CHOICE BASED CREDIT SYSTEM SCHEME AT UNDER-GRADUATE LEVEL

PROGRAMME: BACHELOR OF SCIENCE (BSc) **SUBJECT: BIO-TECHNOLOGY**

SEMESTER	COURSE CODE	TYPES OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY (4)	PRACTICAL (2 or 0)	TUTORIAL (0 or 2)
I	BT120C	DSC-1 (6 Credits)	Fundamentals of Biochemistry	4	2	0
II	BT220C	DSC-2 (6 Credits)	Cell Biology, Microbiology and Immunology	4	2	0
III	BT320C	DSC-3 (6 Credits)	Molecular Biology and Genetic Engineering	4	2	0
IV	BT420C	DSC-4 (6 Credits)	Plant Biotechnology and Animal Cell Science	4	2	0
VA	BT520D1	DSE-I (6 Credits)	Biotechniques	4	2	0
OR VB	BT520D2	DSE-II (6 Credits)	Bioprocess Engineering	4	2	0
VIA	BT620D1	DSE-I (6 Credits)	Elementary Biostatistics and Bioinformatics	4	2	0
OR VIB	BT620D2	DSE-II (6 Credits)	Environmental Biotechnology	4	2	0
OR VIC	BT620D3	DSE-III (6 Credits)	Cell cycle, Signaling and Cancer	4	2	0

SKILL ENHANCEMENT COURSES: 4 Credits

(Note: Students opting for the subject as a Core may or may not opt for any of the Skill Courses related to the subject)

SEMESTER	COURSE CODE	TYPES OF COURSE	TITLE OF COURSE	CREDITS		
				THEORY (2)	PRACTICAL (2 or 0)	TUTORIAL (0 or 2)
III	BT320S	SEC (4 Credits)	ClinicalDiagnostics	2	2	
IV	DMC420S	SEC (4 Credits)(COMPULSORY)	DISASTER MANAGEMENT COURSE (Compulsory)	2	-	2
V	BT520S	SEC (4 Credits)	Food Technology	2	2	
VI	BT620S	SEC (4 Credits)	Biosafety, Bioethics and IPR	2	2	

Prof Khalid Majid Fazili
Head of Department
Convener BOUGS in Biotechnology

Programme Specific Outcomes (PSOs) of Biotechnology

PSO1: Biotechnology provides the basic platform to acquaint the students in the areas of biochemistry, immunology, genetics, microbiology, and molecular biology and hence expands their sphere of thinking and makes them more sensitive and responsible towards society and environment.

PSO2: Since most of the theory topics dealt in the biotechnology can be proved experimentally, students will be able to comprehend them in a better way which in turn improves their analytical power and creative thinking.

PSO3: Being interdisciplinary in nature and as innovation is almost inbuilt in many of the core subjects,it offers more possibilities and opportunities for the students to explore the world.

PSO4: Biotechnology and skill development goes hand in hand which means by the time students pass-out, they have enough skill behind them which in turn enhances their employability.

BACHELOR OF SCIENCE

Ist SEMESTER

DISCIPLINE SPECIFIC COURSE - 1 (CORE-1)

BT120C: BIO-TECHNOLOGY: FUNDAMENTALS OF BIOCHEMISTRY

CREDITS: THEORY – 4, PRACTICAL – 2 (4+2)

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This course is aimed to introduce students to basic concepts of life through the coordination of different biomolecules.

Unit – 1 (15 Hours)

Physicochemical properties of water; Concept of pH, pK, pI& buffers; Structure, classification, physical and chemical properties of amino acids; Levels of protein structure- primary, secondary, tertiary and quaternary; Structure and function of fibrous and globular proteins; Forces stabilizing protein structure.

Unit - 2 (15 Hours)

Nomenclature and classificationof enzymes; Basic principles of enzyme catalysis; Concept of active site; Enzyme activity and its measurement, factors affecting enzyme activity; Michaelis–Menten kinetics; Lineweaver-Burk plot; Enzyme inhibition with special focus on the types and mechanism of reversible inhibitors.

Unit - 3 (15 Hours)

General structure, classification and function of carbohydrates; Stereoisomerism in monosaccharides with special reference to the concepts of configuration and conformation; Carbohydrate metabolism – glycolysis, TCA cycle, electron transport chain, oxidative phosphorylation.

Unit - 4 (15 Hours)

Nomenclature and properties of fatty acids; Structure and functions of major types of lipids - triglycerides, phospholipids, sphingolipids, sterols; Transport of fatty acids across the mitochondrial membrane, β oxidation of saturated and unsaturated fatty acids; Biosynthesis of fatty acids and triglycerides.

Structure and classification of nitrogenous bases, composition and bonding in nucleotides and polynucleotides.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Preparation of molar, molal, normal solution and buffers.
2. Qualitative and quantitative estimation of carbohydrates in a given solution.
3. Qualitative and quantitative estimation of proteinsin a given solution.
4. Enzyme activity assay: Acid/Alkaline Phosphatase.
5. Effect of temperature and pH on enzyme activity.

BOOKS RECOMMENDED

1. *LehningerPrinciples of Biochemistry*: Nelson, D. L. and Cox, M. M. – Worth Publishers, New York.
2. *Biochemistry(Latest Edition)*: Stryer, L. - W. H. Freeman and Company, New York.
3. *Biochemistry(Latest Edition)*: Voet, D. and Voet, J. G. - John Wiley and Sons Inc. New York.
4. *Understanding Enzymes*: Palmer, T. – Ellis Horwood Limited, UK.
5. *Enzymology*: Devasena, T. – Oxford University Press.

Expected Learning Outcomes:

1. Understanding of structure, classification, function and physio-chemical properties of different bio-molecules.
2. Understanding of nature, classification and mode of action of enzymes along with study of kinetics and energetics of enzyme catalyzed reactions.
3. Hands on training on enzyme assay and estimation of different bio-molecules.

BACHELOR OF SCIENCE

2nd SEMESTER

DISCIPLINE SPECIFIC COURSE - 2 (CORE-2)

BT220C: BIO-TECHNOLOGY: CELL BIOLOGY, MICROBIOLOGY AND IMMUNOLOGY

CREDITS: THEORY – 4, PRACTICAL– 2 (4+2)

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This course is aimed to introduce students about the creation of life through cellular processes.

Unit – 1 (15 Hours)

Structure and organization of prokaryotic and eukaryotic cells; Structure and function of plasma membrane with special reference to membrane transport; Structure and function of cell organelles - Endoplasmic Reticulum, Golgi Apparatus, Mitochondria, plastids, Ribosomes, Lysosomes and Nucleus; Organization of genomic DNA in prokaryotes and eukaryotes

Unit – 2 (15 Hours)

Introduction to microbiology – definition, basic features of prokaryotic and eukaryotic members of microbial world, brief history (spontaneous generation, fermentation, germ theory of disease, Koch's postulates); Bacteria: classification based on Gram staining; Structure and function of bacterial cell wall, flagella and cytoplasmic inclusions; Special features of Archaebacteria; Gene transfer in bacteria - transformation, conjugation and transduction (generalized, specialized); Viruses: general structure and basis of viral classification.

Unit - 3 (15 Hours)

Principles of microbial nutrition; Principle and procedure of sterilization (moist heat, filtration and chemical treatment); Commonly used techniques of culturing microorganisms; Microbial growth - growth kinetics, growth curve& its phases, synchronous batch and continuous culture, measurement of microbial growth, factors affecting microbial growth.

Unit – 4 (15 Hours)

Brief history of immunology;Basic concept ofinnate & adaptive immunity, cell &humoral immunity; Hematopoiesis; Cells of the immune system (B lymphocyte, T lymphocyte, NK cell, APCs, Granulocytes); Organs of the immune system – Primary (Bone marrow, Thymus), Secondary (Lymph node, Spleen, MALT); Nature and properties of antigens / immunogens; Structure, types and functions of antibodies.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Identification of prokaryotic and eukaryotic cell.
2. Preparation and sterilization of culture media for bacterial cultivation.
3. Gram staining
4. Culture Techniques: Streaking, Spreading etc.
5. Total and differential Leukocyte count.
6. Total RBC count.
7. Blood grouping

BOOKS RECOMMENDED

1. *Molecular Biology of the Cell*: Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. - Garland Publishing Inc. New York.
2. *Cell and Molecular Biology - Concepts and Experiments*: Karp, G. - John Wiley Inc. New York.
3. *General Microbiology*: Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. – Macmillan Press Ltd., UK.
4. *Microbiology*: Prescott, L. M., Harley, J. P. and Klein, D. A. – McGraw-Hill.
5. *Microbiology*: Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. – McGraw-Hill.
6. *Kuby Immunology*: Goldsby, R. A., Kindt, T. J., Osborne, B. A. and Kuby, J. - W.H. Freeman and Company, New York.
7. *The Immune System*: Parham, P. - Garland Publishers.

Expected Learning Outcomes:

1. Understanding of basic differences between eukaryotic and prokaryotic cell system, structure-function relationships of different cell organelles.
2. Detailed understanding of bacteria/virusesandgene transfer methods in bacteria.
3. Description of different types of blood cells and organs involved in primary and secondary immune response.
4. Practical know-how of different techniques/methods used in microbiology and immunology.

BACHELOR OF SCIENCE

3rd SEMESTER

DISCIPLINE SPECIFIC COURSE -3 (CORE-3)

BT320C: BIO-TECHNOLOGY: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

CREDITS: THEORY – 4, PRACTICAL–2 (4+2)

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective:This course is designed to providestudents about the information flow in a living system at molecular level.

Unit - 1 (15 Hours)

DNA as genetic material; Building blocks of DNA; Structure of B-DNA, A-DNA and Z-DNA; Forces stabilizing DNA structure; General features of replication (mode of replication, directionality of replication, origin of replication); Enzymes and proteins involved in replication with emphasis on DNA polymerases; Mechanism of replication (initiation, elongation and termination) in prokaryotes; Differences in prokaryotic and eukaryotic replication.

Unit - 2 (15 Hours)

Structure and types of RNA (mRNA, tRNA, rRNA); Overview of transcription process; Detailed study of basic transcription machinery in prokaryotes – promoter elements and RNA polymerases (types, structure & function); Mechanism of transcription process in prokaryotes (initiation, elongation and termination); Differences in prokaryotic and eukaryotic transcription;Operon concept - positive and negative regulation with reference to lac and trp operons.

Unit - 3 (15 Hours)

Genetic code - salient features, wobble hypothesis; Concept of reading frame; Elaborate study of basic translation machinery - ribosome, tRNA, protein factors involved in translation, aminoacyl-tRNAsynthetases; Mechanism of translation (initiation, elongation and termination) in prokaryotes; Differences in prokaryotic and eukaryotic translation; Overview of post-translational modifications.

Unit - 4 (15 Hours)

Recombinant DNA technology tools – restriction endonucleases, ligases, phosphatases, T4 polynucleotide kinase, DNA polymerase I and Klenow fragment; Cloning vectors - general features of plasmids, bacteriophages (lambda & M-13), cosmids, phagemids; Selectable marker genescommonly used in bacterial vectors; Screening by blue-white selection; Basic concept of C-DNA and genomic DNA libraries.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Isolation of genomic DNA.
2. Quantification of DNA by spectrophotometry.
3. Analysis of DNA by agarose gel electrophoresis.
4. Restriction digestion of genomic/plasmid DNA.

BOOKS RECOMMENDED

1. *Lewin'sGenes-XI*: Krebs, J. E. *et al*. – Jones and Bartlett Learning.
2. *Molecular Biology*: Weaver, R. F. – McGraw-Hill.
3. *Molecular Biology of the Gene*: Watson, J. D. *et al*. – Pearson.
4. *Molecular Biotechnology - Principles and Applications of Recombinant DNA*: Glick, B. R. and Pasternak, J. J. - ASM Press.
5. *Principles of Gene Manipulation - An Introduction to Genetic Engineering*: Old, R. W. and Primrose, S. B. - Blackwell Scientific Publishers.

Expected Learning Outcomes:

1. Understanding of the structure of DNA, process of replication, transcription and translation.
2. Brief description of cloning vectors and various tools utilized in recombinant DNA technology.
3. Hands-on training on various commonly used techniques in molecular biology.

BACHELOR OF SCIENCE

4th SEMESTER

DISCIPLINE SPECIFIC COURSE - 4 (CORE-4)

BT420C: BIO-TECHNOLOGY: PLANT BIOTECHNOLOGY AND ANIMAL CELL SCIENCE

CREDITS: THEORY – 4,PRACTICAL– 2 (4+2)

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This course has been aimed to introduce students towards advancement in plant and animal biotechnology that can be used for benefit of mankind.

Unit – 1 (15 Hours)

Basic concepts regarding plant cell; Concept of totipotency and plasticity; Plant tissue culture media composition and role of its essential components with specific reference toMurashige and Skoog Medium; Plant hormones and their usefulness in plant tissue culture;Micropropagation and its applications; Brief account of various culture types – callus culture, cell-suspension culture, anther / microspore culture, ovule culture, embryo culture, shoot tip / meristem culture, root culture; Plant regeneration through organogenesis and somatic embryogenesis.

Unit – 2 (15 Hours)

Overview of plant transformation techniques; Agrobacterium-mediated transformation – biology of *Agrobacterium tumefaciens*, Ti-plasmid & its features (T-DNA &vir region) and mechanism of gene transfer leading to crown-gall disease; Direct gene transfer methods – biolistics, electroporation, polyethylene glycol (PEG)-mediated transformation, transformation using silicon carbide fibres with advantages and limitations of each method; GM crops with specific reference to Golden Rice &Bt cotton; Concerns about GM crops.

Unit – 3 (15 Hours)

Basic facilities and equipment required for setting up a tissue culture facility; Culture media – introduction to balanced salt solutions and complete media along with the role of their essential constituents including serum, advantages of serum-free media, commonly used media formulations with their specific uses; Aseptic technique – objectives & elements, commonly employed techniques in sterile handling; Biology of cultured cells.

Unit – 4 (15 Hours)

Types of tissue culture; Primary and secondary cultures; Suspension and adherent monolayer cultures; Subculturing and development of cell lines – criteria for subculturing, phases of culture,

understanding of cell line / cell strain / passage number / generation number / split ratio, properties of finite and continuous cell lines, transformation and immortalization; Transfection of cell lines, commonly used cell lines with their specific applications; Principles of cryopreservation; Applications of animal cell culture technology - monoclonal antibodies, viral vaccines and therapeutic recombinant glycoproteins.

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

1. Preparation of plant tissue culture media.
2. Preparation of different explants for culturing and steps of explant inoculation.
3. Explant culture (embryo/ovary).
4. Establishment and maintenance of cell lines.
5. Subculture of monolayer cells.
6. Determination of cell viability by trypan blue assay.

BOOKS RECOMMENDED

1. *Plant Biotechnology – The Genetic Manipulation of Plants*: Slater, A., Scott, N. W. and Fowler, M. R. – Oxford University Press.
2. *Introduction to Plant Biotechnology*: Chawla, H. S. – Science Publishers Inc.
3. *Culture of Animal Cells – A Manual of Basic Technique and Specialized Applications*: Freshney, R. I. - Wiley-Blackwell.
4. *Animal Cell Culture and Technology*: Butler, M. – BIOS Scientific Publishers.
5. *Animal Cell Culture – A Practical Approach*: Masters, J. R. W. – Oxford University Press.

Expected Learning Outcomes:

1. Understanding of basic concept of plant and animal tissue culture, and their applications.
2. Practical know-how of basic techniques used for initiation and maintenance of cultured tissues/ cells.

BACHELOR OF SCIENCE

5th SEMESTER

DISCIPLINE SPECIFIC ELECTIVES (DSEs)

BT520D1: BIO-TECHNOLOGY: BIOTECHNIQUES

CREDITS: THEORY – 4, PRACTICAL – 2(4+2)

OPTION-I

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This course is designed to give students exposure to various techniques and instruments used in biotechnology.

Unit – 1 (15 Hours)

Microscopy:principle, working and applications of light microscopy - bright-field, dark-field, phase-contrast, fluorescence & confocal microscopy, electron microscopy - TEM and SEM; Staining – principle and procedure of simple staining, negative staining & differential staining; **Spectroscopy:** principle, working and applications of ultraviolet / visible light spectroscopy (UV/Vis spectroscopy).

Unit – 2 (15 Hours)

Centrifugation- Basic principles and applications of preparative and analytical centrifugation (differential centrifugation &density-gradient centrifugation), ultracentrifugation and its applications; **Chromatography –**Principle, working and applications of thin-layer chromatography, ion-exchange chromatography, gel filtration and affinity chromatography.

Unit – 3 (15 Hours)

Electrophoresis: General principle and types; Principle, procedure and applications ofnative polyacrylamide gel electrophoresis, sodium dodecyl sulphate-polyacrylamide gel electrophoresis, isoelectric focusing, two-dimensional gel electrophoresis and agarose gel electrophoresis; **Blotting techniques:** Southern, northern & western blotting; **PCR** – principle, types and application.

Unit – 4 (15 Hours)

Immunological techniques: Principle, procedure and application of immunodiffusion, immunoelectrophoresis, enzyme linked immunosorbent assay (ELISA) and radioimmunoassay (RIA); **Radioisotope techniques:** Concept of radioisotopes, types and properties of radioactive decay,units of radioactivity, characteristics of radioisotopes commonly used in biology, measurement of radioactivity.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Paper chromatography.
2. SDS-PAGE.
3. Agarose gel electrophoresis.
4. Demonstration of Western blotting.
5. Demonstration of ELISA/RIA
6. Demonstration of PCR.

BOOKS RECOMMENDED

1. *Principles and Techniques of Biochemistrv and Molecular Biology*: Wilson, K. and Walker, J. – Cambridge University Press.
2. *Physical Biochemistry – Applications to Biochemistry and Molecular Biology*: Freifelder, D. – W. H. Freeman and Company.
3. *Molecular Cloning - A Laboratory Manual*: Sambrook, J. and Russell, D. W. - Cold Spring Harbor Laboratory Press.

Expected Learning Outcomes:

1. Understandingof biophysical and molecular biology techniques and their applications.

BACHELOR OF SCIENCE

5th SEMESTER

DISCIPLINE SPECIFIC ELECTIVES (DSEs)

BT520D2: BIO-TECHNOLOGY: BIOPROCESS ENGINEERING

CREDITS: THEORY – 4, PRACTICAL– 2(4+2)

OPTION-II

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This course aims at training the students for application of biotechnology principles for production of biobased products.

Unit–1 (15 HOURS)

Introduction to bioprocess technology; Microbial culture and its growth kinetics; Growth rate parameters - specific growth rate, doubling time,growth yield,metabolic quotient; Validity of exponential growth law;Measurement of microbial growth.

Unit– 2(15 HOURS)

Open and closed system;Batch, fedbatch and continuous culture; Chemostat and its elaborations;Product formation in microbial cultures - growth associated and non-growth associated; Factors affecting product formation.

Unit– 3(15 HOURS)

Design of bioreactors/fermenters – functions of Impeller, Baffles, Sparger; Types ofbioreactors – stirred tank, airlift, packed bed, photobioreactor; Media preparation, Inocula development and sterilization.

Unit– 4(15 HOURS)

Downstream processing - cell disruption techniques, product recovery and purification; Membrane processes - basic concept of ultrafiltration, reverse osmosis, liquid membranes;Separtion techniques – fractionation, centrifugation, chromatography; lyophilization.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Isolation of microorganism from natural resource.
2. Study of microbial growth characteristics.
3. Isolation and assay of amylase.

4. Purification of amylase through fractionation.

BOOKS RECOMMENDED

1. *Industrial Microbiology*, Casida - New Age International Private Limited
2. *Biotechnology: A textbook of Industrial Microbiology*,Crueger and Crueger,-Panima Publishing Co. New Delhi.
3. *Industrial Microbiology*, Patel AH, - Laxmi Publications, New Delhi
4. *Principles of Fermentation Technology*,Stanbury, Whitaker and Hall, Elsevier Science Ltd.

Expected Learning Outcomes:

1. Understanding of microbial growth, kinetics and measurement.
2. Idea of bioreactors along with the complementary components and processes.
3. Understanding of various methods and techniques involved in downstream processing of products.

BACHELOR OF SCIENCE

6th SEMESTER

DISCIPLINE SPECIFIC ELECTIVES (DSEs)

BT620D1: BIO-TECHNOLOGY: ELEMENTARY BIOSTATISTICS AND BIOINFORMATICS

CREDITS: THEORY – 4, PRACTICAL – 2(4+2)

OPTION-I

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: This courseintroduces students to basic statistical concepts involved in biology and illustrates the power of computing in modern biology.

Unit-1 (15 HOURS)

Introduction to statistics; Understanding of data & variables (with their types and categories); Data production – experiments vs sample surveys, principles & types of experimental design, idea of randomization, detailed account of sampling designs; Graphical representation of data (bar graph, pie chart, stemplot, histogram).

Unit – 2 (15 Hours)

Measures of central tendency (mean, median, mode) & dispersion (quartiles, standard deviation) with their properties and comparison; Understanding of correlation, least-squares regression & scatterplots; Overview of probability & probability rules, statistical inference with emphasis on confidence intervals and p-values.

Unit – 3 (15 Hours)

Introduction to bioinformatics; Scope and application of bioinformatics; Introduction to biological databases (types-sequence, structure & pathway), Nucleic acid databases (NCBI, GenBank, EMBL), Protein databases (PIR, Swiss-Prot, PDB); Introduction to PubMed.

Unit – 4 (15 Hours)

Sequence similarity and alignment – local & global alignment, pairwise & multiple sequence alignments, BLAST, FASTA & CLUSTALW; Basic idea of phylogenetic tree; Protein structure analysis - levels of protein structure, primary structure analysis (protparam), secondary structure predictions (ExPASy, JPred), tertiary structure prediction methods (homology, threading).

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Use of excel for calculating: Mean, Mode, Median.
2. Use of excel for drawing, histogram, bar-chart &piechart.
3. Use of NCBI, GenBank, EMBL, SwissProt, PDB, TREMBL.
4. Pairwise and multiple sequence alignment (BLAST and ClustalW)
5. Use of protparam, Expasy and JPred.

BOOKS RECOMMENDED

1. *Basic Biostatistics:* Bert Gurtsman
2. *Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery,* - Rastogi, Prentice Hall India Learning Private Limited.
3. *Essential Bioinformatics,*Jin Xiong, - Cambridge University Press.
4. *Bioinformatics – Principles and Applications,*Ghosh, Z. and Mallick, B.,-Oxford University Press (India).

Expected Learning Outcomes:

1. Understanding of basic statistical methods as applied to biological sciences.
2. Concept of Bioinformatics, types of data and databases.
3. Understanding of tools used for data analysis and prediction of different levels of protein structure.

BACHELOR OF SCIENCE

6th SEMESTER

DISCIPLINE SPECIFIC ELECTIVES (DSEs)

BT620D2: BIO-TECHNOLOGY: ENVIRONMENTAL BIOTECHNOLOGY

CREDITS: THEORY – 4, PRACTICAL – 2(4+2)

OPTION-II

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objective: The objective of this course is to familiarize the students with various problems concerning environment and their possible solutions employing the biotechnological approaches.

Unit–1 (15 HOURS)

Environment- basic concepts and issues; Pollution - types of pollutants, air, water and soil pollution; Global environmental problems – Green house effect, acid rain, ozone depletion, deforestation, desertification, salination, biodiversity loss.

Unit– 2(15 HOURS)

Water as a scarce natural resource;Sourcesand measurement of water pollution; Waste water treatment-physical, chemical and biological treatment processes; Microbiology of waste water treatments: Aerobic processes - activated sludge, oxidation ponds and ditches, trickling filter, towers, rotating discs and drums; Anaerobic processes - anaerobic digestion, anaerobic filters

Unit– 3(15 HOURS)

Solid waste and soil pollution management; Treatment and disposal of solid waste - Aerobic (composting and Vermiculture), Anaerobic treatment of solid waste and biogas generation.

Unit– 4(15 HOURS)

Bioremediation - principle and process; Bioremediation of contaminated soils, water and waste land, spilled hydrocarbons; Biodegradation of organic pollutants, pesticides and xenobiotics; Biopesticides; Biopollution; Macroplastics;Biomining.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Collection, processing and storage of effluent samples
2. Determination of BOD/COD in waste water samples
3. Determination of dissolved oxygen/ total dissolved solids in waste water samples
4. Analysis of total hardness/temporary hardness of waste water samples.
5. Analysis of waste water/sludge for heavy metals.

BOOKS RECOMMENDED

1. *Wastewater Engineering – Treatment, Disposal and Reuse*, Tchobanoglous, G., Franklin, B. and Stensel, H. D- Tata McGraw Hill, New Delhi
2. *Comprehensive Biotechnology*, M.Moo-Young -Pergamon Press, Oxford
3. *Environmental Chemistry* De, A. K. - Wiley Eastern Ltd., New Delhi
4. *Environmental Biotechnology*,Kumar, A. -Daya publishing house.
5. *Advances in industrial waste water treatment*,Goel, P.K. - ABD Publishers.
6. *Environmental risks and Hazards*,Cutter, S. L. - Prentice Hall.
7. *Biotechnology in Environmental Management*, Pathade, G. R. and Goel, P.K - ABDPublications.

Expected Learning Outcomes:

1. Basic concept of Environmental pollution, its types, causes and treatment.
2. Understanding of global environmental issues and their mitigation.
3. Brief idea of bioremediation and biodegradation of organic pollutants.

BACHELOR OF SCIENCE

6th SEMESTER

DISCIPLINE SPECIFIC ELECTIVES (DSEs)

BT620D3: BIO-TECHNOLOGY: CELL CYCLE, SIGNALING AND CANCER

CREDITS: THEORY – 4, PRACTICAL– 2(4+2)

OPTION-III

THEORY (4 CREDITS: 60 HOURS) **MAXIMUM MARKS: 60, MINIMUM MARKS: 24**

Objectives: This course acquaints the students with coordination and communication at cellular level.

Unit–1 (15 HOURS)

Cell cycle: stages of cell cycle, cell cycle regulation - cyclin, CDKs, check points in cell cycle (G1 and G2), DNA damage check points.

Unit- 2(15 HOURS)

Types of mutations - base substitution, mis-sense, non-sense, deletion, insertion, frameshift, silent mutations, spontaneous and induced mutations;Chemical and physical mutagens; Reversion (brief idea); Overview of recombination (homologous recombination); DNA Repair - mismatch repair system, excision repair, specialized repair systems, photo reactivation, recombination repair, SOS repair, double stranded repair in eukaryotes.

Unit- 3(15 HOURS)

Signaling - autocrine, paracrine and endocrine signaling;Types of receptors and action (steroid and peptide); GPCR signaling; Second Messengers - cAMP, cGMP, Ca^{2+}, NO (importance and role in signaling and signal transduction); Receptor tyrosine kinases.

Unit- 4(15 HOURS)

Characteristic of tumour cells; Use of cell culture in cancer research; Cancer- causes, types and stages; Role of tumor suppressor genes and (proto)-oncogenes; Cancer treatment- molecular approach; Apoptosis vs necrosis; Autophagy.

PRACTICALS (2 CREDITS: 60 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

1. Study of different stagesof cell cycle.
2. Study of different stages of mitosis and meiosis.
3. DNA fragmentation assay.
4. Permanent slides for different types of cancer.

BOOKS RECOMMENDED

1. *Cell and Molecular Biology: Concepts and Experiments,* Karp G. - John Wiley & Sons. Inc.
2. *The Cell: A Molecular Approach.* Cooper, G.M. and Hausman, R.E. - ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. *Genomes 3*, TA Brown, - Garland Science
4. *Genetics: A Conceptual Approach*, Benjamin Pierce, - WH Freeman

Expected Learning Outcomes:

1. Understanding of the process of cell cycle, cell division and its control.
2. Understanding different types of mutations, mutagens and the mechanism of repair.
3. Basic concept of cell signaling andcancer.

BACHELOR OF SCIENCE (GENERAL)

3rd SEMESTER

SKILL ENHANCEMENT COURSE (SEC)

BT320S: BIOTECHNOLOGY: CLINICAL DIAGNOSTICS

CREDITS: THEORY – 2, PRACTICAL – 2 (2+2)

THEORY (2 CREDITS: 30 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Objective: This course introduces students to different diagnostic tools, procedures and their application.

Unit-1 (15 HOURS)

Specimen handling, transport, preservation and disposal; Chemical composition of Biological Fluids - Blood, Urine and Cerebrospinal fluid; Reference range, Quality Control and Quality Asssurance; Accuracy and Precision; Factors affecting accuracy of results.

Unit- 2 (15 HOURS)

Metabolite based Diagnostics - Routine blood & urine analysis; Liver function test; Renal function Test; Thyroid Function Test; Lipid Profile; HaematologicalAnanlysis; **DNA based Diagnostics**- PCR; RAPD; RFLP; DNA finger printing; **Immunodiagnostics** - Immunohistochemistry – principle and techniques; ELISA; RIA

PRACTICAL (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

1. Preparation of solutions (Buffer,Molar, Normal, percent solution)
2. Demonstration of Lab instruments –pH meter, centrifuge, spectrophotometer, etc.
3. Sample preparation - specimen collection, handling, preparation, processing, containment, barcoding, and tracking.
4. Visit to various Laboratories.

BOOKS RECOMMENDED

1. *Molecular Cloning. A Laboratory Manual* Sambrook, J. Fritsch, E.F. and Maniatis, T. - Cold Spring Harbor Laboratory Press.
2. *Gene cloning & DNA analysis: An introduction,*T.A.Brown, - Wiley-Blackwell.
3. *Textbook: Molecular Diagnostics: Fundamentals, Methods and Clinical Applications,* Lela Buckingham and Maribeth Flaws.

Expected Learning Outcomes:

1. Understandingand interpretation of diagnostic tools and investigations.

2. Concept of working principle, methodology and application of different diagnostic lab instruements.

BACHELOR OF SCIENCE (GENERAL)

4th SEMESTER

SKILL ENHANCEMENT COURSE (SEC)

BT420S: BIOTECHNOLOGY: DISASTER MANAGEMENT

CREDITS: THEORY – 2, TUTORIAL – 2 (2+2)

THEORY (2 CREDITS: 30 HOURS) **MAXIMUM MARKS: 30, MINIMUM MARKS: 12**

Objectives / Expected Learning Outcomes:

This course is compulsory to all the students across all streams and the syllabus for the course is same for all. The course content has already been framed by the concerned departments.

BACHELOR OF SCIENCE (GENERAL)

5th SEMESTER

SKILL ENHANCEMENT COURSE (SEC)

BT520S: BIOTECHNOLOGY: FOOD TECHNOLOGY

CREDITS: THEORY – 2, PRACTICAL – 2 (2+2)

THEORY (2 CREDITS: 30 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Objective: This course is aimed to provide insight into food quality and control.

Unit-1 (15 HOURS)

Introduction to Food technology; Food preservation technologies- blanching, pasteurization, sterilization, canning, dehydration, irradiation, ultrafiltration; Spoilage of food products (fruit, vegetables, meat, milk and cereal products); Food borne diseases - infections and intoxications; Food adulteration - common food adulterants; detection of food adulteration; Food additives - colour, flavour, vitamins, antioxidants, preservatives; Food safety and standards act 2006 and regulation 2011.

Unit-2 (15 HOURS)

Functional foods (brief idea);G.M Foods - advantages, safety evaluation, allergenicity, public attitudes; G.M. Crops -Bt Corn, BtBrinjal& Golden Rice; Probiotics - its health benefits; Fermented milk and vegetable products; Single cell proteins (SCP).

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

1. Heat preservation of foods.
2. Detection of adulteration of milk and milk products.
3. Preparation of fermented products (dahi, cheese, sauerkraut, vegetable pickle).
4. Spoilage detection and isolation of any food borne bacteria from food products.
5. Visit to food processing industries.

BOOKS RECOMMENDED

1. *Food Science,* Norman N Portter and JH Hotchkiss - CBS Publishers.
2. *Food Biotechnology principles & Practices*,Joshi, V. K. and Sing., R.K.
3. *Modern Food Microbiology* James M. Jay, - CBS Publishers Delhi.

Expected Learning Outcomes:

1. Understanding of different food preservation techniques and detection of food adulteration.
2. Basic concept of GM foods, GM crops and public attitudes towards them.

BACHELOR OF SCIENCE (GENERAL)

6th SEMESTER

SKILL ENHANCEMENT COURSE (SEC)

BT620S: BIOTECHNOLOGY: BIOSAFETY, BIOETHICS AND IPR

CREDITS: THEORY – 2, PRACTICAL – 2 (2+2)

THEORY (2 CREDITS: 30 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

Objective: This course is intended to remind the students about their responsibilities towards themselves and society, and promotes creativity among them by providing detailed insight into intellectual property rights.

Unit-1 (15 HOURS)

Biosafety– Introduction to Good Laboratory Practices (GLP); Introduction to biosafety; Biosafety levels; Definition of GMOs and LMOs; Roles of institutional biosafety committees; Cartagena Protocol;

Bioethics – Introduction to bioethics; Ethical issues involved in molecular technologies, genetic manipulations, germline therapy and transgenics; Human genome project and its ethical issues; Human cloning and bioethics.

Unit- 2 (15 HOURS)

Introduction: Property – tangible, intangible; Intellectual property – patents, trade secrets, copyright, trade mark, service mark, industrial design, geographical indications, traditional knowledge, layout design of circuits; Main features of WIPO, GATT, and TRIPS agreement.

Patent: meaning, types of patents; Patentability criteria; Patentable and Non-patentable inventions; Rights of patentee; Brief procedure for filing a patent (national, international).

PRACTICALS (2 CREDITS: 60 HOURS) MAXIMUM MARKS: 30, MINIMUM MARKS: 12

1. Proxy filing of Indian Product patent to learn the process.
2. Planning of establishing a hypothetical biotechnology industry in India
3. A case study on clinical trials of drugs in India with emphasis on ethical issues.
4. A study on medical errors and negligence.

BOOKS RECOMMENDED

1. *IPR, Biosafety and biotechnology Management.*Senthil Kumar Sand Mohammed Jaabir,- Jasen Publications
2. *Intellectual Property Law,* Lionel Bently& Brad Sherman, OUP.
3. *Law of Patent,*Elizabeth Verkey, - Eastern Book Company, Lucknow.
4. *IPR, Biosafety and Bioethics,*Goel D &Prashar S - Pearson

Expected Learning Outcomes:

1. Understanding of Good laboratory practices, and biosafety.
2. Know-how of issues and bioethics related to molecular technologiesand GMOs.
3. Understanding the intellectual property rights,concept of patenting organisms and process of filing for a patent.