With effect from the Academic year 2022-23

# CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

## Department of Bio-Technology
## Scheme of Instructions of V Semester of B. Tech Bio-Technology
## as per AICTE Model Curriculum 2022-23
## 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 | 20BTC18 | Fluid Mechanics and Heat Transfer | 3 | - | - | 3 | 40 | 60 | 3 |
| 2 | 20BTC19 | Genetic Engineering and rDNA Technology | 3 | - | - | 3 | 40 | 60 | 3 |
| 3 | 20BTC20 | Plant Biotechnology | 3 | - | - | 3 | 40 | 60 | 3 |
| 4 | 20MTC24 | Biostatistics | 3 | - | - | 3 | 40 | 60 | 3 |
| 5 | 20BTC21 | Introduction to Anatomy and Physiology of Humans | 3 | - | - | 3 | 40 | 60 | 3 |
| 6 | | **Open Elective-I** | 3 | - | - | 3 | 40 | 60 | 3 |
| 7 | 20EGM02 | Indian Traditional knowledge | 2 | - | - | 2 | - | 50 | Non-credit |
| **PRACTICALS** | | | | | | | | | |
| 8 | 20BTC22 | Fluid Mechanics and Heat Transfer Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 9 | 20BTC23 | Genetic Engineering Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 10 | 20BTC24 | Plant Biotechnology Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 11 | 20BTI02 | Industrial / Rural Internship -II | 3-4 weeks/ 90 hours | | | - | 50 | - | 2 |
| **Total** | | | **20** | **0** | **6** | **29** | **440** | **560** | **23** |
| **Clock Hours Per Week – 26** | | | | | | | | | |

**L: Lecture T: Tutorial P: Practical**

**CIE – Continuous Internal Evaluation SEE – Semester End Examination**

**20BT C18**

# FLUID MECHANICS AND HEAT TRANSFER

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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. Calculate the rate of heat transfer through various geometries.
5. Calculate the overall heat transfer coefficient in different evaporators and condensers.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 3 | 3 |
| **CO2** | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 3 |
| **CO3** | 2 | 2 | 0 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 3 | 3 |
| **CO4** | 2 | 1 | 0 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 3 | 3 | 3 |
| **CO5** | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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 impeller viscometer, 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(Ergun Equation); 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(principal of centrifugal and positive displacement 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", 6$^{th}$edition, cGraw Hill Intl. Ed, 2005.
2. Christie J. Geankoplis, "Transport Processes and Unit Operations", 3$^{rd}$ 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.
3. Pauline M. Doran, "Bioprocess Engineering Principles", Academic press, 1995.

**20BT C19**

# GENETIC ENGINEERING AND rDNA TECHNOLOGY

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 3 | | | | 2 | 2 | | 2 | 2 | 2 |
| **CO2** | 2 | 2 | | | 3 | | | | 2 | 2 | | 2 | 3 | 2 |
| **CO3** | 2 | 2 | | | 3 | 2 | 2 | | 2 | 2 | | 3 | 3 | 2 |
| **CO4** | 2 | 2 | | | 3 | 2 | 2 | | 2 | 2 | | 3 | 3 | 2 |
| **CO5** | 2 | 2 | 2 | | 3 | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Isolation and Purification of DNA and Enzymes Used in Cloning:** Isolation and purification of nucleic acids (genomic/plasmid DNA& RNA), quantification and storage of nucleic acids; Agarose gel electrophoresis; Enzymes used in genetic engineering - Restriction enzymes – Exo and Endo nucleases, Methylases, Polymerases, Ligase, Phosphatase, Kinase, DNase, RNase; Homopolymer tailing, Linkers & Adaptors; 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; Viral Vectors – SV40, Baculovirus, Retrovirus; Ti-Plasmid; 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 cDNA and Genomic library; Gene transfer techniques: biological methods, chemical methods, physical or mechanical methods, Agrobacterium- mediated gene transfer in plants; Detection o clones with the desired gene; DNA Sequencing-Chain termination DNA Sequencing, Pyro sequencing, 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 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", 7thedition. Wiley Blackwell, 2016.
2. Primrose, S.B., Twyman, R.M., "Principles of Gene manipulation and Genomics", 7thedition, John Wiley & Sons,2013.
3. Glick, B.R., Patten, C.L, "Molecular Biotechnology: Principles and applications of Recombinant DNA", 6th edition, ASM Press,2022


**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.

**20BT C20**

# PLANT BIOTECHNOLOGY

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:** The course aims to

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 the production of secondary metabolites in vitro using plant cell and tissue culture.
4. To understand the methods of gene transfer in plants for the 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 the 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 a commercial scale.
4. Analyze the appropriate vectors and gene transfer methods for the production of Transgenics.
5. Outline the strategies for the production of transgenics for crop improvement and environmental concerns.

## CO-PO/PSO Articulation Matrix

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | | | | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 1 | | 2 | 2 | 2 | 1 | | | | 2 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | | 2 | 3 | 3 | 2 | 1 | | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 2 | 2 | | 1 | 2 | 2 | 2 | | | | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | | 2 | 3 | 3 | 2 | | | 1 | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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; Genetic fidelity of plants raised through tissue culture; 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; 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. Marker-free transgenics and environmental, social and legal issues associated with transgenic plants.

**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, and longer shelf life. Edible vaccines and Nutraceuticals; 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.

**20MTC24**

# BIO-STATISTICS
## (For Bio-Technology only)

| | |
|---|---|
| Instruction | 3L Periods per week |
| Duration of Semester End Examination | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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. Use basic counting techniques to compute probability
2. Compute conditional probabilities using Bayes Theorem
3. Analyze the probability function using statistical averages
4. Distinguishing the data using different methods of hypothesis
5. Analyze the data using analysis of variance technique

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | | | | | | 1 | 1 | | 1 | 1 | |
| **CO2** | 2 | 2 | 1 | | | | | | | | | 1 | 1 | 1 |
| **CO3** | 2 | 2 | 1 | | | | | | | | | 1 | 1 | |
| **CO4** | 2 | 2 | 2 | | | | | | | | | 1 | 1 | |
| **CO5** | 2 | 2 | 2 | 2 | 1 | - | | | | | | 1 | 1 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**
**BASIC 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.

**UNIT-II**
**PROBABILITY**

Classical approach- Axiomatic approach of probability, Basic theorems addition and product theorem, conditional probability, Baye's theorem.

**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) Discrete Distributions- Binomial distribution, Poison distribution-their Expectation, variance, mgf, cgf Continuous distributions: Normal Distribution- mean, variance, m.g.f and c.g.f. Properties of Normal curve. Exponential Distribution, Expectation variance, m.g.f and c.g.f.

**UNIT-IV**
**INFERENCIAL STATISTICS**

Parameter and Statistic, Tests of significance, tests of significance for large samples. Tests of significance for single proportion, and difference of proportions. Tests of significance for single mean and difference of means. Small sample test, t-test for single mean and differences of Means. F-test for equality of two population variances.

**UNIT-V**

**Hypothesis Testing**

Testing of many proportions-$\chi^2 - test$ independent of attributes-r x c-tables. Analysis of variance-CRD.

**Text Books:**


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


**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.Kapoor,"Fundamentals of Mathematical Statistics: A Modern Approach", tenth edition, Publishers: Sultan Chand & Sons,2005.

**20BT C21**

# INTRODUCTION TO ANATOMY AND PHYSIOLOGY OF HUMANS

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. Student gets an overview of the human body tissues and endocrine system.
2. The various organs associated with skeletal, muscular, digestion and excretion is taught.
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. Reproductive anatomy and physiology is explained.

**Course Outcomes:**

At the end of the course the students are able to

1. Outline the structure of Human body and explain the structure and function of endocrine glands
2. Discuss the anatomical structures and the physiological functions of Skeletal, Muscular and digestive systems.
3. Explain the anatomical structures and the physiological functions of excretory, 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

**CO-PO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | 2 | 2 | 1 | 2 | 2 | | 2 | 2 | 1 |
| **CO2** | 2 | | | | | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | 2 |
| **CO3** | 2 | | | | | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | 2 |
| **CO4** | 2 | | | | | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | 2 |
| **CO5** | 2 | | 2 | | | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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, Muscular and Digestive System:** Structure and function of bones, Bone cells - osteoblasts, osteocytes, and osteoclasts; Structure and function of muscles, Histology of Muscle Fibers, Sarcomere; Digestive system- organs and functions; role of liver and pancreas.

**UNIT- III**

**Anatomy and Physiology of Excretory Systems, Circulatory and Respiratory Systems:** Excretory system-kidney and urinary bladder, physiology of excretory system- urine formation; 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. Cinnamon VanPutte, Jennifer Regan, Andrew Russo, Rod Seeley Trent Stephens, Philip Tate "Seeley's Anatomy and Physiology" 12th edition, McGraw Hill education
2. Elaine N. Marieb "Essentials of Human Anatomy and Physiology", 8th Edition, Pearson Education, New Delhi 2006


**Suggested Reading**:


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

**20EG M02**

# INDIAN TRADITIONAL KNOWLEDGE

| | |
|---|---|
| Instruction | 2 L Hours per week |
| Duration of SEE | 2 Hours |
| SEE | 50 Marks |
| CIE | 0 Marks |
| Credits | No credit |

**Prerequisite: Knowledge on Indian Culture**

**Course Objectives:**

1. To get a knowledge in Indian Culture
2. To Know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India

**Course Outcomes:** After completion of this course, students will be able to:

1. Understand philosophy of Indian culture
2. Distinguish the Indian languages and literature
3. Learn the philosophy of ancient, medieval and modern India
4. Acquire the information about the fine arts in India
5. Know the contribution of scientists of different eras.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 |
| **CO4** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| **CO5** | 2 | 3 | 1 | 3 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Culture and Civilization:** Culture, civilization and heritage, general characteristics of culture, importance of culture in human life, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian cuisine, Martial arts

**UNIT-II**

**Education System:** Education in ancient, medieval and modern India, aims of education, subjects, Languages, Science and Scientists of ancient, medieval and modern India

**UNIT-III**

**Linguistic Wealth:** Indian Languages and Literature: the role of Sanskrit, Paleography, Significance of scriptures to current society, Indian semantics and lexicography, Bhakti literature, Darsanas

**UNIT-IV**

**Art, Technology & Engineering:** Sculpture, Painting and Handicrafts, Indian Music, Dance Drama and Theatre, Introduction to Mayamatam, Iron and steel technology, Use of metals in medicinal preparations

**UNIT-V**

**Science and Logic:** Helio-centic system, Sulbasutras, Katapayadi, Hindu calendar, 6 pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka – Induction &Deduction, Ayurvedic biology, Definition of health

**Text Books:**


1. Kapil Kapoor, **Text and Interpretation: The Indian Tradition,** ISBN: 81246033375, 2005
2. Samskrita Bharati, **Science in Samskrit**, ISBN-13: 978-8187276333, 2007
3. Satya Prakash, **Founders of sciences in Ancient Indi**a, GovindramHasanand, ISBN-10: 8170770009, 1989
4. Brajendranath Seal, **The Positive Sciences of the Ancient Hindus**, MotilalBanarasidass, ISBN-10: 8120809254, 1915
5. KanchaIlaiah, Turning the Pot, Tilling the Land: Dignity of Labour in Our Times

**Suggested Readings:**


1. Swami Vivekananda, Caste, Culture and Socialism, AdvaitaAshrama, Kolkata ISBN-9788175050280
2. Swami Lokeswarananda, Religion and Culture, AdvaitaAshrama, Kolkata ISBN-9788185843384
3. Kapil Kapoor,Language, Linguistics and Literature: The Indian Perspective, ISBN-10: 8171880649, 1994.
4. Karan Singh, A Treasury of Indian Wisdom: An Anthology of Spiritual Learn,ISBN: 978-0143426158, 2016
5. Swami Vivekananda, The East and the West, AdvaitaAshrama, Kolkata 9788185301860
6. Srivastava R.N., Studies in Languages and Linguistics, Kalinga Publications ISBN-13: 978-8185163475
7. SubhashKak and T.R.N. Rao, Computation in Ancient India, Mount Meru Publishing ISBN-1988207126
8. R.N Misra, Outlines of Indian Arts Architecture, Painting, Sculpture, Dance and Drama, IIAS, Shimla & Aryan Books International, ISBN 8173055149
9. Examinations in ancient India, Arya Book Depot, 1993
10. M. Hiriyanna, Essentials of Indian Philosophy, Motilal Banarsi dass Publishers, ISBN-13: 978-8120810990, 2014
11. Ravi Prakash Arya, Engineering and Technology in Ancient India, Indian Foundation for Vedic Science, ISBN-10: 1947593072020
12. Shashi Tharoor, The Hindu Way
13. Amartya Sen, Argumentative Indian


**SWAYAM/Nptel:**

1. History of Indian Science and Technology - https://onlinecourses.swayam2.ac.in/arp20_ap35/preview
2. Introduction to Ancient Indian Technology – https://onlinecourses.nptel.ac.in/noc19_ae07/preview
3. Indian Culture & Heritage - https://onlinecourses.swayam2.ac.in/nos21_sc11/preview
4. Language and Society - https://nptel.ac.in/courses/109/106/109106091/
5. Science, Technology & Society - https://nptel.ac.in/courses/109/103/109103024/
6. Introduction to Indian Philosophy - https://nptel.ac.in/courses/109/106/109106059/
7. Introduction to Indian Art - An appreciation - https://onlinecourses.nptel.ac.in/noc20_hs09/preview

**20BT C22**

# FLUID MECHANICS AND HEAT TRANSFER LAB

| | |
|---|---|
| Instruction | 2P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Course Objectives:**

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

**Course Outcomes:**

At the end of the course the students are able to

1. Calculate the coefficient of discharge of different flow measuring devices and Reynold's Number based on the distinction between the types of flow. (Expt. 1,2,3,4,5)
2. Determine the friction losses in pipe fittings & verify Bernoulli's Theorem. (Expt. 6,7)
3. Predict the Thermal conductivity of homogeneous wall insulating powder under steady-state conditions. (Expt.8)
4. Determine the heat transfer coefficient in Natural, Forced convection using PIN FIN apparatus and Predict the emissivity of a non-black surface. (Expt. 9,10,11)
5. Calculate the overall heat transfer coefficient for parallel flow and counter flow in a Double pipe heat exchanger. (Expt. 12,13)

## CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | 2 | 1 | | 3 | 3 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | | 2 | 3 | 3 |
| **CO3** | 2 | 2 | 2 | 3 | 2 | 2 | 2 | | 3 | 3 | | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 2 | 2 | | 3 | 3 | | 2 | 3 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | 2 | 2 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**Atleast 10 experiments to be conducted from the following list of experiments.**

**LIST OF EXPERIMENTS**

1. Determination of discharge coefficient for orifice meter and venturimeter and their variation with Reynolds number.(CO1)
2. Determination of discharge coefficient for Mouth piece for constant head method and time of fall method(CO 1)
3. Determination of weir meter constant K for v-notch and rectangular notch (CO 1)
4. Calibration of rotameter and study of variation of flow rate with tube to float diameter (CO 1)
5. Determination of viscosity of different fluids (CO 1)
6. Determination of friction losses in pipe fittings (CO 2)
7. Determination of Reynold's Number based on the types of flow. (CO 2)
8. Verification of Bernoulli's Theorem (CO 2)
9. Determination of Thermal conductivity of homogeneous wall insulating powder under steady state conditions. (CO 3)
10. Determination of heat transfer coefficient in Natural convection.( CO 4)
11. Determination of heat transfer coefficient in forced convection.( CO 4)
12. Determination of emissivity of non black surface.( CO 5)
13. Determination of Overall heat transfer coefficient for parallel flow in a double pipe heat exchanger.( CO 6)
14. Determination of Overall heat transfer coefficient for counter flow in a double pipe heat exchanger.(CO 6)

**Suggested Reading:**

1. WLMcCabeandJCSmith,"UnitoperationsinChemicalEngineering",6th edition,McGrawHillIntl.Ed, 2005

**20BT C23**

# GENETIC ENGINEERING LAB

| | |
|---|---|
| Instruction | 2P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 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 and visualization of nucleic acids. (Expt. 1,2,3)
2. Characterize the DNA by restriction digestion and restriction mapping. (Expt. 4,5)
3. Plan different steps involved in cloning strategies of DNA (Expt. 6,7,8,9,10)
4. Perform the polymerase chain reaction. (Expt. 11)
5. Analyze the DNA Sequencing and recombinant protein by using SDS PAGE (Expt. 12,13)

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | **2** | | **2** | **2** | **3** | **3** | **2** | **3** | **3** | | **3** | **3** | **3** |
| **CO2** | 2 | 2 | | 2 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO3** | 2 | 2 | | 2 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO4** | 2 | 2 | | 2 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO5** | 2 | 3 | | 2 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**Atleast 10 experiments to be conducted from the following list of experiments.**

**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(Structured Experiment)
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
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

**20BT C24**

# PLANT BIOTECHNOLOGY LAB

| | |
|---|---|
| Instruction | 2 P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Course Objectives:**

1. The students should be able to understand explicitly the concepts of Plant 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.(Expt 1,2)
2. Execute the protocols for Surface sterilization, Organ culture, and Callus induction using various explants.(Expt 3,4,5,10)
3. Develop in vitro techniques for micropropagation of meristem /nodal explants of horticulture and medicinal plants.(Expt. 6,7,8,9)
4. Demonstrate the Protoplast isolation from various plant tissues using enzymatic methods. (Exp.11)
5. Develop a system for genetic transformation in plants using Agrobacterium strains (Expt 12)

**CO-PO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | | | | 1 | | | | | | | 1 | | 2 |
| **CO2** | 1 | 1 | | 1 | 1 | | | | | 1 | 1 | 1 | | 2 |
| **CO3** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 2 | 3 |
| **CO4** | 1 | 1 | 1 | | | 1 | 1 | | | | | 1 | | 2 |
| **CO5** | 1 | 1 | | | 1 | 1 | 1 | 1 | | 1 | | 2 | 2 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**At least 10 experiments to be conducted from the following list of experiments.**

**LIST OF EXPERIMENTS**

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

**Text Books:**


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.

**20BT I02**

# INDUSTRIAL / RURAL INTERNSHIP-II

| | |
|---|---|
| Instruction | 3-4 week |
| Duration of Internship | 90 Hours |
| CIE | 50 Marks |
| Credits | 2 |

**Course Objectives:** This course aims to:

1. Expose students to industrial and rural environments, including those relevant to biotechnology.
2. Create awareness of current industrial technological developments, particularly in the field of biotechnology.
3. Provide opportunities to understand the social, economic, and administrative considerations within organizations and rural areas, with a focus on biotechnological applications where applicable.

**Course Outcomes:** Upon completion of this course, students will be able to:

1. Execute established biotechnological protocols and techniques with precision and adherence to organizational safety standards.*(Assessed primarily by the Mentor Evaluation and confirmed in the Viva-Voce.)*
2. Uphold professional standards of conduct, including teamwork, ethical responsibility, and effective communication within the organizational culture.*(Assessed primarily by the Mentor Evaluation.)*
3. Analyze the purpose and importance of assigned tasks and protocols within the host organization's workflow and quality management framework.*(Assessed primarily by the "Evaluation of the Industry" component and the Report.)*
4. Accurately document observations, manage scientific data, and interpret results in the context of the specific project or operational goal.*(Assessed primarily through the quality of the Report, Presentation of data, and Viva-Voce questioning.)*
5. Communicate the internship activities, technical findings, and professional growth effectively through a structured written report and oral presentation.*(Assessed directly by the quality of the final Presentation and Report.)*

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | | 2 | | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 |
| **CO 2** | 2 | | 2 | 2 | 3 | 2 | 2 | | 3 | 3 | 2 | 3 | 3 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | 3 | 3 |
| **CO 4** | 2 | 2 | | | 2 | 2 | 2 | 3 | 3 | 2 | | 3 | 3 |
| **CO 5** | 2 | 2 | 2 | 1 | | 2 | 2 | | 3 | 3 | 2 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

Schedule for the internship schedules will be given in a flexible manner according to the availability opportunities. The minimum and maximum requirement regarding Internship duration and credits is given in Table-1

**Table 1:** Internship Frame work

| Schedule | Activities | Duration | Credits |
|---|---|---|---|
| Summer / Winter vacation ($4^{th}$/ $5^{th}$ Semester) | Industrial / Govt. /NGO / MSME/ Rural Internship/ Innovation/ Entrepreneurship/ NSQF level 3, 4,5 | 3-4 weeks or 90 hrs | 2 Credits |

**INTERNSHIP GUIDELINES:**

**a) Student's Diary/Daily Log:** The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the Industry supervisor or the Faculty Mentor at any point of time. Failing to produce the same, Intern may be debarred for the remaining period of his/her internship. Daily diary needs to be submitted to Faculty Mentor at the end of Internship along with the attendance record and an evaluation sheet duly signed and stamped by the industry. Daily diary is evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary/log
- Adequacy & quality of information recorded

- Drawing, sketches, and data recorded.
- Thought process and recording techniques used
- Organization of the information

**b) Internship Report**: At the end of the internship, each student should prepare a comprehensive report to indicate what he/she observed and learned in the training/internship period. It should be signed by the internship supervisor. The report will be evaluated by the Industry Supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

**EVALUATION OF INTERNSHIP**:

The industrial training/internship of the students will be evaluated in three stages:

a) Evaluation by the Industry ( in the range of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
b) Evaluation by faculty supervisor on the basis of site visit(s) or periodic communication (15 marks)
c) Evaluation through seminar presentation/Viva-Voce at the Institute(This can be reflected through marks assigned by Faculty Mentor (25 marks))

**Evaluation through Seminar presentation/Viva-Voce at the institute**: Students will give a seminar based on his/her training report, before an Expert Committee constituted by the concerned department as per the norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills
- Attendance record, daily diary, departmental reports shall be analyzed along with the internship Report

\ With effect from the Academic year 2022-23

# CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

## Department of Bio-Technology
## Scheme of Instructions of VI Semester of B. Tech Bio-Technology as per AICTE ModelCurriculum2022-23
## 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 | 20BTC25 | Bioseparation Engineering | 3 | - | - | 3 | 40 | 60 | 3 |
| 2 | 20BTC26 | Bioinformatics and Computational Biology | 3 | - | - | 3 | 40 | 60 | 3 |
| 3 | 20MBC01 | Engineering Economics and Accountancy | 3 | - | - | 3 | 40 | 60 | 3 |
| 4 | 20BTC27 | Animal Biotechnology | 3 | - | - | 3 | 40 | 60 | 3 |
| 5 | 20BTC28 | Mass transfer Operations | 3 | - | - | 3 | 40 | 60 | 3 |
| 6 | | **Professional Elective – II** | 3 | - | - | 3 | 40 | 60 | 3 |
| | **PRACTICALS** | | | | | | | | |
| 7 | 20BTC29 | Bioseparation Engineering Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 8 | 20BTC30 | Bioinformatics and Computational Biology Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 9 | 20BTC31 | Animal Biotechnology Lab | - | - | 2 | 3 | 50 | 50 | 1 |
| 10 | 20EGCO3 | Employability Skills | - | - | 2 | 3 | 50 | 50 | 1 |
| 11 | 20BTC32 | Mini Project | - | - | 1 | - | 50 | - | 1 |
| **Total** | | | **18** | **0** | **9** | **30** | **490** | **560** | **23** |
| **Clock Hours Per Week – 27** | | | | | | | | | |

**L: Lecture T: Tutorial P: Practical**

**CIE – Continuous Internal Evaluation SEE – Semester End Examination**

| **Professional Elective-II (Medical Biotechnology stream)** | |
|---|---|
| 20BT E06 | Virology |
| 20BT E07 | Medical Biotechnology |
| 20BT E08 | Pharmaceutical Biotechnology |
| 20BT E09 | Cancer biology |

**20BT C25**

# BIOSEPARATION ENGINEERING

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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 lyophilization.

**Course Outcomes:**

At the end of the course the students are able to

1. Outline the key aspects of downstream processing of biotechnological process and develop process design for bio products.
2. Distinguish the various techniques of cell disruption and unit operations for separation of bio products.
3. Compare and contrast various membrane separation processes.
4. Interpret application of various chromatographic process for separation of bio products.
5. Analyze various product finishing techniques and case studies of important bio products

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | 2 | | | 2 | 2 | 2 | | 2 | | 2 | 3 | 3 |
| **CO 2** | 2 | 3 | 2 | | | 2 | 2 | 2 | | 2 | | 2 | 3 | 3 |
| **CO 3** | 2 | 3 | 2 | | | 2 | 2 | 2 | | 2 | | 2 | 3 | 3 |
| **CO 4** | 2 | 3 | 2 | | | 3 | 3 | 2 | | 2 | | 2 | 3 | 3 |
| **CO 5** | 2 | 3 | 2 | | | 3 | 3 | 2 | | 2 | | 2 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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; Case study from a recent literature: Process design criteria for bio products and 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: GC and HPLC; 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. Noorala bettu Krishna Prasad, Downstream Process Technology by PHI publications.

**20BT C26**

# BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

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

**Course Outcomes:**

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

1. Explain various types of biological databases used for the retrieval and analysis of the information
2. Identify the methods used for sequence alignment and construction of the phylogenetic tree
3. Discuss genome sequencing and gene prediction tools.
4. Describe biochemical databases and protein structure prediction tools
5. Demonstrate docking methods for Identification of lead molecules

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | | | 2 | 3 | 3 | | 2 | 2 | | 2 | 3 | |
| **CO2** | 2 | 2 | | | 3 | 3 | 3 | | 2 | 2 | | 2 | 3 | |
| **CO3** | 2 | 2 | | | 3 | 3 | 3 | | 2 | 2 | | 2 | 3 | |
| **CO4** | 2 | 2 | | | 3 | 3 | 3 | | 2 | 2 | | 3 | 3 | |
| **CO5** | 2 | 2 | | | 3 | 3 | 3 | | 2 | 2 | | 3 | 3 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Bioinformatics and Biological Databases:** Bioinformatics - Scope, and application of Bioinformatics; Biological databases - types of biological database, file formats for biological sequence (NCBI, EMBL, SWISSPROT, FASTA); Information retrieval from biological Databases. Sequence database search- FASTA, BLAST, various versions of BLAST and FASTA; Amino acid substitution matrices - PAM and BLOSUM.

**UNIT-II**

**Sequence Alignments and Phylogenetic Analysis: Sequence** Alignment - Local, Global alignment; Methods of pair-wise sequence alignment; Multiple Sequence alignment methods. Concept of evolutionary trees; Methods of Phylogenetic analysis, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis.

**UNIT-III**

**Genome Sequencing and Gene Prediction:** DNA sequencing, Genome Mapping; Genome sequencing, cDNA sequencing, Genome Sequence Assembly and tools; Genome Annotation; Human genome project; Basis of Gene Prediction, Gene Prediction Methods in Microbial genomes and eukaryotes, Other Gene Prediction Tools.

**UNIT-IV**

**Structural Bioinformatics and Biochemical Databases:** Protein structure basics, protein structure classification, visualization and comparison, protein secondary structure prediction, and protein tertiary structure prediction; Introduction to Biochemical databases – KEGG, BRENDA, MMDB

**UNIT-V**

**Molecular Docking:** Methods of Docking – Flexible and Rigid Docking, Applications and limitations of docking, Docking algorithms – Genetic algorithm, QSAR overview and its significance in Docking,

**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.

**20MBC01**

# ENGINEERING ECONOMICS AND ACCOUNTANCY

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:** The Objectives of the Course are:

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:** After Completion of the Course, Student will be 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.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | | | | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 1 | | 2 | 2 | 2 | 1 | | | | 2 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | | 2 | 3 | 3 | 2 | 1 | | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 2 | 2 | | 1 | 2 | 2 | 2 | | | | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | | 2 | 3 | 3 | 2 | | | 1 | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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.


**Suggested Readings:**


1. Panday I.M. "Financial Management", 11th edition, VikasPublishing House, 2015.
2. Varshney and K L Maheswari, Managerial Economics, Sultan Chand, 2014.
3. M. Kasi Reddy and S. Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of a.India Pvt Ltd, 2007.
4. A. R. Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2013.

**20BT C27**

# ANIMAL BIOTECHNOLOGY

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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 the 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 the generation of transgenic animals and their 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 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.

## CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | 3 |
| **CO2** | 2 | 2 | | | 3 | 2 | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| **CO3** | 2 | 2 | | | 3 | 2 | 2 | 3 | 2 | 2 | | 3 | 3 | 2 |
| **CO4** | 2 | | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| **CO5** | 2 | 2 | | | 3 | 3 | 3 | 3 | 2 | 2 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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.

## 20BT C28

### MASS TRANSFER OPERATIONS

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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. Predict the rate of molecular diffusion in solids, liquids and gases.
2. Determine the number of trays needed for separation by Distillation.
3. Determine the number of trays needed for separation by Extraction and Leaching.
4. Calculate the rate and time of drying in constant head and falling rate methods.
5. Write the principles and application of membrane separation processes and understand the types of adsorbents.

### CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| **CO3** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 1 |
| **CO4** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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 Raoul'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. Equipment 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.

**20BT E06**

# VIROLOGY
## (Professional Elective -II)

| | |
|---|---|
| Instruction | 3L Hours per week |
| Duration of SEE | 3Hours |
| SEE | 60Marks |
| CIE | 40Marks |
| 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 earn the lifecycles of animal viruses and development of vaccines.

**Course Outcomes**

By the end of the course the students are able to

1. Explain classification, morphology 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.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | | | | | 2 | 2 | | | | | 1 | 3 | 3 |
| **CO2** | 1 | | | 1 | 1 | 3 | 3 | | | | | 1 | 3 | 3 |
| **CO3** | 1 | | | 1 | 1 | 3 | 3 | | | | | 1 | 3 | 3 |
| **CO4** | 1 | | | 1 | | 3 | 3 | | | | 1 | 1 | 3 | 3 |
| **CO5** | 1 | | 1 | 1 | 1 | 3 | 3 | | | | 1 | 1 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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, Creutzfeld t-jakob; Satellite viruses.

**UNIT-II**

**Cultivation of Viruses:** 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.

**UNIT-III**

**Characterization of viruses:** Characterization of viruses-Electron microscopy, X-ray crystallography, sedimentation analysis. Enumeration of viruses By electron microscopy, plaqueassay,acid end point method, Haemagglutininassay; Detection of viruses-By serological characterization, detection of viral antigen, detection of viral nucleic acid; chemical determination, UltrastructureandlifecyclesofBacteriophages-Ml3,T4andlambda.

**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, bio pesticides with examples.

**UNIT-V**

**Animal viruses:** Taxonomy; Detailed structure and brief account on life cycles of RNA viruses- Polio, Influenza, Rotavirus, Corona viruses: Covid 19andHIV;Ultrastructureandbrief account on lifecycles 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", 4$^{th}$edition, Blackwell Scientific Publications, 1994.
2. Matthews REF"Fundamentals of Plant Virology". Academic Press, San Diego, 1992.


**Suggested Readings:**


1. CarterJ and SaundersV "Virology: Principles and Applications" John Wiley and Sons ltd, 2007.
2. Morag C,TimburyM,Chrchill Livingstone, "Medical Virology", London,1994.

**20BT E07**

# MEDICAL BIOTECHNOLOGY
## (Professional Elective -II)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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 bio ethical issues.

**Course Outcomes:**

At the end of the course the students are able to

1. Outline the various diagnosis and treatment of Cancer.
2. Explain the concepts of Stem cell therapy and Tissue engineering.
3. Discuss the principle and applications of biomedical devices and molecular diagnostics.
4. Classify the molecular therapies and bioethical issues.
5. Classify the molecular therapies and bioethical issues.

### CO-PO/PSO Articulation Matrix

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | 3 | 2 | 2 | | 3 | 3 | | 3 | 2 | 2 |
| **CO2** | 2 | | | | 3 | 2 | 2 | | 3 | 3 | | 3 | 2 | 2 |
| **CO3** | 2 | 2 | | | 3 | 2 | 2 | | 3 | 3 | | 3 | 2 | 3 |
| **CO4** | 2 | 2 | | | 3 | 2 | 2 | | 3 | 3 | | 3 | 2 | 2 |
| **CO5** | 2 | 2 | | | 2 | 2 | 2 | | 3 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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,sicklecellanaemia,cysticfibrosis,Taysachsdisease,Fragile–X-syndrome;polygeneticdisorders;Alzheimersdisease, Type-1diabetisandmitochondrialdisorders (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; Induced Pluripotent Stem cells, concept of tissue engineering; role of scaffolds;clinicalapplicationsofstemcells;stemcellbankingandethical issues.

**UNIT-IV**

**Biomedical Instrumentation, Molecular Diagnostics and Biomarkers:** Concepts in Biomaterials; principle, properties of Biomaterials and applications of different types of biomedical devices; pacemakers, drug coated stents, knee replacement implants, dental implants, prosthetics), molecular diagnostics by DNA approaches(Taq MAN approach, RT-PCR, Applications of biosensors in medicine. Cellular imaging, in vivo imaging of the biomarkers of the disease, epigenetic markers, fluid-based biomarkers, imaging-based biomarkers (PET, MRI).

**UNIT-V**

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

**Text Books:**


1. JudithPongracz, MaryKeen, "Medical Biotechnology", illustrated edition, Elseiver health sciences, 2009.
2. BernardRGlick, CherylL.Patton, TerryL.Delovitch,"Medicalbiotechnology",1st edition,ASMpress, 2013.


**Suggested Reading**s:


1. Truepenny, Emerys"Elemental Medical Genetics", 14thedition, ChurchillLivingstone, 2012.
2. R.J.B.King, Robins,"Cancerbiology",3rd edition,PrenticeHall, 2006.

**20BT E08**

# PHARMACEUTICAL BIOTECHNOLOGY
## (Professional Elective -II)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To understand the origin, scope, and importance of pharmaceutical biotechnology.
2. To learn ADME properties of drugs, pharmacokinetics, pharmacodynamics, and drug deliverysystems.
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 pharmaceutical products and their use in the treatment of infectiousdiseases.

**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 deliverysystems.
3. Outline the different manufacturing procedures of drugs.
4. Discuss the blood and plasma substitutes.
5. Describe the therapeutic activity of drugs used for treating diseases

### CO-PO/PSO Articulation Matrix

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 0 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Fundamentals of Biopharmaceuticals:** Pharmaceutical Biotechnology: Definition, Scope, and Importance. Human protein replacements, Biosimilar (insulin analog), Therapeutic agents for human diseases: Tissue Plasminogen activator, Interferon, Recombinant vaccines, Clinical Trails and Regulations (Basic), History and development of Pharma covigilance.

**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,controlofBloodproducts,Transfusionproducts, Blood and Plasma based bioproducts, Blood based and plasma-based Biomarkers.

**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), Anti-histamines, Electrolytes, and Diuretics, 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

**20BT E09**

# CANCER BIOLOGY
## (Professional Elective -II)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | 2 | 2 | 3 | 3 | 2 | | 3 | 3 | 3 |
| **CO2** | 3 | | | | | 2 | 2 | 3 | 3 | 2 | | 3 | 3 | 3 |
| **CO3** | 3 | | | | | 2 | 2 | 3 | 3 | 2 | | 3 | 3 | 3 |
| **CO4** | 3 | 2 | | | 2 | 2 | 2 | 3 | 2 | 2 | | 3 | 3 | 2 |
| **CO5** | 3 | 2 | | | 2 | 2 | 2 | 3 | 3 | 2 | | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Fundamentals of Cancer Biology:** Introduction to cancer, origin and classification of different cancers, Hall marks of cancer, Cell cycle control, Regulation of the cell cycle by cyclins, cyclin-dependent kinases, cdk inhibitor. Two-Hit Hypothesis, Tumor suppressor genes. Case studies for carcinoma ex: breast cancer and stomach cancer, Diet and cancer.

**UNIT-II**

**Principles of Carcinogenesis:** Classical theory of Carcinogenesis, Types of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Laboratory chemicals induces 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:** Retroviruses and Oncogenes, Activation of proto-oncogenes to oncogenes. Identification of Oncogenes, Growth factor and Growth factor receptors (RTK's) that are oncogenes, signalling pathways in cancer (MAPK, WNT pathway).

**UNIT-IV**

**Cancer Metastasis and Diagnosis:** Seed & Soil theory, heterogeneity of metastatic phenotype, Metastatic cascade, clinical significance of invasion: angiogenesis and EMT, Three-step theory of invasion (Basement Membrane disruption, role of Proteinases in tumor invasion and tumor cell locomotion), cancer stem cells. Diagnosis of cancers, Advances in Cancer detection (Biomarkers technology and nanotechnology).

**UNIT-V**

**Principles of Cancer Therapy:** Different forms therapy- conventional therapy-Chemotherapy, Radiation therapy and immunotherapy, Advances in Cancer therapy – personalized, targeted therapies and Thermo therapy. Classification of antineoplastic 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. Introduction to cell and Molecular biology of cancer, Franks and Teich, Oxford medical Publications, 2002.
2. Introduction to Cancer Biology, Robin Hesketh, Cambridge University Press, 2012.
3. King, Roger J B, Robins, Mike W, "Cancer Biology", 3rdedition, Prentice Hall, USA. 2003.
4. Molecular Biology of Cancer. Lauren Pecorina, 4th edition. Oxford University Press – 2016


**Suggested Reading**:


1. Robert A. Weinberg, "The Biology of Cancer", 5th edition, Garland Science. 2013
2. Fiona Macdonald, Christopher Ford, Alan Casson, "Molecular Biology of Cancer", 2nd Edition, Taylor & Francis, 2004.Molecular biology of the cell. Bruce Alberts, 6th Edition
3. Textbook readings; primary literature; in-class discussion. The Molecular Biology of Cancer: A Bridge from Bench to Bedside. Stella Pelengaris, Mike Khan -2nd Edition - 2013

**20BT C29**

# BIOSEPARATION ENGINEERING LAB

| | |
|---|---|
| Instruction | 2 P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**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. Evaluate various techniques for cell disruption, filtration and separation of bioproducts. (Expt: 1-8,13)
2. Analyze the optimum protein precipitation technique. (Expt: 9)
3. Demonstrate chromatographic separation process for a given compound. (Expt: 10,11,12)
4. Apply a strategy for final product purification/ polishing of a bioproduct. (Expt: 14)
5. Develop methods for determining enzyme activity. (Expt: 15)

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | 3 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO2** | 2 | 2 | | 3 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO3** | 2 | 2 | | 3 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO4** | 2 | 2 | | 3 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO5** | 2 | 2 | | 3 | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**At least 10 experiments to be conducted from the following list of experiments.**

**List of Experiments:**

1. Cell Disruption of microorganism by Enzymatic method
2. Cell Disruption of plant cells / animal cells by Physical methods (Temperature or Osmolysis)
3. Cell Disruption of microorganism by Ultrasonication method
4. Separation of biomolecules by Aqueous two-phase extraction.
5. Separation of solids from liquid by Sedimentation and Centrifugation
6. Separation of microorganisms from fermentation broth by Microfiltration or ultra-filtration.
7. Separation of solute particles by Dialysis.
8. Separation of protein by Ammonium Sulphate Precipitation (Structured expt)
9. Isolation and quantification of protein from milk by Isoelectric Precipitation.
10. Separation of biomolecules by Gel Exclusion Chromatography.
11. Purification of lysozyme from chicken egg white extract by Ion Exchange Chromatography.
12. Purification of proteins by Affinity Chromatography.
13. Separation of a binary mixture by simple distillation.
14. Purification of bio products by drying or crystallization
15. Estimation of 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

**20BT C30**

# BIOINFORMATICS AND COMPUTATIONAL BIOLOGY LAB

| | |
|---|---|
| Instruction | 2 P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Course Objective:**

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

**Course Outcomes:**

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

1. Retrieve the information from biological databases (Expt. 1,2)
2. Utilize BLAST, FASTA and other online tools (Expt. 3, 4)
3. Use online sequence alignment tools and construction of evolutionary tree by phylogenetic analysis (Expt. 5,6,7)
4. Predict gene and protein structure and design primers and construct restriction map. (Expt. 8, 9, 10, 11)
5. Retrieve macromolecular structures and perform docking of a ligand to its target (Expt 12, 13)

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 2 | 2 | 3 | 3 | | 2 | 2 | | 3 | 3 | |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | | 2 | 2 | | 3 | 3 | |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | | 2 | 2 | | 3 | 3 | |
| **CO4** | 2 | 2 | 2 | 3 | 2 | 3 | 3 | | 2 | 2 | | 3 | 3 | |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 3 | 3 | | 2 | 2 | | 3 | 3 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**Atleast 10 experiments to be conducted from the following list of experiments.**

**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. Identification of Genes in Genomes.
9. NCBI ORF Finder.
10. Restriction Mapping (Structured enquiry)
11. Primer Design (Open-ended experiment)
12. Protein Databank retrieval and visualization.
13. Molecular docking with Auto docking Vina

**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.

**20BT C31**

# ANIMAL BIOTECHNOLOGY LAB

| | |
|---|---|
| Instruction | 2 P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Course Objectives:**

1. Students are expected to understand the sterility and aseptic conditions necessary for animal cell culture.
2. Students will learn various steps involved in maintenance and culture of animal cells.
3. Students will know about measurement of cell viability & cytotoxicity and cell death.

**Course Outcomes:**

At the end of the course the students are able to

1. Demonstrate aseptic culture techniques and preparation of animal cell culture media. (Expt. 1, 3, 4)
2. Identify and enumerate animal cells by using microscopic techniques. (Expt. 2, 8)
3. Apply animal cell culture techniques to the establishment of primary culture. (Expt. 5, 6, 7)
4. Evaluate cell viability and cytotoxicity of animal cell culture. (Expt. 9, 10)
5. Perform the maintenance and preservation of animal cells. (Expt.11, 12, 13 )

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | 3 | 2 | 2 | 2 | 3 | 2 | 3 | | 3 | 2 | 3 |
| **CO2** | 2 | 2 | | 2 | 2 | 2 | 2 | 3 | 2 | 3 | | 3 | 3 | 3 |
| **CO3** | 2 | 2 | | 3 | 2 | 2 | 2 | 3 | 2 | 3 | | 3 | 2 | 3 |
| **CO4** | 2 | 2 | | 2 | 2 | 2 | 2 | 3 | 2 | 3 | | 3 | 3 | 3 |
| **CO5** | 2 | 2 | | 3 | 2 | 2 | 2 | 3 | 2 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**Atleast 10 experiments to be conducted from the following list of experiments".**

**List of Experiments**

1. Maintaining sterility and aseptic techniques within the animal biotechnology lab.
2. Microscopic visualization of Human Buccal Epithelial cells. (structured enquiry)
3. Separation of serum from whole blood.
4. Preparation of cell culture growth media
5. Primary culture of chicken embryo fibroblast culture.
6. Isolation of Hepatocytes from Chicken liver cells
7. Enumeration and counting of animal cells using a Haemocytometer.
8. Staining and microscopic visualization of adherent animal cells.
9. Evaluation of cell viability/cytotoxicity in animal cells.
10. Cell viability of cells using trypan blue dye. (Open ended experiment)
11. Trypsinization or subculture of the adherent cell line.
12. Cryopreservation of animal cells
13. Monitoring and trouble shooting of microbial contamination in animal biotechnology lab. (Open ended experiment)

**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

**20EGCO3**

## EMPLOYABILITY SKILLS

| | |
|---|---|
| Instruction | 2 P Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 50 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Prerequisite:** Basic Knowledge of Soft skills in the professional setting.

**Course Objectives**: To help the students

1. Learn the art of communication; participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

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

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 1 | | | | 1 | | 2 | 3 | 3 | 1 | 3 | | 1 |
| **CO2** | | | | | | | | 1 | | 2 | | 1 | | |
| **CO3** | | | | | | 1 | | 1 | 2 | 1 | 1 | 3 | | 1 |
| **CO4** | | 1 | 1 | | | 1 | | 2 | 3 | 3 | 1 | 3 | | 2 |
| **CO5** | | | | | | | | 1 | 2 | 2 | 1 | 3 | | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Verbal Aptitude**: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences-Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

**UNIT II**

**Group Discussion & Presentation Skills**: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT.

**UNIT III**

**Behavioural Skills**: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-

**Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

**UNIT-IV**

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

**UNIT-V**

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre- Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

**TEXT BOOKS:**


1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005.
2. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006.
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2nd edition, Pearson Education, 2007.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010.


**SUGGESTED READING:**


1. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004.
2. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", 2018.
3. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989.
4. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006.

**20BT C32**

## MINI PROJECT

| | |
|---|---|
| No. of Practical | 1 hr Per Week |
| CIE | 50 Marks |
| Credits | 1 |

**Prerequisite:** Knowledge of basic lab techniques and tools in Biotechnology

**Course Objectives:** This course aims to:

1. To enable students learning by practical realization.
2. To develop the capability to analyze and solve real world problems.
3. To develop technical writing and presentation skills.

**Course Outcomes:** Upon completion of this course, students will be able to:

1. Formulate mini project proposal through a literature survey.
2. Plan, design, and analyze the proposed mini project.
3. To Simulate and execute the mini project for validation.
4. Enhance oral presentation skills.
5. Prepare and submit the mini project report.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | | | | | 2 | 3 | | 3 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | 3 | 3 | | 3 | 2 | 3 |
| **CO3** | 2 | 2 | 2 | 3 | 3 | 3 | 3 | | 3 | 3 | | 3 | 3 | 2 |
| **CO4** | 2 | | | 3 | | | | | 2 | 2 | | 2 | 2 | 3 |
| **CO5** | 2 | 2 | | 2 | 2 | | | | 2 | 3 | | 2 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 – Substantially

Dealing with a real time problem should be the focus of under graduate project.

All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 50 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 50 Marks in the end examination:

1. Power point presentation 20 Marks
2. Thesis/Report preparation 30 Marks

With effect from the Academic year 2023-24

# CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

## Department of Bio-Technology

## Scheme of Instructions of VII Semester of B. Tech Bio-Technology as per AICTE Model Curriculum 2023-24

## B.Tech (Bio-Technology)

**SEMESTER VII**

| S. No. | CourseCode | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours Per week | | | Durationof SEE in Hours | Maximum Marks | | |
| | | | L | T | P | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1 | | Professional Elective - III | 3 | - | - | 3 | 40 | 60 | 3 |
| 2 | | Professional Elective - IV | 3 | - | - | 3 | 40 | 60 | 3 |
| 3 | | Professional Elective - V | 3 | - | - | 3 | 40 | 60 | 3 |
| 4 | | Open Elective – II | 3 | - | - | 3 | 40 | 60 | 3 |
| 5 | 20EGMO4 | Gender sensitization | 2 | - | - | 2 | - | 50 | Non-Credit |
| **PRACTICALS** | | | | | | | | | |
| 6 | 20BTC33 | Project Part-I | - | - | 4 | - | 50 | - | 2 |
| 7 | 20BTI03 | Internship-III | 4-6weeks/ 180hours | | | - | - | 50 | 3 |
| **Total** | | | **14** | **0** | **4** | **64** | **260** | **290** | **17** |
| **Clock Hours Per Week – 18** | | | | | | | | | |

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

| **Professional Elective–III (Plant and Animal Biotechnology)** | |
|---|---|
| 20BT E10 | Tissue Engineering |
| 20BT E11 | Genome Editing |
| 20BT E12 | Phytochemical and Herbal Products |
| 20BT E13 | Developmental Biology |

| **Professional Elective–IV (Industrial applications of Biotechnology)** | |
|---|---|
| 20BT E14 | Food Biotechnology |
| 20BT E15 | Nanobiotechnology |
| 20BT E16 | Good Manufacturing Laboratory Practice |
| 20BT E17 | Regulatory Affairs and Clinical Trials |

| **Professional Elective–V (Computational Biology)** | |
|---|---|
| 20BT E18 | Rational Drug Discovery |
| 20BT E19 | Molecular Modeling and drug design |
| 20BT E20 | Structural Biology |
| 20BT E21 | Genomics and Proteomics |

**20BT E10**

# TISSUE ENGINEERING
## (Professional Elective -III)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives**

1. To provide fundamental principles and elements of tissue engineering.
2. To get an insight into 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 the 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 the fabrication of scaffolds in Tissue engineering.
5. Summarize the therapeutic applications of tissue engineering.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 2 | 2 |
| **CO2** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO3** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO4** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO5** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Tissue Engineering:** Basic definition of Tissue engineering; origin and history of Tissue Engineering, an 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 Extracellular matrix (ECM) –components.

**UNIT-III**

**Biomaterials of Tissue Engineering:** Biomaterials Properties, Types of Biomaterials, Biological polymers; Synthetic polymers; a hybrid of synthetic and biological polymers; Scaffolds, 3D scaffolds, Scaffold fabrication conventional techniques: Solvent casting, porogen leaching, freeze drying, electro spinning and 3D bio-printing.

**UNIT-IV**

**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 and combined bioreactors.

**UNIT-V**

**Applications of Tissue Engineering:** Tissue replacement –crucial factors, Skin tissue engineering, Bone tissue engineering; Cardiac tissue engineering; Neural tissue engineering; Vascular tissue engineering; Lab on chip/Organ on chip technology.

**Text Books:**


1. Robert.P.Lanza, Robert Langer & Vacanti, Principles of tissue engineering. Academic Press. 4th edition 2014.
2. B. Palsson, J.A. Hubbell, R. Plonsey & J.D. Bronzino. Tissue engineering. CRC Taylor & Francis press 2003.
3. B. Palsson & S.N. Bhatia. Tissue engineering. Pearson Education India Education Services Pvt. Ltd. 2016.


**Suggested Reading:**


1. Atala O.P &Lanza.L, Methods of tissue engineering. Woodhead Publishing Ltd. Cambridge. UK. 2009.

**20BT E11**

# GENOME EDITING
## (Professional Elective -III)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To learn Genome editing and its tools for genome engineering
2. To understand the genome editing strategy and target site
3. To know the genome editing tools applications in plant, animals and industry
4. To understand the emergent challenges for CRISPR technologies

**Course Outcomes:**

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

1. Outline the Genome editing and its tools for genome engineering
2. Describe the genome editing strategy and target site
3. Explain the Genome editing in Plants for crop improvement
4. Discuss the Genome editing in animals and for human welfare
5. Summarize the application genome editing and emergent challenges for CRISPR technologies

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 2 | 3 | 3 | | 2 | 2 | | 2 | 2 | 2 |
| **CO2** | 2 | 2 | | | 2 | 3 | 3 | | 2 | 2 | | 2 | 2 | 2 |
| **CO3** | 2 | 2 | | | 2 | 3 | 3 | | 2 | 2 | | 2 | 2 | 2 |
| **CO4** | 2 | 2 | | | 2 | 3 | 3 | | 2 | 2 | | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 1 | | 2 | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Genome Editing and its tools:** Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems. Engineered enzyme systems: Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), meganucleases and the clustered regularly interspaced short palindromic repeats(CRISPR/Cas9) system.

**UNIT-II**

**Genome editing strategy and target site:** Gene Knockout with single site targeting, Gene Knockout with double sit targeting, Gene Knockout via sequence insertion and the problem of noncoding RNAs, Inserting or correcting mutations, inserting a gene or other DNA Sequence. Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE).

**UNIT-III**

**Genome editing in Plants for crop improvement:** The history of targeted mutations in plants. Use of ZFNs and TALENs as early tools for genome editing. Discovery of CRISPR-Cas system and its applications. GM plants, Recent innovations in the technology and case studies where CRISPRC as has been used for plant improvement. Regulaory approaches for genome edited crops.

**UNIT-IV**

**Genome editing in Animals**: Therapeutinc Genome editing – Ex Vivo therapeutic genome and in vivo therapeutic genome editing, creating chromosome rearrangement, Study gene function with stem cells, Transgenic animals, Endogenous gene labeling, targeted transgene addition,

**UNIT-V**

**Genome Editing Applications**: Genome editing of Algal species by CRISPR Cas9 for Biofuel production, genome editing its role in bioremediation; Devlopment and use of CRISPR in Industrial applications, Emergent challenges for CRISPR : Ethics,

Biosafety and risk of targeted gene editing, Biosecurity, Patenting CRISPR Technologies and products, regulator issues with CRISPR products.

**Text Books:**

1. CRISPR Gene Editing, Methods and Protocols, Editors: Luo, Yonglun (Ed.)
2. Genome Editing and Engineering, From TALENs, ZFNs and CRISPRs to Molecular Surgery. Edited by Krishnarao Appasani.

**Suggested Reading:**

1. Progress in Molecular Biology and Translational Science Vol 149-Genome Editing in Plants. Edited by Donald P. Weeks and Bing Yang. Academic Press.
2. Precision Medicine, CRISPR, and Genome Engineering, Moving from Association to Biology and Therapeutics, Editors: Tsang, Stephen H. (Ed.). Springer

**20BT E12**

# PHYTOCHEMICALS AND HERBAL PRODUCTS
## (Professional Elective -III)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To impart knowledge on medicinal plants and the extraction of crude drugs.
2. To provide comprehensive knowledge on analysis, types, and detection of phytochemicals and adulterants.
3. To impart knowledge on the applications of various phytochemicals and herbal products.

**Course Outcomes:**

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

1. Classify the sources of various crude drugs and their medicinal values.
2. Outline the procedures involved in the detection, extraction, and analysis of crude drugs and adulterants.
3. Interpret the structure, types and extraction procedure of different plant secondary products.
4. Outline the applications of phytochemicals.
5. Discuss the various aspects of herbal products and licensing of herbal drugs

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 3 | | 3 | 3 | 2 |
| **CO2** | 2 | 2 | 2 | | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO3** | 2 | 3 | 2 | | 3 | 2 | 2 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO4** | 2 | 2 | 2 | | 2 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | | 2 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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, Mentha; Alkaloids - Taxus, Papaver, 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; Classification of active components of therapeutic plant and herbal products; 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, NiraliPrakashan, 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.

**20BT E13**

# DEVELOPMENTAL BIOLOGY
## (Professional Elective -III)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. Students are made to understand the basic concepts of developmental biology.
2. Students are taught the structure of gametes, and how they are generated.
3. Students are taught the influence of genes on body axis formation in Drosophila and Mammals.
4. Students are enlightened about the later embryonic developments i.e. Organogenesis.
5. Students are made aware of sex determination in Drosophila and Mammals.

**Course Outcomes:**

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

1. Discuss basic concepts of Developmental Biology.
2. Describe the anatomy of gametes and biochemistry involved in gamete recognition
3. Analyze the role of genes in the body axis formation of drosophila.
4. Outline the importance and differentiation of germinal layers into different organs and compare the role of genes in the sex determination of Drosophila and Mammals.
5. Explain the genetic anomalies that lead to diseases.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 1 | 2 |
| **CO2** | 2 | | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 1 | 2 |
| **CO3** | 2 | | | | | 3 | 3 | 3 | 2 | 2 | | 2 | 1 | 2 |
| **CO4** | 2 | | | | | 3 | 3 | 3 | 2 | 2 | | 2 | 2 | 2 |
| **CO5** | 2 | | | | | 3 | 3 | 3 | 2 | 2 | | 2 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Developmental Biology:** Overview of anatomical approach, Evolutionary Embryology, Medical embryology & teratology, Mathematical modeling for development, Stages of animal development: The Frog life cycle, Development dynamics of cell specification (Autonomous, Conditional, Syncytial and Morphogenetic Gradients), Induction and Competence.

**UNIT-II**

**Gametogenesis and Fertilization 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).

**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:** 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 Drosophila and 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. ManjuYadav, “Molecular Developmental Biology” Discovery Publishing, September, 2008.
2. Scott F Gilbert, Michael JF Barresi. “Developmental Biology”, 11th edition, Sinauer Associates, Inc, 2013.


**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.

**20BT E14**

# FOOD BIOTECHNOLOGY
## (Professional Elective -IV)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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. Differentiate types of food and explain their nutritive value
3. Examine the types of pathogens and their effect on food
4. Demonstrate the physical and chemical methods of food processing.
5. Apply the techniques to preserve the food material to avoid food spoilage.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 |
| **CO2** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 |
| **CO3** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 |
| **CO4** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 |
| **CO5** | 3 | 2 | | | | 3 | 3 | 3 | 2 | 3 | | 3 | 3 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction To Food Biotechnology:** Introduction to scope and importance of food biotechnology, Nutritive value of the food; Shelf life of food. Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymic, physical and microbial changes). Lipids of biological importance like cholesterol and phospholipids. Food Pigments &Flavoring Agents: Importance, types and sources

**UNIT- II**

**Food Products:** Introduction to Probiotics, Nutraceuticals and GM foods; Processing and post-harvest technology of various food products (High Fructose Corn syrup, Single Cell Protein and Bakery Products, Milk Products). Fermented food: origin, scope and development, sourkraut, youghurt, cheese, miso, tempeh.

**UNIT- III**

**Food Spoilage And Food Microbiology:** Shelf life of food. Microbes found in raw materials and foods that are detrimental to quality, Factors that influence the development of microbes in food, Food spoilage by bacterial agents (Clostridium, Salmonella, Vibrio and Shigella), Non-bacterial agents (Protozoa, Algae, Fungi and Viruses)

**UNIT- IV**

**Food Processing Applications:** Principles and methods of food processing (freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, dielectric heating). Enzymes and chemicals used in food processing for flavor development; Processing of meat, fisheries, vegetables, and dairy products. Food adulteration and food safety.

**UNIT- V**

**Food Preservation:** Application of sugar and salt, antimicrobial agents, biological agents, non-ionizing and ionizing radiations in preservation of foods. Basic concepts in thermal destruction of microorganisms D, Z, F values. Blanching, Pasteurization and Sterilization of foods. Controlled and Modified atmosphere storage of foods. Intelligent packaging concept.

**Text Books:**


1. Roger Angold, Gordon Beech & Taggart, Food Biotechnology1st edition, Cambridge End Press, 1989.
2. Frazier, William, C.Westhoff, Dennisc, Food Microbiology, 2nd Edition 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, 7th edition, Springer, 2006.
3. Romeo T. Toledo, Fundamentals of Food Process Engineering, 3rd edition, Springer, February, 2007.

**20BT E15**

# NANO BIOTECHNOLOGY
## (Professional Elective -IV)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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**

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

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | 3 | 3 | | 2 | 3 | | 2 | 2 | 2 |
| **CO2** | 2 | | | | | 3 | 3 | | 2 | 3 | | 2 | 2 | 2 |
| **CO3** | 2 | | | | | 3 | 3 | | 2 | 3 | | 2 | 2 | 2 |
| **CO4** | 2 | | | | | 3 | 3 | | 2 | 3 | | 2 | 2 | 2 |
| **CO5** | 2 | | 2 | | | 3 | 3 | 2 | 2 | 3 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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 in Bionanotechnology; Limitations of micron size, need for nano-size—surface volume ratio significance, significance and key feasstures of nano-size, comparison of particle behaviour 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, nanoflakes, nanoshells, quantum dots, dendrimers, micelles, 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. DebasisBagchi, ManashiBagchi, 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.

**20BT E16**

# GOOD MANUFACTURING LABORATORY PRACTICE
## (Professional Elective -IV)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objective(s):**

1. Basic understanding of the regulatory requirement of cGMP
2. To know about drug development approval process and regulations related to clinical trials
3. To safely practice laboratory protocols

**Course Outcomes:**
**After studying this course, students will be able to:**

1. Learn and adopt quickly in a GMP environment and understand the principles and applications of the GMP.
2. Evaluate the criteria for drug approval related documentation and quality systems Importance of GMP and GLP for drug regulation
3. Describe quality assurance, design of quality systems, risk analysis and risk assessment
4. Able to apply knowledge of laws related to drug development approval process and regulations related to clinical trials
5. Safely practice basic laboratory procedures and protocols, maintain laboratory records compliant with current industry standards.

### CO-PO/PSO Articulation Matrix

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | | 2 | 1 | 3 | 3 | 2 | 2 | 2 | | 1 | 3 | 2 |
| **CO2** | 2 | 2 | | | 1 | 2 | 2 | 1 | 2 | 3 | | 1 | 3 | 3 |
| **CO3** | 2 | 2 | | 2 | 1 | 2 | 2 | 2 | 2 | 2 | | 1 | 2 | 3 |
| **CO4** | 2 | 1 | | 1 | 1 | 2 | 2 | 1 | 2 | 2 | | 2 | 2 | 2 |
| **CO5** | 2 | 2 | | 1 | 2 | 2 | 2 | 1 | 2 | 3 | | 2 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to GMP and GLP:** Introduction to Good Manufacturing Laboratory Practice, Definitions, History, Requirement of GLP and GMP compliance for regulatory approval. Role of FDA in CGMP, recent milestones in FDA.

**UNIT-II**

**Ethics and design of experiments in GMP:** Ethics in manufacturing and control, Principles of quality by design (QBD), Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development.

**UNIT-III**

**Case studies in GMP:** Example of QBD and DOE in Process Development, Example of DOE in analytical development, Introduction to ICH guidelines and their usage. National and international regulatory authorities and their function. Risk management methods and tools; FMEA, HACCP.

**UNIT-IV**

A**pproval and regulation process in GMP:** Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies State level (DCA) and central level (DCGI/CDSCO**)**

**UNIT-V**

**General measures in GLP practices** General Rules/Protocols for Lab Safety measures, Precaution and Safety in handling of chemicals, Laboratory tools, Glassware's and instruments. Internal and External Audit. Basic SOP for instrument handling and maintenance.

**Text Books:**


1. Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles andapplication, Academic press, March 2019.(QBD).
2. cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Create space Independent Publishing Platform, April 2016.
3. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.


**Reference Books:**


1. Good manufacturing practices for pharmaceuticals . Edited by Graham P. Bunn. Seventh edition. Boca Raton, Florida, DRUGS AND THE PHARMACEUTICAL SCIENCES A Series of Textbooks and Monographs Series Executive Editor James Swarbrick, CRC Press Taylor & Francis Group. 2019.
2. ICH guidelines available in the official website "https://www.ich.org".
3. Handbook Good Laboratory Practices-World health organization(WHO)

**20BT E17**

# REGULATORY AFFAIRS AND CLINICAL TRIALS
## (Professional Elective–IV)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:.**

1. To make the students understand about Intellectual property rights and their importance, National and
2. International regulatory affairs, GCP & ICH guidelines.
3. To introduce and provide a comprehensive introduction to Regulatory Affairs as typically practiced by Regulatory Affairs professionals in medical device and biopharma companies.
4. 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. Classify the role of regulatory committees in controlling the risk and information on ethical issues linked to research on animal models, transgenics.
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.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | 2 | 3 |
| **CO2** | | | | | 2 | 3 | 3 | 3 | 2 | 3 | | 2 | 2 | 2 |
| **CO3** | | 2 | 2 | | | 3 | 3 | | | 3 | | | 2 | 2 |
| **CO4** | | | 3 | | 3 | | | | 3 | 3 | | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | | | 3 | 3 | 3 | 2 | 2 | | 2 | 2 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Regulatory affairs:** Definitions of ACT, regulation, guidance, responsibilities of RA professional. Investigational New drug, applications. Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990),

**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, CDSCO) Exclusivities (NCE, NS, NP, NDF, PED, ODE, PC). ADR : definition and classification

**UNIT-III**

**Regulatory Affairs- Global:** Introduction to FDA, WHO, Code of federal Regulations, ICH guidelines in Pharma covigilance. Related quality systems- objectives and guidelines of USFDA, WHO & 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, Phases, Scope and stake holders in clinical research, Declaration of Helenski, 2000 amendment, Principles of GCP, Roles and responsibilities in clinical research according to ICH GCP, Sponsor, Investigator, 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 Drugs and Cosmetics Act, 1940.
2. 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.

**20BT E18**

# RATIONAL DRUG DISCOVERY

## (Professional Elective-V)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. The student is made to understand the fundamentals of molecular modeling and drug discovery
2. Students are made to understand quantum Mechanics and molecular mechanism
3. Students are enlightened about molecular dynamics simulation methods.
4. Students are enlightened about the methods for Molecular Docking and lead optimization, ADMET properties of the drug.
5. Students are made to understand the basics of Pharmacophore and QSAR

**Course Outcomes:**

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

1. Describe drug discovery process, CADD, molecular modeling etc.
2. Explain the quantum Mechanics and molecular mechanism.
3. Identify various molecular dynamics simulation methods.
4. Discuss the methods for Molecular Docking and lead optimization, ADMET properties of the drug.
5. Summarize about the Pharmacophore and QSAR.

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | |
| **CO2** | 2 | 1 | | | 2 | | | 2 | 2 | 2 | | 2 | 2 | |
| **CO3** | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO4** | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO5** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Molecular Modeling in Drug Discovery**: Drug discovery process, Role of Bioinformatics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modeling of target-small molecule interactions, Molecular simulations. Protein Modeling.

**UNIT-II**

**Quantum Mechanics and Molecular Mechanics:** Features of molecular mechanics force fields; Bond structure and bending angles –electrostatic, van der Waals and non – bonded interactions, hydrogen bonding in molecular mechanics; Derivatives of molecular mechanics energy function; Application of energy minimization.

**UNIT-III**

**Molecular Dynamics simulation methods:** Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials and at constant temperature and pressure; Time – dependent properties; Solvent effects in Molecular Dynamics; Conformational changes from Molecular Dynamics simulation and application.

**UNIT-IV**

**Molecular Docking and lead optimization:** Molecular Docking; Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design.

**UNIT-V**

**Pharmacophore and QSAR**: Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery;

QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principal Components Analysis in the QSAR equations.

**Text Books:**


1. Computational methods in drug design Fred E. Cohen, Walter Hamilton Moos Publisher: ESCOM Science, 1993.
2. Molecular Modelling for Beginners - Alan Hinchliffe Publisher: John Wiley & Sons Inc, 2008. ISBN: 978-0470513149.
3. Combinatorial Library Design and Evaluation: Principles, Software, Tools, Applications in Drug Discovery – Arup Ghose, VellarkadViswanadhan Publisher: CRC Press, 2001. ISBN: 0-8247-0487-8.


**Suggested Reading:**


1. Molecular Modeling Basics - Jan H. Jensen Publisher: CRC Press, 2010. ISBN 978- 1420075267.
2. 3D QSAR in Drug Design: Recent Advances – Hugo Kubinyi, GerdFolkers, Yvonne C. Martin Publisher: Springer Science & Business Media. ISBN: 0-306-46858-1.
3. Computational Chemistry and Molecular Modeling - K. I. Ramachandran, GopakumarDeepa, Krishnan Namboori Publisher: Springer – Verlag Berlin Heidelberg. ISBN: 978 3540773023.

**20BT E19**

# MOLECULAR MODELING & DRUG DESIGN
## (Professional Elective -V)

| | |
|---|---|
| Instruction | 3L Periods per week |
| Duration of university Examination | 3 Hours |
| University Examination | 60 Marks |
| Sessional | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. Empirical force fields and Hydrogen bonding in different molecules.
2. Simulation methods to calculate Thermodynamic properties of molecules.
3. Molecular dynamics simulation of molecules by simple and continuous potential.
4. Practical aspects in setting and running the molecular dynamics simulation.
5. Montecarlo simulation method for rigid and flexible molecules.
6. QSAR between different protein-ligand interactions.

**Course Outcomes:**

After completion of the course students gain knowledge in the following concepts:

1. Calculate the total energy of the molecule by using force field potentials.
2. Calculate Internal energy, Heat capacity, Temperature, and pressure.
3. Hard sphere potential, Continuous potential by Finite differential method.
4. Choosing the initial configuration and analyzing the results of computer simulation.
5. Simulation of polymers by Random walk method, Self-avoiding walk method.
6. Classification of Drug Design. CADD to treat Alzheimer's and Tuberculosis diseases

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 2 | | | | 2 | 2 | | 2 | 2 | |
| **CO2** | 2 | 2 | 2 | | 2 | | | | 2 | 2 | | 3 | 3 | |
| **CO3** | 2 | 2 | 2 | | 2 | | | | 2 | 2 | | 3 | 3 | |
| **CO4** | 2 | 2 | 2 | | 2 | | | | 2 | 2 | | 3 | 3 | |
| **CO5** | 2 | 2 | 2 | | 2 | | | | 2 | 2 | | 2 | 3 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Empirical Force Fields and Molecular Mechanics:** Introduction to Molecular Mechanics, Coordinate system, Molecular graphics, Force fields, Bond stretching, Angle bending, Torsions, out of plane bending motions, Electrostatic interactions, Van der Waals interactions, Effective pair potentials, Hydrogen bonding.

**UNIT-II**

**Computer Simulation Methods:** Calculation of Thermodynamic properties, Phase space, Practical aspects of computer simulation, Periodic boundary condition, Boundaries monitoring Equilibrium, Truncating the potential and minimum image convention, Long-range process, Analyzing results of simulation and estimating errors**.**

**UNIT-III**

**Molecular Dynamics Simulation Methods:** Molecular Dynamics using simple modules, Molecular Dynamics with continuous potentials: Finite difference methods and Predictor corrector integration method, Constraint Dynamics, Transport properties, Time-dependent properties, Molecular Dynamics at Constant Temperature and Pressure.

**UNIT-IV**

**Monte Carlo Simulation Methods:** Metropolis methods, Importance of Hamiltonian equation, Monte Carlo simulation of Rigid and Flexible molecules, Monte Carlo simulation of Polymers: Lattice model & continuous polymer model, calculating chemical potential, Differences between Molecular dynamics & Monte Carlo simulation method.

**UNIT-V**

**Applications Of Molecular Modeling And Drug Design:** Production of Drugs in Pharmaceutical companies, CADD: Structure-Based Drug Design and Ligand Based Drug Design, Quantitative Structural Activity Relationship (QSAR) studies in Protein-Ligand interactions, Case studies of Alzheimer's disease, Tuberculosis, and Cancer, etc.

**Text Books:**

1. Molecular modeling principles and Applications AR Leach, Longman, (1996).
2. Molecular Dynamics simulation -Elementary Methods- John Wiley and Sons, (1997).

**Suggested Reading:**

1. Protein Engineering - Moody PCE and AJ Wilkinson. IRL Press.
2. Introduction to protein structure by C. Brandon and J. Tooze, Garland, 2nd edition, (1998).
3. Essentials of Drug Designing V. Kothakar, Dhruv publications

**20BT E20**

# STRUCTURAL BIOLOGY
## (Professional Elective -V)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

This course focuses on

1. To provide the foundation for understanding, the basic structural biology of macromolecules such as Proteins, DNA, and RNA.
2. To give an understanding of the energetics and kinetics of proteins that will facilitate application to current and future research problems.
3. To provide knowledge about various biophysical techniques for protein structure determination.
4. To give an understanding of various bioinformatics tools in structural biology.

**Course Outcomes:**

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

1. Demonstrates the hierarchy in protein organization and structure-function relationship
2. Outlines the mechanisms, dynamics, and physical interactions that maintain protein structure.
3. Demonstrate the basic techniques involved in determining the structure of a biomolecules
4. Assess conceptual basics of structural dynamics of other macromolecules DNA, RNA & enzyme
5. Illustrates the computer-based visualizations and molecular simulations

### CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | | | | | 2 | 2 | | | 1 | | 2 | 3 | 3 |
| **CO2** | 1 | | | | | 2 | 2 | | | 1 | | 1 | 2 | 2 |
| **CO3** | 1 | 1 | | 1 | 1 | 2 | 2 | | | 1 | | 3 | 3 | 2 |
| **CO4** | 1 | | | | 1 | 2 | 2 | | | 1 | | 2 | 3 | 3 |
| **CO5** | 1 | 1 | | 1 | 1 | 2 | 2 | 1 | | 1 | | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Protein structural biology**: Conformational effect of amino acid on protein structure, basic polypeptide stereochemistry, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Motifs and domains of protein structures. Structure Conformational analysis.

**UNIT-II**

**Protein Kinetics and Energetics**: Mechanism of Protein folding- kinetics intermediates- transition states. Thermodynamics of protein stability: Driving forces in protein folding - Estimation of solvation free energies. Bonds and energies in macromolecules- Covalent, Ionic, coordinate, hydrophobic and Vander walls interactions. Phase problem and methods of phase separation

**UNIT-III**

**Methods for structure determination:** Basics of Crystallization, methods of protein crystallization, Macromolecular crystallography: X-ray crystallography, Bragg equation, scattering factor, Nuclear Magnetic Resonance (NMR), Single particle Cryo Electron Microscopy, FRET advantages and disadvantages of all the processes.

**UNIT-IV**

**DNA, RNA, and Enzyme structures**: DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction. Structural dynamics: Dynamics of Protein-RNA complexes, Enzyme-ligand interaction, Structure-function relationship.

**UNIT-V**

**Computational Structure Biology**: Protein Structure visualization tools, Protein fold-function relationships, best practices on the use of protein structures from protein data bank: Protein Data Bank (PDB) and EM Data Bank, BioMagResBank (BMRB).Introduction to molecular dynamics simulation, the need for simulation in studying biology, case studies on structure-based drug designing and protein engineering.

**Text Books:**


1. Liljas L, Nissen P, Lindblom G, Textbook of Structural Biology, Volume 8 of Series in structural biology, World Scientific, 2016.
2. Introduction to Protein Architecture: The Structural Biology of Proteins, 2014, Lesk A. M., Oxford University Press; 4threvised Edition.
3. Schwede T, Computational Structural Biology: Methods and Applications, World Scientific, 2008.


**References:**


1. Principles of nucleic acid structure, by Stephen Neidle.
2. K.P.Murphy. Protein structure, stability and folding (2001) Humana press. ISBN 0-89603682-0
3. Arthur M.Lesk Introduction to protein architechcture (2001) Oxford University Press. ISBN0198504748
4. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.
5. Biochemistry, Berg J, M., Stryer L., Tymoczko J, Gatto G. WH Freeman & Co, 2019, 9th Edition

**20BT E21**

# GENOMICS AND PROTEOMICS
## (Professional Elective -V)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

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

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO2** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO3** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO4** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | |
| **CO5** | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 2 | |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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; Pre-processing of data and analysis; Introduction to rRNA sequencing and Single-cell sequencing

**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 Inter Pro) 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 Reading:**


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.

**20EG MO4**

# GENDER SENSITIZATION

| | |
|---|---|
| Instruction | 2 L Hours per week |
| Duration of SEE | 2 Hours |
| SEE | 50 Marks |
| CIE | 0 Marks |
| Credits | No Credit |

**Prerequisite:** No specific prerequisite is required.

**Course Objectives**

This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

**Course Outcomes**

After successful completion of the course the students will be able to:

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways in which gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

## CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | 1 | | | 2 | 2 | 1 | 1 | | | 1 | 1 | 1 |
| **CO2** | | | 1 | | | 2 | 2 | 1 | 1 | | | 1 | 1 | 1 |
| **CO3** | | | 1 | | | 2 | 2 | 2 | 2 | 1 | 1 | 1 | | |
| **CO4** | | | 1 | | | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | | | 1 | | | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT–I**

**Understanding Gender:**

**Gender:** Why Should We Study It? (*Towards a World of Equals*: Unit -1)

**Socialization:** Making Women, Making Men (*Towards a World of Equals*: Unit -2)

Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste .Different Masculinities.

**UNIT–II**

**Gender and Biology:**

**Missing Women:** Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4)

Declining Sex Ratio. Demographic Consequences.

**Gender Spectrum:** Beyond the Binary (*Towards a World of Equals*: Unit -10)

Two or Many? Struggles with Discrimination.

**UNIT–III**

**Gender and Labour:**

**Housework:** the Invisible Labour (*Towards a World of Equals*: Unit -3)

"My Mother doesn't Work." "Share the Load."

**Women's Work**: Its Politics and Economics (*Towards a World of Equals*: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work.

Additional Reading: Wages and Conditions of Work.

**UNIT-IV**
**Issues of Violence**
**Sexual Harassment:** Say No! (*Towards a World of Equals*: Unit -6)
Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading:"*Chupulu".*
**Domestic Violence:** Speaking Out (*Towards a World of Equals*: Unit -8)
Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice.
Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)
Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

**UNIT–V**
**Gender: Co - Existence**
**Just Relationships:** Being Together as Equals (*Towards a World of Equals*: Unit -12)
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers.
Additional Reading: Rosa Parks-The Brave Heart.

**Textbook:**

1. A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu "Towards a World of Equals: A Bilingual Textbook on Gender"**,** Telugu Akademi, Hyderabad, 2015.

**Suggested Reading:**

1. Menon, Nivedita. "Seeing like a Feminist", Zubaan-Penguin Books, New Delhi, 2012.
2. Abdulali Sohaila,"I Fought For My Life…and Won", Available online at: http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

**Web Resources:**

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india.

**Note:** Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

**20BT C33**

## PROJECT PART-I

| | |
|---|---|
| Instruction | 4P Hours per week |
| SEE | 0 Marks |
| CIE | 50 Marks |
| Credits | 2 |

**Course Objectives:**

1. 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.
2. To provide a good initiation for the student(s) towards R&D.

**Course Outcomes:** Upon completion of this course, students will be able to:

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

### CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | | | | 1 | 1 | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 2 | 2 | 1 | 3 | 3 | 2 | 2 | | 3 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | | 2 | 2 | | | 1 | | | | 1 | 3 | 3 |
| **CO4** | 1 | 2 | | 1 | | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 | 2 |
| **CO5** | | 1 | 1 | 2 | | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

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 |

**GUIDELINES:**

**These guidelines assure consistency in the quality and components of project to be taken in VII$^{th}$ Semester within the Department and they are segregated into 3 sections**

**A) Section 1 describes guidelines and procedures for allotment, submission, and acceptance of the project**

1. Students will be allotted with a faculty supervisor based on their topic/ area of interest.
2. There will be a maximum of 3 students attached to each of the staff for each research project
3. Students are encouraged to select a topic that has scope to be continued as major project in VIII$^{th}$ Semester
4. Tentative area of research, title and objectives along with novelty statement have to be surveyed with proper discussion and guidance of internal guide
5. All the above mentioned should be finalized in consultation with the faculty supervisor
6. Care should be taken that no two project problems should be same. Care should be taken that the problem should not be same as done in the department over last three years
7. No change in project or group after the department research committee and HoD finalizes the list
8. Soft bound project reports (3 Nos) duly certified by internal guide, DRC and the HOD should be submitted at the time of final review
9. The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the internal guide or DRC or HoD at any point of time.
10. Responsibilities of students include
    a. Schedule meetings as needed with the guide, or others as needed.
    b. Meet the deadlines as specified in the departmental curriculum.
    c. Submit working drafts to the project guide during the writing process.
    d. The student is responsible for making all arrangements for preparation of the report

**B) Section 2 provides an overview of the structure and content of the project report and minimal formatting requirements for preparation of the report.**

1. The report consists of three general sections: The preliminary pages, text and references.
    - ✓ Title page (mention the guide's name-both internal and external also)
    - ✓ Certificates (INTERNAL AND EXTERNAL)
    - ✓ Declaration
    - ✓ Acknowledgements
    - ✓ Contents
    - ✓ Abbreviations
    - ✓ List of Tables
    - ✓ List of Figures
    - ✓ Abstract (in 250 words) and Keywords
    - ✓ Novelty statement
    - ✓ Aim and objectives
    - ✓ Introduction
    - ✓ Review of literature
    - ✓ Materials and Methods (if any)
    - ✓ Results and Discussion (if any)
    - ✓ Expected Conclusions (200 words)
    - ✓ References
    - ✓ Appendix (if any)
    - ✓ Published research papers (if any)
2. The report should be written in Times New Roman (12 size), 1.5 or double spacing, headings and side headings in bold, well defined margins, pagination, etc.
3. Students are instructed to prepare a comprehensive PowerPoint presentation with all findings to present before DRC during final review

**C) Section 3 suggests the time schedule.**

Students should attend all the reviews and follow the deadlines as per the almanac will be allotted with a faculty supervisor

**Suggested schedule:**

| | |
|---|---|
| Starting Date | Day 1 (As per almanac) |
| Literature review / survey | End of 4 Weeks |
| Tentative aim and objectives | End of 8 Weeks |
| Process Manuscript submission | End of 10 Weeks |
| Material and microbes procurement (if any) | End of 12 Weeks |
| Results and Analysis (if any) | End of 14 Weeks |
| Approval of printout draft and Manuscript | End of 16 Weeks |

| | |
|---|---|
| Submission of bound copies | Last Day (As per almanac) |

**The project would be evaluated on a regular basis by the DRC by conducting periodical reviews and marks will be awarded following the rubrics**

**The students have to fill the checklist provided by the DRC in order to evaluate the project's feasibility to be carried out in department**

**FEASIBILITY CHECK LIST**

| S. No | Detail | Response |
|---|---|---|
| **1** | Tentative title of the project | |
| **2** | Tentative objectives | |
| **3** | Novelty statement/Gaps identified | |
| **4** | No. of papers referred to identify the gaps and frame the objectives | |
| **5** | No. of days required for literature survey | |
| **6** | Time required to complete the project in $8^{th}$ semester | |
| **7** | Chemicals/Materials required for the project | |
| **8** | Equipment/Software required | |
| **9** | If equipment/software not available, identification of any alternatives | |
| **10** | Microorganisms required | |
| **11** | Planning to do project internally/external | |
| **12** | If external, the topic should be related to the ones in $8^{th}$ semester | |
| **13** | Expertise available in CBIT | |
| **14** | Any ethical approvals required (animal/human testing) | |

**20BT I03**

## INTERNSHIP-III

| | |
|---|---|
| Instruction | 4-6 weeks |
| Duration of Internship | 180 Hours |
| SEE | 50 Marks |
| Credits | 3 |

**COURSE OBJECTIVES:** This course aims to

1. Familiarize students in biotechnology and allied fields with industrial environments and state-of-the-art technologies.
2. Provide avenues for learning and skill development tailored to real-world technical and managerial requirements within the biotechnology sector.
3. Expose students to current technological breakthroughs relevant to biotechnology and its allied domains.
4. Cultivate an understanding of engineers' ethical responsibilities within the context of biotechnology, and facilitate interaction with industry and societal stakeholders to grasp the practical implications of their work.

**COURSE OUTCOMES:** After completion of this course, students will be able to

1. Execute established biotechnological protocols and techniques with precision and adherence to organizational safety standards. *(Assessed primarily by the Mentor Evaluation and confirmed in the Viva-Voce.)*
2. Uphold professional standards of conduct, including teamwork, ethical responsibility, and effective communication within the organizational culture. *(Assessed primarily by the Mentor Evaluation.)*
3. Analyze the purpose and importance of assigned tasks and protocols within the host organization's workflow and quality management framework. *(Assessed primarily by the "Evaluation of the Industry" component and the Report.)*
4. Accurately document observations, manage scientific data, and interpret results in the context of the specific project or operational goal. *(Assessed primarily through the quality of the Report, Presentation of data, and Viva-Voce questioning.)*
5. Communicate the internship activities, technical findings, and professional growth effectively through a structured written report and oral presentation. *(Assessed directly by the quality of the final Presentation and Report.)*

## CO-PO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | 2 | | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 2 | | 2 | 2 | 3 | 2 | 2 | | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 2 | | | 2 | 2 | 2 | 3 | 3 | 2 | | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | 1 | | 2 | 2 | | 3 | 3 | 2 | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

Schedule for the internship schedules will be given in a flexible manner according to the availability opportunities. The minimum and maximum requirement regarding Internship duration and credits is given in Table-1

**Table 2:** Internship Frame work

| Schedule | Activities | Duration | Credits |
|---|---|---|---|
| Summer / Winter vacation after (6th Semester) | Industrial / Govt. /NGO / MSME/ Rural Internship/ Innovation/ Entrepreneurship/ NSQF level 3, 4,5 | 4-6 weeks | Summer / Winter vacation after (6th Semester) |

**INTERNSHIP GUIDELINES:**

**a) Student's Diary/Daily Log:** The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the Industry supervisor or the Faculty Mentor at any point of time. Failing to produce the same, Intern may be debarred for the remaining period of his/her internship. Daily diary needs to be submitted to Faculty

Mentor at the end of Internship along with the attendance record and an evaluation sheet duly signed and stamped by the industry. Daily diary is evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary/log
- Adequacy & quality of information recorded
- Drawing, sketches, and data recorded.
- Thought process and recording techniques used
- Organization of the information

**b) Internship Report**: At the end of the internship, each student should prepare a comprehensive report to indicate what he/she observed and learned in the training/internship period. It should be signed by the internship supervisor. The report will be evaluated by the Industry Supervisor on the basis of the following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

**EVALUATION OF INTERNSHIP**:

The industrial training/internship of the students will be evaluated in three stages:

1. Evaluation by the Industry ( in the range of 1 to 10 where 1-Unsatisfactory; 10-Excellent)
2. Evaluation by faculty supervisor on the basis of site visit(s) or periodic communication (15 marks)
3. Evaluation through seminar presentation/Viva-Voce at the Institute(This can be reflected through marks assigned by Faculty Mentor (25 marks))

**Evaluation through Seminar presentation/Viva-Voce at the institute**: Students will give a seminar based on his/her training report, before an Expert Committee constituted by the concerned department as per the norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented
- Proper planning for presentation
- Effectiveness of presentation
- Depth of knowledge and skills
- Attendance record, daily diary, departmental reports shall be analyzed along with the internship Report

With effect from the Academic year 2023-24

# CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

## Department of Bio-Technology
## Scheme of Instructions of VIII Semester of B. Tech Bio-Technology as per AICTE Model Curriculum 2023-24
## 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 | | **Professional elective-VI** | 3 | - | - | 3 | 40 | 60 | 3 |
| 2 | | **Open Elective –III** | 3 | - | - | 3 | 40 | 60 | 3 |
| **PRACTICALS** | | | | | | | | | |
| 3 | 20BTC34 | Technical Seminar | - | - | 2 | - | 50 | - | 1 |
| 4 | 20BTC35 | Project Part-II | 4-6 weeks of industry Internship (180 hours)/12 hours | | | - | 100 | 100 | 4 |
| **Total** | | | **6** | **0** | **14** | **6** | **230** | **220** | **11** |
| **Clock Hours Per Week –20** | | | | | | | | | |

**L: Lecture T: Tutorial P: Practical**

**CIE – Continuous Internal Evaluation SEE - Semester End Examination**

| **Professional elective-VI (Advanced applications of Biotechnology)** | |
|---|---|
| 20BT E22 | Immunodiagnostics |
| 20BT E23 | Biomaterials |
| 20BT E24 | Metabolic Engineering |
| 20BT E25 | Biosimilar Technology |

**20BT E22**

# IMMUNODIAGNOSTICS
## (Professional Elective -VI)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 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 tests.
3. To learn the steps involved in the production, diagnosis, and applications of monoclonal antibodies.
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 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.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | 2 | 2 | 2 | 2 | 2 | | 3 | 3 | 2 |
| **CO2** | 2 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | 2 |
| **CO3** | 2 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | 2 |
| **CO4** | 2 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | 2 |
| **CO5** | 3 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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, Immunoelectrophoresis, 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; Immuno monitoring of Clinical Trials; Immunological Assays Used in Vaccine Clinical Trials.

**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 Reading:**


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

**20BT E23**

# BIOMATERIALS
## (Professional Elective–VI)

| | |
|---|---|
| Instruction | 3LHoursperweek |
| Duration of SEE | 3Hours |
| SEE | 60Marks |
| CIE | 40Marks |
| Credits | 3 |

**Course Objectives:**

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

1. To learn the types and trends of Biomaterials.
2. To recognize the procedures for manufacturing of Metallic Biomaterials.
3. To be aware of the types of ceramic Biomaterials.
4. To elaborate the detailed features of polymer and composite Biomaterials.
5. To learn the applications of Biomaterials.

**Course outcomes:**

By the end of the course the students are able to

1. Explain types and properties of Biomaterials.
2. Compare the techniques for manufacture of metallic Biomaterials and their use in health care industry.
3. Outline the physiological properties and various techniques for manufacture of ceramic biomaterials.
4. Illustrate the preparation of polymer and composite Biomaterials.
5. Apply the different type of Biomaterials in health industry.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 3 | 3 | 2 | 2 | 2 | | 3 | 2 | 2 |
| **CO2** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO3** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO4** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |
| **CO5** | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Biomaterials:** Introduction and importance of biomaterials; Types of biomaterials: metallic, ceramic, polymeric and composite biomaterials; Future trends in biomaterials.

**UNIT-II**

**Metallic Biomaterials**: Properties of metallic biomaterials; Stainless steels; CoCr alloys; Ti alloys; Corrosion of metallic implants; Manufacturing of implants. Case study for manufacturing of Cardiac implants, Dental implant and their biocompatibility and hemocompatibility.

**UNIT-III**

**Ceramic Biomaterials**: Properties of ceramic biomaterials; Classification according to physiological response of ceramic biomaterials: bioinert, bioactive and bioresorbable ceramics; Deterioration of ceramics; Bio ceramic manufacturing techniques (ex; Manufacturing of orthopaedic implants and their biocompatibility and hemocompatibility.

**UNIT-IV**

**Polymeric and composite biomaterials**: Polymerization and basic structure; Polymers used as biomaterials; Properties of polymeric and composite biomaterials; Sterilization; Surface modifications for improving biocompatibility; Surface-protein interactions.

**UNIT-V**

**Applications of Biomaterials**: Applications of biomaterials in tissue engineering; Drug delivery; Biosensing; Diagnostics.

**Text Books:**


1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E An Introduction to Materials in Medicine, (Elsevier Academic Press, ISBN: 0-12-582463-7),2002.
2. J.B. Park and J.D. Bronzino. Biomaterials: Principles and Applications. CRC Press. 2002. ISBN: 0849314917
3. K.C. Dee, D.A. Puleo and R. Bizios. An Introduction to Tissue-Biomaterial Interactions. Wiley 2002. ISBN: 0-471-25394-4.


**Reference Books**


1. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications. World Scientific. 2004. ISBN 981-256-061-0
2. B. Rolando (Ed.) Integrated Biomaterials Science. Springer. 2002. ISBN: 0-306-46678-3.

**20BT E24**

# METABOLIC ENGINEERING
## (Professional Elective-VI)

| | |
|---|---|
| Instruction | 3LHoursperweek |
| Duration of SEE | 3Hours |
| SEE | 60 Marks |
| CIE | 40 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.

**CO-PO/PSO ARTICULATION MATRIX**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 3 |
| **CO2** | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 3 |
| **CO3** | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 3 |
| **CO4** | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 3 | 3 |
| **CO5** | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 3 | 3 | 2 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**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. Experimental determination of metabolic fluxes C13 labeling, NMR and GC-MS based methods for flux determination.

**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 SangyYuplee 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.

**20BT E25** With effect from the Academic year 2023-24

# BIOSIMILAR TECHNOLOGY
## (Professional Elective -VI)

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. Student is made to understand about the design and development of different kinds of biologics, biomimetics, and biosimilars.
2. Students are taught about different biotechnological applications of biologics, biomimetics, and biosimilars.
3. Students are made to study the regulatory framework about the biosimilars.

**Course Outcomes:**

At the end of the course the students are able to

1. Outline the biologics, biosimilars and super biologics.
2. Distinguish the various biosimilar drugs
3. Compare and contrast various biosimilar characterization methods.
4. Interpret various bioequivalence studies.
5. Analyze various case studies of biosimilar products of Indian companies

### CO-PO/PSO Articulation Matrix

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 1 | | | 2 | 2 | | | 2 | | 2 | 3 | 1 |
| **CO2** | 1 | 1 | | | | 2 | 2 | | | 2 | | 1 | 3 | 2 |
| **CO3** | 1 | | | | 1 | 2 | 2 | | | 2 | | 3 | 3 | 2 |
| **CO4** | 1 | 1 | | | 1 | 2 | 2 | 1 | | 2 | | 3 | 3 | 2 |
| **CO5** | | 1 | | | | 2 | 2 | 1 | | 2 | 1 | 2 | 2 | 1 |

1 - Slightly, 2 - Moderately, 3 - Substantially

**UNIT-I**

**Introduction to Biopharma**: Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

**UNIT-II**

**Types of Biosimilar drugs**: Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid based therapies (DNA, NA, etc), Cell based therapies (including stem cells)

**UNIT-III**

**Characterization methods**: Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins.

**UNIT-IV**

**Bioequivalence studies**: Immunogenicity &allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual).

**UNIT-V**

**Case studies**: Indian companies working in this space & their product pipeline (Biocon, Intas, Dr Reddy's, Reliance, Bharat Biotech, Lupin, Cipla, Sanofietc); products -Insulin analog, Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

**Text Books**:


1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.


**Reference Material:**


1. https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281/

**20BT C34**

# TECHNICAL SEMINAR

| | |
|---|---|
| Instruction | 2P Hours per week |
| SEE | 0 Marks |
| CIE | 50 Marks |
| Credits | 1 |

**Course Objectives:** This course aims to:

1. 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.
2. 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.
3. Documenting the seminar report in a prescribed format.

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

1. Study and review research papers of new field/areas and summarize them.
2. Identify promising new directions of various cutting edge technologies in Computer Science and Engineering
3. Impart skills to prepare detailed report describing the selected topic/area.
4. Acquire skills to write technical papers/articles for publication.
5. Effectively communicate by making an oral presentation before the evaluating committee.

**CO-PO/PSO Articulation Matrix**

| PO/PSO CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | 2 | 2 | 3 | 3 | 3 | | 3 | | 2 | 2 | 3 |
| **CO2** | 2 | | | 2 | 2 | 3 | 3 | 3 | | 2 | | 2 | 2 | 2 |
| **CO3** | 2 | 2 | | 2 | | 3 | 3 | | | 3 | 1 | 2 | 2 | 2 |
| **CO4** | 2 | 1 | | 3 | 3 | | | | | 3 | 1 | 3 | 2 | 2 |
| **CO5** | 2 | | | 3 | | 3 | 3 | 3 | | 2 | | 2 | 2 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

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 followingaspects:**

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 for20 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 scheduleshall be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral andwritten 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 |

**20BT C35**

# PROJECT PART-II

| | |
|---|---|
| Instruction | 12 L Hours per week |
| SEE | 100 Marks |
| CIE | 100 Marks |
| Credits | 4 |

**Course Objectives:** This course aims to:

1. Enable the student to 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.
2. Provide a good training for the student(s) in R&D work and technical leadership.

**Course Outcomes:** Upon completion of this course, students will be able to:

1. Summarize the literature review to identify and formulate engineering problems
2. Design the experiments by selecting the engineering tools/components for solving the identified problem
3. Develop skills of problem solving, interpreting analysis and evaluation
4. Illustrate written and oral communication skills through project report and presentation
5. Demonstrate the knowledge, skills, attitude and ethics of a professional engineering graduate and ability to work in a team by adapting to the working environment of Industry and institute

**CO-PO/PSO Articulation Matrix**

| PO/PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |

1 - Slightly, 2 - Moderately, 3 - Substantially

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 | MaxMarks | Evaluation Criteria / Parameter |
|---|---|---|
| External and Internal Examinerstogether | 20 | Power Point Presentation |
| | 40 | Thesis Evaluation |
| | 20 | Quality of the project<br>• Innovations<br>• Applications<br>• Live Research Projects<br>• Scope for future study<br>• Application to society |
| | 20 | Viva-Voce |

**PROJECT PART II GUIDELINES:**

**These guidelines assure consistency in the quality and components of project within the Department and they are segregated into 3 sections**

**A) Section 1 describes guidelines and procedures for allotment, submission, and acceptance of the project**

1. Students will be allotted with a faculty supervisor based on their topic/ area of interest.
2. There will be a maximum of 3 students attached to each of the staff for each research project
3. Students are encouraged to continue the topic of Project Part I in their previous semester
4. Project problem statement and topic should be finalized in consultation with the faculty supervisor
5. Care should be taken that no two project problems should be same. Care should be taken that the problem should not be same as done in the department over last three years
6. No change in project or group after the department research committee and HoD finalizes the list
7. Hard bound project thesis (4 Nos) duly certified by internal guide, external guide (if any), DRC and the HOD should be submitted at the time of external viva-voce examination
8. The students should record the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. Students shall be ready to show the diary to the internal guide or DRC or HoD at any point of time.
9. Responsibilities of students include
    - Schedule meetings as needed with the guide, or others as needed.
    - Meet the deadlines as specified in the departmental curriculum.
    - Submit working drafts to the project guide during the writing process.
    - The student is responsible for making all arrangements for preparation of the thesis

**B) Section 2 provides an overview of the structure and content of the project thesis and minimal formatting requirements for preparation of the thesis.**

1. The thesis consists of three general sections: The preliminary pages, text and references.
    - ✓ Title page (mention the guide's name-both internal and external also)
    - ✓ Certificates (INTERNAL AND EXTERNAL)
    - ✓ Declaration
    - ✓ Acknowledgements
    - ✓ Contents
    - ✓ Abbreviations
    - ✓ List of Tables
    - ✓ List of Figures
    - ✓ Graphical Abstract or comprehensive overview of work
    - ✓ Abstract (in 250 words) and Keywords
    - ✓ Novelty statement
    - ✓ Introduction
    - ✓ Review of literature
    - ✓ Materials and Methods
    - ✓ Results and Discussion
    - ✓ Conclusions(200 words)
    - ✓ References
    - ✓ Appendix (if any)
    - ✓ Published research papers (if any)
2. The thesis should be written in Times New Roman (12 size), 1.5 or double spacing, headings and side headings in bold, well defined margins, pagination, etc.
3. Students are instructed to prepare a comprehensive PowerPoint presentation with all findings to present before external examiner

**C) Section 3 suggests the time schedule.**

Students should attend all the reviews and follow the deadlines as per the almanac will be allotted with a faculty supervisor

**Suggested schedule:**

| | |
|---|---|
| Starting Date | Day 1 (As per almanac) |
| Literature review / survey | End of 1 Weeks |
| Process Manuscript submission | End of 2 Weeks |
| Material and microbes procurement | End of 4 Weeks |
| Results and Analysis | End of 12 Weeks |
| Approval of printout draft and Manuscript | End of 15 Weeks |
| Submission of bound copies | Last Day (As per almanac) |

**The project would be evaluated on a regular basis by the DRC by conducting periodical reviews and marks will be awarded following the rubrics**