Model Curriculum for Three/Four Year Degree Course

(With Multiple Entry /Exit Option)

Based on NEP-2020

Biotechnology

Odisha State Higher Education Council, Bhubaneswar
Government of Odisha

Semester	Subjects
I	Core I - Cell Biology and Genetics
	Core II- Biochemistry and Metabolism
II	Core III- Microbiology and Microbial Technology
	Core IV - Biostatistics and Computer Applications
III	Core V- Instrumentation and Analytical Techniques
	Core VI- Molecular Biology
	Core VII- Immunology and Immunotechnology
IV	Core VIII- Genetic Engineering and Gene Therapy
	Core IX- Bioprocess Engineering and Industrial Biotechnology
	Core X- Plant Biotechnology
V	Core XI- Environmental Biotechnology
	Core XII- Animal Biotechnology
	Core XIII- Pharmaceutical Biotechnology and Drug Designing
VI	Core XIV- Bio-Entrepreneurship, Biosafety, Bioethics and IPR
	Core XV- Computational Biology
VII	Core XVI- Medical Biotechnology and Molecular Diagnostics
	Core XVII- Bio resource Technology and Bio products
	Core XVIII- Ethno pharmacology
	Core XIX- Agricultural Biotechnology
VIII	Core XX- Cancer Biology and Stem Cell Therapy
	Core XXI- Review Methodology and Communication Skills
	Core XXII- Food Science and Food Biotechnology
	Core XXIII- Nano biotechnology

Programme Outcomes

- To prepare the students for a career in Biotechnology.
- To prepare the students for Higher Education and Research in Biotechnology.
- To develop a conceptual understanding of the subject and to develop an inquisitiveness in the subject.
- To enable the student to acquire basic skills necessary to understand the subject and to master the skills to handle equipment's utilized to learn the subject.
- To generally promote wider reading on the subject and allied inter disciplinary subject.

Core I

Semester -I

Cell Biology and Genetics

Credit-3

Course Objectives :

The course aims at:

- Illustration of the basics of genetics and inheritance and provide the students an
- understanding of the molecular basis of genetics and Mendel's fundamental work on
- genetics.
- Explaining the concepts of Mendelian genetics and its exceptions
- Making the student understand mutation, linkage and crossing over
- Explaining the modes of inheritance viz. chromosomal & extra chromosomal
- Explaining population genetics and application of Hardy-Weinberg principle

Course Outcomes:

After successful completion of this Course, students will be able to:

1) Understand concepts of Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology, genetics, biochemistry, microbiology, and molecular biology
2) Describe the ultrastructure of cells, structure and function of organelles, cytosol and cytoskeleton
3) Understand phases of cell cycle, cell division, reductional division in gametes, molecular mechanisms that regulate life and death of a cell including programmed cell death or apoptosis and differentiation in plants
4) Comprehend organization and structure of chromosomes, banding techniques and Mendelian laws of inheritance, deviations and exceptions to these laws.
5) Describe mutations at the molecular level, types of mutations, genetic or hereditary disorders and concepts in population genetics

Learning Outcomes:

- Acquire knowledge about the organizational and functional aspects of cell and cell organelles
- Students will be able to learn about the interactions of the cells with outside environment through exchange of information and transport of molecules.
- Learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
- Develop innovative research ideas for curing genetic disorders in humans

Unit I

- Cell as a basic unit of living systems and cellular organelles: Concept, Development and Scope of Biotechnology. Historical perspectives. Discovery of cell, the cell Theory, Ultra structure of a eukaryotic cell- (Both plant and animal cells), Cellular Organelles: Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin). Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments).

- Surface Architecture: Structural organization and functions of plasma membrane and cell wall of eukaryotes Ultra structure of plasma membrane – fluid mosaic model, membrane fluidity, Transport across membranes - Symport, antiport, uniport, active and passive transport, Differentiation of cell surface: Basement membrane, tight junction, gap junctions, Desmosomes, hemidesmosomes.

Unit II

- Chromosomes and cell division: General Introduction, Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Single-stranded and multistranded hypothesis, folded- fibre and nucleosome models; Genome organization.

- Cell Division: Cell cycle, phases cell division. Mitosis and meiosis, regulation of cell cycles cell cycle checkpoints, and enzymes involved in regulation, Significance of cell cycle, mitosis and meiosis interphase nucleus, achromatic apparatus, synaptonemal complex Cell Cycle and regulation, mitosis and meiosis. Cell Senescence and programmed cell death.

Unit III

- Genetics: Introduction and brief history of genetics. Mendelian theory: Laws of inheritance- dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross. Deviations to Mendelian inheritance, complementary, supplementary and interaction of genes (13:3 ratio), epistasis.

- Maternal Inheritance: Plastid inheritance in Mirabilis, Petite characters in yeast and Kappa particles in paramecium, Sex-linked inheritance, Chromosome theory of inheritance.

- Linkage and crossing over: Introduction, Coupling and repulsion hypothesis, Linkage in maize and Drosophila, Mechanism of crossing over and its importance, chromosome mapping-linkage map in maize.

- Gene interaction: Multiple factors–Skin colour in human beings, Epistasis– Plumage colour in poultry, Multiple allelism: Blood groups in Human beings.

Unit IV

- Mutations: Types of mutations, Spontaneous and induced, Mutagens: Physical and chemical, Mutation at the molecular level, Mutations in plants, animals and microbes for economic benefit of man.Sex Determination in Plants and animals: Concept of allosomes and autosomes.

- Non-Mendelian Inheritance pattern: Mitochondrial inheritance, genome imprinting, Lyon Hypothesis, complex inheritance-genetics and environmental variation heritability, behaviuoral traits, analysis of quantitative and qualitative traits.

- Population genetics: phenotype, genotype, gene frequency, Hardy Weinberge Law, factor distinguishing Hardy Weinberge equilibrium, mutation selection, migration, gene flow, genetic drift.

- Inherited disorders – Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down's syndrome and Cri-Du-Chat Syndrome).

Text Books:

- ✓ *Alberts B et al. (2002) Molecular biology of the cell, Garland Publications*
- ✓ *Burke, J D, (1970) Cell Biology, William and Wilkins*
- ✓ *Gardner E.J., Simmons M.J. and Snustad D.P. (2003) Principles of Genetics, 8th Ed., John Wiley & Son Publications*

Reference Books

- ✓ *Clark, CA. (1970) Human Genetics and Medicine, Edward Arnold, London*
- ✓ *Dale JW. (1990) Molecular genetics of bacteria. John Wiley and Sons.*
- ✓ *Darnell J. Lodish H, Baltimore D, (1990) Molecular Cell Biology, Scientific American Books*
- ✓ *De Robertis EDP & Robertis EMF (1980) Cell Biology & Molecular Biology, Saunders College.*
- ✓ *De Robertis EDP and De Robertis EMF. (1995) Cell and molecular Biology. 8th E., BI Waverly Pvt. Ltd., New Delhi.*
- ✓ *Altenburg E. (1970) Genetics, Oxford & IBH publications*
- ✓ *Gupta ML. and ML. Jangir. (2002) Cell Biology-Fundamentals and Applications. Argosies, Jodhpur, India.*

Practical

Credit-1

1) Study and maintenance of simple and compound microscope
2) Use of Micrometer and calibration, measurement of onion epidermal cells and yeast
3) Study of divisional stages in mitosis from onion root tips
4) Study of divisional stages in meiosis in grasshopper testes/onion or Rheo flower buds.
5) Mounting of polytene chromosomes
6) Buccal smear – Barr bodies
7) Karyotype analysis – Human and Onion Human – Normal and Abnormal – Down and Turner's syndromes
8) Isolation and staining of Mitochondria
9) Isolation and staining of Chloroplast
10) RBC cell count by Haemocytometer
11) Simple genetic problems based on theory

Core II

Biochemistry and Metabolism

Credit-3

Course objective:

The course aims to introduce the theories and concepts of biomolecules, provide an advanced understanding of the core principles and topics of biomolecule metabolism and their experimental basis and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of lecture series

Course Outcome

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

Learning Outcome:

Students will be able to

- Know the chemical constituents of cells, the basic units of living organisms.
- Explain various types of weak interactions between the biomolecules.
- Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.
- Correlate the structure-function relationship in various biomolecules
- Know the role of biomolecules for orderly structures of the cells/tissues.

Unit-I:

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

Unit-II:

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

Unit-III:

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

Unit-IV:

- Lipids: Definition, distinction between fats and oils, structure of lipids (fatty acids, glycolipids, sphingolipids).
- Nucleic acids: Structure of nucleic acids; nucleosides, nucleotides, primary structure, A, B and Z form of DNA; preliminary idea of secondary structures of RNA and DNA; melting point and denaturation of DNA.
- Enzymes: Definition of enzymes, important terms (enzyme unit, specific activity), classification of enzymes; physico-chemical properties, factors affecting activity; mechanism of enzyme action, coenzymes, cofactors.

Text Books

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

Practical

Credit-1

1) Qualitative tests for sugars, amino acids, proteins & lipids;
2) Quantitative estimation of proteins (Folin-Phenol).
3) Quantitative estimation of sugars (DNS method)
4) Quantification of DNA (diphenylamine method)
5) Quantification of RNA (orcinol method)
6) analysis, saponification value of fat.
7) Quantitative assay for protease & catalase from plant source.
8) To study the effect of pH, Temperature and subtract concentration on the activity of salivary amylase

Core III **Semester II**

Microbiology and Microbial Technology

Credit-3

Course Objective:

The course aim at Understanding of microbiology from the cellular to molecular levels of organization in Conjunction with bacterial physiology and metabolism. Understanding the prokaryotes with special concentration on the structure, metabolism and genetics of bacteria. Understanding the scope and importance of microorganisms, in particular, bacteria, for human being.

Learning Outcome:

Students will able to understanding the diversity of microbes present and their identification. The central metabolic pathways operating in a bacterial cell for its growth and survival. Beneficial role of bacteria. Learning the three genetic recombination techniques vital to bacterial heredity and variation. Important of microorganismes in pollution control, food and diseases.

Course Outcomes:

Students will be able to:

- Understand the difference between prokaryotic and eukaryotic cellular organization.
- Physiology and metabolism of bacterial growth
- Isolation of pure bacterial culture from different sources and its maintenance
- Differentiate different type of bacteria and its industrial applications

Unit I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used, including molecular approaches, Microbial phylogeny, Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa, Archea (Halophyles, Methanogens, ThermophylesVirus (structure of viruses, Bacterial, plant, animal and tumor viruses, DNA- and RNA- viruses.

Unit II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit III

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Nutritional Classification of Microorganisms.

Unit IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents, Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: molds, Yeasts, bacteria.

Text Book:

- ✓ *Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill BookCompany.*
- ✓ *Prescott/Harley/Klein's Microbiology, by Joanne Willey (Author), Linda Sherwood (Author), Chris Woolverton (Author), McGraw Hill Education; 7 editions*
- ✓ *Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 thedition.John and Sons, Inc.*
- ✓ *Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.*
- ✓ *Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.*
- ✓ *Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12thedition. Pearson/Benjamin Cummings.*
- ✓ *Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thedition. McMillan.*

PRACTICALS

Credit-1

1) Growth curve, measurements of bacterial population and generation time by turbidometry and cell counting.
2) Preparation of liquid and solid media for growth of microorganisms. & sterilization methods
3) Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and slab cultures.
4) Isolation of pure cultures from soil/ water.
5) Microscopic examination of Bacteria, Cyanobacteria, Molds and study of organisms by simple staining, Gram staining, spore staining, negative staining, hanging drop.
6) Determination of bacterial cell size by micrometry.
7) Enumeration of microorganism - total & viable count.

Core IV

Biostatistics and Computer Applications

Credit-3

Course Objective:
The goal is to understand and interpret commonly reported statistical measures published in healthcare research. Analyze the different type of data using appropriate statistical software. Demonstrate a good understanding of graphical tools and analysis of numerical data.

Course Outcome:

- To apply the scientific method and hypothesis testing to experimental design
- To implement appropriate experimental designs to biological investigation
- To assess experimental results with appropriate statistical tests
- To interpret statistical output, both biologically and statistically

Learning Outcome:

- Students will be able to:
- Collect, organize, analyzed and interpret various data with the used of quantified models. Understand different computer application and their use in data interpretation
- Analysis of large group of data and their probablerisk factors

Unit-I
Statistics: Definition, functions and limitations, Treatment of Data, Descriptive measures for group and ungrouped data, Probability, Introduction to hypothesis testing, simple and composite hypotheses, null and alternative hypotheses, two types of errors, critical region, significance level, size and power of the test, p-value and its interpretation. Small sample tests for means and variances based on chi-square, t and F distributions. Test of significance for correlation coefficient.

Unit-II
Multivariate data, sample mean vector, sample dispersion matrix, correlation matrix, partial and multiple correlations, correlation of linear transformation, multivariate normal distribution, random sampling from a multivariate normal distribution.

Unit-III
Introduction to principal component analysis as dimension reduction technique, canonical correlation, canonical variables, Cluster analysis: Hierarchical and Non-hierarchical clustering, single, complete, average linkage methods and k-means clustering.

Unit-IV
Concepts of population projections; population estimates, forecasts and projections, uses of population projections; Methods of interpolation, extrapolation using linear, exponential, polynomial, logistics and Gompertz curves; Cohort component method: basic methodology; projection of mortality, fertility and migration components. Data Integrity and Data

Stewardship (Managing, Storing, Sharing, and Securing Data and Research Records), Working in Industry and Commercializing Science.

Text Books:

- ✓ *Dudewicz E.J. and Mishra S.N.(1988): Modern Mathematical Statistics, Wiley Series*
- ✓ *Anderson T. W. (1984): An Introduction to Multivariate Analysis, 2nd Ed., John Wiley*
- ✓ *Gupta S.C. and Kapoor V.K.: Fundamentals of Applied statistics - Sultan Chand and Sons Publication*
- ✓ *Keyfitz N. (1968):Introduction to Mathematics of Population. Addision-Wesley Publishing Co, Reading ,Messachusetts.*

PRACTICALS

Credit-1

1. Analysis data for different experiments carry out in lab
2. Use of one-way ANOVA for statistical analysis of experimental samples
3. Learn to study different graph types for population genetics

Core V **Semester III**

Instrumentation and Analytical Techniques

Credit-3

Course objective:

The objective of this course is to provide the students with the understanding of various analytical techniques used in biotechnology-based research and industry. The course will acquaint the Students with the various instruments, their configuration and principle of working, operating procedures. In this course, the students will be exposed to basic concepts related with techniques and instrumentation widely used in Biotechnology.

Course Outcome:

This course will equip students with the fundamental knowledge of biotechniques, including buffer preparation and use of different instruments which will help them in their research careers.

Learning Outcome:

Students will gain

- Knowledge of basic theory and principles of chromatography, spectroscopy, microscopy.
- Qualitative and quantitative assessment of the samples.
- In depth knowledge of specific analytical techniques relevant to their project work.

Unit I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy; Immuno-cytochemistry: Principles, techniques and application.

Unit II

Ultraviolet-visible absorption spectroscopy and Fluorescence spectrophotometry: Principle, Instrumentation and application. Other types (IR, NMR, ESR and MASS) of spectrophotometry: Basic principle and application.Elimentary idea about X-ray crystallography, API- Electrospray and MALDI TOF.

Unit III

- Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.
- Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of rotors, Methods in preparatory ultacentrifugation (differential and density gradient centrifugation, centrifugal elutriation). cell fractionation techniques, isolation of sub-cellular organelles and particles.

Unit IV

- Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels).
- Introduction to PCR and Q-PCR, Western blotting.
- Introduction to Biosensors and Nanotechnology and their applications.

Text Book:

- ✓ *Principle and Techniques of Biochemistry and Molecular biology, 7th ed By Keith Wilson and Jhon Walker, Cambridge Press*
- ✓ *Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition*

PRACTICALS

Credit-1

1. Buffer preparation- Phosphate/Acetate/Citrate
2. Operation of shakers, incubators, pH meters and centrifuges
3. Determination of absorption maxima of given chemicals.
4. Validation of Beers and Lambert Law
5. Separation of amino acids by Paper Chromatography/ ThinLayerChromatography methods.
6. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
7. Staining of SDS- PAGE: coomassie brilliant blue and silver staining.
8. Native gel electrophoresis of proteins

Core VI

Molecular Biology

Credit-3

Course Objectives:

The aim is to extend the understanding of molecular mechanisms of cell through which genetic information is stored, expressed and transmitted among generations.

Course Outcomes

On completion of this course student will gain knowledge about

- The advancements in molecular biology with latest trends
- Awareness about normal cellular processes such as replication, transcription, translation and repair mechanism
- Structure, functional relationship of proteins and nucleic acids

Learning Outcome:

Students will able to

- Understand the foundation materials of life along with its biological and chemical organization.
- Learn the central dogma of molecular biology and its outcomes.
- Evolutionary theory and molecular processes to efficiently target new drugs.
- Get the concept of genes and molecular events related to mutations.

Unit I

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Packaging of DNA molecule into chromosomes, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Unit II

DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: models and mechanism.

Unit III

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5 cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit IV

- Prokaryotic and eukaryotic translation: ribosome structure and assembly, Wobble hypothesis, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins
- Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics.

Text Book:

- ✓ *Molecular Biology of the Gene – By J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick*
- ✓ *Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). – W.H.Freeman and Company. 2009*
- ✓ *Molecular Biology by T.A. Brown*
- ✓ *Genomes byT.A. Brown*
- ✓ *Sambrook et al 2000. Molecular cloning Volumes I, II & III, Cold spring Harbor Laboratory Press New York, U SA*

PRACTICALS

Credit-1

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of DNA from animal/Plant/bacterial cells.
3. Isolation of DNA from Plant
4. Isolation of DNA from Bacterial
5. Quantitation of DNA by Spectrophotometry
6. Agarose gel electrophoresis of genomic DNA.
7. Isolation of RNA from animal cells
8. Quantification of RNA and RNA gel electrophoresis
9. Extraction of protein
10. SDS PAGE and Native PAGE

Core VII

Immunology and Immunotechnology

Credit-3

Course Objective:

To introduce the science of immunology and detailed study of various types of immune systems and their classification, structure and mechanism of immune activation. And to get conceptual views about transplantation and its necessity.

Course Outcomes

At the end of the course, the student should be able to:

- Demonstrate comprehension of the underlying structure and function of the immune system and related disorders.
- Demonstrate an understanding of the role of cells and molecules in immune reactions and responses
- Demonstrate technical skills in immunological tools and techniques

Learning Outcome:

On completion of this course student will be able to

- Trace the history and development of immunology.
- Define central immunological principles and concepts
- Outline and compare the key molecules involve in defensive mechanisms of human
- Learn different techniques to assess the immune response of host

Unit I:

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during Blymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination, Antigens.

Unit II:

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity, Monoclonal Antibodies

Unit III:

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Complement system, Autoimmune diseases, Immunodeficiency-AIDS, Hypersensitivity reactions

Unit IV:

Structure and properties of antigens- iso- and allo-antigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion, Immunoelectrophoresis. Agglutination: Agglutination reactions. ELISA, RIA. Immunocy to chemistry, Fluorescent Techniques.

Text Book:

- ✓ *Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W. H. Freeman and Company, New York.*
- ✓ *Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015*

PRACTICALS

Credit-1

1. Separation of serum from blood.
2. Single Immunodiffusion analysis using specific antibody and antigen
3. Double immunodiffusion test using specific antibody and antigen.
4. Haemagglutination assay.
5. Enzyme-Linked Immunosorbent Assay (ELISA) Demonstration.
6. Blood group analysis

Core VIII **Semester IV**

Genetic Engineering and Gene Therapy

Credit-3

Course Objectives:

- To provide knowledge in Basics Genetic engineering. This course would familiarize students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal.

- To train the students in various techniques involved in Genetic engineering.

Course Outcome:

- Students will get a hands-on experience of
- DNA isolation and cloning techniques.
- Differentiate cloning and expression vectors
- Perform agarose gel electrophoresis
- Review various application of genetic engineering

Learning Outcome:

Students will be able to

- Understand the basics of gene cloning, role of enzymes and vectors for genetic engineering.
- Get an idea Genome editing principles and application
- Define the principle of gene silencing, gene knockouts and gene therapy

Unit I

Scope & History of Genetic Engineering; Vectors: Nomenclature, properties, plasmids, phage-based vector (Phagmid, cosmids) yeast vector, Artificial chromosome, plant & animal vectors, cassette vectors.; DNA modifying enzymes ((Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase) required in recombinant DNA technology.; Gene transfer Techniques: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion, Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virus mediated transfection.

Unit II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription.; Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, ; Therapeutic products produced

by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit III

Genome Editing - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.;DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay, CHIP.; Protein-protein interaction cloning and yeast two hybrid system, Phage Display; Protein engineering concepts and examples (any two), production of chimeric proteins

Unit IV

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizo* genes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.; Gene therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation.; Knockout and transgenic technologies; Gene silencing (ribozyme, antisense and RNAi technologies).

Text Book;

- ✓ *Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington*

Suggested Readings:

- ✓ *Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing,Oxford, U.K.*
- ✓ *Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution.Elsevier Academic Press, USA.*
- ✓ *Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.*
- ✓ *Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.*
- ✓ *Biotechnology by B.D.Singh (Kalyani Publishers).*

PRACTICAL

Credit-1

1. Plasmid DNA isolation.
2. Restriction digestion of pBR322
3. Ligation using suitable vector
4. Southern hybridization.
5. Preparation of Competent Cell.
6. Transformation & blue white screening.
7. Isolation of total RNA from Bacteria.
8. Demonstration of Polymerase chain reaction./Q-PCR
9. SDS-PAGE of Bacterial Proteins.

Core IX

Bioprocess Engineering and Industrial Biotechnology

Credit-3

Course objective:

This course updates students' knowledge of new developments in biology of industrial relevance. To make the students understand the fermentation process, using these tools and its combination of bioprocess engineering. In addition, this provides broad understanding and experience of technological processes involved in biotechnological industries.

Course Outcome:

This course enables the students to

- Formulate and operate conversion processes of biological resources into bio-based value-added products
- Design biological reactions and reactors
- Understand the practical aspects of bioprocess engineering and its role in industries**.**

Learning Outcome:

Students will be able to understand

- The kinetics of enzymatic process
- The stochiometry and energetics of cell growth and product formation
- The kinetics of microbial growth and their applications in industries

Unit I

1. Industrial application of enzymes: Enzymes used in detergents, uses of proteases in food, leather and wool industries.
2. Application of enzymes in food processing: Production of glucose syrup from starch using starch hydrolysing enzymes, production of syrup containing maltose, enzymes in sucrose industry, glucose from cellulose, lactase in dairy industry, glucose oxidase and catalase in food industry, Cheese making by protease.
3. Medical applications of enzymes: Use of enzymes in medical diagnostics and clinical treatment.

Unit II

1. Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity
2. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.
3. Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2 - 3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, Microbial electricity, starch conversion processes.

4. Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

Unit III

1. Introduction to bioprocess engineering. Bioreactors: batch, fed batch and continuous bioreactors, Uses of immobilized enzymes, bioreactors using immobilized enzymes.
2. Specialized bioreactors: pulsed, fluidized and photo-bioreactors.
3. Media for industrial fermentation, air and media sterilization.
4. Sources of microbes for industrial use, kinetics of microbial growth and death, measurement and control of bioprocess parameters.
5. Purification & characterization of proteins/byproducts, Upstream and downstream processing, removal microbial cells from bioreactors, foam preparation, filtration, drying and crystallization. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit IV

1. Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions.
2. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Text Book:

- ✓ *Prescott & Dunn's Industrial Microbiology Paperback, 2004 by G. Reed (Author), CBS Publication*
- ✓ *Michael shuler, FikretKargi, Mathew Delisa, Bioprocess Engineering. 3rd Edition, Prentice Hall.*
- ✓ *Pau Loke Show, ChienweiOoi, Tau Chauan Ling, Bioprocess Engineering. CRC press, 1st Edition.*

Suggested Readings:

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

PRACTICALS

Credit-1

1. Fermenter design and structure.
2. Calculation of Mathematical derivation of growth kinetics.
3. Inoculum preparation and sterilization
4. Immobilization of bacterial cells.
5. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.
6. Production and analysis of Amylase.

Core X

Plant Biotechnology

Credit-3

Course Objectives:

- The course curriculum helps in the understanding of the plant tissue culture and applications in the culture techniques.
- The Students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The Students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Course Outcome:

- Students will be able to
- Learn various steps of micropropagation
- Understand the role of hormones during plant growth and metabolism
- Understands the process involves in planning, conducting and execution of plant biotechnology experiments.

Learning Outcome:

- This course aims students to gain understanding the components of plant biotechnology
- Explore the use of biotechnology to generate genetic variation in plants
- Understand the molecular processes that occur during plant growth and environmental adaptation.

Unit I

Conventional plant breeding, Introduction to cell and tissue culture, tissue as technique to produce novel plants and hybrids.; Tissue culture media (composition and media), Initiation and maintenance of callus and suspension culture; single cell clones.; Morphogenesis and Organogenesis in plants; Organization of shoot and root apical meristem, shoot and root development, Leaf development and Phyllotaxy, Transition to flowering, Floral meristem and Floral development in *Arabidopsis* and *Antirrhinum.*

Unit II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Significance and use of haploids; Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

Unit III

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. ; Somaclonal variation Nomenclautre, methods, applications basis and disadvantages. Cryopreservation, slow growth and DNA banking for

germplasm conservation; Chloroplast transformation: advantages, vectors, success with tobacco and potato.; Metabolic Engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway.

Unit IV

Application of plant transformation for productivity and performance: Herbicide resistance, atrazine, Insect resistance, Bt-genes, non-Bt like protease inhibitors, disease resistance. ; Virus resistance, chitinase, 1-3 beta glucanase, antifungal proteins, thionins, PR proteins, nematode resistance.; Abiotic stress, use of ACC synthease, ACC oxidase, male sterile lines, carbohydrate composition and storage, ADP glucose pyrophosphatase.; Alkaloids, biodegradable plastics, edible vaccines, oleosinpartioning technology.

Text Book:

Introduction to Plant Biotechnology, H.S. Chawla,Science Publishers, 2002

Suggested Readings:

- ✓ *Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.*
- ✓ *Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.Elsevier Science Amsterdam. The Netherlands.*
- ✓ *Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.*
- ✓ *Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.*
- ✓ *Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication*
- ✓ *Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.*

PRACTICALS

Credit-1

1. Isolation of total genomic DNA from leaves by CTAB method
2. Extraction of total protein from leaves and PAGE analysis.
3. Amplification of a plant gene by polymerase chain reaction
4. Plant Tissue culture technique - Preparation of Media , Preparation of complex nutrient medium (Murashige & Skoog's medium)
5. To selection, Prue, sterilize and prepare an explant for culture.
6. Significance of growth hormones in culture medium.
7. To demonstrate various steps of Micropropagation.
8. Callus Induction and shoot regeneration.
9. Shoot multiplication
10. Another culture.

Core XI **Semester V**

Environmental Biotechnology

Credit-3

Course Objective:

This course aims to impart basic knowledge about the environment and allied problems and to create the awareness about environmental problems.

Course Outcome:

This course will provide broad knowledge about the major contaminants of soil and water and its degradation process. Emphasize knowledge of different biotechnological processes helps to improve the environment

Learning Outcome:

Students will be able to

- Understand and assimilate the specific concepts and terminology of environmental biotechnology.
- Describe the scientific bases applied by environmental biotechnology.
- Describethe properties of microorganisms with potential application to environmental biotechnology processes.

Unit I

- Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.
- Acid rain, Arid and semi-arid plant biotechnology, green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

Unit II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation, Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

Unit III

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Unit IV

- Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.
- Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs).

- Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures

Text Books

- ✓ *P. K. Mohapatra, Textbook of Environmental Biotechnology, I.K. International Publishing House; 1st Ed. edition.*
- ✓ *Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers*

PRACTICALS

Credit-3

1. Calculation of BOD of water sample.
2. Calculation of COD of water sample.
3. Testing of alkalinity of water sample
4. Testing of hardness and conductivity of polluted water sample

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Core XII

Animal Biotechnology

Credit-3

Course Objectives:

The course provides the basic knowledge and understanding of cell culture techniques. The students will learn the maintenance and applications of cell and molecular techniques. Importance of proper animal model during the experimental design.

Course Outcome:
Students will

- Gain basics of animal cell culture, source of contamination and sterilization techniques.
- Use animal cell culture for developing valuable products for human diseases.
- Gain idea about different cell lines available and their use during experiments.

Learning Outcome:
Students will be able to

- Learn the ethical concern over the use of animals in experiments.
- Describe the structure of animal genes and genomes
- Design the experiments with appropriate animal models
- Understand the genetic modification advances in field of medicine development

Unit I

- Equipment and materials for animal cell culture: Design and layout of culture room, Basic equipment used in cell culture, Sterilization and aseptic techniques.
- Culture media: General considerations in media design, Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture.
- Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures.
- Growth curve, Establishment of cell line, cell counting.

Unit II

- Various methods of cell separation,
- Cell cloning: Dilution cloning and isolation cloning, Transformation of cells, Organ culture. Three dimensional culture.
- Scaling up of cultured cells: Anchorage dependent cell culture: Substrate for cell growth (conventional methods and new trends), Suspension culture: Modes (Batch, Fed-batch, continuous and perfusion culture modes), Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fibre reactors, Air-lift fermentors, chemostats and microcarriers).

Unit III

- Transformation of cells: Characteristics of transformed cells and the process of Immortalization (by suppression of senescence genes, induction by viral genes, by induction of telomerase and by chemical carcinogens).
- Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.
- Animal propagation – Artificial insemination, In vitro Fertilization, Embryo culture Animal Clones.
- Conservation Biology – Embryo transfer techniques.
- Introduction to Stem Cell Technology and its applications.

Unit IV

- Scope of animal cell culture.
- Genetic engineering of animal cells: Transfection, microcell-mediated chromosome transfer, irradiation fusion gene transfer.
- Hybridoma technology and production of monoclonal antibodies.
- Stem cell culture and its application.
- Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Text Book

- ✓ *Animal cell culture techniques, Ian Freshney, Wiley-Leiss*

Suggested Readings

- ✓ *Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.*
- ✓ *Cell Culture LabFAx, M. Butler and M. Dawson, Bios scientific Publications Ltd*
- ✓ *Cell and Tissue Culture: Laboratory Procedures in Biotechnology, A. Doyle and B.Griffith, Wiley publications.*
- ✓ *Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis*
- ✓ *Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.*
- ✓ *Animal Cell Culture - John R. W. Masters - Oxford University Press.*
- ✓ *Introduction to Plant Biotechnology 2017 by H S Chawla - CRC Press.*

PRACTICAL

Credit-1

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Cell counting and cell viability
4. Preparation of Hanks Balanced salt solution
5. Preparation of Minimal Essential Growth medium

Core XIII

Pharmaceutical Biotechnology and Drug Designing

Credit-3

Course Objectives:

The objective of this course is to make Students understand the basic concepts involved in pharmaceutical industry. The course will give knowledge about new drug development and approval process, ADMET of drugs, about the manufacturing and quality control of conventional, new type of dosage forms and biotechnology derived pharmaceuticals.

Course Outcome:

- Students will gain knowledge about role of different compounds and their activities against human diseases.
- Understand basic concept of drug designing and development.
- Know the principles and production of different pharmaceutical products and their applications

Learning Outcome:

Students will be able to

- Understand the importance of grud design and different techniques of drug design
- Understand the chemistry of drugs with respect to its biological activity
- Know the metabolism, adverse effects and therapeutic value of drugs

Unit I

- Brief introduction to Biotechnology with reference to Pharmaceutical Sciences.
- Enzyme Biotechnology- Methods of enzyme immobilization and applications.
- Biosensors- Working and applications of biosensors in Pharmaceutical Industries.
- Brief introduction to Protein Engineering.
- Use of microbes in industry. Production of Enzymes- General consideration - Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillinase.

Unit II

- Study of cloning vectors (Plasmid-based and Phage-based Vectors), restriction endonucleases and DNA ligase.
- Recombinant DNA technology. Application of genetic engineering in medicine.
- Application of r DNA technology and genetic engineering in the production of: (i)Interferon, (ii)Vaccines- hepatitis- B (iii) Hormones-Insulin.

- Fermentation methods and general requirements, study of media, equipment, sterilization methods, aeration process, stirring.
- Large scale production fermenter design and its various controls.
- Study of the production of - penicillins, citric acid, Vitamin B12, Glutamic acid, Griseofulvin,

Unit III

- Types of immunity- humoral immunity, cellular immunity
- Structure of Immunoglobulins
- Structure and Function of MHC
- Hypersensitivity reactions, Immune stimulation and Immune suppressions.
- General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity.
- Storage conditions and stability of official vaccines
- Hybridoma technology- Production, Purification and Applications
- Blood products and Plasma Substituties.
- Immuno blotting techniques- ELISA, Western blotting, Southern blotting.
- Blood Products: Collection, Processing and Storage of whole human blood, dried human plasma, plasma Substituties.

Unit IV

- History of drug design, Stages of drug discovery and development; Drug properties, likeness; Role of Bioinformatics and Chemo-informatics;Classification of Protein Structures – Primary, Secondary, Super-secondary, Tertiary and Quaternary; Active Sites; Allosteric Sites; Domains; Fold; Motif;
- Structural databases- PDB, PDBSUM, SCOP, CATH; Chemical and Drug Molecule Databases – PubChem, Zinc and DrugBank.
- In silico Structure Prediction - Homology Modeling; Threading; Fold Recognition. Ab initio modeling; Model refinement and validation; Prediction of Binding site; Structure Visualization and Analysis tools.
- Types of Virtual Screening methods; Structure Based Virtual Screening; Ligand Based Virtual Screening, Library design; Concept of pharmacophore mapping and pharmacophore based Screening; Molecular Docking: Rigid and Flexible docking; Analysis of Protein-Ligand interactions.

Text Book:

- ✓ *B.R. Glick and J.J. Pasternak: Molecular Biotechnology: Principles and Applications of RecombinantDNA: ASM Press Washington D.C.*
- ✓ *RA Goldshy et. al., : Kuby Immunology.*
- ✓ *J.W. Goding: Monoclonal Antibodies.*
- ✓ *J.M. Walker and E.B. Gingold: Molecular Biology and Biotechnology by Royal*
- ✓ *Lednicer, D. (1998) "Strategies for Organic Drug Discovery Synthesis and Design"; Wiley International Publishers.*

PRACTICALS

Credit-1

1. Preparation of different methods of medicinal plant extracts.
2. Phytochemical screening of primary and Secondary metabolites.
3. Study the Antibacterial activity of above extract
4. Determine the Total antioxidant activity of above extract
5. Estimation of ascorbic acid in multivitamin formulations.
6. In silico drug designing for specific pathogen
7. Purification of IgG and IgM
8. Homology modelling and domain architecture of specific protein

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Core XIV **Semester VI**

Bio-Entrepreneurship, Biosafety, Bioethics and IPR

Credit-3

Course Objectives:

- The aim of this course is to teach factors influencing to start business and legal, and administrational aid for the entrepreneurial venture,
- To clarify the requisite of Biosafety measures in biotechnological applications in the laboratory and its waste management, registration, national and international regulations, bio- ethical issues in medicine, environment and genetics, related regulations and laws.

Course Outcome:

- Students will learn different aspects of protection of inventions, research developments and publication ethics.
- Gain knowledge of working principles in a laboratory with safety measures, handling of live stocks and disposal of infectious materials.

Learning outcome:

- To enable students with basic concepts of philosophy of science, ethics and IPR
- Learn the process of publications and IP protections and registration under different classifications
- Developing strategies foe handling issues related to ethics and plagiarism

Unit I

- Introduction: Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited)
- Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal. Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.
- Funding of biotech business(Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives) Unit-

- Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities

Unit II

- Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.
- General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.
- Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics;
- Radiation safety and nonradio isotopic procedure; Benefits of transgenics to human health, society and the environment.

Unit III

- Distinction among various forms of IPR, Prior art for a patent, Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals.
- Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

Unit IV

- Introduction to Intellectual Property: importance of IPR – patentable and non patentables. Trade secrets and know-how agreements.
- Utility models: Differences between a utility model and a patent. Types of inventions protected by a patent. Need for a patent. Grant of Patent and Patenting Authorities: Claims.
- Searching a patent, Drafting of a patent, Filing of a patent, Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures.

Text Books:

- ✓ *Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.*
- ✓ *Intellectual property rights and Bio-Technology (Biosafety and Bioethics), Anupam Singh,*
- ✓ *Ashwani Singh, NPH, New Delhi*

- ✓ *Sasson A, Biotechnologies and Development, UNESCO Publications.*
- ✓ *Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi*
- ✓ *Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest,*
- ✓ *Government of India, New Delhi*
- ✓ *Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India, New Delhi*

PRACTICAL

Credit-1

1. Project designing and writing
2. Review the literatures of accepted patents
3. Development of creative ideas for commercialization of technology

Core XV

Computational Biology

Credit-3

Course Objective:

This course aims to develop analytical and mathematical modelling of biological systems. This course introduces students to rapidly evolving field of bioinformatics. It also gives idea about different databases available and their advantages over traditional file system.

Course Outcome:

- To understand the basic Bioinformatics and algorithms used in Computational Biology
- Prediction of secondary and tertiary protein structures
- Evolutionary identification of different species through phylogeny analysis
- Deep knowledge regarding whole genome sequencing and its use to address different diseases.

Learning Outcome:

Students will be able to

- Understand the concept of biological data and different types of networks
- Organize, explore and visualize biological data using networks
- Learn different coding foe biological program languages.

Unit I

Introduction to Genomics, DNA sequencing methods manual& automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.Human Genome Project, Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, Gene Bank, DDBJ; Secondary nucleotide sequence databases, Unigene, Understanding the structure of each source and using it on the web.

Unit II

Proteins and Databases: Protein structure and function, Protein Primary structure, Amino acid residues, Secondary, Tertiary, Quaternary Structure of Protein, Protein sequence databases-SwissProt/ TrEMBL, PIR, Sequence motif databases -Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR,Mass Spectrometry.

Unit III

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Introduction to BLAST, using it on the web, Outline of sequence Assembly, Pairwise Alignments, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Unit IV

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Text Book:

- ✓ *Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.*
- ✓ *Wünschiers, R. (2004). Computational Biology: Unix/Linux, data processing and programming. Springer.*
- ✓ *Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.*

PRACTICALS

Credit-1

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Core XVI **Semester VII**

Medical Biotechnology and Molecular Diagnostics

Credit-3

Course Objective:

This course aims to provide solid background in genetic and molecular bases of diseases and the physiopathological mechanisms occurring in human beings in disease states, in order to develop diagnostics and therapeutic strategies

Course Outcome

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

Learning Outcome:

Students will be able to

- Understand the use of molecular techniques in medical sectors.
- Conduct independent research in respect to drug development, pathology and bioinformatics
- Know the role of epigenetics in medical biotechnology

Unit-I

The Advent of Medical Biotechnology, Biotechnology in Medicine: Fundamentals, Biotechnology in Medicine: Advances,

Unit-II

Analytical Techniques in Medical Biotechnology, Immunology in Medical Biotechnology, Immunology in Medical Biotechnology, Epigenetics and Medical Biotechnology, Stem Cell Technology in Medical Biotechnology

Unit-III

Molecular methods in Clinical Microbiology, Applications of PCR, RFLP, Hybridization (Nucleic acid base) methods, Immunofluorescent, Immune diagnostic test. Enzyme Immunoassay- Enzymes available for Enzyme immune assays and conjugation of enzymes: General Idea. Solid phases used in Enzyme Immunoassays. Homogeneous and Heterogenous Enzyme Immunoassays. Enzyme Immune Histochemical Techniques.

Unit-IV

Use of Monoclonal and Polyclonal Antibodies in Enzyme Immunoassays. Introduction and Principles of Forensic Science and Techniques. Forensic Science Laboratory and its

Organization and Services. Tools and Techniques in Forensic Science. Injury types, methods of assessing various types of death. Principles of DNA Fingerprinting: Role of satellite DNA, Different types of repetitive sequences in Fingerprinting. Application of DNA Fingerprinting in Forensic media.

Text Books

- ✓ *Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. B.B. Nanda and R.K. Tiwari,*
- ✓ *Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).*
- ✓ *S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).*

PRACTICALS

Credit-1

1. PCR and real time PCR
2. Immunofluorescence
3. Testing of anti-microbial agents against pathogenic bacteria

Core XVII

Bio resource Technology and Bio products

Credit-3

Course Objective :

This course aims to cover the use of natural renewable materials derived from plants and animals such as products of food, feed and fiber to produce medicines, chemicals and fuels for energy production.

Course Outcomes:

- Fundamental understanding of the bioresources and its applications for attainment of social objectives (energy, environment, product, sustainability).
- Acquire knowledge with respect to the properties of the bioresources and the conversion technologies.
- Exhibiting knowledge of the systems used for bioresources and bioresource technology.
- Understanding about analysis of data and their applications in design of the systems and development of the bioprocess.

Learning Outcome:

Students will be able to

- Understand the importance of natural bio-resources and their role in creating food security.
- Get an idea of microbial conversion process and different fermentation products.
- Understand the importance of biofuel and different physico-chemical processes.

Unit-1

- Bioresources- natural and anthropogenic; importance of bio-resources and their utilization. Natural bio-resources: agricultural, forestry and aquatic biomass. Biomass availability, production and food security, non- edible biomass characteristics.
- Anthropogenic bio-resources: Organic wastes-domestic and industrial; characteristics of municipal sewage / sludge and industrial sludges.

Unit-2

- Conversion processes: biochemical, thermo-chemical and physico-chemical conversion processes Biochemical processes: Microbial anaerobic and aerobic processes, enzymatic processes; fermentation for alcohols and acids; penicillin and other therapeutic products. Production of single cell protein (SCP); bio-pulping, biogasification.

Unit-3

Thermo-chemical processes: pyrolysis (coke and pyro-oils), oxidation-combustion, gasification (downdraft, updraft and fixed bed gasification, fluidized bed and entrained bed gasification). Various methods of manufacture of activated carbons

Unit-4

Biofuels, biomaterials, specialty chemicals (gylcol, acetic acid and downstream chemicals), anhydrous alcohols-ethanol and butanol; biodiesel, bio-aviation turbine fuel (BATF). Physico-chemical processes: Pretreatment, steam/acid/alkali hydrolysis, effect of temperature on hydrolysis

Text Books:

- ✓ *Tripathi, G., "Bioresource Technology", CBS Publications (2002).*
- ✓ *Pandey, A., "Concise Encyclopaedia of Bioresource Technology", CRC Press (2004).*
- ✓ *Shuler, M., Kargi, F., "Bioprocess Engineering, Basic Concept", Prentice Hall of India Pvt. Ltd. (2004)*

PRACTICALS

Credit-1

- Determination of poly-phenols from plant products
- Determinations of starch, carbohydrates
- Estimation of reducing sugar by dinitrosalicylic acid (DNS) method

Core XVIII

Ethno pharmacology

Credit-3

Course Objective:

This course aims to discover natural remedies such as effective drugs based on the therapeutic use of plants. This will provide students idea about innovative approch of plant based drug discovery.

Course Outcome:

- Appreciate the need to conserve floristic and cultural diversity of the region.
- Rescue and document Ethnomedicine for sustainable use of plant resources.
- Understand the need for development of new drugs for safe and more rational use of herbal preparations.
- Develop laboratory skill in testing of herbal drugs and new commercial products.

Learning Outcome:

- Students will be able to
- Understand the relation between pharmacology and traditional medicine.
- Get in depth idea regarding use of medicinal plants in cultures, their documentation and drug discovery.
- Understand the Ethnopharmacology and IPR issue.

Unit I

- Introduction, scope and relevance. Brief account of Phytochemistry, pharmacodynamics and pharmacokinetics. Difference between herbal/botanicals and pharmaceutical medicine.

- Classification and sources of crude drugs. Quality, safety and efficacy of herbal medicines/ neutraceuticals. Role of ethnopharmacology in drug development.

Unit II

Basic definition and types of toxicology, Regulatory guidelines for conducting toxicity studies as per OECD, Alternative methods to animal toxicity testing. Biopiracy, Intellectual Property Rights (IPR). Ethnopharmacology and IPR issue. Integrated drug development programme, technology transfer and commercialization of Traditional medicine.

Unit III

Biological screening of herbal drugs- introduction and need for phytopharmacological screening. In vitro Screening methods used for herbal drugs: Antimicrobial screening of herbal drugs, Screening for anticancer activity, Screening for antioxidant activity, Screening for antiurolythetic activity.

Unit IV

In vivo Screening methods used for herbal drugs: Screening for anti-inflammation and analgesic activity, Screening for antiulcer activity, Screening for antidiuretic activity, Screening for liver related disorders. Database on pharmaceutical uses of plants.

Text Books:

- ✓ *Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009*
- ✓ *Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi*
- ✓ *Medical Pharmacology, PadmajaUdaykumar. Sixth Edition, CBS Publishers & Distributors Pvt Ltd*

PRACTICALS

Credit-1

1. Patent Searching of herbal molecules.
2. Testing of Antimicrobial activity of herbal drug of by disc diffusion method.
3. Estimation of antioxidant activity of herbal drug.
4. Testing of cytotoxicity of herbal drug

Core XIX

Agricultural Biotechnology

Course Objectives:

On taking this course the student will be able to manage sustainable exploitation of plant and microbial resources in an environmentally sensitive manner and also the emerging concepts in agro-biotechnology.

Course Outcomes:

At the end of the Course, the Student will be able to:

- Discuss crop improvement hybridization and plant breeding techniques
- Molecular and biological mechanism of palnt resistance to abotic and biotic stress
- Demonstrate in vitro production of disease-free plants and the molecular basis of plant resistance to various abiotic stresses

Learning Outcome:

Students will be able to

- Illustrate the plant growth promoting microorganisms and phosphate solubilizing bacteria.
- Describe the impact of transgenic plants in agriculture and Horticulture and produce transgenic plants for fungal, bacterial and viral disease resistance.
- Get idea about the microorganisms promoting plant growth.

Unit I

Introduction: Scope and application of agriculture. Crop improvement hybridization and plant breeding techniques. Clonal Germplasm: Micro propagation, In vitro production of disease free plants; Seed pathology.

Unit II

Plant Resistance: Molecular and biochemical basis of plant disease resistance, Molecular basis of plant resistance to various abiotic stresses like drought, salinity, heavy metals, high temperature. Methods for crop improvement for resistance to biotic and abiotic stress.

Unit III

Plant growth promoting microorganisms: Plant Growth promotingbacteria: Nitrogen fixation-and nodulation genes. Biochemistry of nitrogen fixation, Nif genes. Biofertilizers: Azolla and Anabena, Rhizobium, Phosphate solubilizing bacteria. Biopesticide – Trichodermaand Bt

Unit IV

- Applications: Commercial production of Transgenic crops- Impact of transgenic plants in agriculture and Horticulture. Production of transgenic plants for fungal, bacterial and viral disease resistance; herbicide resistance, drought and other abiotic stress resistance.

- Bioethical issue on GM crops. Biosafety norms and controlledfield trials and release of transgenics (GMO). Plant Variety ProtectionAct: TRIPS and WTO. Regulatory issues of biotechnology improvedplants.

Text Books:

- ✓ Nirmala C.B, Rajalakshmi. G and Karthik. C (2009). Plant Biotechnology (1st ed.). MJP Publishers. ISBN-13: 978-8180940378
- ✓ Kumar HD. (2016). Agricultural Biotechnology, New Delhi. Daya Publishing house. ISBN 9788170354123
- ✓ Joshi Rajmohan. (2006). Agricultural Biotechnology, Isha Books. ISBN 10: 8182053803ISBN 13: 9788182053809
- ✓ REFERENCE BOOKS: 1. Ahindra Nag. (2008). Text book of Agricultural Biotechnology, New Delhi.PHI Learning Private Limited. ISBN : 9788120335929
- ✓ Arie Altman, Rita Colwell.R.(2001).Agricultural Biotechnology, New York. Marcel Dekker. ISBN 13: 9780824794392

PRACTICALS

1. Laboratory set-up. Preparation of nutrient media
2. Handling and sterilization of plant material
3. Inoculation, subculturing and plant regeneration.
4. Suspension cultures and production of secondary metabolites.
5. Protoplast isolation, culture and fusion.
6. Gene cloning and vector construction.
7. Isolation of plasmids with reporter gene.
8. Leaf disc transformation using Agrobacterium and establishment of transgenic plants.

Core XX

Semester-VIII

Cancer Biology and Stem Cell Therapy

Credit-3

Course Objective:
This course aims to develop better understanding of cancer biology and molecular mechanisms underlying the initiation and progression of neoplastic growth along with in-depth knowledge aboutStem cell differentiation processes and biology for cancer treatments.

Course Outcome

- To study about tumor, oncogenes, signals, diagnosis and treatment of Cancer.
- Study about the origin and sources of stem cells and study the different signaling pathways involved in cancer stem cell signaling
- Study the uses of stem cell for human benefits

Learning Outcome:
Students will be able to:

- Learn the basic of cancer biology and disease progression.
- Get an idea of carcinogens and their role in initiation of different types of cancers
- Learn molecular diagnostics and available treatments for cancer
- Study the importance of stem cells and their role in cancer treatment.

Unit 1: Fundamentals of Cancer Biology
Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. Cancer screening and early detection, Detection using biochemical assays, tumour markers, molecular tools for early diagnosis of cancer. PRINCIPLES OF CARCINOGENESIS: Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, X –ray radiation - mechanisms of radiation carcinogenesis.

Unit 2: Principles of Molecular Cell Biology Of Cancer
Signal targets and cancer, activation of kinases, Oncogenes, Identification of oncogenes, retroviruses and oncogenes, Oncogenes/proto oncogene activity. Growth factors related to transformation, telomerases.

Unit 3: Principles of Cancer Metastasis
Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

Unit 4
Stem cells-Introduction Definition and basics of stem cells, Classification of stem cells – different types of stem cells human embryonic stem cells, adult stem cells, Sources of Stem

cells Fetus and various adult tissues, Hematopoietic stem cells(HSC) basics, Development and Regulation of HSC, Clinical application of HSC gene therapy- using haematopoietic stem cells HSC for leukemia, Tumor stem cells- basics, Differences and similarities of cancer stem cells and stem cells, Cancer stem cell signaling NOTCH pathway, Stem cell therapies in animal models and human cancers.

Text Books:

- ✓ "*An Introduction To Cellular and Molecular Biology of Cancer", Oxford Medocal Publications, 1991*.
- ✓ *Ruddon.R.W.,Cancer Biology, Oxford University Press, Oxford, 1995*
- ✓ *Hand Book of stem cells, Robert Lanza*
- ✓ *King R.J.B., Cancer Biology, Addision Wesley Longmann Ltd, U.K., 1996*

PRACTICALS

Credit-1

1. Learning different stages of cancer progression
2. Difference between benign and malignant tumors
3. Learning about different types of cancers

Core XXI

Review Methodology and Communication Skills

Credit-3

Course Objective:

The objective of this course is to introduce undergraduate students to the different aspects of professional science communication including written and oral communication, and publication ethics in research.

Course Outcome:

- Students will gain knowledge about reading research articles and developing creative ideas.
- This course will help to develop scientific article writing skill which will be helpful to publish their work in peer reviewed journals
- Student will develop knowledge for arranging of figures and graphs according to journal requirements

Learning Outcome:

Students will be able to

- Understand how scientific evidence is evaluated and communicated.
- Gain knowledge about technical writing and critique original research through a multistep framework,
- Assessed their own writing
- Feel confident in their writing abilities.

Unit-I

Explain the various types of scientific writing: Papers, Reviews Short communications, articles for newspapers, popular science writing, chapters in a text book etc. b) Discuss in detail the structure of a science paper using different journals in your subject. The students are asked to (i) list what all points are included in introduction and in discussion; (ii) Extract relevant method and tabulate it / determine the underlying principle. Preferably select papers of a more descriptive nature.

Unit-II

Writing: start with creating a title, write an abstract, introduction, material and methods and discussion, the rules for: text, figures, tables, graphs etc. for e.g. punctuation, location legends, arrangement of references

Unit-III

Explanation related to making poster presentations and discussion of its positive and negative aspects. How to address the questions after each presentation Session. How to make seminar presentation, preparation of slides and discussion.

Unit-IV

Writing of review papers, collection of different articles for review paper, preparation of pie charts and phylogeny tree

Text Book:

- ✓ *Effective Science Communication (Second Edition): A practical guide to surviving as a scientist.Sam Illingworth, Grant Allen. May 2020.*

PRACTICALS

Credit-1

1. Searching, reading and understanding of different research papers available
2. Writing of review paper
3. Presentation of scientific paper and discussion

Core XXII

Food Science and Food Biotechnology

Credit 3

Course Objectives:

To study the importance microorganisms in food preservation

Learning Objectives*:*

On taking this course the student will be able to understand the basic concepts of food industry and also to establish an ecological balance to prevent soil fertility or pest problems.

Course Outcomes: At the end of the Course, the Student will be able to:

- Discover the role of biotechnology in food processing industries.
- Evaluate the molecular diagnostic techniques pertaining to identification of food adulterants.
- Assess the safety aspects and social issues related to applications and implications of genetically modified foods.

UNIT I: Introduction to Food And Nutrition

- Basic terms used in study of food and nutrition, BMI and Nutritional Status, Understanding relationship between food, nutrition and health.
- Functions of food-physiological, psychological and social, Concept of Balanced Diet, Food Groups, Food Pyramid
- Classification, digestion, functions, dietary sources, RDA, clinical manifestations of deficiency and excess and factors affecting absorption of the following in brief: Energy ; Carbohydrates, lipids and proteins; Fat soluble vitamins-A, D, E and K; Water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C ; Minerals – calcium, iron, iodine, fluorine, copper and zinc

Unit-II

- Microorganisms associated with food - bacteria, fungi & yeast. Enzymes in food preparation. Food contaminations. Food preservation. Food carcinogens & mutagen (N–nitrosamines, Acrylamide & their mode of action).
- Food borne diseases. Food Allergens. Antioxidants. Food colors (natural & artificial food colourants). Food flavoring agents. Properties & function of Emulsifiers & Stabilizers in food. Food Sweeteners – Saccharine, Acesulfane, Aspartame &Sucrolose).Pathogenic microbes – infections; bacterial toxins and mycotoxins sources, physiological effects; methods of prevention and control in foods and feeds.

Unit-III

- Principles of food biotechnology: Basic principles and application of biotechnology in food industries with regard to production, processing regulatory aspect of modern biotechnology application in food industry in the context of environment protection of human and animals. Application of biotechnology in waste treatment of food industries.

- Industrial production of food products: Technological aspects of industrial production of beer and wine, lactic acid, baker's yeast, single cell protein- Bacteriocin production and its use in food preservation Biotechnological approaches to improve nutritional qualities and shelf life of fruits and vegetables by gene modification.

Unit-IV

- Food adulterants & molecular diagnostic tools: Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, general aspects of biosensors- biosensors for food contaminant analysis, commercially available biosensors for food analysis.

- Food safety and ethical issues: Risk associated with GM foods – Allergens, toxins, antibiotic resistance, soil contamination - Creation of superbugs and super weeds - Increased risk of immune suppression and cancer- GMOs- current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects.

Text Book:

- ✓ *Bamji MS, Krishnaswamy K, Brahmam GNV (2009). Textbook of Human Nutrition, 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd.*

- ✓ *Foster, G.N., (2020), Food Biotechnology, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348*

- ✓ *Wardlaw MG, Paul M Insel Mosby 1996). Perspectives in Nutrition, Third Edition.*

- ✓ *RavishankarRai, V,(2015), Advances in Food Biotechnology, (First edition), John Wiley &Sons, Inc, ISBN 9781118864555.*

- ✓ *Joshi, V.K. and Singh, R.S., A. (2013), Food Biotechnology- Principles and practices,I.K.International Publishing House Pvt. Ltd., New Delhi,*

Suggested Readings

- ✓ *Anthony Pometto, KalidasShetty, GopinadhanPaliyath, Robert E. Levin(2005), Food Biotechnology, (2 nd edition), CRC Press, ISBN 9780824753290*

- ✓ *Perry Johnson-Green.(2018), Introduction to Food Biotechnology, Special Indian Edition, CRC Press, ISBN 9781315275703.*

- ✓ *Srilakshmi (2007). Food Science, 4th Edition. New Age International Ltd.*

- ✓ *Introduction to Human Nutrition ed.Gibney et al, Blackwell Publishers, 2005*
- ✓ *Khanna K, Gupta S, Seth R, Mahna R, Rekhi T (2004). The Art and Science of Cooking: APractical Manual, Revised Edition. Elite Publishing House Pvt Ltd.*

PRACTICAL

1. Identification of food sources for various nutrients using food composition tables.
2. Estimation of ascorbic acid and effect of heat treatment on it.
3. Estimation of reducing and non-reducing sugars using potassium ferricyanide method.
4. Estimation of chlorophyll content of green vegetable

Core XIII

Nano biotechnology

Credit-3

Course Objective:

This course aims to provide scitific understanding of application of nanomaterials and technology in agriculture, health and environment. It expoits the unique characteristics of nano-size particles to create new substances for human welfare.

Course Outcome:

Students will be able to

- Understand fundamental concepts of physics which are necessary for nanoscience and technology
- Apply the gained subject knowledge to understand the nano-enabled devices
- Evaluate microscopic scales with macroscopic Impact with the help of Physics.
- Analyse the acquired knowledge and understanding on real time applications of physics

Learning Outcome:

Students will able to

- Apply principles of basic science in understanding and prediction of matter at Nanoscale
- Get advanced ideas in emergent area of nanotechnology
- Understand the principles of quantum mechanics for understanding the nano systems**.**

Unit I

- Basics of Nanotechnology History of nanotechnology, origins of nanotechnology, beyond Moore's Law. Definitions and scales, size scale effects (effects in optical, electrical and thermal properties). Current state of Nanotechnology, future of Nanotechnology. Nanotechnology in Nature and applications. Tools of trade – seeing the Nano scale, nature of light, electron microscope, scanning probe microscope in seeing the nano scale.

- Molecular building blocks for nanostructure systems, Nanomaterials – formation of materials, carbon nanomaterials, Buckyball, Graphene (2D), Carbon nano tubes, Inorganic nano materials, ZeroDimensional Nano-Structures, One Dimensional Structures, Two Dimensional and three dimensional Structures.

Unit II：Nanomaterials Synthesis

- Colloidal nano-precipitation Sol-gel processing, Solvothermal, hydrothermal, coprecipitation, Spray pyrolysis, sonochemical method, Electro spraying and spin coating routes, Self-assembly, self-assembled monolayers, gas phase synthesis. Langmuir-Blodgett (LB) films, micro emulsion polymerization- templated synthesis.
- Synthesis of biological nanoparticles Synthesis of nucleic acid (DNA & RNA), protein and viral nanoparticles and their applications. Applications of inorganic nanomaterials in biology-examples: silver and gold nanoparticles.
- Biological Methods Use of natural plants for synthesis of nanoparticles- synthesis of metal nanoparticles using phytochemicals. Materials and fabrication of nanoparticles for drug delivery, Nanoencapsulation for Drug Delivery, Encapsulation Methods.

Unit-3 : Characterization of Nanomaterials

Nanostructured Materials Characterization Techniques Surface Plasmon Resonance Spectroscopy, X-ray diffraction (XRD), SEM, EDAX,TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Nanomechanical Characterization using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), Scanning Probe Microscopy (SPM), Electrochemcial Characterization measurements, Dynamic Light Scattering, Zeta (potential).

Unit-4 : Applications of Nanomaterials

- Therapeutic Applications Concept of nanomedicine, nanoparticles for controlled drug delivery, general requirements for use of nanoparticles, magnetic nanoparticles for targeting cancer cells.New designs and applications for therapeutic nanoparticles and nanocapsules.
- Therapeutic application in infectious diseases, degenerative and autoimmune diseases. Nanoparticles for delivery of drugs, targeted drug delivery, advantages. Ocular applications of nanocarrier drug delivery. Nanoparticle drug delivery for neuro-inflammatory diseases, nanoparticle delivery for cancer therapy, nanoparticle delivery of natural product therapies.

Text Books

- ✓ Synthesis, Properties, and Applications of Oxide Nanomaterials, edited by José A. Rodriguez,MarcosFernández-García
- ✓ Nanochemistry: A Chemical Approach to Nanomaterials, By Geoffrey A. Ozin, André C.Arsenault, LudovicoCademartiri
- ✓ Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers. Daniel L.Schodek, Paulo Ferreira, Michael F. Ashby
- ✓ Nanomaterial Interfaces in Biology: Methods and Protocols, Paolo Bergese, Kimberly Hamad- Schifferli
- ✓ Optical Properties and Spectroscopy of Nanomaterials, Jin Z. Zhang

PRACTICALS

Credit-1

Synthesis of nano particles and its characterization