With effect from the Academic Year 2020-21

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of V Semester of B.Tech Bio-Technology as per AICTE Model Curriculum 2020-21

B.Tech (Bio-Technology)

SEMESTER V

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	18BT C15	Fluid Mechanics and Heat Transfer	3	-	-	3	30	70	3
2	18BT C16	Enzyme Technology	3	-	-	3	30	70	3
3	18BT C17	Genetic Engineering and rDNA Technology	3	-	-	3	30	70	3
4		**Core Elective I**	3	-	-	3	30	70	3
5		**Core Elective II**	3	-	-	3	30	70	3
6	18MB C01	Engineering Economics and Accountancy	3	-	-	3	30	70	3
	PRACTICALS								
7	18BT C18	Fluid Mechanics and Heat Transfer Lab	-	-	2	2	15	35	1
8	18BT C19	Enzyme Technology Lab	-	-	2	2	15	35	1
9	18BT C20	Genetic Engineering Lab	-	-	2	2	15	35	1
Total			**18**	**-**	**6**	**-**	**225**	**525**	**21**
Clock Hours Per Week -24									

L: Lecture T: Tutorial P: Practical
CIE – Continuous Internal Evaluation SEE - Semester End Examination

CORE ELECTIVE-I	
18BT E01	Virology
18BT E02	Phytochemicals and Herbal Products
18BT E03	Introduction to Anatomy and Physiology of Humans

CORE ELECTIVE-II	
18BT E04	Environmental Biotechnology
18BT E05	Developmental Biology
18BT E06	Metabolic Engineering

18BT C15

FLUID MECHANICS AND HEAT TRANSFER

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. This course aims at providing knowledge on basic concepts in flow of fluids, flow field, flow past immersed bodies.
2. The course is designed to give an understanding on measurement of viscosity, flow measuring devices.
3. The course also deals with basic concepts in heat transfer, evaporation and condensation.

Course Outcomes:

At the end of the course students will be able to

1. Measure the viscosity of different fluids in bio processing.
2. Derive a relation between pressure drop and viscosity.
3. Compare and contrast the merits and demerits of different flow measuring devices.
4. Explain the concepts of heat transfer with and without phase change.
5. Calculate the heat transfer area, overall heat transfer co-efficient required for various processes and explain the operation of various evaporators, condensers and heat exchange equipment.

UNIT-I

Basic Concepts in Flow of Fluids: Introduction, Nature of fluid, Rheology of fluids -Newton's law of viscosity; Concept of Newtonian and non-Newtonian fluids-Different types of non-Newtonian fluids with examples in bioprocessing; Measurement of viscosity using extrusion rheometer, plate and cone viscometer, coaxial cylinder viscometer etc.

UNIT-II

Flow Field: Friction losses in laminar flow through a circular tube (Hagen-Poiseuille equation), Friction losses in turbulent flow (Fanning equation), Pumping of fluids flow through pipes, average velocity, flow regimes, boundary layer concept. Laminar and turbulent flow -characterization by Reynold's number, pressure drop due to skin friction and form friction, friction factor chart, Hagen - Poiseuille equation.

UNIT-III

Flow Past Immersed Bodies: Definition of drag and drag coefficient; Friction in flow through beds of solids; Brief introduction to flow of compressible fluids; Flow measuring and monitoring systems- valves, bends, elbows, prevention of leaks, mechanical seals, stuffing box; Flow measuring devices-manometers, orifice-meter, venturimeter and rotameter; Brief description of Pumps and Blowers.

UNIT-IV

Basic Concepts in Heat Transfer: Introduction and Mechanisms of heat transfer; Conduction heat transfer (through slab, cylinder & Sphere); Conduction through solids in series, Forced convection heat transfer inside pipes, Introduction to radiation heat transfer, Chilling and freezing of food and Biological materials; Heat transfer correlations and calculations, basic heat exchange equipment.

UNIT-V

Basic Concepts in Evaporation and Condensation: Introduction, Types of evaporation equipment and operation methods; Overall heat transfer coefficients in evaporators; simple material balances; Calculation methods for single effect evaporators, Evaporation of biological materials; Types of condensation, numerical problems and condensation equipment.

Text books:

1. W L McCabe and JC Smith, "Unit operations in Chemical Engineering", 6th edition, cGraw Hill Intl. Ed, 2005.
2. Christie J. Geankoplis, "Transport Processes and Unit Operations", 3rd edition, Prentice Hall India Pvt. Ltd. 1993

Suggested Reading:

1. Kothandaraman CP, Rudramoorthy R, "Basic Fluid Mechanics", New Age International Publishers, New Delhi,1998.
2. Sachdeva RC, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.

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18BT C16

ENZYME TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To learn about basic aspects of enzymes.
2. To understand the catalytic strategies and mechanism of enzyme action.
3. To learn the role of enzyme kinetics and its action.
4. To understand the methods of enzyme immobilization
5. To study about mass transfer kinetics of immobilized enzymes.

Course Outcomes:

At the end of the course students will be able to

1. Discuss the nomenclature and classification, properties, isolation and purification of enzymes.
2. Describe the catalytic strategies and mechanism of enzyme action
3. Explain the kinetics of enzyme action and inhibition.
4. Compare various enzyme immobilization techniques and analyze the mass transfer effects in immobilized enzyme systems.
5. Outline the applications of enzymes in different fields.

UNIT-I

Introduction to Enzymes: Enzyme, coenzymes, cofactor; general properties of enzymes; Classification of enzymes, Enzyme nomenclature; Factors affecting the rates of chemical reactions - Collision theory, transition state theory, Mechanism of catalysis; isolation and purification of crude enzyme extracts from plant, animal and microbial sources; Development of enzymatic assays.

UNIT-II

Catalytic strategies and Mechanisms of Enzyme Action: Catalytic strategies – Lysozyme, Ribonuclease A, Caraboxypeptidase A, chymotrypsin; Mechanisms of enzyme action; Concept of active site and energetics of enzyme substrate complex formation; Specificity of enzyme action.

UNIT-III

Kinetics of Enzyme Action and Enzyme Inhibition: Kinetics of single substrate reactions; Turn over number; Derivation of Michaelis -Menten equation; Kinetics of Multi-substrate reaction ; Types of Enzyme Inhibition - Reversible inhibition and Irreversible inhibition ; Allosteric enzymes.

UNIT-IV

Enzyme Immobilization and Mass Transfer Effects in Immobilized Enzyme Systems: Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding; Overview of applications of immobilized enzyme systems; Analysis of Film and pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors.

UNIT-V

Applications of Enzymes: Applications of commercial enzymes; Proteases; Amylases; Lipases; Cellulases; Pectinases; Isomerases in food, pharmaceutical and other industries; Enzymes for analytical and diagnostic purposes; Design of enzyme electrodes and their application as biosensors in industry, health care and environment.

Text Books:

1. Trevor Palmer, Philip Bonner, "Enzymes", 2nd edition, Woodhead Publishing, 2007.
2. Andreas S. Bommarius, Bettina R. Riebel, "Biocatalysis - Fundamentals and Applications", Wiley-VCH, 2004.

Suggested books:

1. Shanmugan, S., "Enzyme technology" I. K. International Pvt Ltd, 2009.
2. Voet and Voet J.G, "Biochemistry", 4nd edition, John C.Wiley and Sons, 2010.

18BT C17

GENETIC ENGINEERING AND rDNA TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To provide theoretical concepts, basic principles and tools used in rDNA technology.
2. To learn essential features and various vectors used in gene cloning and rDNA technology.
3. To learn the principle, methodology and applications of PCR and molecular markers.
4. To learn the range of cloning strategies those are employed to clone a DNA sequence.
5. To know how rDNA technology is used to produce proteins.

Course Outcomes:

At the end of the course, students will be able to

1. Explain the basic principles and tools used in rDNA research starting from the isolation of nucleic acid, enzymes etc.
2. Compare various types of cloning vectors and expression vectors and their use in rDNA technology.
3. Discuss the principle, types and applications of PCR and molecular markers.
4. Describe the cloning strategies and sequencing methods.
5. Summarize the high-level expression of proteins in different hosts and production of recombinant proteins for the human welfare

UNIT-I

Isolation and Purification of DNA and Enzymes Used in Cloning: Isolation and purification of DNA; Host controlled restriction and modifications; Enzymes used in cloning - Restriction endonuclease, Polymerases, Ligase, Phosphatase, Kinase, Nuclease; Restriction mapping; Blotting techniques – Southern, Northern and Western Blotting.

UNIT-II

Cloning Vehicles: Essential features of cloning vectors; Cloning vectors - Plasmid vectors - pBR 322, pUC 18/19; Phage vectors – λZAP, λEMBL4; M13 derived vectors –M13mp18; Phagemid- Blue script vectors; Cosmid- pJB8; Artificial chromosomes - BAC, YAC; Expression vectors - pET vectors.

UNIT-III

Polymerase Chain Reaction and Molecular Markers: PCR – Principle, Designing of primers, PCR Methodology, RT-PCR, Multiplex PCR, PCR for site-directed mutagenesis, Applications of PCR; Molecular marker – RFLP, RAPD, AFLP.

UNIT-IV

Cloning Strategies and DNA sequencing: Construction of genomic and cDNA libraries; the Basic concept of blunt end and cohesive end ligation, homopolymer tailing, use of linkers, adaptors; Introduction of cloned genes into hosts- Transformation, Transfection, packaging phage DNA *In vitro*; Detection of clones with the desired gene; Methods of gene sequencing: - Maxam and Gilbert method, Sanger's dideoxy chain termination method, Pyrosequencing, automation of DNA sequencing.

UNIT-V

Expression of Recombinant Proteins and Applications of rDNA Technology: High-level expression of proteins in different host systems in *E. coli*, yeast, insect and mammalian cells; Applications of Gene cloning and rDNA Technology - Recombinant Insulin, Recombinant Factor VIII, Golden rice. Introduction to Gene therapy (*Ex vivo* & *In vivo*), case study of ADA as an example. Safety guidelines for rDNA research.

Text Books:

1. Brown, T.A., "Gene Cloning and DNA Analysis: An Introduction", 7th edition. Wiley Blackwell, A John Wiley & Son Ltd publications, UK, 2015.
2. Primrose, S.B., Twyman, R.M., "Principles of Gene manipulation and Genomics", 7thedition, John Wiley & Sons, 2013.
3. Glick, B.R., Pasternak, J.J., Patten, C.L,, "Molecular Biotechnology: Principles and applications of Recombinant DNA", 4th edition, ASM Press,2010.

Suggested Reading:

1. Desmond S T Nicholl, "An Introduction to Genetic Engineering", 3rd edition, Cambridge End Press, 2008.
2. Richard J. Reece, "Analysis of Genes and Genomes", Wiley, 2004.

18BT E01

VIROLOGY
(Core Elective - I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

Students are made to understand the following concepts during their course of time:

1. To learn the morphology and genetics of viruses.
2. To recognize the procedures for cultivation of plant & animal viruses.
3. To be aware of the characterization of viruses.
4. To elaborate the detailed features of plant viruses and bacteriophages.
5. To learn the life cycles of animal viruses and development of vaccines.

Course outcomes:

By the end of the course the students are able to

1. Explain classification, morphology, and disease prevention measures of viruses.
2. Compare the techniques for cultivation of plant & animal viruses.
3. Outline various characterization techniques for detection of viruses.
4. Illustrate the structural, functional and disease control measures of plant viruses.
5. Describe the classification, pathogenesis of animal viruses and therapeutic strategy for vaccine development.

UNIT-I

Introduction to Virology: Brief outline of discovery of Viruses; Properties of Viruses; Morphology of Viruses- Structure, Capsid Architecture, Envelopes and peplomers; Chemistry of Viruses- Viral Proteins, Genome- Structure and Types; Study of sub viral agents- Brief account on Diseases caused by Viroids- PSTV, Cadang-cadang; Prions- Scrape, Creutzfeldt-jakob; Satellite viruses.

UNIT-II

Cultivation of Viruses I: General methods of cultivation of viruses- in embryonated eggs, cultivation of animal and plant viruses; cultivation of bacteriophages, Isolation and purification of viruses- plant viruses, animal viruses; Criteria of purity, Maintenance and preservation of infectivity; Characterization of viruses- Electron microscopy, X-ray crystallography, sedimentation analysis.

UNIT-III

Characterization of Viruses II: Enumeration of viruses- By electron microscopy, plaque assay, acid end point method, Haemagglutinin assay; Detection of viruses-By serological characterization, detection of viral antigen, detection of viral nucleic acid; chemical determination, Ultra structure and life cycles of Bacteriophages- Ml3, T4 and lambda.

UNIT-IV

Plant Viruses: Taxonomy; Symptoms of diseases caused by plant viruses (Morphological, Physiological and Histological); Ultra structure and life cycles of TMV; transmission of plant viruses- Mechanical and biological (vector and non-vector); Basic control measures of plant diseases- vector and chemical control, biopesticides with examples.

UNIT-V

Animal viruses: Taxonomy; Detailed structure and brief account on life cycles of RNA viruses- Polio, Influenza, Rota virus and HIV; Ultra structure and brief account on life cycles of DNA viruses- Vaccina, SV40 and Hepatitis Virus; Viral vaccines-types and preparation of conventional vaccines.

Text Books:

1. Dimmock NJ and Primrose SB, "Introduction to Modern Virology", 4th edition, Blackwell Scientific Publications, 1994.
2. Matthews REF "Fundamentals of Plant Virology". Academic Press, San Diego, 1992.

Suggested books:

1. Carter J and Saunders V "Virology: Principles and Applications" John Wiley and Sons ltd, 2007.
2. Morag C, Timbury M, Chrchill Livingstone, "Medical Virology", London, 1994.

18BT E02

PHYTOCHEMICALS AND HERBAL PRODUCTS
(Core Elective - I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

1. To impart knowledge on medicinal plants and extraction of crude drugs.
2. To provide a comprehensive knowledge on detection, extraction and analysis of phytochemicals and adulterants.
3. To impart knowledge on the applications of various phytochemicals and herbal products.
4. To impart theoretical knowledge on various aspects of standard procedures for extracting herbal products

Course outcomes:

At the end of the course the students are able to

1. List the classification and pertinent utilization of important crude drugs.
2. Outline the evaluation and estimation procedures of crude drugs and adulterants.
3. Classify various types and extraction procedures of different plant secondary products.
4. Categorize the applications of phytochemicals.
5. Evaluate the precise extract preparations of herbal products and its licensing issues.

UNIT-I

Crude Drugs, Medicinal and Aromatic Plants: Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Collection and processing of Crude Drugs; Utilization of Medicinal and Aromatic Plants in India; Genetics as applied to Medicinal herbs; Biogenesis of Phytopharmaceuticals.

UNIT-II

Analysis of Phytochemicals: Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical); Preliminary screening, Assay of Drugs - Biological evaluation / assays, Microbiological methods, Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations; Drug adulteration - Types of adulterants.

UNIT-III

Types of Phytochemicals: Carbohydrates and its derived products- Structures, types and extraction methods : Glycosides - Digitalis, Aloe, Dioscorea; Volatile Oils - Clove, Pippermint Oil; Alkaloids - Taxus, Cinchona; Flavonoids-and Resins; Tannins (Hydrolysable and Condensed types).

UNIT-IV

Applications of Phytochemicals: Application of phytochemicals in industry and healthcare; Biocides, Bio-fungicides, Biopesticides.

UNIT-V

Herbal Products: History, Scope, and Current aspects of herbs and herbal medicines; Preparation of standardized extracts of Garcinea, Forskolin, Garlic, Turmeric and Capsicum, issues of licensing of herbal drugs.

Text books:

1. Kokate CK, Purohit AP and Gokhale SB, "Pharmacognosy", 4th edition, Nirali Prakashan, 1996.
2. Trease and Evans WC Evans, " Pharmacognosy" , 14th edition, Harcourt Brace & Company. 1989.
3. Hornok L, "Cultivation & Processing of Medicinal Plants" Chichister, U. K: J. Wiley & Sons.1992.

Suggested Reading:

1. Natural Products in medicine: A Biosynthetic approach Wiley. 1997.
2. Chaudhri RD, "Herbal Drugs industry, A practical approach to Industrial Pharmacognosy" Eastern publishers, 2nd reprint, New Delhi. 1999.

18BT E03

INTRODUCTION TO ANATOMY AND PHYSIOLOGY OF HUMANS
(Core Elective - I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. To give an overview to students about human body tissues and endocrine system.
2. To provide knowledge on various organs associated with digestion and excretion.
3. Heart structure and functioning is detailed, including the gaseous exchange occurring through the respiratory system.
4. Knowledge of Spinal cord, the associated nerves and the different sense organs are imparted.
5. To impart knowledge about human reproductive physiology.

Course Outcomes:
At the end of the course the students are able to
1. Outline the structure of the Human body, structure & function of endocrine glands.
2. Discuss the anatomical structures and the physiological functions of Skeletal, digestive and excretory systems.
3. Explain the anatomical structures and the physiological functions of circulatory and respiratory system.
4. Describe the anatomical structures and the physiological functions of nervous system and other sensory systems.
5. Discuss the anatomical structures and the physiological functions of reproductive system and physiology of blood.

UNIT-I
Introduction to Anatomical Terms and Endocrine Glands: Definition of Anatomy and Physiology; Major types of human tissues. Various systems of human body and their general roles; Homeostasis; Types of endocrine glands- anatomy and physiological of pituitary, thyroid, pancreas

UNIT-II
Anatomy and Physiology of Skeletal, Digestive and Excretory Systems: Structure and function of bones and muscles Digestive system- organs and functions; role of liver and pancreas, Excretory system-kidney and urinary bladder; physiology of excretory system- urine formation

UNIT- III
Anatomy and Physiology of Circulatory and Respiratory Systems: Circulatory system- anatomy of heart, heartbeat, blood circulation Anatomy of blood vessels- arteries and veins. Respiratory system-anatomy of lungs and mechanism of respiration

UNIT-IV
Anatomy and Physiology of Nervous System and Other Sensory Systems: Nervous system- peripheral and autonomous nervous system; Spinal nerves and Cranial nerves, transmission of nerve impulse, reflex arc. Special senses- eye, ear, tongue and nose

UNIT-V
Anatomy and Physiology of Reproductive System And Blood Physiology: Mechanism of blood oxygenation, Blood pressure recording and regulating techniques, Reproductive system- male and female reproductive organs and physiology. Menstrual cycle

Text Books:

1. Shier, David, Butler, Jackie, Lewis, Ricki., "Hole's Human Anatomy & Physiology", 13th edition, McGrawHill 2017.
2. Eric Widmaier, Hershel Raff, Kevin "Vander's Human Physiology: The Mechanisms of Body Function" McGraw-Hill Science/Engineering/Math; 13th edition2013.
3. Anthony A. Goodman –"Understanding the Human Body_ An Introduction to Anatomy and Physiology"-The Teaching Company (2004)

Suggested Reading:

1. Elaine N. Marieb "Essentials of Human Anatomy and Physiology", 8thEdition, Pearson Education, NewDelhi 2006
2. Charles E. Tobin, "Basic Human Anatomy", McGraw Hill, 1980.

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18BT E04

ENVIRONMENTAL BIOTECHNOLOGY
(Core Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

The course aims

1. To provide theoretical concepts and a comprehensive knowledge on bioremediation methods.
2. To provide knowledge on metal leaching and non-conventional fuels production.
3. To impart theoretical basics on various methods used in treatment of waste water.
4. To provide knowledge on degradation of Xenobiotic compounds.
5. To update the students with the available information on biotechnological applications in hazardous waste management.

Course Outcomes:

At the end of the course students will be able to

1. Describe the process of bioremediation in detail.
2. Explain the use of Microorganisms for metal leaching and biofuels generation.
3. Illustrate different methods of waste water treatment and green energy generation.
4. Categorize different types of wastes and their degradation methods.
5. Evaluate various biotechnological applications for hazardous waste management.

UNIT-I

Bioremediation: Introduction to bioremediation and its types- In situ, Ex situ, Intrinsic and Extrinsic Bioremediation ; Constraints and priorities of Bioremediation, Biostimulation of naturally occurring microbial activities Bio-augmentation;; Solid phase bioremediation- Land farming, composting, Biopile; Phytoremediation techniques, Slurry/Liquid phase bioremediation, Biorestoration

UNIT-II

Metal Biotechnology and Biofuels: Metal Leaching- Bioleaching; Biosorption; Types of microbial leaching; Microbial transformation; Microorganisms and their role in energy requirements of mankind; Production of non-conventional fuels: Methane (Biogas), biohydrogen, bioethanol and Algal biofuels; Application of isolated enzymes versus whole cell systems for remediation and biofuels generation

UNIT-III

Biological Waste Water Treatment: Sources of wastewater and its types, General composition of wastewater; Biological processes for domestic and industrial waste water treatment; Aerobic systems – Activated sludge process, trickling filters, Rotating biological contractors (RBC), Fluidized bed (and biofilm) reactor,; Anaerobic biological treatment-Contact digesters, Packed column reactors, UASB, Other advanced bioreactor configurations

UNIT-IV

Degradation of Xenobiotic Compounds: Definition and examples and sources- Xenobiotics, Recalcitrants, Co-metabolism. Biodegradation of Xenobiotics present in Environment; Degradative plasmids; Oil Pollution and Bioremediation of Contaminated soils; Biological Detoxification-Cyanide, Toxic Organics and Phenols.

UNIT-V

Hazardous Waste Management: Introduction to general Solid and Hazardous Waste management- landfills, recycling and processing of organic residues, minimal national standards for waste/wastewater release into environment, Biotechnological applications to hazardous waste management. Global Environmental problems and Biotechnological approaches for management. Nuclear waste generation and treatment.

Text books:

1. Alan Scragg “Environmental Biotechnology”, 2nd edition , Oxford End Press, 2005.
2. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 2007.

Suggested readings:

1. Environmental Biotechnology By Priv.-Doz. Dr.Hans-Joachim Jördening, Prof.Dr. Josef Winter, Wiley-VCH Verlag GmbH & Co. KGaA. 2005.
2. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 2009.

18BT E05

DEVELOPMENTAL BIOLOGY
(Core Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. To give an insight of the basic concepts of developmental biology.
2. To enable the students learn about early developmental stages in embryogenesis.
3. To understand the developmental patterns in Drosophila.
4. Students are made to learn about the Organogenesis and sex determination in humans.
5. To aware the students about the implications of developmental biology in humans.

Course Outcomes:
At the end of the course the students are able to
1. Relate the overview of developmental biology and mechanism of developmental organization
2. Discuss the structure of gametes, events of fertilization and stages of early embryonic development
3. Explain the developmental stages and the role of genes in body axis formation in drosophila
4. Outline the organogenesis process and sex determination in mammals during development process
5. Relate the medical complications of developmental biology

UNIT-I
Introduction to Developmental Biology: Overview of anatomical approach, Evolutionary embryology, Medical embryology& teratology, Mathematical modeling for development, Cycle of Life - An example: A Frog's life, Development dynamics of cell Specification (Autonomous, Conditional, Syncytial and Morphogenic Gradients), Induction and Competence.

UNIT-II
Gametogenesis, Fertilization and Early development in Mammals: Structure of Gametes: Sperm, Egg, Spermatogenesis and oogenesis in Mammals, Recognition of egg and sperm, Mammalian Fertilization (Fusion of Gametes and prevention of Polyspermy). Cleavage, mammalian gastrulation and mammalian axis formation.

UNIT-III
Drosophila Embryonic Development: Early Drosophila developments: Fertilization, Cleavage, Gastrulation, Segmentation and the Anterior-Posterior body plan, Segmentation genes (Gap Genes, pair rule genes and segment polarity genes), The Homeotic selector genes, Generating Dorsal-Ventral axis.

UNIT-IV
Organogenesis and Sex Determination in mammals : The emergence of Ectoderm-The Central nervous system and epidermis, Mesoderm – Osteogenesis and Myogenesis, Lateral plate mesoderm and endoderm – the Heart, Blood cells, Endoderm - Digestive tube and Respiratory tube, Sex determination in Mammals.

UNIT-V
Ramifications of Developmental Biology: Medical Implications of Developmental biology: Genetic errors of human development, Infertility, *In Vitro* fertilization (IVF) and Teratogenesis (Disruptors of teratogenesis), Developmental biology and future of medicine.

Text Books:

1. Scott F Gilbert, Michael JF Barresi. "Developmental Biology", 11th edition, Sinauer Associates, Inc, 2013.
2. ManjuYadav, "Molecular Developmental Biology" Discovery Publishing, September, 2008.

Suggested Reading:

1. Snustad P, Simmons and Jenkins, "Principles of Genetics", 2nd Edition, John Wiley Publications, 1999.
2. P.C.Jain, "Elements of Developmental Biology" International Publications,2013.

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18BT E06

METABOLIC ENGINEERING
(Core Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To identify the different metabolic regulations.
2. To outline various pathways of Biosynthesis of secondary metabolic and their applications.
3. To identify factors and criteria for bioconversions
4. To learn the concept of metabolic flux and its application.
5. To compute metabolic pathways and algorithms.

Course Outcomes:

At the end of the course the students are able to

1. Summarize the basic concepts of metabolic engineering.
2. Describe the various biosynthesis of secondary metabolites & their applications in various fields.
3. Discuss the factors influence the bioconversions and genetic manipulations of metabolic pathways.
4. Explain the analysis & applications of metabolic flux.
5. Outline the metabolic pathway modeling synthesis using bioinformatics tools and its applications.

UNIT- I

Introduction: Identification of metabolic regulation: a key point in Metabolic Engineering. Basic concepts of Metabolic Engineering- Overview of cellular metabolism, Different models for cellular reaction, induction, Jacob monad model & its regulation, Different regulation by Isoenzymes, feedback regulation. Amino acid synthesis, pathways with regulation at enzyme & cell level.

UNIT-II:

Biosynthesis Of Secondary Metabolites: Regulation of secondary metabolic pathways, precursor effect, prophase, Idiophase –relationships. Catabolite regulation bypassing control of secondary metabolism, producers of secondary metabolites and their applications.

UNIT-III

Bioconversions: Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances. Applications of Bioconversions. Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation. The modification of existing or the introduction of entirely new metabolic pathways.

UNIT-IV

Metabolic Flux: Metabolic flux distribution analysis, Experiments determination method of flux distribution, Metabolic flux analysis and its applications.

UNIT-V

Metabolomics & Applications Of Metabolic Engineering: Metabolic pathway modeling, Analysis of metabolic control and the structure metabolic networks, metabolic pathway synthesis algorithms. Application in pharmaceuticals, chemical bioprocess, food biotechnology, agriculture environmental bioremediation and biomass conversion.

Text Books:

1. Stephanopoulos GN, Aristidou AA and Nielsen J, "Metabolic Engineering Principles & Methodologies", Academic Press-Elsevier,1998.
2. Wand. D.I.C Cooney C.L., Demain A.L., Dunnil.P.Humphrey A.E.Lilly M.D. "Fermentation and Enzyme Technology, John Wiley and sons, 1980.
3. Metabolic engineering Sangy Yuplee and E.T.Pa poutsakis Marcel DekkerInc.

Suggested Reading:

1. Zubay G., Biochemistry, Macmillan Publishers, 1989.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology Pergamon Press, 1984.

18MB C01

Engineering Economics and Accountancy

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in achieving a firm's Objective.

Course Outcomes:

At the end of the course the students are able to

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

Unit-I

Introduction to Managerial Economics

Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance; Relationship with other Subjects. Its usefulness to Engineers; Basic concepts of Managerial economics - Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equimarginal Principle, Contribution, Negotiation Principle.

Unit-II

Demand and Supply Analysis

Demand Analysis - Concept of Demand, Determinants, Law of demand - Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply - Determinants of Supply, Law of Supply; Demand Forecasting - Methods.

Unit-III

Production and Cost Analysis

Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns; Internal and External Economies of Scale.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Market structures – Types of Competition, Features, Price Output Determination under Perfect Competition, Monopoly and Monopolistic Competition; Break-even Analysis – Concepts, Assumptions, Limitations, Numerical problems.

Unit-IV

Accountancy

Book-keeping, Principles and Significance of Double Entry Book Keeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments. Ratio Analysis.

Unit-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods - Numerical problems.

Text books:

1. Mehta P.L.,"Managerial Economics: Analysis, Problems and Cases", Sultan Chand & Son's Educational publishers, 2016.
2. Maheswari S.N. "Introduction to Accountancy", Vikas Publishing House, 11th Edition, 2013.
3. Panday I.M. "Financial Management", 11th edition, VikasPublishing House, 2015.
4. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
5. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
6. A. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2013.

18BT C18

FLUID MECHANICS AND HEAT TRANSFER LAB

Instruction	2 P Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objective:

This lab course is designed to understand the mechanics of fluid flow, analysis of various processes viz., Flow measuring devices Venturimeter, Mouth piece, and Triangular notch.) and heat exchangers.

Course Outcomes:

At the end of the course the students are able to

1. Evaluate the coefficient of discharge for different flow measuring devices.
2. Determine thermal conductivity of homogeneous wall.
3. Calculate heat transfer coefficient in unsteady state heat transfer.
4. Predict overall heat transfer coefficient in unsteady state heat transfer.
5. Determine friction losses in pipe fittings.

LIST OF EXPERIMENTS

1. Determination of discharge coefficient for orifice meter and venturimeter and their variation with Reynolds number
2. Determination of weir meter constant K for v-notch and rectangular notch
3. Calibration of Rotameter and study of variation of flow rate with tube to float diameter
4. Determination of viscosity of Glycerol - water solutions at different temperatures
5. Determination of friction factor for flow of water through annulus using Fanning's and Davo's equations.
6. Determination of friction factor for flow through straight pipes of different diameters and study of variation of friction factor with Reynolds number.
7. Determination of friction losses in pipe fittings
8. Determination of Thermal conductivity of homogeneous wall insulating powder under steady state conditions.
9. Determination of interface temperatures in composite wall under steady state conditions.
10. Determination of heat transfer coefficient in Natural convection.
11. Determination of overall heat transfer coefficient in unsteady state heat transfer
12. Determination of inside heat transfer coefficient in coil heat exchangers
13. Determination of overall heat transfer coefficient and effectiveness in a Double pipe heat exchange
14. Determination of heat transfer area in a 1-2- shell and tube heat exchanges
15. Determination of heat transfer coefficient on a single tube by film wise and drop wise condensation.

Suggested Reading:

1. W L McCabe and JC Smith, "Unit operations in Chemical Engineering", 6thedition, McGraw Hill Intl. Ed, 2005.

18BT C19

ENZYME TECHNOLOGY LAB

Instruction	2 P Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objectives:

1. To prepare buffers and chemicals used for isolation and extraction of enzyme.
2. To know the optimum ranges of physical parameters for enzyme activity.
3. To learn the Michaelis-Menten and enzyme inhibition kinetics.
4. To observe the growth curve for the determination of substrate utilization.
5. To understand the methods of immobilization of enzymes and their kinetics.

Course Outcomes:

At the end of the course students will be able to

1. Select the suitable buffers for isolation and extraction of enzymes from various sources.
2. Evaluate the optimum enzyme activity at various process parameters.
3. Evaluate Michaelis-Menten kinetic parameters and enzyme inhibition kinetics.
4. Demonstrate the growth curve for the determination of substrate utilization.
5. Compare the methods of immobilization of enzyme and its activity.

LIST OF EXPERIMENTS

1. Preparation of buffers
2. Isolation and extraction of enzymes (Microbial, plant and animal source).
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity.
5. Effect of substrate concentration on enzyme activity.
6. Effect of time interval on enzyme activity.
7. Development of Enzyme Assay
8. Evaluation of Michaelis-Menten kinetic parameters.
9. Kinetic studies of enzyme inhibition (Open ended Experiment).
10. Determination of growth curve of a supplied microorganism and to determine substrate degradation profile.
11. Studies on immobilization of enzyme/cell by gel entrapment method (Structured Enquiry).
12. Comparative study of activities of free and immobilized enzyme systems.

Suggested Reading:

1. Trevor Palmer, Philip Bonner, “Enzymes”, 2nd edition, Woodhead Publishing, 2007.
2. Andreas S. Bommarius, Bettina R. Riebel, “Biocatalysis - Fundamentals and Applications”, Wiley-VCH, 2004.

With effect from academic year 2020-21

18BT C20

GENETIC ENGINEERING LAB

Instruction	2 P Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course objectives:

1. To know the isolation and analysis of DNA.
2. To know the incision of DNA by using the restriction endonucleases.
3. To learn the amplification DNA by polymerase chain reaction
4. To understand the cloning strategies of DNA.
5. To know about DNA sequencing and expression of recombinant protein from transformed bacterial cultures.

Course outcomes:

At the end of the course the students are able to

1. Demonstrate the isolation of nucleic acids.
2. Characterize the DNA by restriction digestion and restriction mapping.
3. Perform the polymerase chain reaction.
4. Plan different steps involved in cloning strategies of DNA
5. Analyze the DNA Sequencing and recombinant protein by using SDS PAGE

LIST OF EXPERIMENTS

1. Isolation of genomic DNA
2. Isolation of plasmid DNA
3. Visualization of Genomic and Plasmid DNA on Agarose gels
4. Restriction digestion
5. Restriction mapping
6. Gel elution.
7. DNA ligation.
8. Preparation of competent cells.
9. Genetic transformation and screening for recombinant bacterial cells.
10. Blotting techniques- southern blotting.
11. Amplification of DNA fragments by Polymerase Chain Reaction (PCR).
12. DNA sequencing- Sanger's Method (Structured enquiry)
13. Analysis of Recombinant Proteins using SDS-PAGE (Open ended experiment)

Suggested Reading:

1. Green MR and Sambrook J, “Molecular Cloning-A laboratory manual”, Vol I, II and III, Cold spring \ Harbor Laboratory Press, 2012

With effect from the Academic Year 2020-21

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of VI Semester of B.Tech Bio-Technology as per AICTE Model Curriculum 2020-21

B.Tech (Bio-Technology)

SEMESTER-VI

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	18BT C21	Fermentation Technology	3	-	-	3	30	70	3
2	18BT C22	Bioinformatics	3	-	-	3	30	70	3
3	18BT C23	Mass Transfer Operations	3	-	-	3	30	70	3
4		**Core Elective III**	3	-	-	3	30	70	3
5		**Core Elective IV**	3	-	-	3	30	70	3
6		**Open Elective I**	3	-	-	3	30	70	3
	PRACTICALS								
7	18BT C24	Fermentation Lab	-	-	2	2	15	35	1
8	18BT C25	Bioinformatics Lab	-	-	2	2	15	35	1
Total			**18**	**-**	**4**	**-**	**210**	**490**	**20**
Clock Hours Per Week – 22									

L: Lecture T:Tutorial P:Practical
CIE – Continuous Internal Evaluation SEE - Semester End Examination

Core Elective III	
18BT E07	Medical Biotechnology
18BT E08	Food Biotechnology
18BT E09	Bioprocess Dynamics and Control
18BT E10	Artificial Intelligence in Biology

Open Elective I	
18MT O01B	Numerical Methods
18EC O02	Biomedical Instrumentation
18ME O03	Research Methodologies

Core Elective IV	
18BT E11	Pharmaceutical Biotechnology
18BT E12	Intellectual Property Rights Regulatory Affairs And Clinical Trials
18BT E13	Nanobiotechnology

18BT C21

FERMENTATION TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Providing knowledge to students on scope and chronological development of fermentation technology.
2. Understanding the types of fermentation process and design of fermentation.
3. Learning about the ancillaries of fermenter and its applications.
4. Determination of the power requirements for operating bioreactors under various conditions
5. Gaining in-depth knowledge about the working principles and operation offer mentors.

Course Outcomes:

At the end of the course the students are able to

1. Apply the knowledge of fermentation processes and aseptic transfer of spore suspension in bioprocess industries.
2. Outline the construction of fermenters, control process parameters and media formulation in bioprocesses.
3. Discuss the concepts of solid state and slurry fermentation processes in bioprocess.
4. Determine the steps involved in oxygen transfer during aerobic fermentation.
5. Assess the power requirements for bioreactors with and without agitation.
6. Interpret the working principles of different bioreactors.

UNIT-I

Introduction to Fermentation Processes: The range of fermentation processes; the chronological development of fermentation industry; Industrial applications; Future trends in fermentations; Aseptic transfer of spore suspension; Transfer of inoculums from seed tank to Fermenter.

UNIT- II

Fermentation Processes and Media Design: General requirements of fermentation processes, Basic design and construction of fermenter and ancillaries, Main parameters to be monitored and controlled in fermentation processes; Typical media, Media formulation, energy resources, carbon and nitrogen components Solid-substrate, slurry fermentation and its applications

UNIT- III

Aeration and Agitation in Fermentations: Basic Mass transfer concepts; Oxygen transfer from gas bubble to cells; Oxygen transfer in fermentations; Bubble aeration and Mechanical agitation; Correlations for mass transfer coefficients; Gas Hold up; Power consumption concepts; Determination of oxygen transfer rates, K_La values; Other Factors affecting the values of mass transfer coefficients in fermentation vessels.

UNIT- IV

Scale Up and Rheology in Fermentations: Scale up of fermentation processes; Principles, theoretical considerations and techniques used; Scale down methods; The Rheology of fermentation broths; Rheological models; Measurement of rheological parameters; Rheological Control of fermentations; Mixing concepts, power requirement for mixing and improvement of mixing in fermentations.

UNIT-V

Fermenters: Batch, Fed-batch and Continuous Fermentation systems; Dual and multiple fermentations; Comparison between batch and continuous fermentations; Steady state, unsteady state continuous fermentation theories; Examples of continuous fermentation; Practical problems with continuous operations. Monitoring and Control of fermentations, behavior of microbes in different reactors (air lift, fluidized, batch, and continuous fed batch condition).

Text Books:

1. Stanbury PF, Whitaker A and Hall S J, "Principles of Fermentation Technology" 2nd edition, Elsevier, 2013.
2. Bailey JE and Ollis DF, "Biochemical Engineering Fundamentals", 2nd edition, McGraw Hill, 1986.
3. Pauline M. Doran, "Bioprocess Engineering Principles", Academic press, 1995.

Suggested Reading:

1. Shuler M and Kargi F, Bioprocess Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
2. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering" 1st edition, CRC, 1997.

With effect from the Academic Year 2020-21

18BT C22

BIOINFORMATICS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To provide elementary knowledge in bioinformatics and biological information available to biologist on the web and learn how to use these resources on their own.
2. To learn fundamentals of biological databases and sequence alignment
3. To learn methods for determining the order of the nucleotide and to predict gene
4. To aid in understanding structural bioinformatics and Human genome project
5. To understand evolutionary relationship among organisms

Course Outcomes:

At the end of the course the students are able to

1. Explain the need of bioinformatics and biological databases are used for the retrieval of information
2. Demonstrate the methods of sequence alignment and its use
3. Discuss about genome sequencing and Human genome project
4. Predict gene sequences and protein structure
5. Describe an evolutionary tree and different methods and software tools used for phylogenetic analysis

UNIT-I

Introduction to Bioinformatics and Biological Databases: Need of Computers in Biotechnology Research, Elementary commands and protocols, ftp, telnet, http; Bioinformatics- Introduction, scope and application of Bioinformatics; Introduction to biological databases, types of biological database, file formats for biological sequence (NCBI, EMBL, SWISSPROT, FASTA); Information retrieval from biological Databases.

UNIT-II

Sequence Alignments: Sequence database search- FASTA, BLAST, various versions of BLAST and FASTA; Amino acid substitution matrices - PAM and BLOSUM. Sequence Alignment - Local, Global alignment; Methods of pair-wise sequence alignment; Multiple Sequence alignment methods.

UNIT-III

Genome Sequencing and Gene Prediction: DNA sequencing, Genome Mapping; Genome sequencing, cDNA sequencing, Genome sequence assembly; Basis of Gene Prediction, Gene Prediction Methods in Microbial genomes and eukaryotes, Other Gene Prediction Tools; Genome Annotation.

UNIT-IV

Structural Bioinformatics and Human Genome project: Protein structure basics, protein structure classification, visualization and comparison, protein secondary structure prediction and protein tertiary structure prediction; Human genome project: Goals, work scope, impact, practical applications and limitations of Human Genome Project.

UNIT-V

Phylogenetic Analysis: Understanding Evolutionary process; Origin of Molecular Phylogenetics; Relationship of phylogenetic Analysis to sequence alignment; Concept of evolutionary trees; Methods of Phylogenetic analysis, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis.

Text Books:

1. David Mount, "Bioinformatics Sequence and Genome Analysis", 2nd edition, CBS Publishers and Distributors Pvt. Ltd., 2005.
2. Rastogi SC, Mendiratta N and Rastogi P, "Bioinformatics: Methods and Applications Genomics, Proteomics and Drug discovery", 3rd edition, PHI Learning Private Limited, New Delhi, 2010.

Suggested Reading:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.
2. Vittal R Srinivas, "Bioinformatics: A modern approach. PHI Learning Private Limited", New Delhi, 2009.

18BT C23

MASS TRANSFER OPERATIONS

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To provide the students with knowledge about various unit operations such as absorption, distillation, extraction, leaching.
2. To give insight about various membrane separation processes such as adsorption, Ion-exchange, dialysis and the application of these unit operations in commercial aspects of biotechnology.

Course Outcomes:

At the end of the course the students are able to

1. Distinguish between molecular diffusion in solids, liquids and gases.
2. Determine the number of trays needed for the separation.
3. Solve material balance problems for different unit operations.
4. Explain the principles of the various separation processes involved in the downstream processing of products, especially those of biological origin.
5. Explain the principles and application of membrane separation processes and understand the types of adsorbents.

UNIT-I

Principles of Mass Transfer: Introduction to Mass transfer and Diffusion, Molecular diffusion in Gases, Molecular diffusion in Liquids, Molecular diffusion in Biological solutions and gels, Molecular diffusion in Solids, Inter phase mass transfer and Mass transfer coefficients.

Gas-Liquid operations: Equilibrium relations between phases, Mass transfer between phases, Choice of solvent for absorption, Single stage and multi stage co current and counter current operations, Estimation of Mass transfer coefficient, packed columns and plate columns.

UNIT-II

Principles of VLE for Binary System: Phase rule and Raoult's law, Boiling point diagrams and x-y plots, Relative volatility, Flash distillation, Differential distillation, Simple steam distillation. Distillation with reflux and McCabe - Thiele method. Special Cases for rectification using McCabe - Thiele; Stripping column distillation, Enriching Column distillation, Rectification with direct steam injection, Rectification with single side stream.

UNIT-III

Liquid-Liquid Extraction and Leaching: Introduction to Extraction process: Equilibrium relations in extraction, Analytical and graphical solutions for single and multistage operations co-current and counter current operations without reflux. Equipments for liquid-liquid extraction: mixer settlers for extraction, Plate and Agitated Tower Contactors for Extraction, Packed and spray Extraction towers. Introduction to leaching process: Equilibrium diagrams for leaching, analytical and graphical solutions for single and multi-stage counter current operations.

UNIT-IV

Basic Concepts in Drying of Process Materials: Methods of drying, Equipment for drying; Free moisture content of materials; Concept of bound and unbound moisture content of biological materials; Rate of drying curves; Calculation methods for constant-rate & falling rate drying methods; Freeze drying of biological materials.

UNIT-V

Adsorption And Membrane Separation Process: Theory of adsorption, Industrial adsorbents, Adsorption equilibria, Frendlich equation-single and multiple operations- processing variables and adsorption cycles; Introduction and Types of Membrane separation process: Principles of ion exchange. Dialysis, Gas permeation membrane processes, types of membranes and permeability's for separation of gases, Introduction to types of flow in gas permeation.

Text Books:

1. C J Geankoplis, "Transport Processes in chemical Operations", 4th edition, Prentice Hall India, 2004
2. Robert E Treybal, "Mass Transfer operations", 3rd edition. McGraw-Hill, 1981
3. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations of Chemical Engineering", 7th Edn., McGraw Hill Book Co., New York, 2004.

Suggested Reading:

1. Jaime Benitez, "Principles and Modern Applications of Mass Transfer Operations", 2nd edition, 2009.
2. J M Coulson and J F Richardson, "Chemical Engineering", Vol-II, 3rd edition, Pergamom Press.

18BT E07

MEDICAL BIOTECHNOLOGY
(Core Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. To understand the scope and importance of medical biotechnology
2. To understand the differences between the normal cells and cancer cells and various diagnostic methods used in cancer detection.
3. To gain the in-depth knowledge about the clinical applications of stems cells & tissue engineering.
4. The course aims at providing knowledge about the working principles and types of advanced materials used in medical field.
5. To learn current molecular therapies and bioethical issues.

Course Outcomes:
At the end of the course the students are able to
1. Outline the various types of genetic disorders.
2. Compare etiology, diagnosis and treatment of Cancer.
3. Explain the concepts of Stem cell therapy and Tissue engineering.
4. Discuss the principle and applications of biomedical devices and molecular diagnostics.
5. Classify the molecular therapies and bioethical issues.

UNIT-I
Introduction To Medical Biotechnology: Introduction, scope and importance of medical biotechnology; The genetic basis of the disease; chromosomal disorders; single gene disorders-modes of inheritance, Thalassemia, sickle cell anaemia, cystic fibrosis, Tay sachs disease, Fragile –X- syndrome; polygenetic disorders; Alzheimers disease,Type-1diabetis and mitochondrial disorders (neurological disorders).

UNIT-II
Medical Oncology: Cancer types; Normal cells vs. cancer cells; cancer genetics; oncogenes and their proteins; tumor suppressor genes and their functions, diagnosis of cancer, Treatment of cancer; Radiation therapy, chemotherapy.

UNIT-III
Stem Cell Treatment and Tissue Engineering: Cellular therapy, stem cells- definition, types, properties and uses of stem cells; sources of embryonic and adult stem cells; concept of tissue engineering; role of scaffolds; clinical applications of stem cells; stem cell banking and ethical issues.

UNIT-IV
Biomedical Instrumentation And Molecular Diagnostics: Concepts in Biomedical Engineering; principle, properties of Biomaterials and applications of different types of biomedical devices; pacemakers, drug coated stents, knee replacement implants, dental implants, prosthetics, Molecular diagnosis by immunological approaches to detect protein biomarkers of the disease (types of ELISA), DNA approaches (Taq MAN approach, RT-PCR, epigenetic markers, detection of SNP by mass spectrometry; Applications of biosensors in medicine.

UNIT-V
Molecular Therapeutics And Bioethical Issues: Types of molecular therapies; protein therapy by recombinant Monoclonal Antibodies, Enzymes (DNase-1, Alpha -1 antitrypsin), Lactic acid bacteria by Leptin, antisense therapy, recombinant vaccines; Bioethical issues in IVF, surrogacy and cloning technologies.

Text Books:

1. Judith Pongracz, Mary Keen, "Medical Biotechnology", illustrated edition, Elseiver health sciences, 2009.
2. Bernard R Glick, Cheryl L.Patton, Terry L.Delovitch, "Medical biotechnology", 1st edition, ASM press, 2013.

Suggested Reading:

1. Truepenny PD, Emerys "Elemental Medical Genetics", 14th edition, Churchill Livingstone, 2012.
2. R.J.B.King, Robins, "Cancer biology", 3rd edition, Prentice Hall, 2006.

18BT E08

FOOD BIOTECHNOLOGY
(Core Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. Student is made to understand the importance of food biotechnology and its nutritive value.
2. Students are taught the types of food available in the nature and its consumption value.
3. Students made to understand the food spoilage.
4. Students are enlightened about the importance of food processing.
5. Students are made aware of chemical and physical methods of food processing.

Course Outcomes:
At the end of the course the students are able to
1. Apply the fundamentals of food biotechnology to their real life situation.
2. Explain the types of food, their consumption value and production process.
3. Outline the types of pathogens and their effect on food.
4. Discuss about the physical and chemical methods of food processing.
5. Describe the methods to preserve the food material to avoid food spoilage.

UNIT-I
Scope and Importance of Food Biotechnology: Introduction to Scope and importance of food biotechnology, Nutritive value of the food ; consumption and structure of foods and the importance of industrial processing of foods, Recent techniques involved in packaging, food grade polymers; Food labeling.

UNIT-II
Food Products: Introduction to Probiotics, Nutraceuticals and GM foods ; Development of Industrial Food products: High Fructose Corn syrup, Single Cell Protein and Fermented foods, Bakery Products, Beverages, Milk Products and Mushroom Development.

UNIT-III
Food Spoilage and Food Microbiology: Food spoilage, Bacterial agents of food borne illness; Clostridium, Salmonella, Vibrio and Shigella, Non bacterial agents; Protozoa, Algae, Fungi and Viruses.

UNIT-IV
Food Processing: Various technologies and methods in food preservation and processing, Enzymes and chemicals used in food processing for flavour development; Processing of meat, fisheries, vegetables, dairy products; Thermal processing of foods; Microwave heating; Thermal inactivation of microorganisms; Freezing and thawing methods of food processing.

UNIT-V
Food Preservation: Food preservation using Irradiation: Characteristics of Radiations of Interest in food preservation, Principles underlying the destruction of microorganisms by irradiation, Processing of foods for Irradiation, Legal status of food irradiation, Effect of Irradiation of Food constituents and Storage Stability; Food Preservation with low and High Temperatures and Preservation of foods by Drying, Equipment for Drying.

Text Books:

1. Roger Angold, Gordon Beech & Taggart, “Food Biotechnology” 1/e, Cambridge End Press, 1989.
2. Frazier, William, C.Westhoff, Dennisc, “Food Microbiology” 2/4e, TATA Mcgraw Hill Publishers, 1989.

Suggested Reading:

1. Ashok Pandey, “Biotechnology: Food Fermentation” Asia Tech Publishers Inc, New Delhi,1999.
2. J.M. Jay, M.J.Loessner and D.A.Golden, “Modern food microbiology”, 7/e,Springer, 2006.

18BT E09

BIOPROCESS DYNAMICS AND CONTROL
(Core Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

The course aims at

1. Providing knowledge in basic concepts of transfer function, dynamics of system process, forcing functions
2. Imparting knowledge with respect to various types of controllers and understanding the block diagram for a process.
3. Determination of optimum controller settings
4. Inculcating the concepts of advanced control strategies

Course Outcomes:

At the end of the course the students are able to

1. Explain the response of interacting and non interacting systems by applying the concepts of transfer function.
2. Develop block diagrams with set point and load variable changes.
3. Apply the knowledge of closed loop and open loop tuning methods to fine tune the control parameters.
4. Interpret the knowledge of control valve sizing in the design of control valve system in bioprocess units.
5. Assess the advanced control strategies and perform a case study in Bioprocess.

UNIT-I

Process Dynamics: Laplace transform of simple functions, transforms of derivatives, solutions of differential equations, inversion by partial fractions, Partial fractions. Process variables, Dynamics of simple processes – Flow, level, Temperature, Pressure and Concentration; Transfer function – Properties, response of simple processes for Step, Impulse and Sinusoidal Forcing functions. Concept of Time Constant, Linearization, Response of first order systems in series - Non-interacting and Interacting systems. Physical examples of second order system

UNIT-II

Control Actions And Controllers: Controller and Control system – measuring device and final control elements, Open and Closed loop control, Negative and Positive feedback control, Servo and Regulatory problems. Ideal transfer functions –Control valve, Controllers, Proportional, Integral and derivative actions – PI. PD and PID controls. Block diagram- Development of block diagram, Over all Transfer function for single loop system, overall transfer function for change in set point and load, transportation lag.

UNIT-III

Optimum Controller settings: Controller Tuning – Evaluation criteria with l/4th decay ratio, Criteria for good control- IAE. ISE, ITAE. Controller Tuning – Ziegler –Nicholas and Cohen Coon methods .Continuous cycling method, Control of processes with a time delay.

UNIT-IV

Final Control Element: I/P Converter– pneumatic, electric and hydraulic actuators. Control valves – Construction, valve sizing, valve characteristics, valve positioner. Control of Globe, Butterfly and Diaphragm valves.

UNIT-V

Advanced Control Strategies: Brief description of Cascade control. Feed forward control, Ratio control, with a simple example. Dynamics and Control of pH of a process and Biochemical reactor.

Text Books:

1. Donald R.Coughanowr, Process Systems Analysis and Control, 2nd ed., McGraw Hill Inc., 1991.
2. George Stephanpoulos,"Chemical process control" ,Pearson PrenticeHall,1984.
3. Seborg, Edgar, Mellichamp, Doyle, "Process Dynamics and Control", 3rd edition John Weilyand Sons, 2010.
4. Harriott P, "Process control", Tata McGraw-Hill publishing Co., New Delhi, Reprint1991.

Suggested Reading:

1. Patranabis D, Principles of Process Control by 2nd ed., Tata McGraw-Hill publishing Co., New Delhi, Reprint1997.
2. Eckman D.P., Automatic process control, Wiley Eastern Ltd., New Delhi, 1993.

18BT E10

ARTIFICIAL INTELLIGENCE IN BIOLOGY
(Core Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives

1. Become familiar with basic principles of AI towards problem solving, inference, perception knowledge representation and learning
2. Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
3. To understand the applications of AI, expert systems.

Course Outcomes

At the end of the course, the students are able to:

1. Compare AI with human intelligence and traditional information processing and discuss its strengths and limitations.
2. Apply the basic principle, models and algorithms of AI to recognize, model and solve problems in the analysis and design of information systems and also to solve molecular biology problems.
3. Relate language processing to address the questions related to DNA.
4. Explain the neural networks in biology especially in protein characterization etc.
5. Outline an expert system to for the identification of optimized solutions.

UNIT I

Artificial Intelligence Introduction: Overview of Artificial Intelligence (AI); The AI Problems; AI Techniques; The level of the model; Criteria for success.

Problems, Problem Spaces and Search: Problem as a State Space Search; Production Systems; Problem Characteristics; Production Systems Characteristics; Issues in the Design of Search problems

UNIT II

Heuristic Search Techniques: Generate-and-test; Hill-Climbing; Simulation Annealing; Best-First-Search; Local Search, Greedy Algorithms; Problem Reduction; Constraint Satisfaction; Means-ends Analysis

RNA secondary structure prediction problem (*2˚RNA***):** Secondary Structure of RNA; Structure and Free Energy—A Mathematical Model; RNA secondary structure prediction as a Search problem

UNIT III

Computational Linguistics

Formal Language Theory: The Formal Specification of Languages; Chomsky Hierarchy and Subdivisions; Lindenmayer Systems; Properties of Language Families; Parsing. Computational Applications of Language Theory: Natural Language; Computer Languages and Pattern Recognition; Developmental Grammars; Gene Grammars

Structural Linguistics of Nucleic Acids: Properties of Reverse Complementarity; Closure Properties for Nucleic Acids. Structural Grammars for Nucleic Acids: Context-Free and Indexed Grammars;

UNIT IV

Artificial Neural Networks: Introduction: Model of a neuron; Feedback and Feed-forward Networks; Training Procedure; Network Optimization.

Protein Structure Prediction with Neural Networks: a -Helix, b-Strand, and Coil Predictions; b-turn Predictions; Secondary Structure Composition Predictions.

UNIT V

Evolutionary Algorithms: Introduction; Evolution of Solutions; Components in a Genetic Algorithm; Representation of a Solution in the Genetic Algorithm; Operation of the Genetic Algorithm; Evolution; Selection and Crossover Strategies; Encoding; Repairing String Damage; Fine Tuning; Traps; Other Evolutionary

Algorithms

Genomic Regulatory Networks and Modeling Development: Description of Sample Problem; Representations of Potential Solutions; Simple Model of Development, Developmental Procedures; Fitness Evaluation; Overall Evolution.

Text Books:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair; Artificial Intelligence; Third Edition; Tata McGraw Hill.
2. Lawrence Hunter; Artificial Intelligence And Molecular Biology; AAAI Press, First Edition
3. Hugh Cartwright , Using Artificial Intelligence In Chemistry And Biology- A Practical Guide, CRC Press, Taylor & Francis Group (2008)

With effect from academic year 2020-21

18BT E11

PHARMACEUTICAL BIOTECHNOLOGY
(Core Elective - IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To understand origin, scope and importance of pharmaceutical biotechnology.
2. To learn ADME properties of drugs, pharmacokinetics, pharmacodynamics and drug delivery systems.
3. To understand the materials and formulations of pharmaceuticals.
4. To learn the collection, processing and storage of blood and plasma substitutes
5. To gain knowledge about the pharmaceutical products and their use in treatment of infectious diseases.

Course Outcomes:

At the end of the course the students are able to

1. Summarize the fundamentals of biopharmaceuticals.
2. Explain the ADME properties of drugs, pharmacokinetics, pharmacodynamics and drug delivery systems.
3. Outline the different manufacturing procedures of drugs.
4. Discuss about blood and plasma substitutes.
5. Describe the therapeutic activity of drugs used for treating diseases

UNIT-I

Fundamentals of Biopharmaceuticals: Pharmaceutical Biotechnology: An introduction, Origin, definition, Scope and Importance. Human protein replacements, Therapeutic agents for human diseases: Tissue Plasminogen activator, Interferon, Recombinant vaccines. Methods of Biotechnology and their applications of Gene transfer.

UNIT-II

Biopharmaceutics and Pharmacokinetics: ADME properties- Physiochemical properties of Drug Absorption, Distribution, metabolism (Biotransformation), bioavailability and Excretion. Pharmacokinetics and Pharmacodynamics. Basic considerations: Drug receptors, Drug interactions, Surgical supplies, Oral, Parenteral, Transdermal, Ophthalmic, Intravaginal and Intrauterine Drug Delivery systems.

UNIT-III

The Drug Manufacturing Practices: Good manufacturing practices and facilities for drug production. Types of Tablets and capsules. Materials and Formulations for Manufacture of Tablets, Capsules. Excipients and its ideal properties, Parenteral solutions, Oral liquids, Emulsions, Ointments, Suppositories, Aerosols.

UNIT-IV

Blood and Plasma Substitutes: Collection, processing and storage of whole human blood, concentrated human RBC, dried human plasma, Human plasma protein fraction, Dried human serum, Human fibrinogen, Human thrombin, Human normal Immunoglobulin, Plasma substitutes- Ideal requirements, PVP, Dextran 40, control of Blood products, Transfusion products

UNIT-V

Pharmaceutical Products: Fundamentals of Therapeutic categories such as Analgesics, Antipyretic, Anti-inflammatory drugs, Anesthetics, Antacids, Alkaloids, Glycosides, Anti-neoclassic drugs, Biologicals (Immunizing agents and allergenic extracts), Chemotherapy of Tuberculosis and Urinary tract infections.

Text books:

1. Purohit SS, Kakrani HN and Saluja AK., “Pharmaceutical Biotechnology”, Student Edition Jodhpur, 2003.
2. Brahmankar, D.M., Sunil, B.Jaiswals - Biopharmaceutics & Pharmacokinetics a Treatise , 2nd edition, M.K.Jain Publication, Delhi,2009.
3. Cooper and Guns, “Pharmaceutics”, CBS publishers, 1989.

Suggested Reading:

1. David B Troy and Paul Beringer, “Remington’s: The Science and practice of Pharmacy”, Vol 1 and 2, Lippincott Williams & Wilkins Publications, 2006.
2. Tripathi, K.D. "Essentials of Medical pharmacology", Jaypee Brothers Medical Publishers 6th Edition, John Wiley, New Delhi, 2000.

18BT E12

INTELLECTUAL PROPERTY RIGHTS REGULATORY AFFAIRS AND CLINICAL TRIALS
(Core Elective - IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To make the students understand about Intellectual property rights and their importance, National and international regulatory affairs, GCP &ICH guidelines.
2. To introduce and provide a comprehensive introduction to Regulatory Affairs as typically practiced by Regulatory Affairs professionals in medical device and bio pharma companies.
3. To enable students to follow the Current trends in Clinical research and regulations.

Course Outcomes:

At the end of the course, the students are able to

1. Explain about the IPR, methods of filing patents and legal implications.
2. Summarize the Government of India rules and regulations about the ICH, GCP, FDA guidelines.
3. Discuss the role of regulatory affairs and their significance globally.
4. Outline the criteria for drug approval related documentation.
5. Discuss the various phases of clinical trials and the basis of approval of new drugs, their outcome in new drug discovery.

UNIT-I

Intellectual Property Rights: Intellectual property rights, and intellectual property protection, patents and methods of application of patents, trade secret, copyrights, trademarks, legal implication, trade-related aspects (TRIPS), farmers rights, plant breeder's rights.

UNIT-II

Regulatory Affairs- India: Indian contest- requirements and guidelines of GMP, understanding of Drugs and Cosmetic Act 1940 and rules 1945 with reference schedule M, U & Y. The Narcotics Drugs and Psychotropic Substances Act Medicinal and Toilet Preparations (Excise Duties) Act, 1955 The Pharmacy Act, 1948 Types of ANDA filing (Para I, II, III, IV filing) Clinical trial approval by Drug Controller General of India (DCGI) Exclusivities (NCE, NS, NP, NDF, PED, ODE, PC)

UNIT-III

Regulatory Affairs- Global: Introduction to FDA, WHO, Code of federal Regulations, ICH Guidelines, Related quality systems- objectives and guidelines of USFDA, WHO & ICH, European Medicines Agency and its responsibility, EU clinical trial directive. Requirement of GLP: Guidance and recommendation on Dissolution and Bio-equivalence requirement. Hatch Waxmann Act.

UNIT-IV

Documentation And Protocols: Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, IND, BLA, CTD, DMF, Dealing with post approval changes- SUPAC, handling and maintenance including electronic documentation, 510K device application.

UNIT-V

Introduction To Clinical Research: History, Importance and Scope, stake holders in clinical research, Framework of clinical research, Declaration of Helenski, 2000 amendment, medical and clinical research terminology, Principles of GCP, Roles and responsibilities in clinical research according to ICH GCP, Sponsor, Investigator, IRB/IEC, Essential documentation, Confidentiality issues. Clinical data management system, Double data entry.

Text Books:

1. Good Clinical Practices, Central Drugs Standard Control Organization, Govt. of India
2. Drugs and Cosmetics Act,1940
3. Dominique PB and Gerhardt Nahler, "International Clinical Trial", Volume 1&2, , Interpharm Press, Denver,Colorado

Suggested Reading:

1. Code of Federal Regulations by USFDA-Download
2. ICH-GCP Guidelines-Download.
3. Fleming DA, Hunt DL, "Biological Safety Principles and Practices", 3rd edition, ASMPress, Washington, 2000.

18BT E13

NANOBIOTECHNOLOGY
(Core Elective - IV)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives

1. To introduce the concept of nanotechnology and nano-size
2. To gain knowledge on the synthesis and characterization of nanomaterials
3. To have awareness about different types of Nanostructures
4. To get familiarize with applications of Nanobiotechnology in different fields

Course Outcomes

At the end of the course, the students are able to:

1. Discuss the multidisciplinary nature of nanotechnology and nanoscale paradigm in terms of properties at the nanoscale dimension.
2. Describe different methods used for the synthesis and characterization of nanomaterials.
3. Explain various types of nanostructures.
4. Summarize general applications of Nanobiotechnology.
5. Outline the current applications of Nanobiotechnology.

UNIT I

Introduction and Significance of Nano Domain: Nanotechnology - A Historical Perspective, definition of nanoscale with special reference to biosystems, scope and future prospects of Nanotechnology, Nanobiotechnology and Bionanotechnology, Opportunities and Challenges of Bionanotechnology; Limitations of micron size, need for nano-size—surface volume ratio significance, significance and key features of nano-size, derivation of Bohr's atomic radius of a hydrogen atom, comparison of particle behavior at nano-size to Macro Size: Gold and Titania, advantages of scaling down—nano-size.

UNIT II

Synthesis and Characterization of Nanomaterials: Synthesis of Nanomaterials – Top-down and bottom up approaches with examples, physical, chemical and biological methods, characterization of nanomaterials- Optical (UV-Visible/fluorescence), X-ray diffraction, Imaging and size- (Electron Microscopy- SEM, TEM), Atomic force microscopy, Scanning tunneling microscopy, Spectroscopy- NMR, Raman FT-IR and Plasma Resonance.

UNIT III

Nanostructures: Smart materials, nanoscale biostructures, carbon nanotubes, nanowires, nanoshells, quantum dots, dendrimers, nanosomes, liposomes, virosomes, polymersomes.

UNIT IV.

General Applications Of Nanobiotechology: Application of nanotechnology in medical diagnosis, drug discovery, drug development, drug delivery, Photodynamic Therapy.

UNIT V

Current applications of Nanobiotechology: Application of nanotechnology in Protein Engineering, Tissue engineering, Agriculture, Environment, food processing, Nanotechnology and Nanoparticles: Clinical, Ethical, and Regulatory Issues.

Text Books:

1. Christof M. Niemeyer and Chad A. Mirkin, "Nanobiotechnology: Concepts, Applications and Perspectives" Wiley Publishers, April 2004.
2. Mark Ratner and Daniel Ratner, " Nanotechnology: A Gentle Introduction to Next Big Idea", Low Price edition, Third Impression, Pearson Education.

Suggested Reading:

1. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.
2. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon S hahidi, "Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley -Blackwell, 2013.
3. Elisabeth S P, Aravind P, "Bionanotechnology", Morgan & Claypool publishers, 2007.

With effect from the Academic Year 2020-21

18MT O01B

Numerical Methods
(For Bio-Technology only)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Learn interpolation and extrapolation techniques to fit the numerical tabulated data.
2. Numerical integration to get approximate solution of given date using Simpson's 1/3 rd, 3/8th Weddle's rules
3. Numerical differentiation to get approximate solution of ODE using Taylor, Picard's , Euler's, modified Euler's , Runge kutta methods.
4. Algebraic and transcendental equations.
5. Solve simultaneous equations when the number of unknown increases by iterative methods and ill condition and well condition equations.

Course Outcomes: On the successful completion of this course, the student shall be able to

1. Compute the interpolation and extrapolation techniques to fit the numerical tabulated date.
2. Apply the numerical integration of given data using Simpson's 1/3 rd, 3/8th Weddle's rules
3. Evaluate numerical differentiation to get an approximate solution of ODE using Taylor, Picard's , Euler's, modified Euler's , Runga kutta methods.
4. Solve algebraic and transcendental equations.
5. Solve initial value problems by using Numerical Differential Equations.

UNIT-I: Solutions of Algebraic and Transcendental Equations: Method of Bisection, Regular Falsi Method (method of false position); Newton Raphson Method, Approximate solution of equations by Horner's method.

UNIT-II: Solutions of Simultaneous Equations: Gauss elimination method, Jacobi iteration Method, Gauss Seidel Method of Iteration, Solutions of Non-Linear simultaneous equations by Newton Raphson method.

UNIT III: INTERPOLATION: Finite difference operators, Newton's forward and backward interpolation formulas, Newton's divided difference interpolation for unequal intervals, Lagrange's interpolation, inverse interpolation.

UNIT IV: NUMERICAL DIFFERENTIATION & INTEGRATION: Numerical differentiation using Newton's forward & backward interpolation formulas, and Newton's divided difference interpolation formula. Numerical integration: Simpson's 1/3 rd, 3/8th rules. Weddle's rule.

UNIT V: NUMERICAL SOLUTIONS FOR DIFFERENTIAL EQUATIONS: Solution of differential equation: Taylor's method, Picard's method, Euler's method, modified Euler's method, Runga kutta fourth order method.

Text Books:

1. Numerical Methods by S. S. Shastry
2. Numerical Analysis for Scientists and Engineers- by Mittal
3. Numerical and statistical Methods in Computer by V.K.Singh

Suggested Reading:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 35th Edition, 2010.
2. Miller and Freund, "Probability and Statistics for Engineers", PEARSON, 2005.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

18EC O02

BIOMEDICAL INSTRUMENTATION
(Open Elective - I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. To understand the physiological systems, present in the human body.
2. To understand the application of electronic systems used in modern healthcare.
3. To acquire, process and analyses Bio medical signals.

Course Outcomes:
At the end of the course, the students are able to:
1. Describe the physiological, physical and chemical background of the most common bioelectrical phenomena.
2. Understand the electrode theory, different types of electrodes and transducers required to detect bioelectric signals.
3. Elucidate cardiovascular system, human assist devices and other physiological measurements.
4. Analyze and compare the different medical imaging systems using computers.
5. Explain patient monitoring systems through bio-telemetry and realize safety requirements of biomedical instrumentation.

UNIT-I
Introduction to Bio Medical Instrumentation: Components of the Man-Instrument system, Physiological systems of the body, Problems encountered in measuring a living system. Sources of Bio electric potentials: Resting and action potentials, propagation of action potentials, Bio electric potentials.

UNIT-II
Basic Transducer Principles: Transducer principles, active and passive transducers, their bio medical applications.
Electrodes: Electrode theory, bio potential electrodes, bio chemical transducers.

UNIT-III
Cardiovascular System: The heart and cardiovascular system, the heart, blood pressure, blood flow, heart sounds, ECG, Measurement of blood pressure, blood flow, cardiac output, and heart sounds and PCG. Patient care and monitoring systems: Elements of Intensive care systems, patient monitoring systems, other instruments, organization of the hospital for patient care monitoring, pace makers, defibrillators.

UNIT-IV
Bio Medical Amplifiers: Basic requirements, differential amplifier, carrier amplifier, chopper amplifier, phase sensitive detector. EEG: Signal sources, EEG recording, applications of EEG. EMG: Surface and needle electrodes, EMG, measurement of conduction velocity, ERG and EOG

UNIT-V
Bio telemetry: Introduction, physiological parameters adaptable to biotelemetry, components of telemetry system, implantable units, applications of telemetry in patient care. Computer in Biomedical instrumentation: digital computer, microprocessor, interfacing computer with other medical equipment, biomedical computer applications, Introduction to CAT scanner. X-Ray: X-ray unit, radiation therapy, Introduction to MRI.

Text Books:

1. LeslieCromwell, Fred J Weibell andErich A.P Feiffer,'Bio Medical Instrumentation and Measurements', PHI, 2nd edition, 2003.
2. C Raja Rao and SK Guha, 'Principles of Medical Electronics and Bio Medical Instrumentation', Universities press, 2013.

Suggested Reading:

1. R.S Khandpur, 'Handbook of Biomedical Instrumentation', McGraw-Hill Education, 3rd edition, 2014
2. Andrew G. Webb, 'Principles of Biomedical Instrumentation', Cambridge University Press, 2017

18ME O03

RESEARCH METHODOLOGIES
(Open Elective - I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To make the students to formulate the research problem
2. To identify various sources for literature review and data collection.
3. To prepare the research design
4. To equip the students with good methods to analyze the collected data
5. To explain how to interpret the results and report writing

Course Outcomes:

At the end of the course, the students are able to

1. Define research problem.
2. Review and assess the quality of literature from various sources.
3. Understand and develop various research designs.
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square.
5. Improve the style and format of writing a report for technical paper/ Journal report.

UNIT – I

Research Methodology: Objectives and Motivation of Research, Types of Research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Research Approaches, Significance of Research, Research Methods verses Methodology, Research process, Criteria of Good Research, Problems Encountered by Researchers in India, Technique involved in defining a problem.

UNIT–II

Literature Survey: Importance of Literature Survey, Sources of Information-primary, secondary, tertiary, Assessment of Quality of Journals and Articles, Information through Internet.

UNIT – III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Steps in sample design

UNIT – IV

Data Collection: Collection of primary data, Secondary data, Measures of central tendency-mean, mode, median, Measures of dispersion- Range, Mean deviation, Standard deviation, Measures of asymmetry (skewness), Important parametric tests -z, t, F, Chi-Square, ANOVA significance

UNIT – V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. Research Proposal Preparation- Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Text Books:

1. C.R Kothari, “Research Methodology, Methods & Technique”, New Age International Publishers, 2004.
2. R. Ganesan, “Research Methodology for Engineers”, MJP Publishers, 2011

Suggested Reading:

1. Vijay Upagade and Aravind Shende “Research Methodology”, S. Chand &Company Ltd., New Delhi, 2009
2. G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.
3. Naval Bajjai, “Business Research Methods”, Pearson2011.
4. Ratan Khananabis and Suvasis Saha, “Research Methodology”, Universities Press, Hyderabad, 2015

18BT C24

FERMENTATION LAB

Instruction	2 P Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objectives:

To provide the hands on training to students and practically prove the theoretical concepts with respect to integrated bioprocess

Course Outcomes:

At the end of the course the students are able to

1. Demonstrate the working and ancillaries of bioreactor.
2. Examine the favorable conditions for growth of microorganism.
3. Analyze the batch vs fed batch culture techniques.
4. Evaluate the growth kinetics of microorganisms.
5. Develop and Design a statistical method for production process.

LIST OF EXPERIMENTS

1. Bioreactor instrumentation and control.
2. Isolation of microorganisms from soil or water samples for commercially useful ended experiments(open ended)
3. Preparation of Media and measuring viscosity.
4. Sterilization of Media and Air.
5. Estimation of specific growth rate and doubling time of a microorganism
6. Growth of E.coli using Batch fermentation technique
7. Growth of E.coli using Fed batch culture techniques.
8. Optimization of citric acid production from *A.niger* using Plackett-Burman method
9. Estimation of biomass (dry weight), substrate and product analysis post citric acid fermentation.
10. Estimation of Monod parameters for determining growth kinetics.(structured)
11. Production of Lactic acid by using batch reactor.

Suggested Reading:

1. Gopal Reddy M, M.N. Reddy, D.V.R. SaiGopal and K.V. Mallaiah , "Laboratory Experiments in Microbiology",3rd edition, Himalaya Publishing House Pvt Ltd,2008,
2. Gunasekaran P., "Laboratory manual in Microbiology", 3rdedition, New Age International Publ., New Delhi, 2007.
3. Kannan N., "Laboratory manual in General Microbiology", 1st edition, Panima Publishing Corp., New Delhi, 2002.

18BT C25

BIOINFORMATICS LAB

Instruction	2 P Hours per week
Duration of SEE	2 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1

Course Objective:

To provide practical instructions to the students on using the specific databases and learn how to use these resources on their own and analysis the output.

Course Outcomes:

At the end of the course the students are able to

1. Retrieve the information from biological databases
2. Utilize BLAST, FASTA and some online tools
3. Use and compare the online sequence alignment tools
4. Construction evolutionary tree by phylogenetic analysis
5. Predict gene and protein structure and design primers and construct restriction map.

LIST OF EXPERIMENTS

1. Searching Bibliographic databases for relevant information.
2. Sequence retrieval from DNA and Protein databases.
3. BLAST services.
4. FASTA services.
5. Pair wise comparison of sequences (Local and global alignment).
6. Multiple Sequence Alignment.
7. Evolutionary studies/Phylogenetic Analysis.
8. Protein Databank retrieval and visualization.
9. Structure Exploration of Proteins.
10. Restriction Mapping (Structured enquiry)
11. Identification of Genes in Genomes.
12. NCBI ORF Finder.
13. Primer Design (Open ended experiment)

Suggested Reading:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.

With effect from the Academic Year 2021-22

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of VII Semester of B.Tech Bio-Technology as per AICTE Model Curriculum 2021-22

B.Tech (Bio-Technology)

SEMESTER-VII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1	18BT C26	Downstream Processing	3	-	-	3	30	70	3
2	18BT C27	Plant Biotechnology	3	-	-	3	30	70	3
3	18MT C08	Biostatistics	3	-	-	3	30	70	3
4		**Core Elective V**	3	-	-	3	30	70	3
5		**Open Elective II**	3	-	-	3	30	70	3
	PRACTICALS								
6	18BT C28	Downstream Processing Lab	-	-	3	3	25	50	1.5
7	18BT C29	Tissue Culture Lab	-	-	3	3	25	50	1.5
8	18BT C30	Project Part 1	-	-	4	-	50	-	2
Total			**15**	**-**	**10**	**-**	**250**	**450**	**20**
Clock Hours Per Week – 25									

L: Lecture T:Tutorial P:Practical
CIE – Continuous Internal Evaluation SEE - Semester End Examination

Core Elective V	
18BT E14	Animal Biotechnology
18BT E15	Cancer Biology
18BT E16	Computer Applications in Bioprocess
18BT E17	Principles of data analytics

Open Elective II	
18 CS O13	Block chain technologies
18CS O04	Basics of Data Science Using R
18EG O01	Technical Writing
18EE O05	Waste Management

18BT C26

DOWNSTREAM PROCESSING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Student is made to understand the role and, importance of downstream processing.
2. Students are taught the various techniques of cell disruption and the principles of solid liquid separation processes, filtration and centrifugation
3. Students are made to understand the principles of membrane based separations and their applications.
4. Students are enlightened about chromatographic separations, types and their importance in product purification.
5. Students are made to study the principle of crystallization, drying and lyophilisation.

Course Outcomes:

At the end of the course the students are able to

1. Explain the key aspects of downstream processing from both a technical and economic perspective.
2. Describe the various techniques of cell disruption and unit operations for separation of insoluble.
3. Compare and contrast various membrane separation processes.
4. Interpret application of various chromatographic process for separation of bioproducts.
5. Analyze various case studies involving high throughput and low value, Low throughput and high value products.

UNIT-I

Role Of Downstream Processing In Biotechnology: Role and Importance of Downstream Processing in Biotechnological Processes; Characterization of Biomolecules and fermentation broths; Physico-Chemical basis of Bio-separations; Characteristics of Bio-separations; Process design criteria for bioproducts; Downstream process economics.

UNIT-II

Primary Separation And Recovery Processes: Cell Disruption methods for intracellular products-Mechanical, Chemical and Enzymatic Methods; Removal of Insolubles, Biomass separation techniques; Flocculation; Sedimentation; Centrifugation; Filtration: Theory, Equipment-Depth filters, Plate and frame filters, Pressure leaf filters, Continuous rotary drum filters, filter media and filter aids, Problems on specific resistance of the cake, time taken for filtration and, compressibility of cake.

UNIT-III

Product Enrichment Operations: Membrane-based separations-Types of membranes, solution diffusion model, capillary flow model; Types of flow-Cross flow, Tangential flow and mixed flow; Types of membrane based separations: Micro-filtration, Ultra-filtration, Dialysis, Electro dialysis, Reverse Osmosis; Theory, design and configuration of membrane separation equipment, Applications; Aqueous Two-phase extraction of proteins; Precipitation of proteins with salts and organic solvents; Adsorption processes.

UNIT-IV

Product Purification: Chromatographic separations- Principles, Classification, General description of column chromatography; IMAC, Bio-affinity Chromatography; Design and selection of chromatographic matrices; Design of large-scale chromatographic separation processes

UNIT-V

Finishing techniques: Pervaporation, super critical fluid extraction; Electrophoretic Separations; Final Product Polishing- Crystallization: nucleation, crystal growth, Industrial crystallizers, Drying: drying terminologies, drying curve, Industrial dryers, Lyophilization: principles and applications; Case studies (Citric acid / Penicillin and Low volume high value product like recombinant proteins).

Text Books:

1. Sivasankar B, J M Asenjo, Separation processes in Biotechnology, Marcel-Dekker, 1993.
2. Keith Wilson, John Walker, John M. Walker, Principles and Techniques of Practical Biochemistry 5th edition Cambridge University Press, 2000.

Suggested Reading:

1. Nooralabettu Krishna Prasad, Downstream Process Technology by PHI publications.

With effect from the Academic Year 2021-22

18BT C27

PLANT BIOTECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Enable the students to understand explicitly the basic concepts and applications of Plant Tissue culture.
2. To understand the developmental pathways of callus induction and plant regeneration.
3. To understand the techniques for production of secondary metabolites in *in vitro* using plant cell and tissue culture.
4. To understand the methods of gene transfer in plants for production of Transgenics.
5. To understand the various strategies and sources of transgenes for crop improvement.

Course Outcomes:

At the end of the course the students are able to

1. Describe the theoretical concepts behind establishment of in vitro techniques.
2. Explain the importance and applications of various in vitro techniques.
3. Identify methods used for the production of plant secondary metabolites in in vitro at commercial scale.
4. Analyze the appropriate vectors and gene transfer methods for production of Transgenics.
5. Outline the strategies for the production of transgenics for crop improvement and safety regulations.

UNIT-I

Introduction To Plant Tissue Culture: Introduction to cell and tissue culture: History, Totipotency, Plasticity, Cell Theory, Tissue culture media (composition, preparation); Sterilization techniques; Callus and cell suspension culture; Organogenesis and Embryogenesis and their applications.

UNIT-II

Tissue Culture In Crop Improvement: Micropropagation of virus-free plants; Somaclonal variation; Haploids in plant breeding; Germplasm conservation (Cryopreservation). Protoplast isolation, culture and fusion, Somatic hybridization and its applications.

UNIT-III

Molecular Farming & Industrial Products: In vitro production of short chain and long chain fatty acids; Industrial enzymes; Edible vaccines. Production of secondary metabolites from plant cell cultures using Cell suspension cultures, Immobilized cell systems, Precursor feeding (elicitation) and hairy roots. Bioreactor systems and models for mass cultivation of plant cells.

UNIT-IV

Plant Genetic Engineering - I Techniques: Agrobacterium mediated gene transfer; Plant vectors and their use in genetic manipulation; Direct gene transfer methods: electroporation, microinjection, particle bombardment and chemical methods.

UNIT-V

Plant Genetic Engineering - II Productivity and Safety Regulations: Transgenics in crop improvement: Biotic Stress resistance: Herbicide, Insect, Disease, virus etc., Abiotic stress tolerance: Drought, Temperature, Salt. Transgenics for improved nutritional quality, storage, longer shelf life. Environmental impact and gene flow.

Text Books:

1. Bhojwani SS and Razdan, “Plant Tissue Culture Theory and Practice”, Elsevier Science, 2004.
2. Chawla HS, “Introduction to Plant Biotechnology”, 4th edition, Oxford and IBH publishers, 2002.

Suggested Reading:

1. Nigel G Halford, “Plant Biotechnology : Current and future applications of genetically modified crops”, John Wiley & Sons Ld. 2006
2. Surabh Bhatia, Kiran Sharma, RandhirDahiya and, TanmoyBera, “Modern applications of Plant Biotechnology in Pharmaceutical Sciences”, Elsevier publication, Academic press, 2015.

With effect from the Academic Year 2021-22

18MT C08

Bio-Statistics
(For Bio-Technology only)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Learn the language and core concepts of probability theory.
2. Understand basic principles of Random variable and probability distributions
3. Understand the concept of Statistical Inference
4. Understand the construction of fitting of linear curves.
5. Learn the methods for analyzing one way classification of data.

Course Outcomes: On the successful completion of this course, the student shall be able to

1. Compute counting techniques to Statistical Methods
2. Recite conditional probabilities using Bayes Theorem
3. Define and classify discrete and continuous Random Variables and Probability Distributions
4. Calculate confidence intervals and illustrate parameter estimation
5. Test the classification for analyzing the data

UNIT-I: DISCRIPTIVE STATISTICS: Types of data – Methods of collection of data-Graphical representation of data-Histogram-frequency polygon-Pie chart. Frequency distribution, Measures of central tendencies, Measures of dispersion (mean deviation and standard deviation) coefficient of variation and its significance, Measures of dispersion, Skewness, Kurtosis-Boweyls coefficient, Karl Pearson's coefficient of skewness- correlation-Lines of regression- applications of Bio-technology.

UNIT-II: PROBABILITY: Classical approach- Axiomatic approach of probability, Basic theorems addition and product theorem, conditional probability, Baye's theorem- applications to Biotechnology.

UNIT-III: PROBABILITY DISTRIBUTIONS: Random variable- types of Random variable-probability mass function-probability density functions-Expectation, variance, co variance and their properties. Probability function-Moment generating function (mgf), Cumulant generating function(cgf) and Characteristic function C(t).Discrete Distributions- Binomial distribution, Poison distribution-their expectation, mgf, cgf and C(t) Continuous distributions: Normal Distribution- mean, variance, m.g.f and c.g.f. Properties of Normal distribution.

UNIT- IV: INFERENCIAL STITISTICS -I: Estimation-Hypothesis-Testing of Hypothesis-Types of Errors. Testing the single sample mean (σ-known), Testing of single sample mean (σunknown), Testing the single sample proportion, single sample variance, Testing the differences between two means, two proportions and two variances. Testing of n-proportions- 2-test.

UNIT-V: INFERENCIAL STITISTICS –II: Testing of many proportions-2-test independent of attributes-r x c-tables. Analysis of variance-CRD.

Text Books:

1. P.S.S Sunder Rao and J.Richard, “Introduction to Bio-Statistics and Research Methods” fifth edition, PHI Learning Pvt. Ltd.2012.
2. S.C.Gupta and Dr.V.K.Kapoor, “Fundamentals of Applied Statistics”, tenth edition, Publishers: Sultan Chand & Sons,2005

Suggested Reading:

1. Mahajan, “Methods in Bio-Statistics”,Japee Brothers Publishers, 2002.
2. A.K.Sharma ,”Text Book of Bio-Statistics”; Discovery Publishing House, 2005.
3. S.C.Gupta and Dr.V.K.Kapor, “Fundamentals of Mathematical Statistics: A Modern Approach”, tenth edition, Publishers: Sultan Chand & Sons, 2005.

18BT E14

ANIMAL BIOTECHNOLOGY
(Core Elective - V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Students are expected to understand the techniques used for animal cell culture.
2. Students will learn various steps involved in the establishment of primary culture, maintenance and scale up of animal cells.
3. Students will know about measurement of cell viability & cytotoxicity and cell death.
4. Students are expected to know about stem cells and their applications.
5. Students will know about IVF and embryo transfer, cloning and gene transfer methods for generation of transgenic animals and its applications.

Course Outcomes:

At the end of the course the students are able to

1. Explain the animal cell culture requirements and techniques.
2. Outline the establishment maintenance and scale up of animal cell culture.
3. Discuss about Stem cells and their applications and procedure for measurement of cell viability and cytotoxicity and cell death.
4. Explain various methods for IVF and embryo transfer, cloning and generation of transgenic animals and their applications.
5. Outline various applications of animal biotechnology.

UNIT-I

Animal Cell Tissue Culture: History and scope of animal cell tissue culture, advantages and disadvantages of tissue culture; Laboratory facilities for animal tissue culture; Aseptic techniques; the substrate on which cells grow; Treatment of substrate surfaces; Culture media for cells and tissues.

UNIT-II

Primary Culture and Cell Lines: Disaggregation (Enzymatic and Mechanical) of tissue and Primary culture. Culture cells and evolution of cell lines. Maintenance of cultures- Cell lines, Cell separation, Cell synchronization; Cloning of cell lines; Cell transformation; Bioreactors for animal cell culture; Scaling-up of animal cell culture.

UNIT-III

Stem Cells, Cell Viability and Toxicity: Stem cells, types of stem cells, embryonic stem cells and their applications; Measurement of cell viability and cytotoxicity, Measurement of cell death; Senescence, Apoptosis, Necrosis.

UNIT-IV

Embryo Transfer, Cloning and Transgenic Animals: Artificial insemination, in vitro fertilization and embryo transfer; Cloning of animals - Reproductive cloning, Therapeutic cloning; Gene transfer or Transfection methods; Transgenic animals- Mice, Sheep, Pig, Rabbit, Goat, Cow and fish.

UNIT-V

Applications of Animal Biotechnology: Application of animal cell culture; Mammalian cell products; viral vaccines produced from animal cell cultures. Three dimensional culture; Tissue engineering.

Text Books:

1. Ian Freshney, R., "Culture of Animal Cells: A manual of basic technique and specialized applications" Seventh edition, John Wiley and Sons,2016.
2. John Masters, "Animal Cell culture: A practical approach" OUP Oxford,2000.
3. Gupta P.K., "Biotechnology and Genomics" Rastogi Publications, 1st edition, 6th reprint,2013.

Suggested Reading:

1. Srivastava, A.K., Singh, R.K., Yadav, M.P., "Animal Biotechnology" Oxford & IBH Publishing Co. Pvt. Ltd.,2005.
2. Ranga, M.M., "Animal Biotechnology", 3 reprint, Agrobios, India,2010.

18BT E15

CANCER BIOLOGY
(Core Elective - V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To understand the fundamentals of cancer biology.
2. To know the importance of physical and chemical carcinogens and their effects on cell cycle.
3. To learn the Molecular aspects of cell cycle control.
4. To learn the theories of metastasis, diagnosis and treatment of cancer.
5. To understand the principles of cancer pharmacology

Course Outcomes:

At the end of the course the students are able to

1. Summarize the etiology of cancer.
2. Explain the principles and mode of action of physical and chemical carcinogens.
3. Discuss the molecular genetics of cancer.
4. Outline the cancer metastasis, diagnosis and different forms of therapy
5. Describe the principles of cancer pharmacology.

UNIT-I

Fundamentals Of Cancer Biology: Definition and hall marks of cancer, Cell cycle control, regulation of the cell cycle by cyclins, cyclin-dependent kinases, cdk inhibitors, Mutations that cause changes in signal molecules, Effects on receptor, Tumor suppressor genes, Different forms of cancer(Case studies for carcinoma ex: breast cancer and stomach cancer), Diet and cancer.

UNIT-II

Principles Of Carcinogenesis: Natural History of Carcinogenesis, Types of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, Ionizing radiation and UV radiation mechanism of Carcinogenesis.

UNIT-III

Principles Of Molecular Cell Biology Of Cancer: Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, Detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes, Activation of protooncogens to oncogens.

UNIT-IV

Cancer Metastasis And Treatment: Metastasis, Classic theory of tumor Metastasis, Clinical significance of invasion, Three-step theory of invasion (Basement Membrane disruption, role of Proteinases in tumor invasion and tumor cell locomotion). Diagnosis of cancers, Advances in Cancer detection (Biomarkers technology and nanotechnology), Different forms of therapy- Chemotherapy, Radiation therapy and immunotherapy. , Advances in Cancer therapy

UNIT-V

Principles Of Cancer Pharmacology: Pharmacokinetics and pharmacodynamics of antineoplastic drugs. Metabolism of anticancer drugs, inter individual differences in response to anticancer drugs, mechanisms of anticancer drug resistance, mechanism of gene silencing (antisense, ribozymes, RNAi) and chemoprevention studies.

Text Books:

1. FranksLM and N.M.Teich, "Introduction to Cellular and Molecular Biology of Cancer", 2nd edition, Oxford Medical Publications, 1991.
2. Raymond W. Ruddon "Cancer Biology", 3rd edition, Oxford University Press, USA1995.
3. King, Roger J B, Robins, Mike W, "Cancer Biology", 3rd edition, Prentice Hall, USA. 2003.

Suggested Reading:

1. Fiona Macdonald, Christopher Ford, Alan Casson, "Molecular Biology of Cancer", 2nd Edition, Taylor & Francis, 2004.
2. Robert A. Weinberg, "The Biology of Cancer", 5th edition, Garlan

18BT E16

COMPUTER APPLICATIONS IN BIOPROCESS
(Core Elective - V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. This course aims at providing knowledge on basic concepts in software development processes, Algorithm design and Process Models.
2. The course is designed to give an understanding on obtaining. solutions of differential equations by Euler`s, Modified Euler`s, Runge-Kutta methods
3. This course aims at providing an insight into the solution of set of simultaneous equations by Gauss elimination, Gauss Jordan and Gauss Seidel methods.
4. The aim of the course is also to give the students an understanding of obtaining solutions of numerical methods.

Course Outcomes:

At the end of the course student are able to

1. Distinguish between different process models
2. Formulate process models leading to set of ordinary differential equations and solution procedures numerical methods.
3. Formulate process models leading to set of linear simultaneous equations and solution procedures.
4. Formulate process models leading to transcendental and polynomial equations and solution procedures.
5. Understand the steps involved in optimization that are a prerequisite for the development of process flow sheets and optimize biochemical process.

The Programs are to be written in C only

UNIT-I

Computers and Software: Computing environments, the software development processes, Algorithm design, Program composition, Quality Control, Documentation, Storage and •Maintenance, Software strategy. Process Models: Uses, Distributed & Lumped parameter models, Linear and Nonlinear models, Steady state and Dynamic models, Continuous and Discrete models, Empirical models. Formulation of Process Models: Momentum, mass and energy balances, constitutive rate equations, transport rate equations, biochemical kinetic rate expressions, thermodynamic relations. Review on "C" Language Fundamentals.

UNIT-II

Function Approximation: Function Approximations by Linear and nonlinear least square analysis, Formulation Process Models leading to set of ordinary differential equations and solution procedures by Eulers, Modified Eulers and RungeKutta methods.

UNIT-III

Formulation of Process Models : Formulation of Process Models leading to set of linear simultaneous equations and solution procedures by Method of determinants, Gauss Elimination, Gauss Jordan, Jacobi and Gauss-Seidel methods.

UNIT-IV

Process Models Leading to Transcendental and Polynomial Equations:

Formulation of Process Models leading to transcendental and polynomial equations and solution procedures by Bisection, Reguli-falsi, Newton Raphson, Richmond, Muller's and Bairstow methods

UNIT-V

Process Optimization : Nature and organization, basic concepts and elements of Optimization, Scope and hierarchy of optimization, Essential features and general procedure of optimization problems and applications of optimization , single variable functions, direct, indirect and random search methods – with and without acceleration Elimination methods for unrestricted and exhaustive search, Fibonacci search, Dichotomous search, Golden-section (gradient) search methods.

Text Books:

1. DR. B.S. Grewal, Higher engineering mathematics Khanna publishers, 1998.
2. Steven C. Chapra and Raymond P Canale, Numerical methods for Engineers 2nd edition, MCGraw Hill International edition,1988.

Suggested books:

1. Henry R. Bungay Computer Applications in Bioprocessing Volume 70 Springer, 2000.
2. Edger T.E., and Himmelbau D.M., "Optimization of chemical processes", McGraw Hill international edition, 1988 3. Bioprocess engineering Enrique Galindo and Octavio T. Ramírez Volume 16, Issue 7, 1998.

18BT E17

PRINCIPLES OF DATA ANALYTICS
(Core Elective - V)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives

1. Students were made to understand about the concepts of Statistical methods for designing experiments, collection of data and estimating the probability
2. Students were taught about design of experiments, about null and alternate hypothesis and decision making
3. Students were made aware of how to understand the relationship between the given data and predictive analytics
4. Students were taught the concepts of identification of differences in given data by analysis of variance and multivariate analysis
5. Students are enlightened about the concepts of clustering of the biological data, dimensionality reduction to represent entire data

Course Outcomes

At the end of the course, the students are able to

1. Students gains knowledge how to collect data and also apply appropriate method for statistical analysis.
2. Students would learn how to make proper decisions by understanding the results derived out of the statistical analysis performed.
3. Students would learn how to build relationships between the parameters in the given data and also would learn how to predict the future outcomes.
4. Students would learn the basic differences between the obtained data and can judge about the possible causative factors responsible for the given cause.
5. Students can use these concepts such as clustering and PCA in handling the data obtained from next generation sequencing and can learn about the genotypes and phenotypes.

Unit I

Introduction: Scientific method; Experiments and other tests; Data, observations and variables; Probability; Probability distributions

Estimation: Samples and populations; Common parameters and statistics; Standard errors and confidence intervals for the mean; Methods for estimating parameters; Resampling methods for estimation; Bayesian inference – estimation.

Unit II

Hypothesis testing: Statistical hypothesis testing; Decision errors; Multiple testing; Combining results from statistical tests; Bayesian hypothesis testing

Graphical exploration of data: Exploratory data analysis; Analysis with graphs; Transforming data; Standardizations; Outliers; Censored and missing data;

Unit III

Correlation and regression: Correlation analysis; Linear models; Linear regression analysis; Smoothing; Power of tests in correlation and regression; Multiple linear regression analysis; Regression trees; Nonlinear models

Design and power analysis: Sampling; Experimental design; Power analysis; Analysis of variance- Single factor (one way) designs, Factor effects, ANOVA diagnostics and Robust ANOVA

Unit IV

Analyzing frequencies: Single variable goodness-of-fit tests; Contingency tables; Log-linear models;

Multivariate analyses: Multivariate data; Distributions and associations; Linear combinations, eigenvectors and eigen values; Multivariate distance and dissimilarity measures; Multivariate graphics; Multivariate analysis of variance (MANOVA); Discriminant function analysis

Unit V

Principal components and correspondence analysis-Principal components analysis; Factor analysis; Correspondence analysis; Canonical correlation analysis; Redundancy analysis

Multidimensional scaling and cluster analysis: Multidimensional scaling; Classification; Scaling (ordination) and clustering for biological data

Presentation of results: Presentation of analyses; Layout of tables; Displaying summaries of the data; Error bars

Text Books:

1. Experimental Design and Data Analysis for Biologists; Gerry P. Quinn & Michael J. Keough; Cambridge University Press
2. Beckerman, Childs & Petchey (2017) Getting started with R: An introduction for Biologists (2nd edition).Oxford University press.

With effect from the Academic Year 2021-22

18CS O13

BLOCKCHAIN TECHNOLOGIES
(Open Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Outcome

1. Student is made to understand about the concept of distributed systems, block chain technology
2. Student will understand about the what is cryptocurrency, its components and use
3. Student will understand the importance of bitcoin as an alternate for real currency, about its nature of transfer and other concepts
4. Student will understand the way to use hyperledger and its importance
5. Student will understand how implementation of blockchain technology will improve science and health sector

Unit I:

Introduction: Overview of distributed system; introduction to Blockchain; Properties of Blockchain; Evolution of Blockchain

Cryptocurrency And Blockchain: Anonymity and Pseudonymity in Cryptocurrency; Programmable Money; Hash Functions and MerkleTrees; Components of Blockchain Ecosystem; Cryptography and Consensus Algorithms; Types of Blockchain; Side Chains: another type of Blockchain; Blockchain Implementations; Blockchain Platforms

Unit II:

Bitcoin Platform: Bitcoin and its uses; Bitcoin Trading: Buying, selling and storing Bitcoins; Bitcoin Ecosystem; Structure of a Bitcoin Transaction; Scripting language in Bitcoin; Applications of Bitcoin script; Nodes in a Bitcoin Network

Bitcoin Mining: Bitcoin Economics; Bitcoin Mining and Types of Mining; Mining and Consensus; Assembling and selecting chains of blocks; Mining and the hashing race; Mining Pools

Unit III:

Introduction To Ethereum: What is Ethereum; Introducing Smart Contracts; Cryptocurrency in Ethereum; Mining in Ethereum; Consensus Mechanism in Ethereum; Platform Functions used in Ethereum; Technologies that support Ethereum; Ethereum Programming Language; Components for development of Ethereum DApps; Editors and tools; Frontend Development; Ethereum Test Networks; ERC Tokens

Basic Solidity : Introducing Solidity; Sample Code; Layout of Source File; Structure of a Contract; State Variables; Functions Types; Reference Types; Units; Special Variables and Functions; Expressions and Control Structures; Function Calls; Error Handling; Visibility for Functions and State Variables

Unit IV:

Hyperledger: Introduction to Hyperledger; Hyperledger architecture; Consensus; Hyperledger API and Application Model; Network Topology; Exploring Hyperledger frameworks; Business Network Deployment on Hyperledger Composer Playground; Setting up Development Environment using Hyperledger Composer; Introduction to Hyperledger Fabric; Creating Hyperledger Fabric Blockchain Network

Deploying Private Blockchain On MultiChain : What Is MultiChain; Privacy and Permissions in MultiChain; Mining in MultiChain; Multiple configurable Blockchains using MultiChain; Setting up a Private Blockchain

Unit V:

Blockchain in Science: Reproducibility Crisis; Clinical Trials; Reputation System; Pharmaceutical Drug Tracking-Prediction Markets and Augar

Blockchain in Health Care: Payer–Providers–Patient Model; Workflow-Hot Switching; Waste Management: Capital One, Ark Invest, and Gem

Text Books:

1. Mastering Bitcoin. Programming the Open Blockchain; Andreas M. Antonopoulos; O'Reilly, 2017
2. Bitcoin and Blockchain Security**;** Ghassan Karame, Elli Androulaki; Artech House, 2016.
3. Blockchainand Clinical Trial; Hamid Jahankhani et.al. Springer (2019)
4. Blockchain Enabled Applications; Vikram Dhillon et al, Apress (2019)

18CS O04

BASICS OF DATA SCIENCE USING R
(Open Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Pre-requisites: Probability and Statistics, basics of programming languages.

Course Objectives:

1. Understand R programming language.
2. Explore the programming skills needed to use R tool for statistical analysis of Biological data.
3. Analyze biological data.

Course Outcomes:

At the end of the course, the students are able to

1. Summarize the basics of R and in-built data visualization packages.
2. Describe the data analysis using Bayesian and stochastic modeling.
3. Relate Gibbs, Z- sampling distributions and compare the binomial, chi-square, Wilcoxon and Fisher's exact tests in hypothesis testing.
4. Explore the ANOVA in Regression analysis and classify the multivariate data.
5. Experiment with the biological data using R tool and apply clustering algorithms to biological data.
6. Identify R commands for data manipulation and database technologies for datasets of bioinformatics.

UNIT - I

Basics of R: Introduction, R features, setting up and exploring R environment, loading packages, types of data objects in R, working with R data objects, Controlling work space, importing files. Programming with R: Variables and assignment, operators, control structures, Functions-built-in, writing own functions, package creation.

UNIT - II

Data Analysis and Graphics: Data summary functions in R, Graphics technology in R, saving graphics, additional graphics packages. Bayesian Data Analysis: Need of Bayesian approach, Application of Bayes rule, Priors, Likelihood functions, evaluating the posterior, Applications of Bayesial Statistics in Bioinformatics. Stochastic Modeling: Stochastic process and Markov Processes, Classification of Stochastic processes, modeling a DNA sequence with Markov Chain, Characteristics of Markov Chain.

UNIT - III

MCMC using Brugs: ABO blood type example. Gibbs sampling. Statistical Inference: Sampling distributions, Parameter estimation, interval estimation, bootstrapping, R packages for bootstrapping. Hypothesis Testing: Package ctest, Binomial test, comparing variances, Wilcoxon tests, Chi-Square test, Fisher's Exact tests, Likelihood Ratio tests.

UNIT - IV

ANOVA and Regression: ANOVA table, perforating ANOVA using R, graphical analysis of ANOVA comparison, Regression: Correlations, linear regression model, fitting and testing of regression model, generalization of the model. Working with Multivariate Data: Multivariate data, sample statistics, display of multivariate data, outliers and principal components. Classification of discriminate analysis- classification with two population and more than two populations, cross validation classification trees.

UNIT - V

Clustering methods: measures of dissimilarities, K-means clustering, K-Medoid clustering, Hierarchical clustering-Agglomerate and divisive. R Packages: Bio-conductor and Seqin R.

Data Technologies: R for Data manipulation, example, Database technologies, Bioinformatics resources on the

WWW.

Text Books:

1. Kim Seefeld, Ernest Linder, "Statistics using R with Biological examples", 2007 (https://cran.r-project.org/doc/contrib/Seefeld_StatsRBio.pdf).
2. Robert Gentleman, "R Programming for Bioinformatics", 1st Edition, CRC Press, 2008.

Suggested Reading:

1. Arvil Cohhlan "A Little Book of R for Bioinformatics", Release 1.0, CC ver 3.0

Online Resources:

1. https://epdf.tips/r-programming-for-bioinformatics.html
2. https://epdf.tips/r-programming-for-bioinformatics.htmlhttps://www.cyclismo.org/tutorial/R/objectOriented.html
3. https://www.w3schools.in/r/object-oriented/

With effect from the Academic Year 2021-22

18EG O01

TECHNICAL WRITING SKILLS
(Open Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Process of communication and channels of communication in general and technical writing.
2. Technical Writing and also contextual use of technology specific words.
3. Business letters and technical articles.
4. Technical reports and technical proposals.
5. Transferring data from verbal to graphic and vice versa and making technical presentations.

Course Outcomes:

At the end of the course, the students are able to

1. Understand the channels of communication and define nature and aspects of Technical communication
2. Compare and contrast technical communication to that of general communication while constructing error free sentences applying features of technical writing.
3. Analyze data, draw inferences to write Journal articles and conference papers and to compose business letters.
4. Evaluate data to draft technical reports and technical proposals.
5. Design a technical presentation by understanding the nuances of presentation skills and also transfer data from verbal to graphic and vice versa.

Unit I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal and lateral communication. Barriers to communication.

Technical Communication – Definition; oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

Unit II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

Unit III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature significance and types of technical articles. Writing an abstract. Journal articles and Conference papers. Elements of technical articles.

Unit IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.

Technical Proposals: Definition, types, characteristics, structure and significance.

Unit V

Information Transfer – Graphic to verbal (written) and verbal to graphic.

Technical Presentations: Important aspects of oral and visual presentations.

Text Books:

1. Meenakshi Raman & Sangeeta Sharma, **"Technical Communications-Principles and Practice",** Oxford University Press, Second Edition, 2012.
2. 1.M Ashraf Rizvi, **"Effective Technical Communication",** Tata McGraw Hill Education Pvt Ltd, 2012.

Suggested Reading:.

1. .Kavita Tyagi & Padma Misra, **"Basic Technical Communication",** PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, **"Business Correspondence and Report Writing",** Tata McGraw Hill, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

With effect from the Academic Year 2021-22

18EE O05

WASTE MANAGEMENT
(Open Elective - II)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To imbibe the concept of effective utilization of any scrap
2. To become familiar with the processes of all disciplines of engineering.
3. To learn the technique of connectivity from waste to utility.

Course Outcomes:

At the end of the course, the students are able to

1. Understand the various processes involved in allied disciplines of engineering
2. Infer the regulations of governance in managing the waste
3. Distinguish the nature of waste materials concerned to the particular branch of engineering
4. Explore the ways and means of disposal of waste material
5. Identify the remedies for the disposal of a selected hazardous waste material

UNIT-I

Introduction to waste management: Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules. Municipal Solid Waste Management – Fundamentals Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options.

UNIT-II

Hazardous Waste Management : Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects, Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.

UNIT-III

Environmental Risk Assessment: Defining risk and environmental risk; methods of risk assessment; case studies, Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapor extraction, air stripping, chemical oxidation); ground water contamination and remediation

UNIT-IV

Biological Treatment: Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.

UNIT-V

Landfill design aspects: Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration

Text Books:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997

Suggested Readings:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L.Shah 1999, Prentice Hall.
2. Solid and Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & dist.

18BT C28

DOWNSTREAM PROCESSING LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

Course Objectives:

1. To provide an opportunity to experimentally verify the theoretical concepts studied.
2. To give extensive exposure to various unit operations of downstream processing.
3. To design protocol for separation of bioproduct based on characteristics

Course Outcomes:

At the end of the course the students are able to

1. Demonstrate chromatographic separation process for a given compound.
2. Apply a strategy for final product purification/ polishing of a bioproduct.
3. Analyze the optimum protein precipitation technique.
4. Evaluate various techniques for cell disruption and filtration.
5. Develop methods for determining enzyme activity.

List of Experiments:

1. Cell Disruption of microorganism using enzymatic method
2. Cell Disruption of plant cells / animal cells using physical methods
3. Liquid-liquid extraction.
4. Separation of solids from liquid by Sedimentation
5. Separation of microorganisms from fermentation broth by Microfiltration.
6. Separation of solute particles by Dialysis.
7. Separation of protein by Ammonium Sulphate Precipitation.(Structured expt)
8. Isolation and quantification of protein from milk by Isoelectric Precipitation.
9. Separation of biomolecules by Gel Exclusion Chromatography.
10. Purification of lysozyme from chicken egg white extract by Ion Exchange Chromatography.
11. Purification of proteins by Affinity Chromatography.
12. Simple distillation- vapor liquid equilibrium.
13. Solid liquid extraction./Drying technique
14. Alpha amylase activity (open ended expt)

Suggested Readings:

1. David Plummer, "An introduction to Practical Biochemistry" 3rd edition, John Wiley &Sons
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith John Walker John Walker, Cambridge University Press; 6 edition (2005).
3. Laboratory Manual in Biochemistry By J. Jayaraman, Kunthala Jayaramanj, New Age International

18BT C29

TISSUE CULTURE LAB

Instruction	3 P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

Course Objectives:

1. The students should be able to understand explicitly the concepts of Plant Tissue culture and Animal tissue culture.
2. Develop their skills in plant tissues culture techniques in horticultural/medicinally important plants.
3. Get extensive exposure to various techniques of plant cell and tissue culture.
4. To develop a protocol for genetic transformation using Agrobacterium strains.

Course Outcomes:

At the end of the course the students are able to

1. Prepare plant tissue culture medium for in vitro studies.
2. Execute the protocols for various plant tissue culture applications using cell suspension cultures.
3. Develop in vitro techniques for micropropagation of horticulture and medicinal plants.
4. Demonstrate the Protoplast isolation from various plant tissues using enzymatic method.
5. Develop a system for genetic transformation in plants using Agrobacterium strains

List of Experiments

1. Preparation of Plant tissue Culture Media
    - Preparation of MS stock solutions
    - Preparation of MS callus induction media
2. Surface sterilization
3. Callus induction from mature embryo.
4. Cell suspension cultures initiation and establishment
5. Organogenesis and Embryogenesis
6. Meristem tip culture for production of virus free plants
7. Micropropagation of horticultural/medicinally important plants (Open ended experiment)
8. Root induction and acclimatization of in vitro plantlets
9. Production of synthetic seeds. (Structured enquiry)
10. Protoplast isolation(demo)
11. Agrobacterium mediated gene transfer: induction of Hairy roots

Suggested Readings:

1. H. Jones and John M. Walker, “Plant Gene Transfer and Expression Protocols: Methods in Molecular Biology, 49, Humana Press, 1996.
2. J. G. Chirikjian, Biotechnology: Theory and Techniques (Plant Biotechnology, Animal Cell Culture and Immunobiotechnology), Jones & Bartlett Publishers, U.K., 1996.

With effect from the Academic Year 2021-22

18BT C30

PROJECT: PART-1

Instruction	3 Hours per week
CIE	50 Marks
Credits	2

The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D.

The work shall include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminaryAnalysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for Presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental Committee.

Guidelines for the award of Marks: Max. Marks: 50

Evaluation by	Max .Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Department Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

With effect from the Academic Year 2021-22

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of VIII Semester of B.Tech Bio-Technology as per AICTE Model Curriculum 2021-22

B.Tech (Bio-Technology)

SEMESTER-VIII

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours Per week			Duration of SEE in Hours	Maximum Marks		
			L	T	P		CIE	SEE	
	THEORY								
1		**Core Elective VI**	3	-	-	3	30	70	3
2		**Open Elective III**	3	-	-	3	30	70	3
	PRACTICALS								
3	18BT C31	Technical Seminar (On the latest trends and other than project)	-	-	2	-	50	-	1
4	18BT C32	Project Part II	-	-	20	Viva	100	100	10
Total			**6**	**-**	**22**	**-**	**210**	**240**	**17**
Clock Hours Per Week – 28									

L: Lecture T:Tutorial P: Practical

CIE – Continuous Internal Evaluation SEE - Semester End Examination

Core Elective VI	
18BT E18	Tissue Engineering
18BT E19	Immunodiagnostics
18BT E20	Genomics and Proteomics

Open Elective III	
18ME O04	Entrepreneurship
18CS O08	Open Source Technology
18CS O01	Python for Bioinformatics

Credit Summary for B. Tech Biotechnology									TOTAL CREDITS
Semester	I	II	III	IV	V	VI	VII	VIII	
Credits	20.5	21.5	20	20	21	20	20	17	**160**

18BT E18

TISSUE ENGINEERING
(Core Elective-VI)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives

1. To provide fundamental principles and elements of tissue engineering.
2. To get insight about the roles of cells, tissue organization and matrix in tissue engineering.
3. To learn the tissue culture techniques and scale up designs.
4. To learn the different biomaterials used for the fabrication of scaffolds.
5. To gain knowledge about the therapeutic applications of tissue engineering.

Course Outcomes:

At the end of the course students will be able to

1. Outline the concepts of tissue engineering, ethical issues, and future prospects
2. Illustrate the molecular mechanisms at tissue level and in cell matrix in tissue engineering.
3. Identify in vitro culturing techniques and scale up designs.
4. Classify the compatible biomaterials used for fabrication of scaffolds in Tissue engineering.
5. Summarize the therapeutic applications of tissue engineering.

UNIT-I

Introduction to Tissue Engineering: Basic definition of Tissue engineering; origin and history of Tissue Engineering, overview of its basic steps and its applications; General scientific issues, Ethical issues; current challenges and future prospective.

UNIT-II

Cells and Tissue Organization: Cells- cell growth and death; cell differentiation; Cells in tissues and organs. Cell to cell interactions; cell adhesion molecules (CAM) Organization of cells into higher ordered structures- Mesenchymal cells; EMT, Molecular mechanisms and control of EMT process. Tissues- Vascularity; angiogenesis; wound healing. Extra cellular matrix (ECM) –components.

UNIT-III

Functional Tissue Engineering: Cell and tissue culture- media; culture initiation; transformation and immortalization; validation; differentiation; maintenance of cells in vitro; cryopreservation. Stem cells in tissue engineering Bioreactors for tissue engineering- Bioreactor design requirements; Spinner flask bioreactors. Rotating-wall bioreactors, Compression bioreactors, Strain bioreactors, Hydrostatic pressure bioreactors, Flow perfusion bioreactors, Combined bioreactors

UNIT-IV

Biomaterials of Tissue Engineering: Scaffolds- fabrication; 3D scaffolds Biodegradable polymers; synthetic polymers; hybrid of synthetic and biological polymers; prosthetic devices. Engineering biomaterials for tissue engineering.

UNIT-V

Applications of Tissue Engineering: Tissue replacement –crucial factors Skin grafting Bone tissue engineering; Cardiac tissue engineering; Neural tissue engineering; Vascular tissueengineering;

Text Books:

1. Robert.P.Lanza, Robert Langer & Vacanti, Principles of tissue engineering. Academic Press. 2nd edition2000.
2. B. Palsson, J.A. Hubbell, R. Plonsey& J.D. Bronzino. Tissue engineering. CRC Taylor & Francis 2000.

Suggested Readings:

1. Bernard Prish, Tissue engineering- Design, practice & reporting, Woodhead Publishing Ltd. Cambridge. UK 2009.
2. Atala O.P &Lanza.L, Methods of tissue engineering. Woodhead Publishing Ltd. Cambridge. UK. 2009.

With effect from the Academic Year 2021-22

18BT E19

IMMUNODIAGNOSTICS
(Core Elective - VI)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To learn the basic principles, procedures and applications of immunodiagnostic tests.
2. To understand the principles and applications of immunodiagnostic test.
3. To learn the steps involved in the production, diagnosis and applications of monoclonal antibody.
4. To learn the development of prophylactic agents such as vaccines.
5. To learn the novel methods used for immunodiagnostics.

Course Outcomes:

At the end of the course students will be able to

1. Outline the principle, importance, scope, classification of immunodiagnostic tests and antigen antibody reaction
2. Explain the principles and application of immunodiagnostics tests for diagnosing various diseases
3. Discuss about the production of monoclonal antibodies for diagnosis, treatment and prevention of disease.
4. Describe various methods used for vaccine development.
5. Summarize the various novel techniques used in immunodiagnostics.

UNIT-I

Introduction to Immunodiagnostics: Principles of immunodiagnostic tests and their development; classification of immunodiagnostic tests; Immunodiagnostics importance and scope; the antigen antibody reaction; Selection and preparation of reagents; Assay design; Antibody engineering; Catalytic antibodies.

UNIT-II

Immunodiagnostics Techniques: Immunodiagnostics techniques – Precipitation, Immunoelctrophoresis, Agglutination, RIA, ELISA, Fluoroimmunoassay, Luminescent immunoassay, Immunofluorescence, Cell separation techniques, Western blotting.

UNIT-III

Hybridoma Technology: Hybridoma technique - choice of host for immunization and myeloma cells, choice of immunogen, preparation of antigen for immunization, growth of myeloma cell lines, preparation of cells for fusion, cell fusion, selection and screening of hybridoma, purification and application (biochemical research, clinical diagnosis and treatment) of monoclonal antibodies.

UNIT-IV

Vaccines: Whole organism Vaccines; Subunit vaccines - Herpes Simplex virus, Foot and Mouth disease; Peptide vaccines - Foot and Mouth disease, Malaria; Live recombinant vaccines- Cholera, Salmonella; Vector vaccines - directed against viruses and bacteria; Purified vaccines, Conjugate polysaccharide vaccines; DNA vaccines; Antifertility vaccines.

UNIT-V

Novel Techniques in Immunodiagnostics: Imaging as an Immunodiagnostic Tool; Multicolor Flow Cytometry; Immunoglobulin and Free-light Chain Detection; Methods for Autoantibody Detection; Immunodiagnostic of Allergy; Multiplex Analysis of Cytokines; Immunomonitoring of Clinical Trials; Immunological Assays Used in Vaccine ClinicalTrials.

Text books:

1. Edwards R, “Immunodiagnostics: A practical approach” Oxford University Press, 1999.
2. Rastogi SC, “Immunodiagnostics Principles and Practice” New Age Publishers, 1996.

Suggested Readings:

1. Shepherd, P., Dean C., “Monoclonal Antibodies: A Practical Approach” Oxford University Press, 2000.
2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen., “Kuby Immunology” 8thedition, Macillan learning, 2018.
3. Ralph M Aloisi Lea, Principles of Immunology and Immunodiagnostics, Lea &Febiger, 1988.

With effect from the Academic Year 2021-22

18BT E20

GENOMICS AND PROTEOMICS
(Core Elective - VI)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Student is made to understand the fundamentals of genome
2. Students are made to understand DNA sequencing and various DNA sequencing methods.
3. Students are enlightened about construction and screening of cDNA libraries.
4. Students are enlightened about the current methods existing in the field of genomics.
5. Students are made to understand the basics of proteomics, tools for proteomics and protein modifications

Course Outcomes:

At the end of the course the students are able to

1. Describe about genomes, types of genomes and the advanced techniques used for analyzing genome.
2. Explain about the methods of functional genomics.
3. Discuss about the various sequencing technology in genomics.
4. Describe the tools used for the characterization of proteins
5. Explain the about personalized medicines their uptake, action and metabolism

UNIT-I

Structural Genomics: Overview of Genome - Types, analysis of genomes; comparative homologies; evolutionary changes; Genetic analysis: Linkage mapping and analysis, High resolution chromosome maps, Physical mapping, Hybrid mapping strategies, Sequence specific tags(SST), Sequence tagged sites(STS), FISH.

UNIT-II

Functional Genomics: Gene disruption and methods; DNA microarray and its Applications; Serial analysis of gene expression (SAGE); Genome wide association studies; Chip-Seq; RNA-Seq; Metagenomics.

UNIT-III

Next Generation Sequencing: Next generation sequencing - importance; Different sequencer platforms available; Methods of Sequencing; File formats; Data generation tools; Preprocessing of data and analysis.

UNIT-IV

Proteomics: Protein arrays: basic principles. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein-protein interactions

UNIT-V

Metabolomics And Pharmacogenomics: Metabolomics - Basics; Pharmacogenomics - Basics, Diseased genes and their identification; Drug uptake and metabolism; Drug targets; Designer medicine; Genomics perspective of bioterrorism; Ethical and legal implications.

Text Books:

1. Sahai S, “Genomics and Proteomics-Functional and Computational Aspects”, Plenum Publications, 1999.
2. Rastogi SC, Mendiratta N, Rastogi P, “Bioinformatics-Methods and Application, Genomics, Proteomics,and drug discovery”, 2nd edition, Prentice Hall of India, New Delhi,2003.
3. Hunt SP, Levessy FJ, “Functional genomics” Oxford University Press, UK, 2000.

Suggested Readings:

1. Lieber DC, “Introduction to Proteomics, Tools for the new biology”, Humana Press, UK, 2000.
2. CendricGondro, “Primer to Analysis of Genomic Data Using R”, Springer, 2015.

18ME O04

ENTREPRENEURSHIP
(Open Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Objectives:
Student will understand

1. Concept and procedure of idea generation.
2. The nature of industry and related opportunities and challenges.
3. Elements of business plan and its procedure.
4. Project management and its techniques.
5. Behavioral issues and Time management.

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

1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey.

UNIT-I
Entrepreneurship: Definition, functions of entrepreneurship, qualities of entrepreneurs, Identification and characteristics of Entrepreneurs, Entrepreneur vs intrapreneur, First generation entrepreneurs, women entrepreneurs, Conception and evaluation of ideas and their sources.

UNIT-II
Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries, Types of enterprises, Corporate Social Responsibility.

UNIT-III
Business Plan: Introduction, Elements of Business Plan and its salient features, Business model canvas, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary, Selection of Technology and Collaborative interactions.

UNIT-IV
Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden.

UNIT-V
Behavioral Aspects of Entrepreneurs: Personality, determinants, attributes and models, Leadership concepts and models, Values and attitudes, Motivation aspects, Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

Text Books:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw-Hill Publishing Company Ltd. 1995.
3. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi

Suggested Readings:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", 5/e, Tata Me Graw Hill Publishing Company Ltd., 2005
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.
3. G.S. Sudha, "Organizational Behavior", National Publishing House, 1996.

18CS O08

OPEN SOURCE TECHNOLOGIES
(Open Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Familiarity with Open Source Technologies.
2. Examples of OSS Projects, Advantages of Open Source.
3. Understand the principles, methodologies of OSS.
4. Understand the policies, licensing procedures and ethics of OSS.

Course Outcomes:

At the end of the course, students will be able to:

1. Able to differentiate between Open Source and Proprietary software and Licensing.
2. Recognize the applications, benefits and features of Open Source Technologies.
3. Understand and demonstrate Version Control System along with its commands.
4. Gain knowledge to start, manage open source projects.
5. Understand and practice the Open Source Ethics.

UNIT – I

Introduction to Open Source: Open Source, need of Open Source, Open Source Principles, Open Source Standards Requirements for Software, OSS success, Free Software, Examples, Licensing, Free Software Vs. Proprietary Software, Public Domain software, History of free software, Proprietary Vs Open Source Licensing Model, use of Open Source Software.

UNIT – II

Fault Tolerant Design: Principles and Open Source Methodology- History, Open Source Initiatives, Open Standards Principles, Methodologies, Philosophy, Software freedom, Open Source Software Development, Licenses, Copyright vs. Copyleft, Patents, zero marginal cost, income-generation Opportunities, Internationalization.

UNIT – III

Case Studies: Apache, BSD, Linux, Mozilla Firefox, Wikipedia, Git, GNU CC, Libre Office.

UNIT – IV

Open Source Project: Starting and Maintaining an Open Source Project, Open Source Hardware, Open Source Design, Open Source Teaching (OST), Open Source Media, What Is A License, How to create your own Licenses. Important FOSS Licenses (Apache, BSD, PL, LGPL), copyrights and copy lefts, Patent.

UNIT – V

Open Source Ethics: Open Source Vs. Closed Source, Open Source Government, Ethics of Open Source, Social and Financial Impact of Open Source Technology, Shared Software, Shared Source, Open Source as a Business Strategy.

Text Books:

1. Kailash Vadera, Bjhavesh Gandhi “Open Source Technology”, University Science Press, 1st Edition, 2009.
2. Fadi P. Deek and James A. M. McHugh, “Open Source Technology and Policy”, Cambridge University Press.

Suggested Readings:

1. Wale Soyinka, “Linux Administration- A beginner’s Guide”, Tata McGraw Hills.
2. Andrew M. St. Laurent, “Understanding Open Source and Free Software Licensing”, O'Reilly Media.
3. Dan Woods, Gautam Guliani, “Open Source for the Enterprise”, O'Reilly Media.
4. Bernard Golden, “Succeeding with Open Source”, Addison-Wesley Professional.
5. Clay Shirky and Michael Cusumano, “Perspectives on Free and Open Source Software”, MIT press.

18CS O01

PYTHON FOR BIOINFORMATICS
(Open Elective - III)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:
1. Introduce Python with reference to bioinformatics.
2. Understanding of various algorithms useful for biological sequences.
3. Identification Python modules useful to analyze gene and Biological sequences

Course Outcomes:
At the end of the course, students will be able to:
1. Understand the basics of Python Programming.
2. Develop applications using Python to solve problems.
3. Identify and use Python modules related to Biology.
4. Analyze biological and gene sequences using Python.
5. Understand advanced analysis techniques.
6. Formulate step-wise implementation of a python script for a given problem in bioinformatics

UNIT - I
Introduction to Python: Basics of Python, Python IDEs, Running Python programs, types and operations, Functions, modules, classes, Exceptions.

UNIT - II
Object-Oriented Programming, Modules: Object Oriented Programming, Threads, process, synchronization, databases and persistence, NumPy, SciPy, Image manipulation, Akando and Dancer modules.

UNIT - III
Biological Sequence Analysis: Biopython: Parsing DNA data files, Sequence Analysis, Dynamic Programming, Hidden Markov Model, Genetic Algorithms, Multiple Sequence Alignment, gapped alignment.

UNIT - IV
Advanced Analysis Techniques: Trees, Text Mining, Clustering, Self-Organizing Map, Principal Component Analysis and Numerical Sequence Alignment.

UNIT - V
Expression Analysis: Gene expression array analysis, Spot finding and Measurement, Spreadsheet Arrays and Data Displays, Applications with expression Alignment.

Text Books:
1. Jason Kinser, “Python for Bioinformatics”, Jones & Bartlett Publishers, 2nd Edition, 2013.
2. Reema Thareja “Python Programming”, Oxford Press, 2017.

Suggested Reading:
1. Mark Lutz, “Learning Python”, 3rd edition, O’Reilly, 2007.
2. Alex Martelli, David Ascher, “Python cookbook”, O’Reilly, 2002.

Online Resources:
1. http://www.biopython.org

With effect from the Academic Year 2021 - 2022

18BT C31

TECHNICAL SEMINAR

Instruction	2 Hours per week
CIE	50 Marks
Credits	1

The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on state of the art topics in a broad area of his/her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule shall be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar shall be preferably from any peer reviewed recent journal publications.

Guidelines for awarding marks		
Sl No.	Description	Max Marks
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20

With effect from the Academic Year 2021-22

18BT C32

PROJECT: PART-II

Instruction	10 Hours per week
CIE	100 Marks
SEE	100 Marks
Credits	10

The object of 'Project: Part-2' is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including teamwork;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee.

Guidelines for the award of marks in CIE: (Max. Marks: 100)

Evaluation by	Max .Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for awarding marks in SEE: (Max. Marks: 100)

Evaluation by	Max .Marks	Evaluation Criteria / Parameter
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce