KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

DEPARTMENT OF BIOTECHNOLOGY
B.TECH BIOTECHNOLOGY
R – 2020 AUTONOMOUS CURRICULUM
CHOICE BASED CREDIT SYSTEM

VISION:

To make the Department of Biotechnology, unique of its kind in the field of research and development activities pertaining to the field of biotechnology in this part of the world.

MISSION:

To impart highly innovative and technical knowledge in the field of biotechnology to the urban and rural student folks through “Total Quality Education”.

PROGRAM EDUCAITON OBJECTIVES:

Educational objectives of the course Bachelor of Biotechnology programme can be divided into

1. **Program Specific Academic Excellence:** The student will be able to pursue higher education in India/Abroad in Biotechnology and its related fields by taking up competitive exams like GATE, CSIR, TANCET, GRE, TOEFL etc
2. **Professional Attitude:** The student will be able to come up with solutions for any scientific or technical problems related to Biotechnological industries/institutes by engaging in independent and life-long learning.
3. **Core Competence:** The student will be able to plan and conduct experiments in modern biotechnology and allied field laboratories using modern tools including interpreting the significance of resulting data, reporting results and writing technical reports
4. **Collaboration:** The students will be able to work in multidisciplinary team with confidence and will be able to venture out with entrepreneurial activities.

PROGRAM OUTCOMES:

After going through the four years of study, the Biotechnology graduates will have the ability to

	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the

		engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES (PSOs):

1. **Future ready graduates:** The student will be able to identify, choose and perform to their best ability in the next career step: Higher education/Job/Entrepreneurial initiatives**.**

2. **Industry ready graduates:** The student will be able to apply the acquired knowledge to provide cost-effective and sustainable solutions in Biotechnology.

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B.TECH. BIOTECHNOLOGY

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

(V and VI)

SEMESTER V

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	BT1501	Bioprocess Principles	PC	3	0	0	3	3
2	BT1502	Genetic Engineering	PC	3	0	0	3	3
3	BT1503	Mass Transfer Operation	PC	3	0	0	3	3
4		Professional Elective I	PE	3	0	0	3	3
5		Professional Elective II	PE	3	0	0	3	3
6		Open Elective – I	OE	3	0	0	3	3
PRACTICALS								
7	BT1511	Bioprocess Laboratory I	PC	0	0	4	4	2
8	BT1512	Molecular Biology and Genetic Engineering Laboratory	PC	0	0	4	4	2
9	HS1521	Professional Communication	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**10**	**28**	**23**

SEMESTER VI

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	BT1601	Bioinformatics	PC	3	0	0	3	3
2	BT1602	Bioprocess Engineering	PC	3	1	0	4	4
3		Professional Elective III	PE	3	0	0	3	3
4		Professional Elective IV	PE	3	0	0	3	3
5		Professional Elective V	PE	3	0	0	3	3
6		Online Course	OL	NPTEL / SWAYAM				3
PRACTICALS								
7	BT1611	Bioinformatics Laboratory	PC	0	0	4	4	2
8	BT1612	Bioprocess Laboratory II	PC	0	0	4	4	2
			TOTAL	**15**	**1**	**8**	**24**	**23**

PROFESSIONAL ELECTIVES COURSES (PE)

PROFESSIONAL ELECTIVE I, SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BT1531	Advanced Biochemistry	PE	3	3	0	0	3
2	BT1532	Chemical Reaction Engineering – I	PE	3	3	0	0	3
3	BT1533	Fundamentals of Intellectual Property Rights	PE	3	3	0	0	3
4.	BT1534	Human Anatomy and Physiology	PE	3	3	0	0	3
5.	BT1535	Principles of Food Science and Processing	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE II, SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	BT1536	Industrial Biosafety and Hazard Management	PE	3	3	0	0	3
2	BT1537	Genetics and Gene therapy	PE	3	3	0	0	3
3	BT1538	Nanoscience and NanoBiotechnology	PE	3	3	0	0	3
4.	BT1539	Protein Engineering	PE	3	3	0	0	3
5.	BT1540	Unit operations	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE III, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	BT1631	Chemical Reaction Engineering – II	PE	3	3	0	0	3
2	BT1632	Lifestyle Diseases	PE	3	3	0	0	3
3.	BT1633	Metabolic Engineering	PE	3	3	0	0	3
4.	BT1634	Plant Biotechnology	PE	3	3	0	0	3
5.	GE1471	Professional Ethics and Human Values	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE IV, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	BT1635	Animal Biotechnology	PE	3	3	0	0	3
2	BT1636	Industrial Waste Management	PE	3	3	0	0	3
3.	BT1637	Introduction to Biofuel	PE	3	3	0	0	3
4.	BT1638	Tissue Engineering	PE	3	3	0	0	3
5.	BT1639	Transport Phenomena	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE V, SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	BT1640	Advanced Process Calculations	PE	3	3	0	0	3
2	BT1641	Cancer Biology	PE	3	3	0	0	3
3.	BT1642	Fundamentals of Clinical Trials	PE	3	3	0	0	3
4.	BT1643	Genomics and Proteomics	PE	3	3	0	0	3
5.	BT1644	Good Manufacturing Practices and Laboratory Practice	PE	3	3	0	0	3

OPEN ELECTIVE COURSES

S.NO	OPEN ELECTIVE	DEPARTMENTS
1	Basics of Bioinformatics	CSE, IT, AI
2	Fundamentals of Microbiology	Civil, Mech, PT
3	Basics of Nanobiotechnology	EEE, ECE, PT
4	Instrumentation and analytical methods	EEE,EIE, ECE, MTR
5	Testing of Biological Materials	CSE, IT, AI
6	Introduction to Food Manufacturing	MTR, EIE, EEE, PT

OPEN ELECTIVE – I

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	OBT151	Basics of Bioinformatics	3	0	0	3	V
2	OBT152	Basics of Nanobiotechnology	3	0	0	3	
3	OBT153	Fundamentals of Microbiology	3	0	0	3	

OPEN ELECTIVE - II

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	OBT171	Instrumentation and analytical methods	3	0	0	3	VII
2.	OBT172	Introduction to Food Manufacturing	3	0	0	3	
3.	OBT173	Testing of Biological Materials	3	0	0	3	

SEMESTER V

BT1501 BIOPROCESS PRINCIPLES

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- To develop an understanding on the basic design of bioreactor and various cultivation strategies involved in bioprocessing.
- To understand various components of media, sterilization kinetics and various strategies involved in growth and product formation.

UNIT I OVERVIEW OF FERMENTATION PROCESSES 9

Overview of fermentation industry - general requirements of fermentation processes, phases of bacterial growth, basic configuration of fermenter and ancillaries; main parameters to be monitored and controlled in fermentation processes (pH, temperature, dissolved oxygen) - sensors.

UNIT II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, medium optimization methods - Plackett Burman design, Response Surface Methodology.

UNIT III STERILIZATION KINETICS 6

Concept of media sterilization; Thermal Death Kinetics; Design of batch and continuous sterilization processes; Filter sterilization of liquid media and air; filter sterilization based numerical problems.

UNIT IV KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 12

Biomass estimation - Direct and Indirect methods, Kinetics of cell growth & substrate utilization; Unstructured kinetic models for microbial growth (Monod & modified Monod models - logistic equation); Kinetics of product formation - Luedeking-Piret equation and analysis; Substrate and product inhibition of cell growth and product formation; Batch and continuous cultivation.

UNIT V METABOLIC STOICHIOMETRY AND ENERGETICS 9

Stoichiometry of cell growth and product formation - elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients; Microbial growth and product formation energetics, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the important parameters in bioreactor, which need to be controlled and monitored for optimum bioprocess.
CO2	Explain the formulation of medium, which supports maximization of product / target.
CO3	Choose an appropriate sterilization design for sterilizing different media.
CO4	Make use of appropriate cultivation strategies for maximum product formation.
CO5	Design an appropriate medium based on the stoichiometric requirement of the microbial system.

TEXT BOOKS

1. Stanbury, P.F., Whitaker, A. and Hall, S.J., 2013. *Principles of fermentation technology*. Elsevier.
2. Michael, L.S., 2017. *Bioprocess engineering: basic concepts*. Pearson Education India.

3. Clark, D.S. and Blanch, H.W., 1997. *Biochemical engineering*. CRC press.

REFERENCE BOOKS

1. Doran, P.M., 1995. *Bioprocess engineering principles*. Elsevier.
2. Bailey, J.E. and Ollis, D.F., 1976. *Biochemical engineering fundamentals.* Chemical Engineering Education.

BT1502 GENETIC ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the fundamentals of recombinant DNA technology and DNA manipulation techniques**.**
- Apply the fundamentals of rDNA technology on construction of vectors and DNA libraries**.**
- Understand the applications of genetic engineering in various fields.

UNIT I INTRODUCTION TO RECOMBINANT DNA TECHNOLOGY 9

Overview of recombinant DNA technology (rDNA) and its applications; rDNA technology tools - Restriction and Modification systems (RM system) – biological importance; restriction enzymes - cohesive ends, blunt ends, isoschizomers, neoschizomers, star activity, compatible cohesive ends; DNA polymerase; DNA ligase, blunt end ligation - linkers and adaptors, Inter and intra molecular ligation; Alkaline phosphatase; Polynucleotide kinase; Terminal transferase and Exonuclease.

UNIT II CLONING VECTORS AND HOST SYSTEMS 9

Introduction to vectors and their types - cloning vector and expression vector; plasmid vector – types, characteristics, importance, copy number regulation; bacteriophage vector - λ DNA vectors, *in-vitro* packaging; single strand DNA vectors - M13 phage vector; viral vectors; combinatorial vectors – cosmid, phagemid and other hybrid vectors; artificial

chromosomes - bacterial and yeast artificial chromosomes; prokaryotic and eukaryotic expression host systems; introduction of rDNA into host cells; methods of selection of recombinants - size-based selection, Spi¯ selection and other selection methods.

UNIT III AMPLIFICATION OF DNA AND SEQUENCING 9

Polymerase Chain Reaction (PCR) - principle and Steps involved; types of PCR - Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, Methylation specific PCR and Single cell PCR; Real-time PCR/qPCR and its advantages – SYBR green assay, TaqMan assay, molecular beacons; DNA sequencing - Maxam-Gilbert's and Sanger's methods of DNA sequencing, pyrosequencing, nanopore DNA sequencing, Next Generation Sequencing (NGS) - 454 sequencing, Solexa method, Ion semiconductor sequencing, Life/APG – SOLiD system.

UNIT IV DNA LIBRARIES 9

Construction of genomic and cDNA library - introduction, methods, limitations; chromosomal walking; screening of DNA libraries - nucleic acid hybridization and PCR (degenerate probes and primers), Southwestern and Northwestern strategies, immunochemical, protein-protein/ligand interaction, functional complementation/gain of function approaches; differential cDNA library - differential expression analysis and screening, subtracted cDNA library, PCR based differential display analysis and difference cloning.

UNIT V APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 9

Site directed mutagenesis - Primer extension method, Kunkel's method and PCR based site directed mutagenesis; creation and application of transgenic animals and plants - Zinc finger nucleases, Transcription Activator-Like Effector Nucleases (TALENs), meganucleases, CRISPR-Cas; specific case studies on site specific mutants, transgenic plants & animals.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Outline the role of R-M system in recombinant DNA technology

CO2 Analyze the suitability of cloning vectors for various recombinant DNA applications.

CO3 Distinguish between different methods of DNA sequencing and amplification in recombinant DNA technology.

CO4 Distinguish between different types of DNA libraries and their screening methods.

CO5 Examine the current techniques and methodologies related to rDNA technology.

TEXT BOOKS:

1. Old, R.W. and Primrose, S.B., 1994. *Principles of gene manipulation: an introduction to genetic engineering* (Vol. 2). Univ of California Press.
2. Primrose, S.B. and Twyman, R., 2009. *Principles of genome analysis and genomics*. John Wiley & Sons.
3. Brown, T.A., 2020. *Gene cloning and DNA analysis: an introduction*. Wiley-blackwell.

REFERENCE BOOKS:

1. Primrose, S. and Twyman, R., 2006. *Principles of Gene Manipulation and Genomics*,
2. Green, M.R., Hughes, H., Sambrook, J. and MacCallum, P., 2012. Molecular cloning: a laboratory manual..

BT1503 MASS TRANSFER OPERATION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn about the principles of adsorption, absorption, leaching, extraction, distillation, drying operations
- Understand the importance and applications of different mass transfer process in industry
- Develop skills of the students in the area of mass transfer operations with emphasis on separation and purification of products

UNIT I DIFFUSION AND MASS TRANSFER 9

Eddy Diffusion - Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Mass Transfer Theories and Analogies; Co-current and counter current operations**.**

UNIT II GAS LIQUID OPERATIONS 9

Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Industrial absorbers; Design principles of absorbers - HTU, NTU concepts.

UNIT III VAPOUR LIQUID OPERATIONS 9

V-L Equilibria; Simple, Steam, Flash and Continuous distillation; McCABE-THIELE principles; Industrial distillation equipment, HETP, HTU and NTU concepts.

UNIT IV EXTRACTION OPERATIONS 9

Liquid-Liquid equilibria; Solvent characteristics; Staged and continuous extraction - Spray, packed and mechanically agitated contactors, Pulsed and centrifugal extractors, supercritical extraction; Solid-liquid equilibria - Leaching Principles, leaching equipment, Percolation tank leaching, Thickeners, Bollman extractor, Rotocell extractor, Kennedy extractor.

UNIT V ADSORPTION AND DRYING OPERATIONS 9

Adsorption equilibria – Nature of adsorbents; Batch and fixed bed adsorption; Adsorbers – steady state moving bed adsorber and unsteady state moving adsorbers, break through curves; Drying- Mechanism, Drying curves, Time of Drying; Batch and continuous dryers.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Solve problems related to different types of molecular diffusion.

CO2 Solve problems related to absorption and stripping process.

CO3 Apply the concepts of HTU, NTU to design the distillation column.

CO4 Design and construct the liquid – liquid, solid -liquid extraction.

CO5 Apply the concept of adsorption to establish isotherms in adsorption process.

TEXT BOOKS

1. Treybal R.E. 2017, *Mass Transfer Operations,* III edition, Mcgraw Hill.
2. Geankoplis C.J. 2015, *Transport Processes and Unit Operations,* IV edition,

Prentice Hall of India.

3. McCabe W.L, Sonith J.C., and Harriot P., *Unit operations of chemical Engineering,* 6th edition, McGraw Hill.

REFERENCE BOOKS

1. Coulson J. M, Richardson J.F, Backhurst J. R. and Harker J. H. 2013, *Coulson and Richardson's Chemical Engineering. Vol II*, V edition, Butterworth-Heinemann.
2. Welty, J. R., Wilson, R. E., Wicks, C. E., and Rorer,G. L., 2010, *Fundamentals of Momentum, Heat and Mass Transfer*, V edition, John Wiley & sons Inc.

BT1511 BIOPROCESS LABORATORY I

L	T	P	C
0	0	4	2

OBJECTIVES:

- To train on methods to investigate the growth of microorganisms in different systems under different conditions.
- To train the students on enzyme characterization, immobilization and medium optimization methods

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LIST OF EXPERIMENTS

1. Batch cultivation - Growth curve of bacterial / yeast cell.
2. Growth kinetics - Estimation of Biomass, Specific Growth Rate, Yield Coefficients.
3. Screening of important parameters for the growth of bacteria through Plackett Burman Design
4. Optimization of medium through Response Surface Methodology
5. Enzyme kinetics – Determination of Michaelis - Menten parameters
6. Enzyme activity – Effect of Temperature and Deactivation Kinetics
7. Enzyme activity – Effect of pH
8. Enzyme inhibition kinetics
9. Enzyme immobilization – Gel entrapment
10. Enzyme immobilization –Cross-linking
11. Enzymatic conversion in Packed bed Column

TOTAL: 60 PERIODS

EQUIPMENT NEEDED FOR 30 STUDENTS

Autoclave, Hot Air Oven, Incubators, Light Microscopes, Incubator Shaker, Colorimeter, Laminar Flow Chamber, and Glassware required.

COURSE OUTCOMES

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

CO1 Determine growth kinetic parameters of microorganism

CO2 Design experiment to optimize media composition for growth of microorganism

CO3 Estimate enzyme kinetic parameters

CO4 Assess the effect of physical parameters on enzyme activity

CO5 Evaluate different immobilization methods

REFERENCES:

1. Bailey and Ollis, 1986.*Biochemical Engineering Fundamentals*, McGraw Hill (2nd Ed.),
2. Shuler and Kargi, 1992., *Bioprocess Engineering* , Prentice Hall,
3. Pauline Doran, 2010, *Bioprocess Engineering Calculation*, Blackwell Scientific Publications.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, 2016, *Principles of Fermentation Technology*, Science & Technology Books.

BT1512 MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

L	T	P	C
0	0	4	2

OBJECTIVES:

This course enables the students

- To learn the basic DNA isolation techniques.
- To learn about the identification and characterization of gene and protein.
- To provide hands-on experience in performing basic recombinant DNA techniques.

LIST OF EXPERIMENTS

1. Agarose gel electrophoresis
2. Isolation of genomic DNA – Microbial, Animal & Plant
3. Isolation of plasmid DNA
4. Restriction enzyme digestion of DNA
5. DNA ligation
6. DNA elution
7. Polymerase Chain Reaction (PCR)
8. Competent cell preparation & Transformation
9. Blue-White screening of recombinants
10. Induction and Analysis of Protein expression- SDS-PAGE
11. Southern Hybridization - Non radio-isotopic method
12. Western Blotting - Non radio-isotopic method

TOTAL: 60 PERIODS

EQUIPMENT REQUIRED (FOR BATCH OF 30 STUDENTS)

Refrigerated centrifuge – 1No.

Spectrophotometer – 2 Nos.

Chemical fume hoods (for handling toxic solvents) – 2 Nos.

Temperature controlled Incubator shaker – 1No.

Temperature controlled water bath – 1No.

Ice flake machine – 1 No.

Agarose gel apparatus with power packs – 2 Nos.

Laminar Air flow (3 or 4 ft length) – 2 Nos.

PCR machine (96/48 Wells) – 1 No.

SDS-PAGE apparatus – 2 Nos.

Western transfer apparatus (wet) – 2 Nos.

Glasswares / Plasticwares/Chemicals/Media as required

COURSE OUTCOMES

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

CO1	Demonstrate isolation and manipulation of plasmid DNA.
CO2	Apply the process of DNA amplification and transformation in recombinant DNA studies.
CO3	Make use of strategies for optimization of foreign gene expression in host system.
CO4	Illustrate the principles underpinning modern tools for analysis of DNA and protein.
CO5	Make use of appropriate good laboratory practices to carry out recombinant DNA studies.

REFERENCES:

1. Green, M.R., Hughes, H., Sambrook, J. and MacCallum, P., 2012. *Molecular cloning: a laboratory manual. In Molecular cloning: a laboratory manual* (pp. 1890-1890).
2. Flanagan, T.D., 1988. *A Review of: "Current Protocols in Molecular Biology*, Edited by FM Ausubel, R. Brent, RE Kingston, DD Moore, JG Seidman, JA Smith, and K. Struhl, Greene Publishing Associates and Wiley-Interscience John Wiley and Sons, New York,

HS1521 PROFESSIONAL COMMUNICATION

L	T	P	C
0	0	2	1

OBJECTIVES:

The course enable the students to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional

- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

UNIT I

Introduction to Soft Skills– Hard skills & soft skills – employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II

Self-Introduction-organizing the material – Introducing oneself to the audience – introducing the topic – answering questions with clarity and appropriate pharases – individual presentation practice— presenting the visuals effectively – 5 minute presentations

UNIT III

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics – brainstorming the topic -– questioning and clarifying –GD strategies-activities to improve GD skills

UNIT IV

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V

Recognizing differences between groups and teams- managing time-managing stress-networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course Learners will be able to:

CO1 Make effective presentations

CO2 Participate confidently in Group Discussions.

CO3 Attend job interviews and be successful in them.

CO4 Develop adequate Soft Skills required for the workplace

AVAILABLE SOFTWARE:

1. Odell

REFERENCES:

1. Butterfield , 2015 *Jeff Soft Skills for Everyone.* Cengage Learning: New Delhi
2. E. Suresh Kumar et al., 2015, *Communication for Professional Success*. Orient Blackswan: Hyderabad
3. *Interact English Lab Manual for Undergraduate Students,* 2016. Orient BalckSwan: Hyderabad,
4. Raman, Meenakshi and Sangeeta Sharma. , 2014, *Professional Communication*. Oxford University Press: Oxford
5. S. Hariharan et al. 2010.*Soft Skills*. MJP Publishers: Chennai,

SEMESTER VI

BT1601 BIOINFORMATICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- Introduce the student to biological data resources handling, algorithms and alignment tools for bioinformatics
- Understand about machine learning techniques and neural networks in the analysis of biological data and protein structure prediction
- Application of basic commands of LINUX and PERL in biological data files.

UNIT I INTRODUCTION ` 9

Introduction to Operating systems, Introduction to Bioinformatics, Computational Biology, Systems Biology and Synthetic Biology. Linux commands used in file handling, File transfer protocols ftp and telnet, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL), DNA computing,

UNIT II SEQUENCE ALIGNMENT METHODS 9

Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms. Applications of local and global alignment.

UNIT III PHYLOGENETIC ANALYSIS 9

Introduction to phylogenetics, Molecular clock theory, Distance based trees UPGMA trees, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure

prediction methods, Homology modelling, ab-initio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV PROTEIN STRUCTURE INFORMATICS 9

Introduction to primary, secondary and tertiary structures and their properties. Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, HMM for gene finding, Decision trees, Support Vector Machines. Active site prediction methods and analysis. Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

UNIT V PERL PROGRAMMING IN BIOINFORMATICS 9

Basics of BIOPERL programming for Bioinformatics: Data types: scalars and collections, operators, Program control flow constructs, Library Functions: String specific functions, User defined functions, File handling.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Handle the computerised biological Data and respective databases.

CO2 Perform multiple sequence alignment and analysis

CO3 Construct phylogenetic tree by using sequenced data.

CO4 Choose the appropriate analytical techniques for structural studies for proteins

CO5 Demonstrate PERL programming in biological data handling

TEXT BOOKS:

1. Lesk, Arthur. *Introduction to bioinformatics.* Oxford university press, 2019.
2. Xiong, J., 2006. *Essential bioinformatics.* Cambridge University Press.
3. Sippl, M.J., 1999. *Biological sequence analysis. Probabilistic models of proteins and nucleic acids*, edited by R. Durbin, S. Eddy, A. Krogh, and G. Mitchinson. 1998. Cambridge: Cambridge University Press.

REFERENCE BOOKS

1. Rice, P., 2002. *Beginning Perl for bioinformatics: An introduction to Perl for biologists*.
2. Coulson, A., 1998*. Algorithms on Strings, Trees and Sequences by Dan Gusfield*, Cambridge University Press.
3. Baldi, P., Brunak, S. and Bach, F., 2001*. Bioinformatics: the machine learning approach*. MIT press.

BT1602 BIOPROCESS ENGINEERING

L	T	P	C
3	1	0	4

OBJECTIVES:

This course enables the students to

- Understand different modelling and simulation concepts of bioprocess
- Develop an understanding on the concepts involved in the design of different bioreactors and its operation mechanism.
- Enhance knowledge in diffusional mass transfer in immobilized enzyme reactor and recombinant cell cultivation with their simulation process.

UNIT I MODELLING & SIMULATION OF BIOPROCESSES – STRUCTURED KINETICS 12

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Cybernetic Model; Black box model

UNIT II OPERATIONAL MODES OF BIOPROCESS AND BIOREACTORS 12

Different modes of cultivation - Batch, fed batch and continuous cultivation; Cell recycle cultivation - application in waste water treatment; Design equations of Batch reactor, Continuous reactor – CSTR & PFR; Chemostat & Turbidostat; Two stage cultivation;

UNIT III AERATION, AGITATION AND SCALE – UP STRATEGIES 12

Concepts of aeration – OUR and OTR; regime analysis in aerated bioprocess; oxygen mass transfer correlations in bioreactors; methods to determine mass transfer coefficients; Concepts of agitation; power requirement in Newtonian Ungassed systems, Non-Newtonian Ungassed systems and Gassed system; Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT IV BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 12

Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors; Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors.

UNIT V BIOPROCESS CONSIDERATIONS IN RECOMBINANT SYSTEMS 12

Different host vector system for recombinant cell cultivation strategies and advantages. Bacteria - *E.coli,* Yeast (*Pichia pastoris / Saccharomyces cereviseae*), insect cell cultivation, plant cell cultivation, animal cell cultivation; High cell density cultivation, process strategies, reactor considerations in the above system.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Apply modeling and simulation concepts of bioprocesses to reduce costs and to enhance the quality of products and systems.
CO2	Outline the various operational modes of bioprocesses and bioreactors towards enhanced growth and product formation.
CO3	Apply the concepts of aeration and agitation in different process conditions to determine the mass transfer and power required for the bioprocess.
CO4	Make use of the concepts of external and internal mass transfer correlations towards the design of immobilized reactors.
CO5	Apply different strategies towards the maximum production of recombinant proteins from microbial bioprocess.

TEXT BOOKS:

1. Kargi, M.S.L.F. and DeLisa, M., 2017. *Bioprocess engineering: basic concepts*. Prentice Hall.
2. Doran, P.M., 2012. *Bioprocess engineering principles*. Elsevier.
3. Clark, D.S. and Blanch, H.W., 1997. *Biochemical engineering*. CRC press.

REFERENCE BOOKS:

1. Stanbury, P.F., Whitaker, A. and Hall, S.J., 2013. *Principles of fermentation technology*. Elsevier.
2. Bailey, J.E. and Ollis, D.F., 1976. *Biochemical engineering fundamental*s. Chemical Engineering Education.

BT1611 BIOINFORMATICS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

This course will help the students to

- Provide theoretical and hands on training on Perl programing
- Develop skills in the analysis and interpretation of various in silico techniques such as molecular docking and homology modelling
- Gain the knowledge about the application of application of sequence and phylogenetic analysis

LIST OF EXPERIMENTS

1. Linux Commands: Directory commands, File Related commands, cut, paste, commands, Sort.
2. Advanced Linux commands : Redirection, Pipes, Grep filter
3. Biological Databases: Data formats and Data retrieval
4. Homology search using BLAST family of programs: BLASTp, PSIBLAST, BLASTn, Standalone BLAST

5. Multiple Sequence Alignment using CLUSTALW
6. Generating Phylogenetic trees and Bootstrapping using MEGA
7. Understanding PDB structures, Ligand databases.
8. Protein Visualization tools: PyMol
9. Homology Modeling and Assessing the quality of models: Swiss Model, Modeller
10. Molecular docking: Docking of macromolecules with ligands: Autodock
11. Perl programming- Basic scripting-Regular expressions-File i/o& control statement-Subroutines & functions
12. Applications of Perl programming in Bioinformatics -Writing scripts for automation

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

One computer for every 2 students with the software indicated

COURSE OUTCOMES

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

CO1	Perform basic operations in Linux operating system, retrieve biological data and use bioinformatics tools
CO2	Utilize the fundamental knowledge of Biological data bases such as Genbank, Protein databank and Uniprot.
CO3	Perform protein and nucleotide sequence analysis, next generation sequencing data analysis and phylogenetic studies
CO4	Design a project comprising of Homology modeling and structural analysis of proteins and molecular docking
CO5	Execute simple PERL programs

TEXTBOOKS:

1. Agostino, M., 2012. *Practical bioinformatics*. Garland Science..
2. Pevsner, J., 2015. *Bioinformatics and functional genomics*. John Wiley & Sons.
3. Tisdall, J., 2001. *Beginning Perl for Bioinformatics: An Introduction to Perl for Biologists*. " O'Reilly Media, Inc.".

REFERENCES:

1. Claverie, J.M. and Notredame, C., 2006. *Bioinformatics for dummies*. John Wiley & Sons.
2. Gibas, C., Jambeck, P. and Fenton, J., 2001. *Developing bioinformatics computer skills*. " O'Reilly Media, Inc.".
3. Su, C., 2006. *Bioinformatics: A Practical Guide to the Analysis of Genes & Proteins*,(third editon). Edited by Andreas D. Baxevanis and BF Francis Ouellette New York: John Wiley & Sons.

BT 1612 BIOPROCESS LABORATORY II

L	T	P	C
0	0	4	2

OBJECTIVE:

The course enables the students to

- Design and evaluate the performance of bioreactors analyzing the mass transfer, heat transfer and mixing capabilities in bioreactors.
- Understand different cultivation strategies in bioreactors
- Gain knowledge in different reactor configurations

LIST OF EXPERIMENTS

1. Reactor Preparation – Dismantle, Cleaning and reassembly.
2. Batch Sterilization – Thermal Death kinetics
3. RTD Profiling in continuous reactor
4. Estimation of Mixing Time in reactor
5. Estimation of K_La – Dynamic Gassing-out method,
6. Estimation of K_La – Sulphite Oxidation Method and Power Correlation Method
7. Batch cultivation: Growth rate, Substrate utilization kinetics, Product analysis
8. Fed batch cultivation: Growth rate, Substrate utilization kinetics, Product analysis
9. Continuous cultivation: Growth rate, Substrate utilization kinetics, Product analysis.
10. Photobioreactor – Cyanobacteria /Algal cultivation

TOTAL: 60 PERIODS

EQUIPMENT NEEDED FOR 30 STUDENTS

UV-Visible Spectrophotometer, Laminar Air Flow Hood, Shaking and static Incubator, Batch Reactor, Continuous Reactor,

COURSE OUTCOMES

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

CO1	Show the different ancillaries of bioreactor.
CO2	Determine the sterilization kinetics
CO3	Estimate the residence time and the mixing time in the bioreactor
CO4	Estimate the oxygen transfer coefficient and transfer rate
CO5	Experiment with substrate, growth and product kinetics in different modes of bioreactor

REFERENCES:

1. Schmauder, H.P., 1990. Anton Moser, *Bioprocess Technology–Kinetics and Reactors.*
2. Bailey, J.E. and Ollis, D.F., 2018. *Biochemical engineering fundamentals*. McGraw-Hill.
3. Clark, D.S. and Blanch, H.W., 1997. *Biochemical engineering*. CRC press.

PROFESSIONAL ELECTIVES

BT1531 ADVANCED BIOCHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Gain in depth knowledge about amino acid synthesis, protein biosynthetic pathway and Degradation
- Understand the importance of vitamins and hormones in metabolism

UNIT I METABOLISM OF AMINO ACIDS 9

Biosynthesis of Gly, Ser and Cys; Biosynthesis of six essential amino acids (Met, Thr, Lys, Ile, Val, Leu) and regulation of branched chain amino acids - synthesis (concerted inhibition, allosteric regulation and enzyme multiplicity, sequential feedback) from oxaloacetate and pyruvate; Biosynthesis of aromatic amino acids - Phenylalanine, Tyrosine, Tryptophan; Metabolic disorders associated with branched chain and aromatic amino acid degradation; Important molecules derived from amino acids -Auxins, DOPA, Serotonin, Porphyrins, T3, T4, Adrenaline, Noradrenaline, Histamine, GABA, Polyamines, etc.

UNIT II PROTEIN TRANSPORT AND TURNOVER 6

Protein targeting; signal sequence; SRP pathway; secretion; Folding; Chaperons and targeting of organelle proteins; Protein degradation; ubiquitination; receptor-mediated endocytosis; turnover.

UNIT III METABOLISM OF CARBOHYDRATE, NUCLEIC ACIDS AND LIPIDS 12

Biosynthesis of Starch – light and dark reactions; Glycogen metabolism – synthesis and degradation; Biosynthesis of nucleotides - de novo and salvage pathways for purines and pyrimidines; regulatory mechanisms; Degradation of nucleic acid by exo and endo nucleases; Triacylglycerol and phospholipid biosynthesis and degradation; Cholesterol biosynthesis – regulation; targets and action of cholesterol lowering drugs- statins.

UNIT IV VITAMINS AND COENZYMES 9

Fat Soluble Vitamins - provitamins (A, D, E and K), Structure, physiological significance and deficiency symptoms; Water soluble vitamins - structure, coenzyme role and deficiency symptoms, Thiamine, riboflavin, pyridoxine, niacin, folic acid, biotin and Vitamin B12; Recommended dietary intake; Coenzymes - Their role in metabolic pathways, NAD, FAD,TPP, PLP, carboxybiotin.

UNIT V HORMONES 9

Definition; Effects of Hormones; Chemical classification of hormones; Peptide hormone – vasopressin; protein hormone- insulin; Lipid and phospholipid derived hormones - prostaglandin and phospholipids; Steroid hormones-testosterone, estrogen, cortisol; Monoamines- thyroxine, adrenaline; Mechanism of action of steroid and peptide hormones; Hormonal disorders - Diabetes, Thyroid disorders, hypercholesterolemia and its role in cardiovascular disease.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the biosynthetic pathways of amino acids, their regulation and physiologically important molecules derived from amino acids
CO2	Summarize the various aspects of protein targeting, folding and degradation
CO3	Differentiate between the biosynthesis of nucleotides and degradation of nucleic acids to yield nucleotides and differentiates between lipid biosynthesis & degradation
CO4	Correlate the importance of vitamins in metabolic processes and nutritional disorders
CO5	Correlate the biochemical processes and the importance of hormones in regulating them

TEXT BOOKS

1. Nelson DL, Cox MM., 2021. *Lehninger Principles of Biochemistry*. 8th Edn. W.H.Freeman & Co Ltd.
2. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer., 2019. *Biochemistry*. 9th Edn. W.H Freeman & Co.
3. Voet, D.J and J.G. Voet and C.W. Pratt., 2018. *Principles of Biochemistry*. 5th Edn. John Wiley & Sons Inc.

REFERENCES

1. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell., 2018. *Harper's Illustrated Biochemistry*. 35th Edn. McGraw-Hill.
2. Creighton. T.E., 2016. *Proteins: Structure and Molecular Properties*. 2nd Edn. W.H. Freeman and Co.
3. Salway, J.G., 2000. *Metabolism at a Glance*. 2nd Edn. Blackwell Science Ltd.

BT1532 CHEMICAL REACTION ENGINEERING – I

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of homogeneous reactions.
- Understand the information about different reactor systems, deriving the performance equations.
- Predict the rate equations in various chemical reaction engineering system.

UNIT I INTRODUCTION TO CHEMICAL REACTION ENGINEERING AND KINETICS OF HOMOGENOUS REACTIONS 9

Classification of reactions; definitions of reactions rate; variables affecting reaction rate; speed of chemical reactions; simple reactor types; the rate equation; concentration dependent term of rate equation; temperature dependent term of rate equations from

Arrhenius theory and comparison with collision and transition state theory; Activation energy and temperature dependency; predictability of reaction rate from theory;development of rate equations for different homogeneous reactions.

UNIT II INTERPRETATION OF BATCH REACTOR DATA 9

Constant volume batch reactor; analysis of total pressure data; integral and differential methods of analysis of data for constant volume and variable volume cases; temperature and reaction rate; search for a rate equation.

UNIT III INTRODUCTION TO REACTOR DESIGN AND IDEAL REACTORS FOR SINGLE REACTION 9

Mass and energy balances around a volume element; ideal batch reactor; steady-state mixed flow reactor; steady-state plug-flow reactor; holding and space time for flow reactors; space-time and space velocity; introduction to semi batch reactor.

UNIT IV DESIGN OF REACTORS FOR SINGLE AND MULTIPLE REACTIONS 9

Size comparison of single reactors; multiple reactor systems; recycle reactor and autocatalytic reaction; introduction to multiple reactions; qualitative and quantitative treatment of product distribution and of reactor size; the selectivity.

UNIT V NON-IDEAL REACTORS 9

Basics of non-ideal flow; residence time distribution; stimulus response techniques; the E,F and C curves – their interrelationship; conversion in non-ideal flow reactors; dispersion model; chemical reaction and dispersion; intensity of fluid mixing; tanks in series model; deviation from plug flow; models for real stirred tanks.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Develop the kinetics and rate equations for different homogeneous reaction systems.

CO2 Interpret the batch reactor data through various methods of analysis.

CO3	Design a homogenous ideal reactors for single reaction systems and interpreting data to obtain an appropriate kinetic expressions .
CO4	Design a homogenous reactors in various arrangement for single and multiple reaction systems.
CO5	Predict conversion for a non-ideal chemical reactor using residence time distributions and appropriate mixing models

TEXT BOOKS:

1. Levenspiel O. 2006. *Chemical Reaction Engineering*. 3rd edition. John Wiley.
2. Fogler H.S. 2002. *Elements of Chemical Reaction Engineering*. Prentice Hall India.
3. Richardson, J.F. & Peacock, D.G. 2006. *Coulson Richardson - Chemical Engineering - Vol.III*. 3rd edition. Butterworth- Heinemann- Elsevier.

REFERENCE BOOKS:

1. Missen R.W., Mims C.A. & Saville B.A. 1999. *Introduction to Chemical Reaction Engineering and Kinetics*. John Wiley.
2. Dawande, S.D. 2001. *Principles of Reaction Engineering*, 1st edition. Central Techno Publications

BT1533 FUNDAMENTALS OF INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Understand the basic types of Intellectual property
- Recognize the relevant criteria for generating and protecting intellectual works
- Understand the relevance and impact of IP Law on academic/scientific works/studies
- Recognize the intellectual property likely to be produced in the academic and professional environment

Unit I INTRODUCTION 9

Invention and Creativity – Intellectual Property – Importance –Types of IPRs- Protection of IPR – Basic types of property - Movable Property - Immovable Property - Intellectual Property- Patents

Unit II THE LAW OF TRADEMARK AND COPYRIGHT 9

Introduction to Trade mark – Trade mark Registration Process – Post registration Procedures – Trade mark maintenance - Transfer of Rights - Inter partes Proceeding-Infringement - Dilution of Trade mark –Trademarks claims –International Trade mark Law Introduction to Copyrights – Principles of Copyright -The subjects Matter of Copy right – The Rights Afforded by Copyright Law – Copy right Ownership, Transfer and duration - International Copyright Law

Unit III THE LAW OF TRADE SECRETS AND UNFAIR COMPETITION 9

Introduction to Trade Secret – Maintaining Trade Secret – Physical Security –Employee Limitation - Employee confidentiality agreement - Trade Secret Law -Unfair Competition – Trade Secret Litigation – Breach of Contract – Applying State Law

Unit IV PATENT AND INTERNATIONAL CONVENTION 9

Concept of Patent- Procedure for Filing of Patent Application and types of Applications- Procedure for Opposition- Revocation of Patents- Patent Agent- Qualification and Registration Procedure-Preparation of Patent document- Recent Developments in Patent System International convention relating to Intellectual Property – Establishment of WIPO – Mission and Activities -General Agreement on Trade and Tariff (GATT)- Indian Position Vs WTO and Strategies – Indian IPR legislations – commitments to WTO - Case Studies – Patents - Basumati rice – Turmeric – Neem

Unit V NEW DEVELOPMENTS IN COPYRIGHT LAW 9

Copyright Protection for Computer Programs- Copyright Protection for Automated Databases- Domain Name Protection-Objectives- domain name and Intellectual Property- Registration of domain names- disputes under Intellectual Property Rights- Jurisdictional Issues- International Perspective-Copyright in the Electronic age-Digital Millennium Copyright Act-Musical Notes-Recent Development in Copyright Law-Terms of the Trade-Vessel Hull Protection -Semiconductor Chip Protection

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Explain the different types of intellectual properties

CO2 Outline the concepts of trade mark and copy rights

CO3 Explains the different laws of trade secrets

CO4 Understand the concepts of patents and patent systems

CO5 Outline the various developments in copy right systems

TEXT BOOKS:

1. Deborah E. Bouchoux, 2012, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, Third Edition.
2. Scople, Vinod, 2012, *Managing Intellectual Property*, Prentice Hall of India pvt Ltd,.
3. Satakar S.V., 2002, *Intellectual Property Rights and Copy Rights,* Ess Publications, New Delhi.

REFERENCE BOOKS:

1. Subbaram N.R., 1998, *Handbook of Indian Patent Law and Practice*, S.Viswanathan Printers and Publishers Pvt.Ltd.
2. Deborah E. Bouchoux, 2005, *Intellectual Property Rights*, Cengage Learning India Private Ltd,.
3. Prabuddha Ganguli,2011, *Intellectual Property Rights: Unleashing the Knowledge Economy*, McGraw Hill Education.

BT1534 HUMAN ANATOMY AND PHYSIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Understand the gross morphology, structure and functions of various organs of the human body.
- Understand the tissues and organs of different systems of human body.
- Describe the various homeostatic mechanisms and their imbalances.
- Understand the physiology of special senses and nervous system.

UNIT I INTRODUCTION 9

Introduction to human body - Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology; cellular and tissue level organization - Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signalling pathway activation by extracellular signal molecule, Classification of tissues, structure, location and functions of epithelial, muscular and nervous and connective tissues.

UNIT II COVERING, SUPPORT, & MOVEMENT OF THE BODY 9

The Integumentary System – structure and function of skin, Bones and Skeletal Tissues -classification, salient feature and functions of bones, Joints – structure and functional classification, types of joints, Muscles – classification, physiology of muscle contraction and neuro muscular junction

UNIT III REGUALTION AND INTEGRATION OF BODY 9

Fundamentals of the Nervous System and Nervous Tissue – structure of neurons and its classification, synapsis and neuro transmission, structure and functions of Central Nervous System – structure and functions of brain, spinal cord and meninges, Peripheral Nervous System and Reflex Activity, Autonomic Nervous System, The Special Senses – structure and function of eye, ear, nose, tongue and their disorders, Endocrine System

UNIT IV MAINTENANCE OF THE BODY 9

Cardiovascular System - Anatomy and physiology of heart and blood vessels, blood constituents, regulation of blood pressure, cardiac cycle and EGC, Lymphatic System, Immune System - Innate and Adaptive. The Respiratory System- anatomy and physiology of lungs, Digestive System – anatomy of GI tract, salivary glands, liver and pancreas, Nutrition, Metabolism, and Body Temperature Regulation, Urinary System – structure and function of Kidney and nephrons, Fluid, Electrolyte, and Acid-Base Balance

UNIT V REPRODUCTIVE AND HERIDITY 9

Reproductive system - Anatomy and physiology of male and female reproductive systems, sex hormones, physiology of menstruation, fertilization, spermatogenesis, oogenesis and pregnancy. Sexually transmitted diseases, Heredity – Genetic pattern of inheritance and genetic diseases

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Define the structural organization and terminology used in human anatomy and physiology
CO2	Interpret the physiological importance of skin, bone and tissues with anatomical knowledge

CO3 Understand the special senses and nervous system of human body

CO4 Understand the fact on anatomy and physiology of human body maintenance

CO5 Explain the principle of heredity and reproduction system related to human

TEXT BOOKS

- Sembulingam, K. and Sembulingam, P., 2012. *Essentials of medical physiology*. JP Medical Ltd.
- Waugh, A. and Grant, A., 2014. *Ross & Wilson Anatomy and physiology in health and illness E-book*. Elsevier Health Sciences.
- Grabowski, S.R. and Tortora, G.J., 2000. Principles of anatomy and physiology. New York, NY: Wiley.

REFERENCE BOOKS

- Alexander, R.S., 1977. Textbook of Medical Physiology, Arthur C. Guyton.
- Shier, D., Butler, J. and Lewis, R., 2018. *Hole's essentials of human anatomy & physiology*. McGraw-Hill Education.
- Solomon, E.P., 2015. Introduction to human anatomy and physiology. Elsevier Health Sciences.

BT1535 PRINCIPLES OF FOOD SCIENCE AND PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, which spoil food and cause food borne diseases & understand the role of beneficial microorganisms in food preservation and processing
- To analyze the methods used to control or destroy the microorganisms commonly found in food.

UNIT I FOOD AND ENERGY 9

Constituents of food: Carbohydrates, Lipids, Proteins, Water, Vitamins and Minerals-dietary sources, role and functional properties in food; Contribution to organoleptic and textural characteristics.

UNIT II FOOD ADDITIVES 9

Classification: intentional and non-intentional additives; Functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 9

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods from various sources-dairy, cereal, meat, beverages; food chemicals, single cell protein.

UNIT IV FOOD BORNE DISEASES 9

Classification: food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products

UNIT V FOOD PRESERVATION 9

Principles involved in the use of sterilization, pasteurization, canning and blanching; thermal death curves of microorganisms; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods-sources, dose rate, effect on quality of food, regulation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After successful completion of the course, The Students will be able to

CO1 Identify the major and minor constituents of food and the chemical reactions in which they participate, the behavior of components of foods and how they influence the final product

CO2 Apply the knowledge on food additives and study the toxicity of food additives

CO3 Relate interrelationships of microorganisms with foods and their role in food manufacture and food products.

CO4 Identify the relationship between food processing and chemical reactions that limit shelf life of foods.

CO5 Apply the knowledge on microorganisms found in food & understand the effects of food processing in inactivation of pathogenic microbes and spoilage causing microorganisms in foods.

TEXT BOOKS:

1. Sivasankar, B., 2002. *Food processing and preservation*. PHI Learning Pvt. Ltd..
2. Adams, M.R. and Nout, M.R. eds., 2001. *Fermentation and food safety*. Gaithersburg, Meryland: Aspen Publishers.
3. Frazier, W.C. and Westhoff, D.C., 1988. *Food microbiology*, New York (NY): McGrow-Hill Book.

REFERENCES:

1. Zeuthen, P. and Bøgh-Sørensen, L. eds., 2003. *Food preservation techniques*. Elsevier.
2. Jay, J.M., Loessner, M.J. and Golden, D.A., 2008. *Modern food microbiology*. Springer Science & Business Media.
3. Coultate, T.P., 2009. *Food: the chemistry of its components*. Royal Society of Chemistry.

BT1536 INDUSTRIAL BIOSAFETY AND HAZARD MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- To apply the basic concepts of biosafety and hazard management that are essential for various types of industries involving biotechnological procedures.

UNIT I SAFETY REQUIREMENTS 9

Need for safety in Biomanufacturing industries; Safety Programmes, components and realization; Potential hazards; Extreme operating conditions; Toxic chemicals - Safe handling.

UNIT II IMPLEMENTATION AND ASSESSMENT OF SAFETY 9

Implementation of safety procedures; periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety.

UNIT III RISK ANALYSIS 9

Overall risk analysis - On site and off site emergency planning; risk management ISO 14000; EMS models case studies; Quantitative risk assessment – rapid and comprehensive risk analysis; Risk due to Radiation; Pandemic preparedness and Risk management system.

UNIT IV GUIDELINES 9

Hazard identification; Safety audits; Checklist; What if analysis; Vulnerability models; Event tree analysis; Fault tree analysis; Hazan past accident analysis.

UNIT V REGULATIONS AND CASE STUDY ANALYSIS 9

Hazop- guide words; parameters; derivation-causes-consequences, recommendation; Coarse Hazop study - case studies: pumping system-reactor, mass transfer system

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Familiarize the safety guidelines in industry

CO2 Enable them to implement and assess various safety procedures

CO3 Enable them to do risk analysis

CO4 Familiarize the concepts of hazard analysis and its application

CO5 Familiarize various case-study reports

TEXT BOOKS:

1. Hyatt, N., 2004. *Guidelines for process hazards analysis, hazards identification & risk analysis*, Dyadem Press, 2004.
2. Fawatt, H.H. and Wood, W.S., 1965. *Safety and Accident Prevention in Chemical Operation*. Wiley Interscience.
3. COVID-19 Risk Assessment Tool: *Dual application of risk communication and risk governance*, Progress in Disaster Science. 2020.

REFERENCES:

1. Marcel, V.C., 1987. *Major Chemical Hazard*- Ellis Harwood Ltd., Chi Chester
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., 1980. *Industrial Accident Prevention.* McGraw-Hill Book Co.
3. Daniel A. Crowl, J.F. Louvar 1990. *Chemical Process Safety: Fundamentals with Applications*, Prentice Hall, NJ.

BT1537 GENETICS AND GENE THERAPY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Get idea about principles and basic concepts of classical genetics and inheritance
- Develop idea about basics of gene therapy, and its applications on animals and human beings.

UNIT I CLASSICAL GENETICS 9

Introduction to heredity; Mendelian genetics; Probabilities in genetics; Variation on

Mendel's laws; Multiple alleles; Incomplete dominance and Co-dominance; Pleiotropic and lethal allele; Polygenic inheritance and Eenvironmental effects.

UNIT II GENETICS OF INHERITANCE 9

Boveri-Sutton chromosome theory; The chromosomal basis of inheritance; Genetic linkage and mapping; X-linked inheritance; Pedigree analysis, Aneuploidy and Chromosomal rearrangements, inheritance of mitochondrial and chloroplast DNA and Mutagenesis.

UNIT III PRINCIPLES OF GENE THERAPY 9

Gene therapy – overview; Types of gene therapy - somatic and germ line, methods of gene therapy - Ex-vivo and In-vivo; Diseases with recessive heredity; Ex-vivo gene therapy with case study – SCID; In- vivo gene therapy with case study - Cystic fibrosis.

UNIT IV GENE DELIVERY SYSTEMS 9

Methods for gene delivery - Physical, Chemical and Viral vectors. Retroviral vectors-Adenoviral vectors, Adeno associated viral vectors; Herpes simplex viral vectors; Non-viral vectors.

UNIT V APPLICATIONS OF GENE THERAPY 9

Stem cells in gene therapy-gene therapy of haematopoietic stem cells; Treatment of genetic diseases - Gene therapy of cancer, Neurodegenerative disorders, Eye diseases, Cardio vascular disorders; Bone regeneration.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After successful completion of the course, The Students will be able to

CO1	Define the basic concepts of classical Mendalian genetics, hereditary, Laws of dominance and expressions.
CO2	Variation and population genetics and predict the genotype and phenotype of simple crosses of relevance to gene interactions, multiple alleles and sex-linked inheritance

CO3 Describe principles, concepts and methods of gene therapy

CO4 Define gene delivery and various types of vectors used in the gene therapy.

CO5 Apply gene therapy in different kind of diseases and disorders

TEXT BOOKS

1. Simmons, M.J. and Snustad, D.P., 2006. *Principles of genetics*. John Wiley & Sons.
2. Giacca, M., 2010. *Gene Therapy*, Springer, Milano.
3. Evelyn B. Kelly, 2007. *Gene Therapy*, Greenwood Press.

REFERENCES

1. Peter J. Quesenberry.,1998, *Stem cell biology and gene therapy*,John Wiley & Sons,
2. Roland W. Herzog, 2010, *A Guide to Human Gene Therapy*, World Scientific Publishing Co Pte Ltd,.
3. Perales, M.A., Abutalib, S.A. and Bollard, C. eds., 2019. *Cell and Gene Therapies*. Springer International Publishing.
4. David Benjamin Turitz Cox et al, 2015. *Therapeutic genome editing: prospects and challenges,* Nature Medicine

BT1538 NANOSCIENCE AND NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

BJECTIVES:

This course enables the students

- To learn about basis of nanomaterial and its preparation.
- To learn about characterization of nanomaterials using advanced techniques.
- To learn about applications of nanomaterials in various biotechnological fields.

UNIT I INTRODUCTION TO NANOTECHNOLOGY 9

A brief history of the Super Small; definition of Nanobiotechnology; classifications of nanostructured materials - nano particles, quantum dots, nanowires, ultra-thin films, multilayered materials; Length Scales involved and effect on properties - Mechanical, Electronic, Optical, Magnetic and Thermal properties; Introduction to qualitative properties of nanomaterials.

UNIT II GENERAL METHODS OF PREPARATION 9

Synthesis of nanomaterials by physical, chemical and biological methods - Bottom-up and Top-down approachs; Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS IN BIOTECHNOLOGY 9

Nanoforms of Carbon - Buckminster fullerene, graphene and carbon nanotube; Structure-property relationships; Functionalization and biotechnological applications of Nanometal oxides - ZnO, TiO_2, MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites; Nanoclays; Quantum wires; Quantum dots preparation - properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

Characterization of nanomaterials - X-ray diffraction technique; Scanning Electron Microscopy - environmental technique; Transmission Electron Microscopy including high-resolution imaging; Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V NANOMATERIALS FOR BIOTECHNOLOGICAL APPLICATIONS 9

Nano biotechology - nanoprobes in medical diagnostics, nano medicines, bioimaging; *In-vitro* methods to study antimicrobial and anticancer properties of nanomaterials; nano artificial cells; nanotechnology in tissue engineering; nanopharmacology & nanotoxicology; drug discovery using nanotechnology; targetted drug delivery using nanobiosensors – bioavailability, sustained and targeted release; nano-drug delivery – benefits, health risks, and challenges.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Compare the fundamental properties of nanomaterials

CO2 Make use of various methods for synthesis of nanomaterials.

CO3 Categorize the different types of nanomaterials used in biotechnological applications.

CO4 Utilize different techniques for nanoparticle characterization

CO5 Analyze the role of nanotechnology in biotechnological applications.

TEXT BOOKS:

1. Edelstein, A.S. and Cammaratra, R.C. eds., 1998. *Nanomaterials: synthesis, properties and applications*. CRC press.
2. N John Dinardo, 2nd edition, 2008. *Nanoscale characterization of surfaces & Interface.* Weinheim Cambridge, Wiley-VCH.
3. Hornyak, G.L., Moore, J.J., Tibbals, H.F. and Dutta, J., 2018. *Fundamentals of nanotechnology*. CRC press.
4. Rosenthal, S.J. and Wright, D.W. eds., 2005. *Nanobiotechnology protocols* (Vol. 303). Totowa: Humana Press.
5. Wilson, M., Kannangara, K., Smith, G., Simmons, M. and Raguse, B., 2002. *Nanotechnology: basic science and emerging technologies*. CRC press.

REFERENCES:

1. Gregory L Timp (Editor), 1999. *Nanotechnology*, New York : AIP Press : Springer.
2. Lakhtakia, A., 2007. *The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations*.

BT1539 PROTEIN ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Provide information about the building blocks and other factors contributing to the structures.

- Provide fundamental knowledge on the existence of various structures of proteins and how these structures relate to their functions.
- To introduce the methods for characterization of proteins

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 9

interactions in protein structure - Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander wall ; Interaction with electromagnetic radiation and elucidation of protein structure -radio, micro, infrared, visible, ultraviolet, X- ray ; Amino acids and their molecular properties- three letter and single letter coding, size, solubility, charge, pKa ; Chemical reactivity in relation to post-translational modification - amino, carboxyl, hydroxyl, thiol, imidazole groups.

UNIT II PROTEIN ARCHITECTURE 9

Primary structure- peptide mapping, peptide sequencing (automated Edman method & mass- spectroscopy, High-throughput protein sequencing setup); Secondary structure- Alpha, beta and loop structures and methods to determine secondary structure (FTIR and Circular dichroism); Super-secondary structure- Alpha-turn-alpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.

UNIT III TERTIARY STRUCTURE 9

Tertiary structure- Domains, folding, denaturation and renaturation; overview of methods to determine 3D structures - X Ray crystallography and NMR spectroscopy; Quaternary structure- Modular nature, formation of complexes; Structure prediction *IN -SILICO* tools.

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins- prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers; Membrane proteins- General characteristics, Trans- membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center; Immunoglobulins- IgG Light chain and heavy chain

architecture, abzymes; Enzymes -Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis.

UNIT V PROTEIN ENGINEERING STRATEGIES 9

Rational design- Site directed mutagenesis; Non-rational design-Molecular evolution; generation of combinatorial libraries; surface display. *De novo* protein design (Specific examples to be taken). Case Studies of engineered proteins- Therapeutic proteins (Insulin) , Therapeutic antibodies (Designer antibodies), Industrial enzyme - protease (engineering as per specific industry needs).

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Apply the concept of the building blocks of proteins and other factors contributing to protein structures
CO2	Illustrate the first two levels of protein structure hierarchy and the tools used to study them
CO3	Identify the higher levels of protein structure organization and the techniques used to study them
CO4	Relate how protein structures relate to protein functions
CO5	Apply protein engineering strategies for industrial applications

TEXT BOOKS:

1. Branden, C.I. and Tooze, J., 2012. *Introduction to protein structure*. Garland Science.
2. Edsall, J.T., 1985. Proteins, Thomas E. Creighton, WH Freeman, New York.
3. Almeida, P., 2016. *Proteins: concepts in biochemistry*. Garland Science.
4. Kessel, A. and Ben-Tal, N., 2010. *Introduction to proteins: structure, function, and motion*. CRC Press.

REFERENCES:

1. Williamson, M., 2012. *How proteins work*. Garland Science.
2. Lutz, S. and Bornscheuer, U.T. eds., 2009. *Protein engineering handbook* (Vol. 1). Weinheim: Wiley-VCH.
3. Voet, D. and Voet, J.G., 1995. Biochemistry.

BT1540 UNIT OPERATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn about the concepts of mixing and agitation which are the basics of bioreactor operation.
- Understand different solid liquid separation process through filtration, centrifugation and membrane separation process.
- Learn about concepts of design of heat exchangers an evaporation.

UNIT I MIXING AND AGITATION 9

Dimensional analysis; power for agitation; agitation of liquids; gas-liquid systems; gas-solid suspensions; agitator scale up.

UNIT II SETTLING SEDIMENTATION AND CENTRIFUGATION 9

Separation based on the motion of particles through fluids, Gravity settling process, Centrifugal settling process, Centrifugation – types, industrial centrifuges.

UNIT III SIZE REDUCTION AND FILTRATION 9

Size reduction equipment – Crushers, Grinders, cutting machines. Screening, Cake filtration - constant pressure, constant volume batch filtration; continuous filtration

UNIT IV MEMBRANE SEPARATION PROCESS 9

Cross flow filtration – Types of membranes, permeate flux for Ultra filtration, Concentration of Polarization, Partial rejection of solute, microfiltration. Separation of Liquids – Dialysis, membrane for liquid – liquid extraction, pervaporation, Reverse

Osmosis. Separation of Gases

UNIT V EVAPORATORS 9

Introduction, types of evaporators, factors influencing evaporation. Principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator. Methods of feeding of evaporators. General design consideration of single and multiple effects evaporator.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the concepts and importance of mixing and agitation process involved in industries
CO2	Apply the knowledge in designing the process of solids – liquid separation through settling and centrifugation process
CO3	Explain the basic principles of different size reduction and continuous filtration process
CO4	Design a membrane separation process to isolate bioproducts from liquid
CO5	Apply the knowledge in design of heat exchanger and evaporators

TEXT BOOKS

1. Geankoplis, C.J. 2015, *Transport Processes and Unit Operations,* IV edition, Prentice Hall of India.
2. McCabe, W.L, Sonith, J. C and Harriot, P, 2001, *Unit operations of chemical Engineering,* 6th edition, McGraw Hill.
3. Brodkey, R. S., and Hershey, H. C., 2003, *Transport Phenomena: A unified approach*, Volume I & II, Brodkey publishing.

REFERENCE BOOKS

1. Welty, J. R., Wilson, R. E., Wicks, C. E., and Rorer,G. L., 2010, *Fundamentals of Momentum, Heat and Mass Transfer*, V edition, John Wiley & sons Inc..
2. Slattery, J. S., 1999, *Advanced Transport Phenomena*, Cambridge University Press, London.
3. Incropera F.P. 1998, *Fundamentals of Heat and Mass Transfer*, John Wiley.

GE1471 PROFESSIONAL ETHICS AND HUMAN VALUES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and
- To impart Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 9

Morals, values and Ethics – Integrity, Work ethic, Service learning, Civic virtue, Respect for others, living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Character, Spirituality; Stress management Techniques

UNIT II ENGINEERING ETHICS 9

Senses of Engineering Ethics; Variety of moral issues; Types of inquiry; Moral dilemmas, Moral Autonomy – Kohlberg‘s theory, Gilligan‘s theory – Consensus and Controversy; Models of professional roles; Theories about right action; Self-interest; Customs and Religion; Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation; Engineers as responsible Experimenters; Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk; Risk Benefit Analysis and Reducing

Risk; Respect for Authority; Collective Bargaining; Confidentiality; Conflicts of Interest; Occupational Crime; Professional Rights – Employee Rights, Intellectual Property Rights (IPR); Discrimination.

UNIT V GLOBAL ISSUES 9

Multinational Corporations; Environmental Ethics; Computer Ethics; Weapons Development; Engineers as Managers – Consulting Engineers, Engineers as Expert Witnesses and Advisors; Moral Leadership; Code of Conduct; Corporate Social Responsibility.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Summarize the various Morals, Values, Ethics, Integrity and other Human Values
CO2	Describe the Senses of Engineering ethics, its related Theories and Models of Professional Role
CO3	Explain the Codes of Ethics for various Engineering Experiments.
CO4	Examine the various Risk, Safety and Risk Benefit Analysis for a Product/Service in an Organization
CO5	Explain the Various Global Issues in Ethics and Review the Responsibilities and Rights of Professionals and Employees in an Organization

REFERENCES:

1. Mike W. Martin and Roland Schinzinger,2017. *Ethics in Engineering*, 4th Edition, McGraw Hill.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, 2004. *Engineering Ethics*, Prentice Hall of India.
3. Charles B. Fleddermann, 2012. *Engineering Ethics*, 4th Edition, Prentice Hall.
4. Charles E. Harris, Michael S. Pritchard, Raw W. James, Elaine E. Englehardt, and Michael J. Rabins, 2019. *Engineering Ethics –Concepts and Cases*, 12th Edition, Cengage Learning.

5. John R Boatright, Jeffery Smith, 2016. *Ethics and the Conduct of Business*, 8th Edition, Pearson Education.
6. Edmund G Seebauer and Robert L Barry, 2001. *Fundamentals of Ethics for Scientists and Engineers*, South Asia Edition, Oxford University Press.

BT1631 CHEMICAL REACTION ENGINEERING – II

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the basic concepts of different types of heterogeneous reactions.
- Predict the rate equations for different types of heterogeneous reactions
- Understand the information about different heterogeneous reactor systems, deriving the performance equations.

UNIT I INTRODUCTION TO HETEROGENEOUS REACTION 9

Rate steps involved in heterogeneous systems; overall rate expression for linear and non-linear process; contacting patterns for two-phase systems.

UNIT II FLUID-FLUID REACTION SYSTEMS 9

Rate equation; rate equation for straight mass transfer; kinetic regimes of mass transfer and chemical reaction; rate equation for mass transfer and chemical reactions; film conversion parameter; fluid-fluid reactor design.

UNIT III FLUID-PARTICLE REACTION SYSTEMS 9

Fluid partial reaction kinetics; selection of a model; shrinking core model for unchanging and changing size spherical partials - diffusion through gas film and through ash layer controlling, chemical reaction controlling; shrinking core model - its limitations, determination of rate controlling step.

UNIT IV SOLID-CATALYSED REACTION KINETICS 9

Adsorption isotherms and rates of adsorption and desorption; kinetic regimes - rate

equations for surface kinetics, pore diffusion, determining rate controlling step; experimental methods for finding rates; product distribution in multiple reactions.

UNIT V INTRODUCTION TO CATALYTIC REACTORS 9

Packed bed catalytic reactors; fluidized bed reactors; three phase-fluidized beds; trickle beds; slurry reactors; enzymatic catalysed reaction systems; plug flow and mixed flow fermentors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Develop the rate equations for different heterogeneous reaction systems.
CO2	Design a heterogeneous Fluid-Fluid reactions systems.
CO3	Design a heterogeneous Fluid-Particle reactions systems.
CO4	Develop the reaction kinetics for different solid-catalysed systems.
CO5	Predict the optimal design criteria for fixed bed and fluidized bed heterogeneous reactors.

TEXT BOOK

1. Levenspiel O. 2006. *Chemical Reaction Engineering*. 3rd edition. John Wiley.
2. Fogler H.S. 2002. *Elements of Chemical Reaction Engineering*. Prentice Hall India.
3. Richardson, J.F. & Peacock, D.G. 2006. *Coulson Richardson - Chemical Engineering - Vol.III*. 3rd edition. Butterworth- Heinemann- Elsevier.

REFERENCE BOOKS

1. Missen R.W., Mims C.A. & Saville B.A. 1999. *Introduction to Chemical Reaction Engineering and Kinetics*. John Wiley.
2. Dawande, S.D. 2001. *Principles of Reaction Engineering*, 1st edition. Central Techno Publications.

BT1632 LIFESTYLE DISEASES

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the various risk factors associated with lifestyle diseases and recognize that lifestyle choices are the root cause of many chronic diseases.
- Describe the aetiology , pathophysiology and diagnosis of lifestyle diseases
- Understand the Control and management of lifestyle diseases such as diabetes, cancer and heart and lung ailments

UNIT I INTRODUCTION 9

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II CANCER 9

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

UNIT III CARDIOVASCULAR DISEASES 9

Coronoary atherosclerosis – coronary artery disease; Causes -Fat and lipids, Alcohol abuse; Diagnosis - Electrocardiograph, echocardiograph; Treatment, Exercise and Cardiac rehabilitation

UNIT IV DIABETESAND OBESITY 9

Types of Diabetes Mellitus; Blood glucose regulation; Complications of diabetes, treatment; Paediatric and adolescent obesity – Weight control and BMI

UNIT V RESPIRATORY DISEASES 9

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking; Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Define the risk factors and lifestyles associated with various lifestyle disorders
CO2	Organize and categorise the types, pathophysiology, diagnosis, Control of various cancers
CO3	Outline the aetiology, pathophysiology, diagnosis, Control and lifestyle choices for cardiovascular diseases
CO4	Outline the types of the diabetic-obesity epidemic and management through maintenance of BMI
CO5	Comprehend the types, pathophysiology, diagnosis, Control and management of respiratory disorders

TEXT BOOKS:

1. Kumar, M. Kumar R., 2004. *Guide to Prevention of Lifestyle Diseases*. Deep and Deep Publications.
2. Gary Eggar et al, 2017 “Lifestyle Medicine”, 3rd Edition, Academic Press,
3. James M.R, 2013, “Lifestyle Medicine”, 2nd Edition, CRC Press,

REFERENCES:

1. Akira Miyazaki Imawari, M. ed., 2008. *New Frontiers in Lifestyle-Related Diseases*. Springer Japan.
2. Barnett, A.H. and Kumar, S., 2009. *Obesity and diabetes* (Vol. 34). John Wiley & Sons.
3. David, A.K., Taylor, R.B., Fields, S.A., Phillips, D.M. and Scherger, J.E. eds., 2005. *Taylor's Cardiovascular Diseases: A Handbook* (Vol. 79). Springer Science & Business Media.

BT1633 METABOLIC ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Understand regulation of metabolic networks in single cells and at the organ level.
- learn the fundamentals of metabolic flux analysis and metabolic control analysis

UNIT I CELLULAR METABOLISM AND REGULATION 9

Introduction to metabolic Engineering; Review of Cellular metabolism- Fueling reactions, biosynthetic reactions, transport processes; regulation of metabolic pathways ; Examples of pathway manipulations-Enhancement of Product Yield and Productivity, Extension of substrate Range, Extension of Product spectrum and Novel products, Improvement of Cellular properties.

UNIT II MATERIAL BALANCES AND DATA CONSISTENCY 9

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations; analysis of over determined systems- identification of gross measurement errors; Introduction to MATLAB®

UNIT III METABOLIC FLUX ANALYSIS 9

Theory of MFA- over-determined systems, under-determined systems- linear programming, sensitivity analysis; methods for the experimental determination of metabolic fluxes by isotope labeling; applications of metabolic flux analysis.

UNIT IV METABOLIC CONTROL ANALYSIS 9

Fundamentals of Metabolic Control Analysis; control coefficients and the summation theorems; Determination of flux control coefficients; MCA of linear pathways, branched pathways; theory of large deviations

UNIT V ANALYSIS OF METABOLIC NETWORKS 9

Control of flux distribution at a single branch point, grouping of reactions- case studies,

extension of control analysis to inter-metabolite; optimization of flux amplifications; consistency tests and experimental validation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Articulate cellular metabolism

CO2 Restate stoichiometry of metabolism.

CO3 Adopt various approaches to analyze metabolic flux

CO4 Apply metabolic control analysis to metabolic pathways

CO5 Analyze flux distribution in metabolic networks

TEXT BOOKS:

1. Stephanopoulos, G., Aristidou, A.A. and Nielsen, J., 1998. *Metabolic engineering: principles and methodologies.*
2. Lee, S.Y., Nielsen, J. and Stephanopoulos, G. eds., 2021. *Metabolic Engineering: Concepts and Applications.*
3. Nielsen J and Villadsen J. 1994 *Bioreaction Engineering Principles*. New york: Plenum Press

REFERENCES:

1. Eberhard O. V., 2000, *Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists*, Cambridge University Press
2. Verpoorte R, Alfermann A. W. and Johnson T. S. (eds). 2007. *Applications of Plant Metabolic Engineering,* Springer,
3. Zoltan S, Jorg S and VipulP(eds) 2006.*Systems Modeling in Cellular Biology: From Concepts to Nuts and Bolts,* MIT Press Cambridge.

BT1634 PLANT BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- understand of the different physiological and developmental processes in plants
- summarize different plant tissue culture methods for plant propagation and production of secondary metabolites
- analyze different biotechnology tools that help to study as well as modify plants suited to industrial exploitation

UNIT I PLANT PHYSIOLOGY 9

Photosynthesis - light reaction and carbon reaction ; Respiration - glycolysis, citric acid cycle, electron transport and ATP Synthesis ; Plant growth regulators - auxin, cytokinin, gibberellins, ethylene, abscisic acid - mode of action and physiological effects ; Photoperiodism and flowering - circadian rhythms, photoperiodism, biochemical signaling involved in flowering.

UNIT II PLANT TISSUE CULTURE 9

Introduction to cell and tissue culture - media, aseptic techniques, initiation and maintenance of callus and suspension cultures ; Organ Culture - anther, pollen, embryo and endosperm culture, hairy root culture, organogenesis and somatic embryogenesis ; Protoplast Culture - Techniques and Applications, protoplast isolation and fusion, selection and regeneration of hybrid plants; Germplasm conservation -cryopreservation, slow growth Cultures ; Applications of plant tissue culture.

UNIT III PLANT TRANSFORMATION 9

Direct gene transformation - particle bombardment, PEG mediated transformation, electroporation, silicon carbide fibre; Indirect gene transformation - Agrobacterium and viral mediated transformation vectors, Gene construct- Promoters, Markers and reporters used for plant transformation ; Chloroplast transformation.

UNIT IV APPLICATIONS OF TRANSGENIC PLANT TECHNOLOGY 9

Production of genetically modified plants : Herbicide resistant – phosphoinothricin and

glyphosate; Insect resistance - Bt genes ; Biotic and abiotic stress tolerance; Virus resistance ; Improvement of quality traits (Golden Rice, Fruit Ripening), Technology protection system - terminator gene technology ; Biopharming- Therapeutic proteins in transgenic plants.

UNIT V MOLECULAR MARKERS AND MARKER ASSISTED BREEDING AND BIOSAFETY 9

Molecular marker systems - Phenotypic, enzyme and molecular markers (single locus and multi-locus markers), co-dominant and dominant markers; Marker assisted breeding ; Global status and bio-safety concerns for production and release of transgenic plants

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 illustrate physiology and metabolism in plants

CO2 demonstrate the scientific principles behind plant cell and tissue culture

CO3 interpret the molecular mechanism behind the gene transfer using Agrobacterium and other plant based vectors

CO4 analyze the contemporary issues about genetically modified plants and discuss the ethical issues related with them

CO5 compare the relative merits of plant transformation, marker-assisted breeding and conventional phenotypic selection for particular situations

TEXT BOOKS:

1. Slater, A., Scott, N. and Fowler, M., 2014. *Plant biotechnology: the genetic manipulation of plants*. OUP Oxford.

2. Heldt, H.W., 1997. *Plant biochemistry and molecular biology*. Oxford University Press.

3. Chawla, H.S., 2015. *Plant biotechnology: a practical approach*.Oxford and IBH Publishing Co. Pvt. Ltd.

REFERENCE BOOKS:

1. Hammond, J., McGarvey, P. and Yusibov, V. eds., 2012. *Plant biotechnology: new products and applications* (Vol. 240). Springer Science & Business Media.

2. Smith, R.H., 2012. *Plant tissue culture: techniques and experiments*. Academic Press.

3. Tortora, G.J. and Derrickson, B.H., 2018. *Principles of anatomy and physiology*. John Wiley & Sons.

BT1635 ANIMAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the culturing methods of animal cells.
- Explain about advanced technologies in diagnostics and therapeutics of animal diseases
- Understand assisted reproduction and transgenic technology in animals and their applications

UNIT I ANIMAL CELL CULTURE 9

Introduction to basic tissue culture techniques; chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures-suspension cultures, continuous flow cultures, immobilized cultures; cell cultures as a source of valuable products; organ cultures.

UNIT II ANIMAL DISEASES AND THEIR DIAGNOSIS 9

Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern

blotting;

RFLP.

UNIT III THERAPY OF ANIMAL DISEASES 9

Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; vaccines and their applications in animal infections; gene therapy for animal diseases.

UNIT IV MICROMANIPULATION OF EMBRYO'S 9

Micromanipulation technology and breeding of farm animals; equipment used in micromanipulation; enrichment of xand y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in-vitro fertilization and embryo transfer.

UNIT V TRANSGENIC ANIMALS 9

Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance; somatic cell fusion; stem cell cultures in the production of transgenic animals; specific case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the different types of animal cell culture and techniques
CO2	Describe different molecular diagnostic techniques and apply them to animal infections
CO3	Illustrate effectively the principles of monoclonal antibodies and recombinant cytokines and apply them in the field of therapeutics
CO4	Make use of the concepts of micromanipulation technology and transgenic animal Technology.
CO5	Restate the concept of transgenic animal production and its applications

TEXT BOOKS:

1. Freshney, R.I., 2015. *Culture of animal cells: a manual of basic technique and specialized applications*. John Wiley & Sons.
2. Ranga M.M., 2002 *Animal Biotechnology*. Agrobios India Limited,

3. Ramadass P, Meera Rani S. 1997 *Text Book of Animal Biotechnology*. Akshara Printers,

REFERENCES:

1. Masters J.R.W. 2000*Animal Cell Culture: Practical Approach*. Oxford University Press.
2. Ralf Pörtner Series 2007 Animal Cell Biotechnology: Methods and Protocols. Publisher: Humana Press
3. Terence Cartwright Series 2008 *Animal cells as bioreactors*. Cambridge University Press
4. Verma A and Singh A 2014 *Animal Biotechnology. Models in Discovery and Translation* Academic Press

BT1636 INDUSTRIAL WASTE MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to,

- Understand scientific and engineering principles to treat and minimize the industrial environmental problems.
- Emphasize the alternatives to the conventional treatment methods with modern engineering approaches to evade the environmental issues.

UNIT I INTRODUCTION 9

Industrial scenario in India - Types of industries - Industrial activity and Environment; Uses of Water in industrial processes; Industrial pollution: Types, Characteristics and environmental impacts of industrial wastes – Solid and Liquid; Toxicity of industrial wastes and Bioassay tests; Regulatory requirements for treatment of industrial wastes on water and land ecosystem.

UNIT II SOLID WASTE AND ITS DISPOSAL STRATEGIES 9

Need for solid waste management; Elements of integrated waste management and roles of stakeholders; Waste disposal through landfills - Landfill Classification, types and

methods - site selection - design and operation of sanitary landfills - landfill gas management - environmental monitoring - closure of landfills - landfill remediation.

UNIT III AEROBIC & ANAEROBIC TREATMENT OF WASTEWATER 9

Aerobic treatment: Design of sewage treatment plant units - Activated Sludge process and variations - Membrane Biological Reactors - Trickling Filters - Moving Bed Reactors. Anaerobic treatment: Different stages of anaerobic digestion - Design of units – UASB, up flow filters, septic tank and disposal - Attached and suspended growth.

UNIT IV ADVANCED WATER TREATMENT TECHNOLOGIES 9

Overview of Advanced Waste Water Treatment: Introduction, need and purpose of advanced waste water treatment; Advanced Oxidation Processes - Electrochemical Wastewater Treatment Processes – Electrochemical Oxidation – Ozonolytic oxidation – Modified Fenton Process – Photo driven Process; Redox Process – High energy Oxidation – Gamma and High electron beam.

UNIT V CLEANER PRODUCTION 9

Waste management Approach; Waste Audit – Volume and strength reduction; Material and process modifications – Recycle, reuse and byproduct recovery – Applications; Environmental Forensics as integral part of governing systems

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Compare the waste of various industries and relate with their toxicity level.

CO2 Outline various solid industrial waste and their corresponding treatment strategies.

CO3 Illustrate various aerobic and anaerobic treatment of industrial wastewater

CO4 Implement the advanced treatment technologies for the management of industrial wastes

CO5 Choose efficient cleaner production strategies towards circular economy

TEXT BOOKS:

1. Shen, T.T., 1999. Total environmental quality management. In *Industrial Pollution Prevention* (pp. 81-139). Springer, Berlin, Heidelberg.
2. Eckenfelder, W., 2000. *Industrial water pollution control*. McGraw-Hill.
3. O'Leary, P.R. and Tchobanoglous, G., 2002. Landfilling. In *Handbook of solid waste management*. New York: Mcgraw-hill.
4. Metcalf, L., Eddy, H.P. and Tchobanoglous, G., 1991. *Wastewater engineering: treatment, disposal, and reuse* (Vol. 4). New York: McGraw-Hill.

REFERENCE BOOKS:

1. Metcalf, L., Eddy, H.P. and Tchobanoglous, G., 1991. *Wastewater engineering: treatment, disposal, and reuse* (Vol. 4). New York: McGraw-Hill.
2. Forster, C.F. and Wase, D.A., 1987. *Environmental biotechnology*.
3. Hendricks, D., 2010. *Fundamentals of water treatment unit processes: physical, chemical, and biological*. CRC Press.

BT1637 INTRODUCTION TO BIOFUELS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course will

- Demonstrate a drive towards products benign to natural environment increasing the importance of renewable materials
- Emphasize the development of biomass as an inexpensive feedstock to replace a wide diversity of fossil based products
- Enhance the comprehension of information regarding bioenergy and biofuel technologies and their sustainable applications.

UNIT I INTRODUCTION 9

Need for alternative fuels, composition of fossil fuels; Importance of bioenergy and biofuels in solving energy crisis and global warming; Policy issues in biofuels, Indian Biofuel Programme; Fossil versus renewable energy, resources, economic impact of biofuels, alternative energies, environmental impact of biofuel, Fuel Ratings.

UNIT II FEEDSTOCKS 9

Harvested Feedstocks: First generation biofuels, Second generation biofuels, third generation biofuels. Residue Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and industrial waste.

UNIT III CONVERSION TECHNOLOGIES 9

Biorefinery concept – biorefineries and end products, Biochemical conversion – hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion and trans-esterification, Thermochemical conversion – Combustion, Gasification, Pyrolysis ; Scalability of conversion technologies.

UNIT IV BIOFUELS 9

Biodiesel: Chemistry and Production Processes; Vegetable oils and chemically processed biofuels, Biodiesel from microalgae and microbes; Bioethanol - Production of Fuel Ethanol by Fermentation of Sugars, engineering strains for ethanol production from variety of carbon sources to improved productivity; Biohydrogen technology-potential of organic waste for hydrogen production.

UNIT V SUSTAINABILITY & RESILIENCE 9

Environmental Sustainability, bioenergy sustainability, emissions of biomass to power generation applications, emissions from biofuels. Indirect Land-Use Change (ILUC) issues, Carbon footprint, Advanced low carbon fuels

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 illustrate the present energy scenario and the need for energy conservation

CO2 demonstrate the different feedstocks available for the production of biofuels and platform chemicals

CO3 illustrate the existing and emerging biomass to energy conversion technologies

CO4 Analyze the advantages and disadvantages associated with different biofuels.

CO5 Analyze the environmental aspects of biofuel production

TEXT BOOKS:

1. Brown, R.C., 2003. Biorenewable resources. *Engineering New Products from Agriculture. Iowa: Blackwell Publishing*.
2. Soetaert, W. and Vandamme, E.J. eds., 2011. *Biofuels* (Vol. 15). John Wiley & Sons.
3. Klass, D.L., 1998. *Biomass for renewable energy, fuels, and chemicals*. Elsevier.

REFERENCE BOOKS

1. Nelson, V.C. and Starcher, K.L., 2015. *Introduction to renewable energy*. CRC press.
2. Dahiya, A. ed., 2014. *Bioenergy: Biomass to biofuels*. Academic Press..
3. Li, Y. and Khanal, S.K., 2016. *Bioenergy: principles and applications*. John Wiley & Sons.

BT1638 TISSUE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn principles of tissue engineering and tissue repair.
- Learn the major components of tissue engineered scaffolds, including polymeric constructs and cellular populations.

UNIT I FUNDAMENTALS OF TISSUE ENGINEERING 9

Basics of tissue engineering; current scope of development; use in therapeutics; cells as therapeutic agents; cell numbers and growth rates; measurement of cell characteristics - morphology, number, viability, motility and functions; Measurement of tissue characteristics - appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT II BIOLOGY OF STEM CELLS 9

Stem cells - Introduction, hematopoietic differentiation pathway, potency and plasticity of stem cells, stem cell markers, FACS analysis; types & sources of stem cell with characteristics - embryonic, adult, haematopoetic, mesenchymal stem cells, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells and Induced pluripotent stem cells.

UNIT III TISSUE ARCHITECTURE 9

Tissue types and tissue components; tissue repair; engineering wound healing and sequence of events; basic wound healing applications of growth factors - VEGF/angiogenesis - basic properties; cell-matrix & cell-cell Interactions; telomeres and self-renewal; control of cell migration in tissue engineering; cells micro-mechanisms for regeneration and repair.

UNIT IV BIOMATERIALS 9

Introduction to Scaffolds in tissue engineering; Biomaterials – Surface, bulk, mechanical and biological properties; types of biomaterials - biological and synthetic materials; biopolymers; applications of biomaterials; modifications of biomaterials; role of nanotechnology; 3D printing; controlled bioactive factor release mechanisms.

UNIT V CLINICAL APPLICATIONS 9

Stem cell application with case study for Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, tissue engineering for skin transplantation, cartilage, bone, neural tissue engineering; tissue engineered product characterization, safety, and efficacy;

cryobiology; vitrification technology; preservation – freezing and drying; patent protection and regulation of tissue-engineered products; ethical issues; organ culture & bioreactors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Apply the fundamentals of cell & tissue characteristics in designing a tissue engineered product.
CO2	Categorize the types of stem cells based on their role in tissue engineering.
CO3	Compare wound healing process and angiogenesis with engineering of tissue *iIn vitro*.
CO4	Make use of appropriate biomaterials for tissue engineering applications.
CO5	List the applications of stem cell technology in tissue engineering.

TEXT BOOKS:

1. Moroni, L., Schrooten, J., Truckenmüller, R., Rouwkema, J., Sohier, J. and van Blitterswijk, C.A., 2014. *Tissue Engineering: An Introduction. In Tissue engineering* (pp. 1-21). Academic Press.
2. Palsson, B.O. and Bhatia, S.N., 2004. *Tissue Engineering,* Upper Saddle River, New Jersey, 7458.
3. Meyer, U., Meyer, T., Handschel, J. and Wiesmann, H.P. eds., 2009. *Fundamentals of tissue engineering and regenerative medicine.* Springer Science & Business Media.
4. Clark, R.A. ed., 2013. *The molecular and cellular biology of wound repair*. Springer Science & Business Media.
5. Ratner, B.D., Hoffman, A.S., Schoen, F.J. and Lemons, J.E., 2004. *Biomaterials science: an introduction to materials in medicine*. Elsevier.
6. Karp, G., Iwasa, J. and Marshall, W., 2020. *Karp's Cell and Molecular Biology.* John Wiley & Sons.

REFERENCES:

1. Pavlovic, M. and Balint, B., 2012. *Stem cells and tissue engineering.* Springer Science & Business Media.

2. Gorodetsky, R. and Schäfer, R. eds., 2011. *Stem Cell-Based Tissue Repair*. RSC Pub.
3. Lanza, R., Blau, H., Gearhart, J., Hogan, B., Melton, D., Moore, M., Pedersen, R., Thomas, E.D., Thomson, J.A., Verfaillie, C. and Weissman, I. eds., 2004. *Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells*. Elsevier.
4. Atala, A., Mao, J., Mikos, A. and Vunjak-Novakovic, G., 2007. *Translational approaches in tissue engineering and regenerative medicine*. Artech.
5. Habib, N.A., Levicar, N., Gordon, M.Y., Long, J. and Fisk, N.M. eds., 2007. *Stem Cell Repair And Regeneration-Volume 2 (Vol. 2).* World Scientific.

BT1639 TRANSPORT PHENOMENA

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- to learn about the concept of simultaneous mass, momentum and energy transport
- to exhibit the knowledge in velocity, temperature and concentration profiles for various systems involving turbulent flow

UNIT I MOMENTUM TRANSPORT 9

Viscosity, temperature effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell balance method, pressure and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II EQUATIONS OF CHANGE AND TURBULENT FLOW 9

Equation of continuity, motion, mechanical energy, use of equations of change to solve flow problems, dimensional analysis of equations of change, comparison of laminar and turbulent flows, time-smoothed equation of change, empirical expressions.

UNIT III ENERGY TRANSPORT 9

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow, with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT IV EQUATIONS OF CHANGE FOR NON ISOTHERMAL SYSTEM 9

Energy equations, special forms, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

UNIT V MASS TRANSPORT, EQUATIONS OF CHANGE FOR MULTICOMPONENT SYSTEMS 9

Diffusivity, temperature and pressure effect, Fick's law, theory of diffusion in gases and liquids, concentration distribution in solids and in laminar flow: stagnant gas film, homogeneous and heterogeneous chemical reaction systems, falling film, porous catalyst. The equation of

continuity, use of equations of change, dimensional analysis, empirical expressions for turbulent mass flux.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Outline the fundamentals of momentum transfer in industrial process

CO2 Apply the energy equations, dimensionless analysis of laminar and turbulent flows for solving problems.

CO3 Apply the energy balance and study the temperature distribution in solids.

CO4 Solve problems related to non-isothermal system and temperature distribution in turbulent flows.

CO5 Explain the concepts of mass transfer operations involves multicomponent system.

TEXT BOOKS:

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. N., 2006, *Transport Phenomena*, II edition, John Wiley.
2. Brodkey, R. S., and Hershey, H. C., 1987, *Transport Phenomena*, McGraw-Hill.
3. Brodkey, R. S., and Hershey, H. C., 2003, *Transport Phenomena: A unified approach*, Volume I & II, Brodkey publishing.

REFERENCE BOOKS

1. Welty, J. R., Wilson, R. E., Wicks, C. E., and Rorer,G. L., 2010, *Fundamentals of Momentum, Heat and Mass Transfer*, V edition, John Wiley & sons Inc.
2. Slattery, J. S., 1999, *Advanced Transport Phenomena*, Cambridge University Press, London.

BT1640 ADVANCED PROCESS CALCULATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- to develop skills of the students in the area of Chemical Engineering with emphasis in material and energy balance calculations without chemical reactions.
- to develop skills of the students in the area of Chemical Engineering with emphasis in material and energy balance calculations with chemical reactions.
- to develop the skills of the students in the unsteady state material and energy balance calculations without and with chemical reactions.

UNIT I STEADY-STATE MATERIAL BALANCES 9

Steady-state material balances - general material balance equations; procedure for material balance calculations; material balances involving multiple sub-systems; simplifications for steady-state processes without chemical reaction.

UNIT II MATERIAL BALANCE FOR VARIOUS UNIT OPERATIONS 9

Concept of limiting; excess reactants; fractional conversion; percentage of conversion; percentage yield; excess air calculations; material balances involving simultaneous equations; stoichiometry of microbial growth and product formation.

UNIT III RECYCLE BY-PASS AND PURGE 9

Material balances involving recycle, by-pass, and purge streams; Uses of recycle, by-pass and purge streams, problems involving recycle, by-pass and purge streams with and without chemical reactions.

UNIT IV STEADY-STATE ENERGY BALANCES 9

General energy balance equations; enthalpy calculation procedures; enthalpy change in non-reactive processes; steam tables; procedure for energy balance calculations without reaction; enthalpy change due to reaction; solving simultaneous material and energy balances; heat of

reaction for processes with biomass production; energy balance equation for cell culture; fermentation energy balances.

UNIT V INTRODUCTION TO UNSTEADY-STATE MATERIAL AND ENERGY BALANCES 9

Unsteady-state material and energy balance equations; solving differential equations; unsteady-state mass balances; unsteady-state energy balances; unsteady-state material and energy balances on non- reactive process; heat of mixing and solution; balances on reactive processes; integrated balances.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Apply the concept of material balance without chemical reaction for steady state operations in chemical and biochemical engineering.
CO2	Make use of the concept of material balance with chemical reaction for steady state operations in chemical and biochemical engineering.
CO3	Utilize the concept of material balance involving recycle, by-pass and purge stream without and with chemical reaction.
CO4	Apply the concept of steady state energy balance without and with chemical and biochemical reactions.
CO5	Solve the problems related to unsteady state material and energy balance without and with chemical reactions.

TEXT BOOKS:

1. Bhatt, B.I. and Thakore, S.B., 2010. *Stoichiometry*. Tata McGraw-Hill Education.
2. Narayanan, K.V. and Lakshmikutty, B., 2016. *Stoichiometry and process calculations*. PHI Learning Pvt. Ltd.

3. Himmelblau, D.M. and Riggs, J.B., 2012. *Basic principles and calculations in chemical engineering*. FT press.

REFERENCE BOOKS:

1. McCabe, W.L., Smith, J.C. and Harriott, P., 1993. *Unit operations of chemical engineering*. New York: McGraw-hill.
2. Sikdar, D.C., 2013. *Chemical Process Calculations*. PHI Learning Pvt. Ltd.
3. Hicks, T.G. and Chopey, N.P., 2012. Handbook of chemical engineering calculations. McGraw-Hill Education

BT1641 CANCER BIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Understand the regulation of cell cycle in cancer
- Understand the molecular mechanisms of carcinogenesis and cancer metastasis
- Familiarize with basic principles and applications of cancer therapies.

UNIT I FUNDAMENTALS OF CANCER BIOLOGY 9

Introduction – Growth characteristics of cancers cells; Morphological and structural properties of cancer cells; Types of growth -hyperplasia, dysplasia, anaplasia and neoplasia. Differences between benign and malignant tumors; Cell cycle - regulation of cell cycle- signal switches- tumour suppressor genes - modulation of cell cycle in cancer; Apoptosis – intrinsic and extrinsic pathways.

UNIT II MECHANISM OF CARCINOGENESIS 9

Carcinogenesis – Introduction and types; Chemical carcinogenesis – Direct acting and indirect acting carcinogens; Metabolism of carcinogens - CYP450 reductase mechanism; Mechanism of radiation carcinogenesis – ionizing and non-ionizing radiation;

Retroviruses - Rous sarcoma virus life cycle and its role in cancer;

UNIT III MOLECULAR MECHANISMS OF CANCER 9

Signal targets and cancer - Activation of kinases; Oncogenes, Identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto-oncogene activity. Growth factors and oncogenes ; Growth factors related to transformation ; Telomerases ; Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumour cell invasion.

UNIT IV DETECTION OF CANCER 9

Cancer screening and early detection - Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer, Prediction of aggressiveness of cancer, Tumor staging; Applications of new technologies in prevention, assessing risk and diagnostics - Use of cancer antigens in cancer detection, Monoclonal antibodies in cancer diagnosis, Cancer imaging Technologies

UNIT V MECHANISMS OF CANCER THERAPY 9

Different forms of therapy (Specific Case studies) - chemotherapy, radiation therapy, Immunotherapy, Chimeric antigen receptor (CAR) T-cell therapy ; Advances in cancer detection- Use of signal targets towards therapy of cancer, Gene therapy, Cancer antigen-based vaccines, cell-based therapy against cancer, Targeted therapy, Prodrug Therapy (ADEPT, GDEPT and Prodrug Monotherapy), Hormone Therapy.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Illustrate the basic facts of carcinogenesis and the role of different carcinogens and their metabolism in cancer biology

CO2 Interpret the mechanism of carcinogenesis by physical and chemical agents

CO3 Sketch the molecular mechanisms and signaling pathways in cancer

CO4 Illustrate the fundamental principles and applications of cancer therapies

CO5 Demonstrate the principles and applications of cancer detection and diagnosis

TEXT BOOKS:

1. Weinberg, R.A., 2013. *The biology of cancer*. Garland science.
2. Pelengaris, S. and Khan, M. eds., 2013. *The molecular biology of cancer: A bridge from bench to bedside*. John Wiley & Sons.
3. Macdonald, F., Ford, C. and Casson, A., 2004. *Molecular biology of cancer*. Taylor & Francis

REFERENCE BOOKS:

1. King, R.J.B. and Robins, M.W., 2006. *Cancer biology*. Pearson Education.
2. Ruddon, R.W., 2007. *Cancer biology*. Oxford University Press.
3. Knowles, M. and Selby, P., 2005. *Introduction to the cellular and molecular biology of cancer*. Oxford university press.

BT1642 FUNDAMENTAL OF CLINICAL TRIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn the fundamentals of epidemiologic methods, study design, protocol preparation
- To gain knowledge in the basic bio-statistical techniques involved in clinical research.
- To describe the principals involved in ethical, legal and regulatory issues in clinical trials.

UNIT I CLINICAL TRIALS AND DRUG DISCOVERY 9

General terms in clinical trials – healthy volunteers, inclusion / exclusion criteria, informed consent, patient volunteer, placebo, randomized, single- or double-blind studies, Mortality and morbidity. Types and phases of clinical trials, nonclinical research, ethical conduct

during clinical trials. Clinical trial protocol and its components

UNIT II FUNDAMENTALS OF TRIAL DESIGN 9

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS 9

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-centre trials.

UNIT IV CLINICAL DATA ANALYSIS 9

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT V REPORTING OF TRIALS 9

EPIDATA Software in clinical trials, Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Understand the clinical trial process

CO2 Design and conduct the clinical trial experiments.

CO3 Understand the alternative designing in clinical trial.

CO4 Analyse clinical data by using statistical methods

CO5 Prepare a complete report on clinical trial experi

TEXT BOOKS:

1. Friedman, L.M., Furberg, C.D., DeMets, D.L., Reboussin, D.M. and Granger, C.B., 2015. *Fundamentals of clinical trials*. Springer.
2. Machin, D., Day, S. and Green, S. eds., 2007. *Textbook of clinical trials*. John Wiley & Sons.

3. Daly, M.J., 1984. *Clinical trials: A practical approach,* John Wiley & Sons.

REFERENCES:

1. Wang, D. and Bakhai, A., 2006. *Clinical trials: a practical guide to design, analysis, and reporting*. Remedica.
2. Durham, T.A. and Turner, J.R., 2008. *Introduction to statistics in pharmaceutical clinical trials*. London: Pharmaceutical Press.
3. Brody, T., 2016. *Clinical trials: study design, endpoints and biomarkers, drug safety, and FDA and ICH guidelines*. Academic press.

BT1643 GENOMICS AND PROTEOMICS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

1. To gain knowledge on the structure and function of genomes.
2. To Understand and learn about different protein characterisation and profiling techniques.

UNIT I INTRODUCTION 9

Introduction to genome, transcriptome, and proteome; Overview of genomes of bacteria, archaea, and eukaryote; Genomes of organelles.

UNIT II GENOME MAPPING AND SEQUENCING 9

Genetic and physical mapping, Linkage analysis, RFLP, SNP, SSLP, Restriction mapping, STS mapping, FISH, Top-down and bottom-up sequencing strategies, Whole genome sequencing, Gap closure, Pooling strategies.

UNITI II FUNCTIONAL GENOMICS 9

Genome annotation, ORF and functional prediction, Gene finding, Subtractive DNA library screening, differential display and Representational difference analysis, SAGE, TOGA, Introduction to DNA microarray; Applications of MATLAB in genomics.

UNIT IV TECHNIQUES IN PROTEOMICS 9

In-vitro and in vivo-labelling of proteins, One and two-dimensional gel electrophoresis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Mass spectrometry principles of MALDI-TOF, Peptide mass fingerprinting.

UNIT V PROTEIN PROFILING 9

Large-scale protein profiling using proteomics, Post-translational modifications, Phosphoprotein and glycoprotein analyses; Analysis of protein-protein interactions, Protein microarrays.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Understand the existence of various levels of protein structures

CO2 Develop and understand the genome mapping and sequencing data with tools

CO3 Choose appropriate tools to analyze the functions of genes and proteins

CO4 Understand the techniques in protein analysis

CO5 Summarize the methods of protein characterization techniques

TEXT BOOKS:

1. Suhai, S. ed., 2007. *Genomics and proteomics: Functional and computational aspects.* Springer Science & Business Media.
2. Pennington, S.R. and Dunn, M.J., 2001. *Proteomics: from protein sequence to function*.
3. Macleod, D., 2006. *Principles of Gene Manipulation and Genomics*, SB Primrose & RM Twyman. Blackwell Publishing.

REFERENCE BOOKS:

1. Cantor, C.R. and Smith, C.L., 2004. *Genomics: the science and technology behind the human genome project* (Vol. 12). John Wiley & Sons.
2. Liebler, D.C., 2001. *Introduction to proteomics: tools for the new biology.* Springer Science & Business Media.
3. Hunt, S., Hunt, S.P., Livesey, F. and Livesey, R. eds., 2000. *Functional genomics:*

a practical approach (Vol. 235). Practical Approach (Paperback).

BT1644 GOOD MANUFACTURING PRACTICE AND GOOD LABORATORY PRACTICE

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- To provide a solid introduction to control and management of manufacturing and quality of biotechnological products.

UNIT I INTRODUCTION 9

History of Good Laboratory and manufacturing Practices; WHO guidelines on GLP and GMP; Quality Standards & Quality Assurance; functions and advantages; Industry-specific safety regulations; HACCP principle and applications.

UNIT II REGULATORY BODIES 9

Government standards of quality for food and pharmaceuticals (Legalization); Trade and Company Standards Control by National, International organizations like EMA, FDA, MHRA, TGA, WHO; Compliance & preparation for certification - ISO / IEC 17025: 2005; Laboratory accreditation – NABL, Pollution control board certification.

UNIT III QUALIFICATION AND VALIDATION 9

Installation qualification (IQ); Operational qualification (OQ); Performance qualification (PQ); Concepts of equipment qualification; Concepts of Validation and its importance; Method & Process development and validation; Validation Master Plan (VMP).

UNIT IV GOOD DOCUMENTATION PRACTICES 9

Importance and need for GDP; Standard Operating Procedures (SOP); Standard Testing Procedures (STP); Raw Data Sheet (RDS) to Reports; Batch Manufacturing Record; Electronic records regulation.

UNIT V GOOD LABORATORY PRACTICES 9

Quality in Biomanufacturing; Quality Control Laboratories – Microbiology, Biochemistry,

Enodotoxin Testing, Microplate method, PCR method, Chromatographic method; controls on animal house; Cleaning and Disinfection; Waste disposal and managements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	To familiarize the fundamental concepts of GMP and GLP
CO2	To demonstrate the roles and responsibilities of various regulatory agencies
CO3	To apply and implement different qualification and validation parameters in GMP environment
CO4	To demonstrate good documentation procedure in GMP / GLP environment
CO5	To familiarize the good laboratory quality control and quality assurance practices in bio manufacturing industries

TEXT BOOKS:

1. The International Pharmacopoeia. 2018. *General methods of analysis quality specifications for Pharmaceutical substances, Excipients, dosage forms*. 8th Edn. WHO
2. Syed Imtiaz Haider., 2002. *Pharmaceutical Master Validation Plan The Ultimate Guide to FDA, GMP, and GLP Compliance*, ST. Lucie Press.
3. B. N. Cooper., 2017. *Good Manufacturing Practices for Pharmaceuticals: GMP in Practice*. Createspace Independent Pub.

REFERENCE BOOKS:

1. B. N. Cooper, 2017. *The GMP Handbook: A Guide to Quality and Compliance*. Createspace Independent Pub.
2. Emmet Tobin., 2016. *An Introduction to Good Laboratory Practices* Kindle Edition. Validation resources.
3. Pradeep Deshmukh., 2020. Principles of Good Laboratory Practice. Adhyyan Books.

OPEN ELECTIVE – I

SL.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	OBT151	Basics of Bioinformatics	3	0	0	3	V
2	OBT152	Basics of Nanobiotechnology	3	0	0	3	
3	OBT153	Fundamentals of Microbiology	3	0	0	3	

OPEN ELECTIVE - II

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	OBT161	Instrumentation and analytical methods	3	0	0	3	VII
2.	OBT162	Introduction to Food Manufacturing	3	0	0	3	
3.	OBT163	Testing of Biological Materials	3	0	0	3	

OBT151 BASICS OF BIOINFORMATICS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course will help the students to

- Adapt basic knowledge on various techniques and areas of applications in bioinformatics.
- Analyze common problem in bioinformatics, alignment techniques, ethical issues, public data sources, and evolutionary modelling.
- Discover the practical use of tools for specific bioinformatic areas.

UNIT I INTRODUCTION 9

Introduction - Motivation of biological database - Central dogma of life - Retrieval methods for DNA sequence, protein sequence and protein structure information

UNIT II DATABASES 9

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats ; Annotated sequence databases - primary sequence databases, protein sequence and structure database ; Organism specific databases.

UNIT III DATA PROCESSING 9

Data – Access, Retrieval and Submission ; Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches - Local versus global, Distance metrics, Similarity and homology, Scoring matrices.

UNIT IV METHODS OF ANALYSIS 9

Dynamic programming algorithms - Needleman-wunsch and Smith-waterman ; Heuristic Methods of sequence alignment - FASTA and PSI BLAST ; Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment.

UNIT V APPLICATIONS 9

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis - Comparative genomics, orthologs, paralogs; Genome analysis – Genome annotation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Understand the fundamentals of different biological data resources and get acquainted with various bioinformatics databases
CO2	Develop basic knowledge on the available online biological databases
CO3	Analyze biological data using different bioinformatics tools
CO4	Perform different types of sequence alignments and various kinds of blast search
CO5	Construct phylogenetic trees and gene networks

TEXT BOOKS

1. Lesk, A., 2019. *Introduction to bioinformatics*. Oxford university press.
2. Mount, D.W. and Mount, D.W., 2001. *Bioinformatics: sequence and genome analysis* (Vol. 1). Cold Spring Harbor, NY: Cold spring harbor laboratory press..
3. Gibas, C., Jambeck, P. and Fenton, J., 2001. *Developing bioinformatics computer skills*. O'Reilly Media, Inc.

REFERENCE BOOKS

1. Attwood, T.K. and Parry-Smith, D.J., 1999. *Introduction to bioinformatics.* Pearson Education.
2. Pevsner, J., 2015. *Bioinformatics and functional genomics*. John Wiley & Sons..
3. Durbin, R., Eddy, S.R., Krogh, A. and Mitchison, G., 1998. *Biological sequence analysis: probabilistic models of proteins and nucleic acids*. Cambridge university press.

OBT152 BASICS OF NANOBIOTECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables students

- To understand about the importance of basic biology and macromolecules to know the basis of nano-biotechnology
- To understand about the nano-materials used in biotechnology
- To characterize the nano-materials using different analytical techniques
- To know about the devises in nano biotechnology

UNIT I BASICS OF BIOLOGY AND MACROMOLECULES 9

Basics of biology - cell, organelles and nucleic acids as genetic material; Bio-macromolecules - carbohydrates, lipids, proteins and nucleic acids.

UNIT II NANOMATERIAL IN BIOTECHNOLOGY 9

Biomimetic nanotechnology; protein-based nanostructures; Nanomotors - bacterial (*E. coli*) and mammalian (Myosin family); DNA nanotechnology - nanostructures in cells study, microarray platforms, Nano printing of DNA, RNA, and proteins biochips applications in nano scale detection, lab-on-a-chip devices (LOC), tissue engineering.

UNIT III NANOMATERIAL CHARACTERIZATION 9

X-ray diffraction; electron microscopy; interaction between electron beam and solids - TEM, SEM, SPM (STM & AFM), AES, XPS, SIMS.

UNIT IV NANO BIOTECHNOLOGY APPLICATIONS 9

Micro- and Nano electromechanical devices in drug delivery; other applications in drug delivery;
photodynamic therapy in targeted drug administration; Nano biosensors; applications of quantum dots in biotechnology; DNA based nanomaterials as biosensors.

UNIT V SOCIETAL IMPACTS OF NANO-BIOTECHNOLOGY 9

Engineered nanomaterial of relevance to human health; routes of entry into the body; toxic effects on health; plants and microbes are nano-factories.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the basic biology and macromolecules in the application of nano-biotechnology
CO2	Explain the role of nano-materials in biotechnology
CO3	Understand the Characterization of Biomaterials
CO4	Explain the applications of nano-biotechnology
CO5	Understand the societal impacts of nano-biotechnology

TEXT BOOKS:

1. Christof M. Niemeyer, Chad A. Mirkin, 2004, *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley VCH, Weinhelm, Germany.
2. Chad A Mirkin and Christ M. Niemeyer, 2007, *Nanobiotechnology - II More concepts and applications*, Wiley VCH, Weinhelm, Germany.
3. David S. Goodsell, 2004, *Bionanotechnology: Lessons From Nature*, A John Wiley & Sons, INC, Publication, New Jersey, USA.

REFERENCE BOOKS:

1. Yubing Xie, 2018, *The Nanobiotechnology Handbook*, 1st Ed, Taylor & Francis Publication, Florida, USA.
2. Alok Dhawan, Sanjay Singh, Ashutosh Kumar, Rishi Shanker, 2018, *Nanobiotechnology: Human Health and the Environment***,** CRC Press, Florida, USA.
3. Arunava Goswami, Samrat Roy Choudhury, 2017, *Nanobiotechnology: Basic and Applied Aspects*, Anthem Press, London, UK.

OBT153 FUNDAMENTALS OF MICROBIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Learn structural organization, Multiplication, growth and control of microorganisms
- Understand Applications of microorganisms in food, industry, medicine and environment

UNIT I INTRODUCTION 9

History and Scope of microbiology, Microscopy: Bright field, Dark field, Phase contrast, Fluorescent and Electron microscopy. Stains and Staining techniques: Simple staining, Differential staining (Gram & Acid fast), Special staining (Capsular, Flagellar& Endospore).

UNIT II GENERAL CHARACTERS OF MICROORGANISM 9

General Characteristics of Microorganisms - Viruses, Fungi (Mould& Yeast), Algae, Actinomycetes and Mycoplasma. Structural organization and multiplication of bacteria,

UNIT III MICROBIAL GROWTH AND CONTROL 9

Nutritional classification of microorganisms based on carbon, energy and electron sources Definition of growth, Growth curve. Physical and chemical control of microorganisms; Antibiotics: anti-bacterial, antifungal and anti-viral agents

UNIT IV FOOD AND INDUSTRIAL MICROBIOLOGY 9

Primary metabolites; secondary metabolites and their applications; Fermented foods – cheese and dairy products; food borne infections and intoxications; Food preservation; Bioprocess technology: Bioreactors; Production of acetic acid, alcohol, PHA’s (bioplastics), Penicillin.

UNIT V ENVIRONMENTAL AND MEDICAL MICROBIOLOGY 9

Microbial Ecology Basic concept of Ecosystem; Environmental Pollution; bioremediation; biofertilizers and biopesticides; leaching of ores by microorganisms; Clinically important microorganisms. Case studies on Salmonella typhi, COVID19.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Define the Historical perspectives of microorganisms, Microscopy and staining techniques.
CO2	Describe general characteristic feature of diversified microbes and structural organization of bacteria.
CO3	Explain method to cultivate microorganisms, Growth and control of microorganisms.
CO4	Explain types of metabolites, fermented food production, food infections and industrial production of metabolites
CO5	Describe microbial systems used in environment and their importance in medical aspects.

TEXT BOOKS

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., 2001. Microbiology. Tata McGraw Hill Edition, New Delhi, India
2. Brock, T.D., Madigan, M.T., Martinko, J.M. and Parker, J., 2014. *Brock biology of microorganisms*. Upper Saddle River (NJ): Prentice-Hall.
3. Ananthanarayan, R., 2006. *Ananthanarayan and Paniker's textbook of microbiology*. Orient Blackswan.

REFERENCE BOOKS

1. Sherwood, L., Willey, J.M. and Woolverton, C., 2020. Prescott's microbiology. McGraw-Hill.

2. Frazier, W.C. and Westhoff, D.C., 2003. Food Microbiology. McGrawHill.
3. Cruger.Wulf and Anneliese Crueger, 2017 “Biotechnology: A Textbook of. Industrial. Microbiology”, 3nd Edition, Panima Publishers.

OBT161 ANALYTICAL METHODS AND INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Gain fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence, NMR, Mass spectroscopy
- Acquire knowledge on the electro analysis and surface microscopy.

UNIT I SPECTROMETRY 9

Properties of electromagnetic radiation- wave properties – components of optical instruments– Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Applications.

UNIT II MOLECULAR SPECTROSCOPY 9

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer’s law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence –Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT III NMR AND MASS SPECTROMETRY 9

Theory of NMR — chemical shift- NMR-spectrometers – applications of 1H and 13C NMR- Molecular mass spectra – ion sources. Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

UNIT IV ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for

potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM

UNIT V MEASUREMENT OF NON-ELECTRICALPARAMETERS 9

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement. Blood gas analyzers and Non-Invasive monitoring, colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Outline the properties of electromagnetic radiation and the spectrometry
CO2	Explain different molecular spectroscopy and its applications
CO3	Choose an appropriate spectrometry towards molecular characterization through NMR and mass spectrometry
CO4	Analyze and design electrochemical cell analysis and surface microscopy
CO5	Apply the instrumentation concepts on different biochemical measurements

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch 2007 *"Instrumental Methods of Analysis"*.Cengage Learning.
2. Willard, Hobart, etal. 1986,, *"Instrumental Methods of Analysis*". CBS,
3. Braun, Robert D. 1987, *" Introduction to Instrumental Analysis*". Pharma Book Syndicate.

REFERENCE BOOKS:

1. Sharma, B.K. "Instrumental Methods of Chemical Analysis : Analytical Chemistry" 1972, GoelPublishing House.
2. Haven, Mary C., etal., "Laboratory Instrumentation", 1995, IVth Edition, John Wiley

OBT162 INTRODUCTION TO FOOD MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students to

- Understand the basics of various food processing techniques.
- Enhance the knowledge on minimal processing and hurdle technology.
- Understand the role of food additives in food industry.

UNIT I REFRIGERATION AND FREEZING 9

Requirements of refrigerated storage, controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes in the food during refrigeration and freezing, freezing methods - direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

UNIT II DRYING AND DEHYDRATION 9

Normal drying curve, effect of food properties on dehydration, changes in food during drying, drying methods, air convection dryer, tray dryer, tunnel dryer, continuous belt dryer, fluidized bed dryer, drum dryer, vacuum dryer, freeze dryer, foam mat dryer.

UNIT III THERMAL PROCESSING OF FOODS 9

Classification of thermal processes, principles of thermal processing, commercial canning operations, Pasteurisation, blanching, irradiation and microwave heating - principles, dosage, applications and mechanism.

UNIT IV MINIMAL PROCESSING AND HURDLE TECHNOLOGY 9

Principles and applications, hurdle effect in fermented foods, shelf stable products, intermediate moisture foods, application of hurdle technology. Minimal processing of foods with thermal methods and non thermal methods, criteria in minimally processed foods, Minimal processing in practice and future developments.

UNIT V FOOD ADDITIVES, CONTAMINANTS AND REGULATIONS 9

Need of food additives in food processing and preservation, characteristics and classification of food additives, chemical, technological and toxicological aspects. Contamination in Food - physical, chemical (heavy metals, pesticide residues, antibiotics, veterinary drug residues, dioxins, environmental pollutants, radionuclide, solvent residues), natural toxins. Food laws and regulations - Codex, HACCP, ISO, FSSA etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Understand the basic principle and application of refrigeration in freezing in food industries
CO2	Outline the applications of drying and dehydration
CO3	Explain the principle and application of thermal processing of food materials
CO4	Understand the need for hurdle technology and minimal processing for certain food
CO5	Understand about the food processing regulations, advantages and disadvantages of food additives

TEXT BOOKS:

1. Potter N.N, and Hotchkiss J.H, 1998, *Food Science*, 5th Edition, Asben Publications.
2. Ramaswamy H, and Marcotte M, 2009, *Food Processing: Principles and Applications*, 2nd Edition, CRC Press.
3. Deman J.M, 2007, *Principles of Food Chemistry*, 3rd Edition, Springer.
4. Manay N.S, and Shadaksharaswamy M, 2001, *Food - Facts and Principles*, 2nd Edition, New Age International Pvt. Ltd. Publishers.

REFERENCE BOOKS:

1. Romeo T.T, Singh R.K, and Kong F, 2018, *Fundamentals of Food Process Engineering*, 4th Edition, Springer.
2. Rao D.G, 2010, *Fundamentals of Food Engineering*, PHI Learning Pvt. Ltd.

3. Desrosier N.W, and Desrosier J.N, 1998, *The Technology of Food Preservation*, 4th Edition, CBS Publishers.
4. Bawa A.S, Raju P.S, and Chauhan O.P, 2013, *Food Science*. New India Publishing Agency.

OBT163 TESTING OF BIOLOGICAL MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

This course enables the students

- To understand the current biomaterials scene, know how these materials are synthesized and fabricated
- To impart knowledge on testing and assessment of biomaterials
- To enhance exposure pertaining to the field of biomaterials and have broad understanding biomaterials research
- To design devices for specific scientific, industrial and medical applications using current biomaterials

UNI I FUNDAMENTALS OF BIOMATERIALS SCIENCE 9

Introduction to Materials, General structure and properties. Concept of biocompatibility, Fundamentals of Biocompatibility Tests. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Desinfection and sterilization of biomaterials.

UNIT II CLASSIFICATION OF COMMON MATERIALS AND APPLICATIONS 9

Nanocomposites, Bioresorbable and Bioerodable Materials, Natural polymers, Carbon nanotubes, Metal and alloys in Medical application: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys). Ceramics and glasses-bio ceramics, Type of Ceramics and their classification

UNIT III PHYSICO-CHEMICAL PROPERTIES OF BIOMATERIALS 9

Mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear

resistance), tribological (friction, wear, lubricity), Morphology and Texture, Physical (electrical, optical, magnetic, thermical), Chemical and Biological properties.

UNIT IV DESIGN AND MANUFACTURING OF BIOCOMPATIBLE MATERIALS 9

Design of materials for biomedical application: Cardiovascular, Dental Implants, Orthopedic Application, Skin, Ophthalmologic Applications, Wound Healing, Sutures, Biomedical and Biosensors, Concept of biomimetic synthesis, Preparation of fiber and wire, Fabrication of Porous Materials, Direct molding Technique, Different advanced fabrication technique

UNIT V METHODS FOR ASSESSMENT OF BIOMATERIALS 9

In Vitro Assessment of Cell and Tissue Compatibility, In Vivo Assessment of Tissue Compatibility, Evaluation of Blood-Materials Interactions, Microscopy for Biomaterials Science, Problems and possible solutions in implant fixation; Failure analysis of medical devices and implants. Toxicokinetics in Biomaterial and Device Safety Evaluation

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1	Understand the current biomaterials scene, know how these materials are synthesized and fabricated
CO2	Outline the different classification of biomaterials
CO3	Understand the physio-chemical characterization of different biomaterials
CO4	Apply the knowledge in designing the biocompatible materials
CO5	Explain the principles in testing and assessment methods of biomaterials

TEXT BOOKS:

1. Buddy D.R, Allan S. H, Frederick J.S, Jack EL. 2004, *Biomaterials Science: An Introduction to Materials in Medicine*, Academic Press, USA
2. Park J.B. and Bronzino J.D.. 2002, *Biomaterials: Principles and Applications*. CRC Press.
3. Gad-McDonald, Samantha, Gad, Shayne C, 2015, *Biomaterials, medical devices, and combination products : biocompatibility testing and safety assessment,* CRC Press.

REFERENCE BOOKS:

1. Dee K.C., Puleo D.A and Bizios R. 2002, *An Introduction to Tissue-Biomaterial Interactions.* Wiley.
2. Ambrosio L. 2009, *Biomedical composites*, Woodhead Publishing Limited.