between urea cycle and citric acid cycle) and its regulation, and conversion of nitrogen to ammonia by microorganisms.

UNIT-V (Cr-0.5)

Enzymes: Introduction and classification, concept of E-S complex, binding sites, active site, specificity, lock and key hypothesis, induced-fit hypothesis, zymogens, Michaelis-Menten equation, enzyme inhibition.

Recommended Books:

1. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
2. Berg J.M., Tymoczko J.L., Gatto G.J.Jr., Stryer L. Biochemistry. 2023. 10th ed. Macmillan Learning.
3. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry: Life at the Molecular Level. 2023. 6th ed. John Wiley & Sons.
4. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
5. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Core Major-II: Advanced Molecular Biology
(Course code: CBT(R)-8) No. of Credits: 5

UNIT-I (Cr- 1)

Chemical and physical properties of nucleic acids: Structure and types of RNA and DNA, Watson-Crick model, different forms of DNA, topological properties of DNA, and DNA renaturation kinetics and DNA as genetic material

UNIT- II (Cr-1)

DNA replication and mechanism: Enzymes and proteins involved in DNA replication, mechanism of DNA replication in prokaryotes and eukaryotes, molecular mechanism of the regulation process of DNA replication in prokaryotes and eukaryotes.
DNA damage: Types and repair mechanisms.

UNIT- III (Cr-1)

Mechanism of transcription: Promoter, *cis* and *trans* elements, and consensus sequences, mechanism of transcription in prokaryotes and eukaryotes, reverse transcription.
Post-transcriptional processing of RNA: Capping, polyadenylation, splicing, and RNA editing.

UNIT-IV (Cr-1)

Mechanism of translation in prokaryotes and eukaryotes: Genetic code, wobble hypothesis, Aminoacyl-t RNA synthetase and its role, steps of initiation, elongation and termination of translation process and the proteins and enzymes involved. Post-translational modifications and its relevance.

UNIT-V (Cr-1)

Regulation of gene expression in prokaryotes and eukaryotes: Positive and negative regulation, *lac* operon, and *trp* operon, regulatory proteins and DNA binding, chromatin modifications associated with gene expression, and regulatory modules for eukaryotic promoters.

Recommended Books:

1. Brown T.A. Genomes 5. 2023. 5th ed. CRC Press.
2. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman & Co.
3. Krebs J.E., Goldstein E.S., Kilpatrick S.T. Lewin's Genes XII. 2018. 12th ed. Jones & Bartlett Learning.
4. Watson J.E. Molecular Biology of the Gene. 2014. 7thed. Pearson Publishers.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Major Practical: Lab Course based on CBT(R)-7 and CBT(R)-8
(Course code: CBT(R)-7(P) No. of Credits: 5

Practical Based on CBT(R)-7 (Biochemistry and Metabolism)

1. Quantitative estimation of protein.
2. Quantitative estimation of carbohydrate.
3. Quantitative estimation of cholesterol.
4. Determination of the acid value of fats.
5. Determination of the saponification value of fat or oil.
6. To determine salivary amylase activity on starch.

Practical Based on CBT(R)-8 (Advanced Molecular Biology)

1. Isolation of genomic DNA.
2. Isolation of total RNA.
3. Determination of the purity of DNA sample
4. Qualitative and quantitative estimation of DNA.
5. Determination of the melting temperature of DNA.
6. To prepare absorption spectra of DNA.

Any other practical based on the facility.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Core Major Elective : Genomics and Proteomics
(Course code: CBTE(R)-1a) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction to genomics: Fundamentals of genomics and proteomics, a brief overview of prokaryotic and eukaryotic genome organization.
Extra-chromosomal DNA: Bacterial plasmids, mitochondria, and chloroplast.

UNIT-II (Cr- 0.5)

Genomic mapping: Importance and characteristics, genetic and physical maps, methods and techniques used for gene mapping, and linkage analysis.

UNIT-III (Cr- 0.5)

Proteomics: Aims, strategies, and challenges in proteomics.
Proteomics technologies: Protein sequencing techniques, 2D gel electrophoresis, MALDI-TOF, and mass spectrometry.

UNIT-IV (Cr- 0.5)

DNA-protein interactions: DNA binding motifs, methods for detecting DNA-protein interactions, protein motifs and domains, protein chips, clinical and biomedical applications of proteomics.

Recommended Books:

1. Rastogi S.C., Rastogi P., Mendiratta N. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. 2022. 5th ed. PHI.
2. Rudolph M. Genomics and Proteomics: Functional and Computational Aspects. 2019. 1st ed. Syrawood Publishing House.
3. Keerthikumar S., Mathivanan S. Proteome Bioinformatics. 2017. 1st ed. Springer, Humana, New York.
4. Kussmann M., Stover P.J. Nutragenomics and Proteomics in Health and Disease. 2017. 2nd ed. John Wiley & Sons Ltd.
5. Campbell A.M., Heyer L.J. Discovering Genomics, Proteomics, and Bioinformatics. 2007. 2nd ed. San Francisco, CSHL Pearsons/Benjamin Cummings.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Core Major Elective : Biofuels and Biopolymers
(Course code: CBTE(R)-1b) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction to biofuels: Generation of biofuels (first, second, third and fourth generations) and their historical development.

UNIT-II (Cr- 0.5)

Microbial metabolism to produce biofuels: Producers of key biofuels such as biohydrogen, biomethane, biomethanol, bioethanol, biodiesel, and biobutanol, and their metabolism.

UNIT-III (Cr- 0.5)

Natural biopolymers: Types of natural biopolymers and their benefits over synthetic plastics. Polyhydroxyalkanoates (PHA): Microbial biodiversity of PHA-producers and PHA production.

UNIT-IV (Cr- 0.5)

PHA application: Biotechnological advancement in application of PHA as biocontrol agents, drug carriers, medical implants, and tissue engineering.

Recommended Books:

1. Soccol C.R., Brar S.K., Permaul K., Pakshirajan K., de Carvalho J.C. Biohydrogen - Advances and Processes. 2024. 1st ed. Springer Cham.
2. Rena Kumar S. Biofuels – Technologies, Policies and Opportunities. 2023. 1st ed. CRC Press.
3. Koller M. The Handbook of Polyhydroxyalkanoates. 2023. 1st ed. CRC Press.
4. Sahay S. Handbook of Biofuels. 2021.1st ed. Academic Press.
5. Kalia V.C. Biotechnological Applications of Polyhydroxyalkanoates. 2019. 1st ed. Springer Singapore

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Elective Practical: Lab Course based on CBTE(R)-1a or CBTE(R)-1b
(Course code: CBTE(R)-1(P) No. of Credits: 2

Practical Based on CBTE(R)-1a (Genomics and Proteomics)

1. Multiple sequence alignment using CLUSTALW.
2. Phylogenetic analysis of bacteria and fungi based on rRNA gene.
3. Prediction of subcellular localization of given protein sequences.

Practical Based on CBTE(R)-1b (Biofuels and Biopolymers)

1. Determination of the composition of biowaste(s).
2. Demonstration of dark fermentative biohydrogen production.
3. Determination of dry cell mass of bacterial culture.

Any other practical based on the facility.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Core Major: Research Methodology
(Course code: CBT(R)-9) No. of Credits: 5

UNIT -I (Cr-1)

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, Characteristics of the scientific method - Understanding the language of Research, Biotechnology Research, and its concept, Need and purpose, characteristics of good research, and, application of biotechnological Research

UNIT -II (Cr-1)

Problem identification: Objectives, significance, scope and limitations.
Literature survey: Use of books, journals, libraries, online survey. Importance and designing of the problem to be undertaken.

UNIT -III (Cr-1)

Sampling techniques, data collection and analysis: Types and sources of data - Primary and secondary, Sampling types, Field survey, site selection, source selection for data acquisition, Probability, and Sampling Error.
Data representation: Tabular and diagrammatic representation of data. Data interpretation.

UNIT -IV (Cr-1)

Types of research: Pure (basic, fundamental) and applied research, qualitative and quantitative research.
Preparation of project report based on biological research: Introduction of the problem, Review of literature, Materials and methods, Results, Discussion, Referencing technique, and Summary of research/Abstract, etc.

UNIT -V (Cr-1)

Use of ICT in Biotechnology.

Computing skills for biotechnological research: Web browsing for information search, search engines and their mechanism of searching, Keywords and its importance in scientific research, internet as a medium of interaction between scientists, and effective email strategy for communication with peers and collaborators/scientists.

Recommended Books:

1. Verma, R., Verma, S., Abhishek, K. Research Methodology. 2024. 1st ed. Bookclinic Publishers.
2. Gurumani, N. Research Methodology for Biological Sciences. 2017. 1st ed. MJP Publishers
3. Arumugam, N. Research Methodology for Life Sciences. 2015. 1st ed. Saras Publication.
4. Holmes, Moody, Dine. Research Methods for the Biosciences. 2010. 2nd ed. Oxford University Press.

B.Sc. (Honours with Research)
Subject: Biotechnology

Seventh Semester
Minor -1 **General Biochemistry**
(Course code: MIBT(R)-1) **No. of Credits: 4**

UNIT-I (Cr- 1)

Carbohydrate: Classification, structure, and functions,
Carbohydrate Metabolism: Pathway and Regulation of Glycolysis, Gluconeogenesis, Citric acid cycle and its regulation, Electron transport Chain and Oxidative phosphorylation.

UNIT-II (Cr- 1)

Amino acids: Structure and functional group properties, peptides and covalent structure of proteins, primary and higher order structures.
Protein: Classification, structure, and functions.
Enzymes: Classification.
Enzyme substrate complex: Lock and Key Hypothesis and Induced-Fit Hypothesis.

UNIT-III (Cr- 1)

Fatty acids: Classification and structure.
Fatty acid metabolism: Fatty acid oxidation and regulation, β-oxidation, Fatty acid biosynthesis and regulation, and reactions of fatty acid synthase.

UNIT-IV (Cr- 1)

Nucleic acid: Structure and functions.
Nucleic acid metabolism: Purine biosynthesis and its regulation, Pyrimidine biosynthesis and its regulation.
Formation of deoxyribonucleotides: Salvage pathway for Purine and Pyrimidine nucleotides.

Recommended Books:

1. Garrett R.H., Grisham C.M. Biochemistry. 2024. 7th ed. Cengage.
2. Berg J.M., Tymoczko J.L., Gatto G.J.Jr., Stryer L. Biochemistry. 2023. 10th ed. Macmillan Learning.
3. Voet D., Voet J.G., Pratt C.W. Fundamentals of Biochemistry: Life at the Molecular Level. 2023. 6th ed. John Wiley & Sons.
4. Nelson D.L., Cox M.M., Hoskins A.A. Lehninger Principles of Biochemistry. 2021. 8th ed. W.H. Freeman.
5. Conn E., Stumpf P. Outlines of Biochemistry. 2009. 5th ed. John Wiley & Sons.

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Core Major-I: Genetic Engineering and Applications
(Course code: CBT(R)-10 No. of Credits: 5

UNIT-I (Cr- 1)

Recombinant DNA technology: Introduction to Recombinant DNA technology and applications.
Nucleic acid modification: Nucleic acid modifying enzymes, and restriction endonucleases.
Cloning vectors: Plasmid and phage based vectors, cosmid, phagemid, yeast cloning vectors, animal and plant viruses as vectors. BAC, PAC & YAC.

UNIT- II (Cr- 1)

Nucleic acid isolation: Isolation of nucleic acid from plant, animal & bacteria.
Basic steps of gene cloning and heterologous expression: Cloning strategies, genomic library, selection of rDNA clones and their expression products, cDNA and cDNA library, expression of cloned genes in heterologous hosts.

UNIT- III (Cr- 1)

DNA sequencing: Chemical and enzymatic methods, NGS.
PCR: Types and applications, and real-time PCR,
Nucleic acid analysis techniques: Gel retardation assay, DNA foot-printing, and DNA finger-printing.

UNIT–IV (Cr- 1)

Probe labeling, and hybridization.
Blotting techniques: Southern, northern, and western blotting (Methodologies and applications).
Site directed mutagenesis.

UNIT-V (Cr- 1)

Transgenic technology: Types, approaches & applications (plants & animals).
Gene therapy: Types and applications.
Genome editing technologies: Principles and applications, and CRISPR technology.

Recommended Books:

1. Glick B.R., Pasternak C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. 2022. 6th ed. Wiley-Blackwell.
2. Grover D.M. Gene Cloning and DNA Analysis. 2021. 8th ed. John Wiley & Sons Ltd.
3. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley-Blackwell.
4. Williamson R. Genetic Engineering 3. 2012. 2nd ed. Springer.
5. Watson J.D., Caudy A.A., Myers R., Witkowski J.A. Recombinant DNA. 2007. 3rd ed. W H Freeman & Company.

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Major Practical: Lab Course based on CBT(R)-10
(Course code: CBT(R)-8(P) No. of Credits: 3

Practicals Based on CBT(R)-10 (Genetic Engineering and Applications)

1. Genomic DNA isolation from bacteria or other organisms
2. Restriction digestion of DNA sample
3. Ligation of fragmented DNA
4. Competent cell preparation and transformation analysis.
5. Demonstration of PCR.
6. Isolation of plasmid from bacterial cell

Any other practical based on the facility.

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Core Major Elective : Nanobiotechnology
(Course code: CBTE(R)-2a) No. of Credits: 2

UNIT-I (Cr- 0.5)

Nanoparticles and nanotechnology: History, origin, and principles,
Introduction to nanobiotechnology: Concepts, historical perspectives, various applications and uses of nanomaterials.

UNIT-II (Cr- 0.5)

Synthesis of nanoparticles: Top-Down" and "Bottom-Up" approaches of nanomaterial synthesis, physical, chemical, and biological approaches of nanoparticle synthesis, limitations of physical and chemical approaches, and advantages of using the green synthesis approach.

UNIT-III (Cr- 0.5)

Nanomedicine: Nanoparticles within a biological environment, nanoparticle dynamics in biological media, and Nanoparticles for therapy.

UNIT-IV (Cr- 0.5)

Environmental impact of nanomaterials: Exposure and risk assessment, and toxicological impacts of nanomaterials.

Recommended Books:

1. Visakh P.M., Bayraktar O. Recent Progress in Nanobiotechnology: Modern Techniques in Biomedical Applications. 2024. 1st ed. Springer, Singapore.
2. Tomar R.S., Jyoti A., Kausik S.K. Nanobiotechnology. 2020. 1st ed. Apple Academic Press Inc.
3. Hermanson G.T. Bioconjugate Techniques. 2013. 3rd ed. Elsevier.
4. Summers H.D. Nanomedicine. 2013. 1st ed. Elsevier.
5. Decher G., Schlenoff J.B. Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials. 2012. 2nd ed. Wiley-VCH Verlag GmbH.
6. Ramsden J.J. Nanotechnology: An Introduction. 2011. 1st ed. Elsevier.
7. Malsch N.H. Biomedical Nanotechnology. 2005. 1st ed. CRC Press.
8. Goodsell D.S. Bionanotechnology: Lessons from Nature. 2004. 1st ed. Wiley-LISS.
9. Niemeyer C.M., Mirkin C.A. Nanobiotechnology: Concepts, Applications and Perspectives. 2004. 1st ed. Wiley-VCH Verlag GmbH.

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Core Major Elective : Epigenetics and Cancer Biology
(Course code: CBTE(R)-2b) No. of Credits: 2

UNIT-I (Cr- 0.5)

Introduction: Basic characteristics of cancer cells, morphological and ultrastructural properties of various types of cancer cells,
Types of growth: Hyperplasia, dysplasia, and differential characteristics of benign and malignant tumors.

UNIT-II (Cr- 0.5)

Cancer biology and biochemistry: Aberrant metabolism in cancer development, para-neoplastic syndromes, tumor markers, cellular proto-oncogenes, and their activation mechanism.

UNIT-III (Cr- 0.5)

Epigenetics: Role of DNA methylation in gene silencing, and epigenetic silencing of tumor-suppressor genes.
Apoptosis in cancer: Cell death by apoptosis, and the role of caspases.
Death signaling pathways: Mitochondrial and death receptor pathways.

UNIT-IV (Cr- 0.5)

Cancer detection methods and therapy: Introduction to the methods of cancer detection. Basic concepts of chemotherapy, radiation therapy, and immunotherapy.

Recommended Books:

1. Kumar D.U. An Introduction to Epigenetics of Cancer. 2025. 1st ed. B P International.
2. Kalkan R. Cancer Epigenetics. 2024. 1st ed. Springer Cham.
3. Gray S.G. Epigenetic Cancer Therapy. 2023. 2nd ed. Academic Press.
4. Qazi A.S., Tariq K. Therapeutic Approaches in Cancer Treatment. 2023. 1st ed. Springer Cham.
5. Tollefsbol T.O. Cancer Epigenetics. 2019. 1st ed. CRC Press.
6. Sarkar F.H. Epigenetics and Cancer. 2013. 1st ed. Springer Dordrecht.

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Elective Practical: Lab Course based on CBTE(R)-2a or CBTE(R)-2b
(Course code: CBTE(R)-2 (P) No. of Credits: 2

Practical Based on CBTE(R)-2a (Nanobiotechnology)
1. Preparation of plant extract for nanoparticle synthesis
2. Green synthesis of nanoparticles using plant extract.
3. Characterization of nanoparticles.

Practical Based on CBTE(R)-2b (Epigenetics and Cancer Biology)
1. Protein sequence analysis of cancer related genes.
2. Homology search for cancer related genes.
3. *In silico* determination of physicochemical properties and 3-D structure analysis of a cancer related protein.

Any other practical based on the facility

B.Sc. (Honours with Research)
Subject: Biotechnology

Eighth Semester
Minor-II: Basics of Genetic Engineering
(Course code: MIBT(R)-2 No. of Credits: 4

UNIT-I (Cr- 1)

Recombinant DNA technology: Introduction to Recombinant DNA technology and applications.
Nucleic acid modification: Nucleic acid modifying enzymes and restriction endonucleases.
Cloning vectors: Different types of cloning vectors and their applications.

UNIT-II (Cr- 1)

Basic steps of gene cloning: Cloning strategies.
Genomic library, cDNA, and cDNA library.
Methods for screening rDNA clones.

UNIT-III (Cr- 1)

DNA sequencing: Chemical and enzymatic methods, and NGS.
PCR: Types and applications, and real-time PCR.

UNIT-IV (Cr- 1)

Blotting techniques: Southern, Northern, and Western blotting (Methodologies and applications).
Introduction to transgenic and genome editing technologies, and gene therapy.

Recommended Books:

1. Glick B.R., Pasternak C.L. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. 2022. 6th ed. Wiley-Blackwell.
2. Grover D.M. Gene Cloning and DNA Analysis. 2021. 8th ed. John Wiley & Sons Ltd.
3. Brown T.A. Gene Cloning and DNA Analysis: An Introduction. 2020. 8th ed. Wiley-Blackwell.
4. Williamson, R. Genetic Engineering 3. 2012. 2nd ed. Springer.
5. Watson J.D., Caudy A.A., Myers R., Witkowski J.A. Recombinant DNA. 2007. 3rd ed. W H Freeman & Company.