BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE
DEPARTMENT OF BIOTECHNOLOGY
SCHEME OF TEACHING AND EXAMINATION

2021-2022

B.E. IV SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT418C	Molecular Biology	3	3	0	0	50	50	100
2	UBT406C	Immunotechnology	3	3	0	0	50	50	100
3	UBT412C	Heat and Mass Transfer	3	3	0	0	50	50	100
4	UBT415C	Biostatistics & Bio-modeling	3	2	2	0	50	50	100
5	UBT419C	Thermodynamics	3	3	0	0	50	50	100
6	UBT408L	Molecular Biology Lab	1.5	0	0	3	50	50	100
7	UBT410L	Immunotechnology Lab	1	0	0	2	50	50	100
8	UBT412L	Biostatistics Lab	1.5	0	0	3	50	50	100
9	UHS001N	Fundamentals of Quantitative Aptitude & Soft skills	1.0	1	0	0	50	50	100
10	UHS004M	Universal Human Values-II	0	3	0	0	50	50	100
Total			**20**	**18**	**02**	**8**	**500**	**500**	**1000**

UBT418C	MOLECULAR BIOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

Introduction:

Genes and their location. Information flow in biological systems: central dogma, updated central dogma. Signalling (signal transduction)-molecular mechanism. Reverse genetics, Genetic code-its features, codon and anticodon.

Replication:

Replication-basic concepts, structure and function of DNA polymerases, ligases, helicase. mechanism of DNA replication in prokaryotes and eukaryotes, End replication problem in eukaryotes, telomerase and its role, DNA damage & Repair (Photo reactivation, excision repair, recombinational repair, SOS repair).

UNIT–II	10 Hrs.

Transcription:

Mechanism of transcription in prokaryotes and eukaryotes, Bacterial RNA polymerase, structure and function of RNA polymerases (prokaryotes & eukaryotes), general transcription factors, post transcriptional processing, Si RNA, Antisense RNA technology.

Translation:

Protein synthesis: Initiators, Elongation factors, termination codons, Mechanism of translation, Structure and function of prokaryotic and eukaryotic ribosomes, Post translational modification. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.

UNIT–III	10 Hrs.

Gene Expression in Prokaryotes:

Regulation of gene expression in prokaryotes: Operon model-structure and function, galactose and lactose operon, tryptophan Operon-regulation by attenuation mechanism; positive versus negative regulation, cyclic AMP effect/catabolite repression.

Gene Expression in Eukaryotes:

Regulation of eukaryotic gene expression, hormonal regulation- peptide and steroid hormones, transcriptional control, super secondary structures-Helix turns Helix. Zinc fingers and Leucine Zippers. Gene silencing- methylation, chromatin modification.

UNIT–IV	10 Hrs.

Transposons and Oncogenes:

Transposons-replicative and non replicative mechanisms, Insertion sequences, AC/DS elements, transposition in maize (McClintock's work), Cut and paste transposition, Oncogenes and Protooncogenes, Tumour suppressor genes, retroviruses and its life cycle.

Genetic Recombination:

Genetic recombination in bacteria- transformation, transduction and recombination, Mechanism of recombination-homologous (Holliday model), site specific recombination.

Reference Books *

1. David Nelson and Michael Cox, (2017), Lehninger Principles of Biochemistry (6^{th} Edition), W.H. Freeman
2. James Watson (2008), Molecular Biology of the Gene (5^{th} Edition) Pearson Education
3. David Freifelder, (2008), Essentials of Molecular Biology (2^{nd} Edition), Narosa Publishing House

Course Outcomes**

After completion of the course student will be able to

1. Emphasize on the basic aspects of molecular biology; the key areas and apply the knowledge in information flow in biological systems, reverse genetics and genetic code.
2. Classify and compare the mechanism of DNA repair processes, replication.
3. Acquire working knowledge on the mechanism of transcription, translation and post translational processes stepwise and their applications in the research.
4. Identify the various mechanism of gene regulation in prokaryotes and eukaryotes.
5. Identify the steps of transposition and concept of oncogenes.
6. Identify, describe and classify the molecular mechanism of genetic recombination.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	1	3	2	1	-	-	-	-	-	3	1	-
CO2	1	-	1	3	3	2	2	-	-	-	-	-	3	2	-
CO3	1	-	1	3	2	1	1	-	-	-	-	-	3	1	-
CO4	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-
CO5	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-
CO6	1	-	3	3	3	2	3	-	-	-	-	-	3	2	-

UBT406C	IMMUNOTECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10Hrs.

The immune system:

Introduction, Cells and Organs of the immune system: Lymphoid cells, phagocytes, mast cells and dendritic cells. Primary (thymus, bone marrow and lymphatic system) and secondary Lymphoid organs (lymph nodes, spleen, MALT, CALT). Innate and adaptive immunity. Antigens, Antibodies, Complement system-complement activation, (classical, alternative and lectin pathway) regulation and biological consequences of compliment activation. Cytokines and their role in immune response. Monoclonal antibodies and applications.

UNIT–II	10 Hrs.

Humoral and cell mediated immunity:

Introduction to humoral and cell mediated immunity. B-lymphocytes and their activation; Basic structure of immuno globulins; immunoglobulin classes (IgG, IgA, IgE, IgD and IgM) and biological activity. Antigenic determinants on immunoglobulin's- Isotype, Allotype and Idiotype. Thymus derived lymphocytes (T cells) and types, T-cell maturation and activation, mechanisms of T cell activation. Cell death and T-cell populations. Major Histocompatibility Complex and antigen presentation. Antigen presenting cells, dendritic cells, macrophages, mechanism of phagocytosis.

UNIT–III	10 Hrs.

Immunological disorders:

Hypersensitivity reactions and its types. Autoimmune disorders- Organ specific, Systemic Autoimmune diseases, Animal models for autoimmune diseases and treatment of autoimmune disease. Primary and secondary immunodeficiency disorders (AIDS). Transplantation Immunology: immunological basis of graft rejection, Types of transplantations.

Vaccines: Active and Passive immunization. Designing vaccines for active immunization: Live, attenuated vaccines. Inactive vaccines, subunit vaccines, recombinant vector vaccines and DNA vaccines.

UNIT–IV	10Hrs.

Immunodiagnosis:

Antigen-antibody reactions- Precipitation reactions, agglutination reactions, Blood typing A, B, ABO & Rh. Principal and applications of ELISA, Radio immuno assay (RIA), western blot analysis, immuno-electrophoresis, Non-isotopic methods of detection of antigens - Enhanced chemiluminescence assay. Purification and synthesis of antigens.

Reference Books *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology(8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

Course Outcomes**

After completion of the course student will be able to

1. Understand Immune system.
2. Analyze the humoral and cell mediated immune system.
3. Explain the immunological disorders.
4. Evaluate the Transplantation immunology.

5. Understand the designing of Vaccines.
6. Understand Ag Ab reaction and applications of Electrophoresis in Immunology.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	2	-	-	-	-	2	-	-	-	3	-	1	3
CO 2	2	2	1	3	2	-	3	-	-	-	-	3	3	1	3
CO 3	3	1	1	-	2	2	3	1	-	-	-	3	1	1	2
CO 4	2	2	2	2	2	2	-	-	-	-	-	2	-	2	1
CO 5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO 6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

UBT412C	HEAT AND MASS TRANSFER	Credits: 03
L:T:P –3:0:0		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

UNIT-I	10 Hrs.

Introduction to Heat Transfer:

Modes of heat transfer; Conduction – steady state heat conduction through uni-layer and multilayer plane wall sphere, cylinder; Insulation – types, critical radius, Optimum thickness of insulation. Forced and Natural convection; Significance of Dimensionless numbers (Nu, Gr, Pr, Re, Pe numbers only); Heat transfer without phase change, heat transfer in laminar and turbulent flow inside closed conducts, concepts of film heat transfer coefficients.

UNIT–II	10 Hrs.

Heat Transfer Equipment's:

Equations and numerical problem for calculations of film heat transfer coefficients, Heat transfer with phase change - Condensation – film wise and drop wise; Boiling – types of boiling. Co current and counter current flow. Individual and overall Heat transfer coefficients, LMTD, Elementary design of double pipe heat exchanger and shell and tube heat exchanger.

UNIT–III	10 Hrs.

Basics of Mass Transfer:

Diffusion - Fick's law of diffusion. Measurement of diffusivity, Theories of mass transfer, Mass transfer coefficients and their correlations. Liquid-Liquid, Solid-Liquid, Liquid-Gas, Solid-Liquid-Gas Mass transfer. Principles, mass transfer considerations, design equations and equipments for leaching, extraction, absorption, adsorption, crystallization and evaporation

UNIT–IV	10 Hrs.

Mass transfer Operations- Distillation:

Methods of distillation –Simple, Flash distillation of binary mixtures – relative volatility, fractionation of binary mixtures -McCabe Thiele method, Extractive and Azeotropic distillation, numerical. Drying: Drying rate, drying curve and calculations, drying equipment.

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations in Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA
2. Treybal RE (2012) Mass Transfer Operations, 3rd Edition, McGraw-Hill Publications, USA.
3. R.P.Chhabra V. Shankar (2018) Coulson and Richardson's Chemical Engineering Volume Heat and Mass Transfer: Fundamentals and Applications, 7th Edition, Butterworth- Heinemann
4. Pauline Doran (2012) Bioprocess Engineering Principles, 2nd Edition, Academic Press
5. Alan S Foust, Wenzel LA, Clump CW, Maus L and Anderson LB (2008). Principles of Unit Operations, 2nd Edn. John Wiley & Sons, USA.
6. Kern (2001). Process Heat Transfer, 2nd Edn. McGraw-Hill Publications, USA.
7. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw- Hill Publications.

Course Outcomes**

After completion of the course student will be able to

1. Define the different modes of heat transfer and solve the problems
2. Determine heat flux and temperature distribution in steady state one- dimensional problems using thermal resistance concept.
3. Estimate the heat transfer rate for different types of heat exchangers.
4. Predict mass transfer rates and mass transfer coefficients.
5. Estimate the number of theoretical plates required for effective separation of liquid mixtures.
6. Determine various parameters of mass transfer operations.

***Books to be listed as per the format with decreasing level of coverage of syllabus**

****** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	2	1	-	-	-	-	-	-	1	2	-	-
CO2	3	2	3	3	2	-	-	-	-	-	-	2	2	-	-
CO3	2	3	2	2	1	-	-	-	-	-	-	1	2	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	1	2	-	-
CO5	2	3	3	2	1	-	-	-	-	-	-	1	2	-	-
CO6	2	2	2	1	1	-	-	-	-	-	-	1	2	-	-

UBT415C	BIOSTATISTICS & BIO-MODELING	Credits: 03
L: T: P - 2:2:0		CIE Marks: 50
Total Hours/Week: 04		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction and Descriptive Statistics:

Scope of biostatistics, presentation of data, Diagrammatic and graphical represent,(simple, multiple, component bar diagrams, pie chart, histogram, frequency polygon, frequency curve, ogive curve). Measure of central tendency (meaning of central tendency, arithmetic mean, median, Quartiles, mode, geometric mean, harmonic mean their merits and demerits). Measure of dispersion: meaning, range, quartile deviation, mean deviation and standard deviation, coefficient of variation, skewness and kurtosis. Correlation and linear regression analysis, curve fitting straight line).

UNIT–II	10Hrs.

Probability and Probability Distributions:

Definition of probability, Event, Mutual Exclusive, Independent, Complimentary Events Addition and Multiplication theorem of probability and examples. Discrete probability distributions: Bernoulli's, Binomial and Poisson distribution. Continuous probability distribution – normal, Standard normal variate, properties of normal curve, T, F and $\chi 2$ (Chi square -goodness of fit test) distributions and their applications in Biology.

UNIT–III	10 Hrs.

Statistical Inference , ANOVA and Design of Experiments:

Estimation theory and testing of hypothesis point estimation, interval estimation. Sample, population, sample size determination. Methods of Sampling techniques- random (simple, stratified and systematic) non random sampling -(Judgement and convenience). Definition of analysis of variance(one way and two way classifications), Basic principles of experimental design and limitations-randomization, replication, local control, Types of statistical designs of biological experiments and limitations-CRD, RCBD, LSD, Plackett-Burmann design, Response surface methodology(RSM).

UNIT–IV	10 Hrs.

Bio-modeling:

Microbial Growth in a Chemo-stat, Growth Equations of Microbial Populations, product formation models, Models of Commensalisms, Batch culture model, Mutualism, Predation and Mutation. Simple Prey predator model, Volterra's Model for n Interacting Species. Basic Models for Inheritance, Applications of probability in genetics, Hardy - Weinberg law. Selection and Mutation Models, Genetic Inbreeding Models. Dose response studies.

Reference Books *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.
3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

Course Outcomes**

After completion of the course student will be able to

1. Demonstrate and understand the basic concepts of biostatistics, analysis of measure of central tendency and dispersion.
2. Ability to know the basic principles of probability and distributions in Biology and Genetics
3. Analyse and interpret data regarding various distributions (T-test, F-test, and chi square)
4. Basic principles and designs of experimentation and ANOVA
5. Perform experimental design (RSM, Plakett Burman, LSD, CRD, RCBD)
6. Ability to study the microbial growth in chemostat, product formation and biomodelling in various parameters

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	3	3	-	-	-	-	-	2	2	2	1	1
CO2	3	3	3	3	3	2	-	-	-	-	1	3	2	1	2
CO3	2	3	1	3	3	-	-	-	-	-	1	2	2	1	1
CO4	2	3	1	3	3	-	-	-	-	-	1	-	-	-	-
CO5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

UBT419C	THERMODYNAMICS	Credits: 03
L: T: P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

System, surrounding & processes, closed and open systems, intensive & extensive properties, state and path functions, equilibrium state, reversible and irreversible processes. First Law of Thermodynamics: General statement of first law of thermodynamics, first law for cyclic process, Non-flow process, flow process.

UNIT–II	10Hrs.

Second law of thermodynamics & P-V-T behaviour

General statement of the second law, concept of entropy, the Carnot principle, calculation of entropy changes, Clausius inequality, entropy and irreversibility, third law of thermodynamics. P-V-T behaviour of pure fluids, equations of state and ideal gas law, processes involving ideal gas law: constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equations of real gases, principles of corresponding states, compressibility charts.

UNIT–III	10 Hrs.

Thermodynamic Properties of Pure Fluids

Derived properties, work function, Gibbs free energy, relationships among thermodynamic properties. Fundamental property relations, Maxwell's relations, Clapeyron equation, entropy-heat capacity relation, Effect of temperature on U, H & Entropy (S), relationships between Cp & Cv, Gibbs Helmholtz equation. Fugacity, fugacity coefficient, Determination of fugacity of pure gases, fugacity's of solids and liquids. Activity and activity coefficient, Thermodynamic diagrams. Properties of solutions.

UNIT–IV	10 Hrs.

Thermodynamic Properties of Pure Fluids

Partial molar properties, Chemical potential, Gibbs-Duhem equation & its applications, Henry's law & Raoult's law. Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour- Liquid Equilibria: VLE in ideal solutions, Consistency test for VLE data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams.

Reference Books *

1. Smith JM and Van Ness HC (2004) Introduction to Chemical Engineering thermodynamics, 6th Edition, McGraw Hill Publications, USA.
2. Stanley I. Sandler (2006) Chemical and Engineering Thermodynamics, 4th Edn., John Wiley & Sons, USA.
3. Narayanan KV (2001) A Textbook of Chemical Engineering Thermodynamics, Prentice Hall Publication, India.
4. Bailey JE and Ollis DF (2010) Biochemical Engg. Fundamentals, 2nd Edition, McGraw Hill, New York, USA.
5. Rao YVC (1997) Chemical Engineering Thermodynamics, New Age International, India.
6. Segel IH (1993) Biochemical Calculations, 2nd Edn., John Wiley & Sons, USA.
7. Shuler ML and Kargi F (2001) Bioprocess Engineering, 2nd Edn., Prentice Hall International, USA. 5. Eruster L (2013) Bioenergetics, Academic Press, New York.

Course Outcomes**

After completion of the course student will be able to

1. Explain the fundamental concepts of the laws of thermodynamics and apply the first law of thermodynamics to solve engineering problems.

2. Understand the second law of Thermodynamics and apply in engineering problems and solve the problems related to properties of fluids.
3. Estimate the thermodynamic properties, such as enthalpies, entropies, Gibbs energies, fugacity coefficients, and activity coefficients of pure fluids as well as fluid mixtures.
4. Analyze and find properties such as Pressure, Volume and Temperature for equations of states. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
5. Predict equilibrium compositions of mixtures under phase.
6. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	-	-	-	-	-	-	-	1	2	-	-
CO2	2	2	3	3	-	-	-	-	-	-	-	1	2	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	1	2	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO5	2	2	3	2	-	-	-	-	-	-	-	1	2	-	-
CO6	3	3	2	3	-	-	-	-	-	-	-	1	2	-	-

UBT408L	MOLECULAR BIOLOGY LAB	Credits: 1.5
L: T: P – 0:0:3		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

LIST OF EXPERIMENTS IN MOLECULAR BIOLOGY LABORATORY

1. Study of standard practices in Molecular Biology Lab
2. Standard Operating Procedure for Centrifuge.
3. Standard Operating Procedure for Gel Documentation Unit.
4. Study of absorption spectra of nucleic acids.
5. Agarose gel electrophoresis.
6. Isolation of genomic DNA (plant / animal / microbial sources).
7. Isolation of plasmid DNA from E. coli.
8. Estimation of DNA by diphenyl method.
9. Estimation of RNA by orcinol method.
10. Purity of nucleic acids, protein by UV-Vis Spectrophotometer.
11. PAGE (DEMO).

Reference Books *

1. Sadashiva and Manickam, (2017), Biochemical Methods, (2nd Edition), W.H. Freeman
2. Sambrook& Russell, (2002), Molecular Cloning, (3rd Edition), Cold Spring Harbor Lab.

Course Outcomes**

After completion of the course student will be able to

1. Analyze the concentration and purity of DNA.
2. Conduct and analyze Agarose gel electrophoresis.
3. Perform absorption spectra and understand SOP for various lab equipments.
4. Conduct observations and experiments including Genomic DNA/plasmid DNA /RNA/protein.
5. Demonstrate the knowledge of quantification and purity analysis of biomolecules.
6. Gain knowledge in demonstration of PAGE.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	3	1	-	-	-	-	-	1	2	1	-
CO2	1	2	2	1	3	2	-	-	-	-	-	1	2	2	-
CO3	1	2	2	1	3	1	-	-	-	-	-	1	1	1	-
CO4	2	2	3	2	3	2	-	-	-	-	-	1	2	2	-
CO5	1	2	3	1	3	1	-	-	-	-	-	1	3	3	-
CO6	1	1	3	2	3	1	-	-	-	-	-	1	3	3	-

UBT410L	IMMUNOTECHNOLOGY LABORATORY	Credit: 01
L: T: P - 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN IMMUNOTECHNOLOGY LABORATORY

1. Agglutination Technique: Blood group identification and Rh factor
2. Laboratory diagnosis of diseases-Widal test (Tube agglutination) and VDRL
3. Ouchterlony Double Diffusion (ODD)
4. Radial Immunodiffusion (RID)
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Rocket immunoelectrophoresis (RIEP)
7. Western blot (IGg Purification)
8. ELISA/ DOT Blot.
9. Quantitative precipitin assay (QPA).

Reference Books *

1. Roitts, (2017), Essential Immunology (13th edition), Wiley Blackwell
2. Kuby, J.(2019), Immunology (8th edition), W H Freeman publishers
3. Chakravarthy, A.K.(2006),Immunology & Immunotechnology, Oxford University Press
4. Rastogi, S. C. (2005), Immunodiagnostics (1st Edition), New Age International

Course Outcomes**

After completion of the course student will be able to

1. Understand Immune system.
2. Analyze the humoral and cell mediated immune system..
3. Explain the immunological disorders.
4. Evaluate the Transplantation immunology.
5. Understand the designing of Vaccines.
6. Understand Ag Ab reaction and applications of Electrophoresis in Immunology.

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	-	-	-	-	2	-	-	-	3	-	1	3
CO 2	2	2	1	3	2	-	3	-	-	-	-	3	3	1	3
CO 3	3	1	1	-	2	2	3	1	-	-	-	3	1	1	2
CO 4	2	2	2	2	2	2	-	-	-	-	-	2	-	2	1
CO 5	3	1	2	-	2	-	1	1	-	-	-	2	1	-	2
CO 6	2	2	2	-	-	1	-	-	-	-	-	2	2	3	2

UBT412L	BIOSTATISTICS LAB	Credits: 1.5
L: T: P - 0:0:3		CIEMarks:50
Total Hours/Week: 03		SEEMarks:50

LIST OF EXPERIMENTSIN BIOSTATISTICS LABORATORY

1. Procedure for creating Data file, Diagram and Graphs.
2. Procedure and calculation of Mean, Median, Mode, Standard Deviation and Variance.
3. Calculation of Regression and correlation
4. Procedure and calculation of t, Z and F test.
5. Calculation of Chi-square test.
6. ANOVA- one-way analysis
7. ANOVA- two-way analysis.
8. Experimental Research Design – CRD- Analysis.
9. Experimental Research design – RBD- Analysis.
10. Experimental Research design – Latin square Design- Analysis.
11. Placket-Burman Design for media optimization.
12. Response Surface Methodology for media optimization.

Reference Books *

1. Khan and Khanum, (2008),Fundamentals of Biostatistics(3rd edition), Ukaaz Publication
2. Kapur J.N.(2001),Mathematical Models in Biology and Medicine(1st edition), New age international Pvt. Ltd.
3. Agarwal B.L. (2009), Basic statistics(5th edition), New age international Publishers
4. Rastogi V. B.(2006), Fundamentals of Biostatistics, Ane Books

Course Outcomes**

After completion of the course student will be able to

1. Draw graphs, charts, enter the data using statistical software tools
2. Calculate measures of dispersion and central tendency
3. Analyse the t, z and f test
4. Solve and analyze ANOVA
5. Know the different types of experimental designs with case studies
6. Aware of media optimization techniques using statistical designs

***Books to be listed as per the format with decreasing level of coverage of syllabus**

****** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	1	3	-	-	-	-	-	-	1	2	2	1	1
CO 2	3	3	2	3	3	-	-	-	-	-	2	2	2	1	-
CO 3	2	3	3	2	2	2	-	-	-	-	-	3	2	1	-
CO 4	3	3	1	3	3	2	-	-	-	-	-	3	2	1	2
CO 5	2	3	1	3	3	-	-	-	-	-	1	2	2	1	1
CO 6	1	3	1	3	2	-	-	-	-	-	-	2	2	1	1

VI SEMESTER

Sl. No.	Subject Code	Subject Title	Hours/Week				Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT615C	Enzyme kinetics and Biotransformation	3	3	0	0	50	50	100
2	UBT616C	Upstream Processing Technology	3	2	2	0	50	50	100
3	UBT617C	Bioprocess Equipment Design	3	2	2	0	50	50	100
4	UHS003N	Career Planning and Professional Skills	1	1	0	0	50	50	100
5	UBT62XE	Elective-2	3	3	0	0	50	50	100
6	UBT62XE	Elective-3	3	3	0	0	50	50	100
7	UBT632N	Environmental Technology (OE)	3	3	0	0	50	50	100
8	UHS004M	Universal Human Values-II	0	3	0	0	50	50	100
9	UBT615L	Bio-kinetics & Enzyme Technology Lab	1	0	0	2	50	50	100
10	UBT614L	Upstream Processing Lab	1	0	0	2	50	50	100
11	UBT609P	Mini Project	3	0	0	3	50	50	100
Total			**24**	**20**	**04**	**7**	**550**	**550**	**1100**

Elective- 2 & 3

UBT621E Microbial BT
UBT622E Genomics & Proteomic
UBT623E Plant BT
UBT624E Animal BT
UBT625E Biofuels technology
UBT626E Pearl programming
UBT627E Tissue engineering
UBT628E Transport phenomena

UBT615C	ENZYME KINETICS AND BIOTRANSFORMATION	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Enzyme action:

Mechanism of enzyme action. Derivations of Km value (Michaelis-Menton constant), Lineweaver-Burk plot., Enzyme inhibition and kinetics

Multi-Substrate Reactions:

Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry

UNIT–II	10 Hrs.

Enzymatic Techniques:

Strategies of purification of enzymes: choice of source, methods of homogenization, Criteria of purity: tests for purity, tests for catalytic activity, active site titrations, Molecular weight determination and characterization of enzymes.

Immobilization of enzymes:

Techniques of enzyme immobilization; design and configuration of immobilized enzyme reactions,Kinetics of immobilized enzymes, immobilized enzymes in bioconversion processes(uses). The design and construction of novel enzymes

UNIT–III	10 Hrs.

Enzymes of biological importance

Enzyme pattern in diseases like in Myocardial infarctions (SGOT, SGPT, & LDH) Acetylcholinesterase, angiotensin converting enzyme (ACE), 5'- nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD). Use of isozymes as markers in cancer.

UNIT–IV	10 Hrs.

Industrial uses of enzymes:

Enzymes used in detergents, use of proteases, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes).Uses of lactase in dairy industry, glucose oxidase and catalase in food industry. Uses of proteases in food industries.

Reference Books *

1. Trevor Palmer (2008). Enzymes: Biochemistry , Biotechnology, Clinical Chemistry. Horwood Publishing Ltd, East-West Press, 2nd Edition.
2. David L. Nelson and Michael Cox (2017). "Lehninger Principles of Biochemistry" –7th Edition.
3. Nicholas C. Price and Lewis Stevens (2009).Fundamentals of Enzymology, Oxford university Press, 3rd edition.
4. James R Hanson (1997). "An Introduction to Biotransformation in Organic Chemistry" Oxford university Press,
5. Daniel L. Purich, Melvin I. Simon, John N. Abelson (2009). Contemporary Enzyme Kinetics and Mechanism" Academic press, 3rd edition.
6. K. Faber (1999). Biotransformations in Organic: Springer- Verlag.1st Edition,.
7. Bailey and Ollis (2017). "Biochemical Engineering Fundamentals", Mcgraw Hill 2nd Ed.

Course Outcomes**

After completion of the course student will have the

1. Ability to understand mechanism of enzyme reactions.
2. Ability to understand how to characterize the enzymes.

3. Ability to apply the techniques of immobilization of enzymes and know its uses.
4. Ability to know the importance of enzymes in diagnostics.
5. Ability to know the application of enzymes in wool, leather and detergent industries.
6. Ability to apply knowledge of using enzymes in food industries.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-
CO5	2	3	-	1	-	-	-	-	-	-	-	-	3	2	-
CO6	2	3	3	2		3	2			-	-	1	3	-	-

UBT616C	UPSTREAM PROCESSING TECHNOLOGY	Credits: 03
L:T:P - 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Fermentation process

Range of fermentation processes, chronological development of fermentation industry, component of the fermentation process. Basic functions of a fermenter for microbial, plant and animal cell culture. Body parts of fermentor, aseptic operation and containment. Sterilization of fermentors. Types of Fermentors, Classification of Fermentation Systems: Batch, fed batch and continuous process and their applications.

Scale Up: Process engineering concepts, engineering considerations, mechanical considerations, energy considerations. Process GMP considerations of scale up, operations and quality.

UNIT–II	10 Hrs.

Raw materials and media sterilization

Media requirement for typical fermentation process, selection of typical raw materials, types of fermentation media. Preparation and handling of fermentation media, sterilization and its practical limits, Batch sterilization, Continuous sterilization and Filter sterilization.Different methods for optimization (Plackett-Burman Design, RSM)

UNIT–III	12 Hrs.

Microbial system

Isolation of industrially important microorganisms, Strain development methods, Preservation of industrially important microorganisms. Development of inoculumfrom laboratory scale to pilot scale and large scale fermentation (for bacterial, yeast, mycelial processes). Criteria for the transfer of inoculum. Aseptic transfer of inoculum to the fermentor. Trouble shooting during fermentation process (microbial contamination).

Secondary metabolite production: secondary metabolite production in bacteria, yeast and fungi. Production of lactic acid, butanol, antibiotics and enzymes.

UNIT–IV	10 Hrs.

Plant Cell system

Isolation and culture of single cells, Bioprocess using plant cell cultures. Bioreactors for suspension cultures, immobilized cells and organized tissues. Secondary metabolite enhancement techniques (alkaloids, steroids, phenolics).

Animal Cell system :

Scale up of animal cell culture, factors affecting cell culture, Batch reactors, continuous culture, and perfusion systems. Scale up of monolayer culture- roller bottles, nunc cell factory microcarriers culture. Growth monitoring.

Genetically engineered cells for bioprocessing; process, selection of host vectors, process constraints- genetic instability, mass transfer and others.

Large scale production of insulin by mammalian cell culture. Cellbank preparation & cell reviving techniques

Monoclonal antibody production: SUDBRCS (Single use disposable bioreactor configuration, types of production (perfusion culture, submerged culture, suspended adhered culture).

Reference Books *

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth-Heinemann; 3rd Edition,2016.
2. Bioprocess Engineering by Michael L. Shuler, Shuler & Kargi, Fikret Kargi, Pearson Publishers, 2nd Edition, 2012.
3. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995.

4. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3nd Edition, 2018.
5. Introduction to Plant tissue Culture, M.K. Razdan, Oxford & IBH Publishers,3rd Edition,2019
6. Culture of animal cells by Ian Freshney , John Willey & Sons Publ. 7th Edition.2016

Course Outcomes**

After completion of the course student will be able to

1. Understand the fermenter and fermentation processes
2. Prepare and sterilize the industrial media
3. Design and optimize the media formulation using design of experiments
4. Develop the inoculum and improve the strain for industrially important microorganism
5. Distinguish the bioreactors for various cell systems
6. Develop plant & animal system for fermentation process and to use the Genetically modified cell into the fermentation process

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-		2	-	1	-	-	-	-	1	3	2	-
CO2	3	3	-	3	-	-	2	-	-	-	-	1	2	-	-
CO3	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-
CO5	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO6	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-

UBT617C	BIOPROCESS EQUIPMENT DESIGN	Credits: 03
L:T:P –2:2:0		CIEMarks:50
Total Hours/Week: 04		SEEMarks:50

UNIT-I	10 Hrs.

Process design of double pipe heat exchanger:

Introduction to heat exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside & overall), area, length, number of hair pins, diameter of tube. Pressure drop calculations. Detailed drawing of sectional front view of Heat exchanger.

UNIT–II	10 Hrs.

Process design of shell & tube heat exchanger:

Introduction to Heat Exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside and overall), area, length, number of tubes, tube sheet diameter, pitch type, diameter of tube sheet. Mechanical design – baffle, thickness of shell, thickness of tube sheet, thickness of head, pressure drop calculations – tube side and shell side. Detailed drawing of sectional front view of Heat exchanger (1-1, 1-2) with tube sheet layout.

UNIT–III	10 Hrs.

Process design of fermenter:

Functional design-Based on the type of bioreactor (batch reactor & MFR) and cell growth kinetics and performance equation, determines the volume of the reactor, according to H/D ratio determine height and diameter. Mechanical design- Thickness of the shell (cylindrical, spherical), thickness of top & bottom cover, flange calculations – width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter.

UNIT–IV	10 Hrs.

Process design of plate column distillation column:

Functional design- material balance, energy balance, height of the packed column using McCabe Thiele's method, Mass transfer coefficients, Diameter of columns (Top and bottom), top and bottom free space. Detailed drawing for the above design (showing clearly inlets, outlets liquid distributors, packing support)

Reference Books *

1. Joshi, M.V., Process Equipment Design, Macmillan India, 1991.
2. Brownell, L.E. and Young, E.H., Process Equipment Design - Vessel Design, John Wiley and Sons, Inc.1959.
3. Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2, 3rd Ed., Gulf Publishing Co. 1997.
4. Indian Standards Institution, Code for Unfired Pressure Vessels, IS – 2825.
5. Bhattacharya, B.C, Introduction to Chemical Equipment Design, CBS Publications, 1985.
6. Perry's Chemical Engineers Handbook. 7th Edition McGraw Hill Publications

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of heat exchangers in industries and can describe the types of industrial heat exchangers
2. Solve problems related to heat exchangers referring the data book

3. Apply the knowledge of design concepts of double pipe heat exchanger and their parts in Engineering applications
4. Apply the knowledge of design concepts of shell & tube heat exchanger and their parts in Engineering applications
5. Apply the knowledge of different types of bioreactors and their design concepts in Industrial applications
6. Apply the knowledge of design concepts of distillation column and their parts in Industrial applications

***Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3	2	2	-	-	-	-	-	-	2	2	-	-
CO2	2	3	2	3	1	-	-	-	-	-	-	2	2	-	-
CO3	2	3	3	2	2	-	-	-	-	-	-	2	2	-	-
CO4	2	3	3	3	1	-	-	-	-	-	-	2	2	-	-
CO5	2	2	3	2		-	-	-	-	-	-	2	2	-	-
CO6	2	3	2	2	1	-	-	-	-	-	-	2	2	-	-

UBT621E	MICROBIAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Microbial biotechnology

a) In Bacteria: Genetic Transfer in bacteria, Transformation, Conjugation, Translation, cloning techniques, polymerase chain reaction, expression of cloned Genes, Recovery and purification of expressed proteins.

b) In Yeast: Introduction of DNA into yeast cells, yeast cloning vectors, expression of foreign genes in yeast, expression of foreign gene products in secreted form.

UNIT–II	10 Hrs.

Industrial microbiology

Vitamins as laxatives and analgesics; non steroidal contraceptives, external antiseptics, antacids and others. Antibiotics and hormones. Impact of Biotechnology on vaccine development; sub unit vaccines, fragments of antigen sub unit as synthetic peptide vaccines. Production of Microbial enzymes, strain -medium, fermentation processes. Large scale application of Microbial enzymes - starch processing, textile designing, detergents, cheese industry.

UNIT 3	10 Hrs.

Microbial by products

Bacillus thuringinesis, Sphaericus, Popilliae, Baculoviruses. Bacterial Polysaccharides - structure & role in nature xanthan Gum - structure, production & Biosynthesis polyesters. Saccherification & fermentation. Metabolites from microorganisms, Amino acids, antibiotics. Organic synthesis & Degradation, classification of enzymes, microbial transformation of steroids & sterols.

Environmental microbiology

Sewage & Waster water microbiology, Microbiological Degradation of xenobiotics microorganisms in mineral recovery microorganisms in the removal of heavy metals from aqueous effluents.

Food microbiology

Microbial spoilage of food and its control; food preservatives; fermented foods; single cell protein (SCP) and single cell oil (SCO); food borne infections and their control.

UNIT–IV	10 Hrs.

Bioremediation and bioleaching

Uses of Bacteria in Bioremediation – Biodegradation of hydrocarbons, Granular sludge consortia for bioremediation, crude oil degradation by bacteria, Immobilization of microbes for bioremediation, Methanotrophs, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Studies of Pyrite Dissolution in Pachuca Tanks and Depression of Pyrite Flotation by Bacteria, Factors Effecting Microbial Coal Solubilization, Sulfur Leaching by Thermophilic Microbes of Coal Particles Varying in size, Microbiological Production of Ferric Ion for Heap and Dump Leaching, New Bacteriophage which infects Acidophilic, Heterotrophic Bacteria from Acidic Mining Environments, Treatment of Coal Mine Drainage with Constructed Wetlands

Reference Books *

1. Fundamentals of Biotechnology. Edited by Paule Prave, Uwe Faust, Wolfgang Sitting and Dieter A Sukatsch. VCH Publishers.
2. Principles of fermentation Technology, P.F. Stanbury and A. Whitaker, Pergamon Press, 1984.
3. Alexander N Glazer, Hiroshi Nikaido by Microbial Biotechnology, W H Freeman & Company New York,2005
4. Bernard Davis & Renato Dulbecco Microbiology by, Lippincott Company, Philadelphia. 2000
5. Prit S J Principle of Microbe & Cell Cultivation, Blackwell Scientific co).1975

Course Outcomes**

After completion of the course student will be able to

1. Able to study about Genetic Transfer in bacteria cloning techniques.
2. Able to study industrial microbiology.
3. Able to study production & Biosynthesis microbial by products.
4. Able to know Uses of Bacteria in Bioremediation
5. Able to analyse microbial products.
6. Able to understand phytoremediation.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2	2	-	-	2	2	2	-	-	-	-	1	1	1
CO 2	2	2	2	-	-	3	2	1	-	-	-	-	2	1	-
CO 3	3	3	2	-	2	2	2	1	-	-	-	1	1	1	-
CO 4	3	3	3	-	2	3	3	2	-	-	-	1	2	1	3
CO 5	2	2	2	-	2	2	3	1	-	-	-	1	2	1	2
CO 6	2	2	2	3	2	2	1	1	-	-	-	1	1	1	2

UBT623E	PLANT BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Plant genetic engineering

Induction of tumours by Agrobacterium, introduction of binary vectors into Agrobacterium by triparental mating, leaf disc transformation using Agrobacterium, GUS expression in transformed tissues, extraction of DNA from transformed plants, Southern hybridization to check plant

22 transformation, PCR amplification of T-DNA in transformed plant tissues. Agrobacterium mediated gene transfer and cloning. Types of plant vectors and their use in gene manipulation. Viruses as a tool to delivery foreign DNA.

Transformation technology

Plant transformation technology -Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of T-DNA transfer, role of virulence genes, use of Ti and Ri-plasmids as vectors, binary vectors. Vectorless or direct DNA transfer-particle bombardment, electroporation, microinjection, transformation of monoctos. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and mainteance of transgenic plants.

UNIT–II	10 Hrs.

Applications

Application of plant transformation for productivity and performance – Herbicide resistance - phosphoinothricin, glyphosate, atrazine, insect resistance -bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation of its impact in on insect control. Non-bt like protease inhibitors, alpha amylase inhibitor, virus resistance -coat protein mediated, nucleocapsid gene, disease resistance - chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, RS proteins, abiotic stress – drought and salinity, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems.

UNIT 3	10 Hrs.

Secondary metabolites & gene markers

Metabolic engineering and industrial products -Plant secondary metabolites. Industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Molecular marker-aided breeding - RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map-based cloning, molecular marker assisted selection.

UNIT–IV	10 Hrs.

Nitrogen fixation

Nitrogen fixation and biofertilizers -Diazotrophic microorganisms, nitrogen fixation genes. Two component regulatory mechanisms. Transfer of nif genes to non-diazotrophic microorganisms, nod genes structure function and role in nodulation, Hydrogenase -Hydrogen metabolism. Genetic engineering of hydrogenase genes.

Algae

Blue-green algae and Azolla -Identification of elite species and mass production for practical application. Mycorrhizae -importance in agriculture and forestry. Algae as a source of food, feed, single cell protein, biofertilizers; industrial uses of algae. Mass cultivation of commercially valuable marine macroalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation of microalgae as a source of protein and feed. 6 Hour

Reference Books *

1. Dixon R.A. & Gonzales Plant Cell Culture: A Practical Approach by, IRL Press.,2008
2. Plant biotechnology in Agriculture by K. Lindsey and M.G.K. Jones (1990), Prentice hall, New Jersey,2000
3. Plant Biotechnology 1994, Prakash and Perk, Oxford & IBH Publishers Co J Hammond, P
4. McGarvey and V Yusibov (Eds): Plant Biotechnology. Springer Verlag, 2000
5. Chawla HS: Biotechnology in Crop Improvement. Intl Book Distributing Company, 1998
6. Biodegradation and Detoxification of Environmental Pollutants – Chakrabarthy AM RJ Henry:
7. Practical Application of Plant Molecular Biology. Chapman and Hall 1997
8. Plant Tissue Culture: Applications and Limitations by S.S. Bhojwani (1990), Elsevier, Amsterdam. TJ Fu, G Singh and WR Curtis (Eds):
9. Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic Press, 1999 PK Gupta:

Course Outcomes**

After completion of the course student will be able to

1. Study plant genetic engineering and transformation technology.
2. Study Application of plant transformation for productivity and performance
3. Study Metabolic engineering and industrial products.
4. Study nitrogen fixation and Identification of elite species and mass production for practical application of algae.
5. Analyse the growth and cultivation of Blue green Algae.
6. Identify various methods of plant transgenics

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	2	-	-	-	-	-	-	-	3	1	-
CO 3	3	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 4	3	2	3	-	2	-	-	-	-	-	-	1	3	1	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 6	2	2	2	3	2	-	-	-	-	-	-	1	1	1	-

UBT627E	TISSUE ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to tissue engineering, Cell and Tissue Biology

Basic definition of tissue engineering;current scope of development; use in therapeutics**.** Introduction to cell – biology and biochemistry. Tissuedevelopment and organization. Stem cells (embryonic), Stem cells (adult). Introduction to cell adhesion,Adhesion Receptors in Tissue Structures, Cell Adhesion to Biomaterials, Measurement of Cell Adhesion,Effect of Biomaterial on Physiological Behavior. Introduction to cell migration, Characteristics ofMammalian Cell Migration, Measurement of cell characteristics morphology, number viability, cell-fateprocesses, cell motility, cell function.

UNIT–II	10 Hrs.

Extracellular Matrix

Introduction, ECM and Functional Integration of Implanted Materials, Basement Membranes and Focal Adhesions, Focal Adhesions as Signaling Complexes, ECM and Skeletal Tissues,Sources of ECM for Tissue Engineering Applications, Properties of ECM , Mining the ECM for Functional Motifs, Summary of Functions of ECM Molecules, Polymeric Materials and their Surface Modification,Formation of Gradient Structures.

UNIT 3	10 Hrs.

Biomaterials & Drug Delivery Systems

Introduction to synthetic polymers, Biodegradable materials vspermanent materials, Natural biopolymers and hydrogels, Mechanical properties of biomaterials, Surface modification and characterization of polymers, Immune response to biomaterials, In vitro assessment/biocompatibility/protein adsorption. Polymeric scaffolds for tissue engineering applications.Drug delivery, Mechanisms of Drug Delivery, Protein-Drug Properties, Drug Delivery in Tissue Engineering.

UNIT–IV	10 Hrs.

Tissue Engineering Bioreactors - Design and Fabrication

Introduction, Most common Bioreactors inTissue Engineering, Cell Seeding in Bioreactors, Bioreactor Applications in Functional Tissues, DesignConsiderations, Challenges in Bioreactor\ Technologies.

Clinical & Regulatory Aspects of Engineered Tissues

Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal, Tissue Engineering, Cardiovascular TissueEngineering, Musculoskeletal Tissue Engineering, (tendon/ligament/muscle).

Reference Books *

1. Channarayappa, Cell Biology, Universities Press, kindle Edition,2010.
2. Robert Lanza Robert Langer Joseph Vacanti Anthony Atala Principles of Tissue Engineering Academic Press 5th Edition 2020.
3. Patrick CW, Mikos AG, McIntire LV, Frontiers in Tissue Engineering, Pergamon Press, 1st Edition, 1998.
4. Bernhard O Palsson, Sangeeta N Bhatia, Tissue Engineering, Pearson Prentice Hall.1st Edition 2003.

Course Outcomes**

After completion of the course student will be able to

1. Identify and differentiate between various stages of tissue development & stem cells.
2. Differentiate between various stages of tissue development & stem cells.
3. Analyze the mechanism and organization of ECM and its functions.
4. Apply the knowledge of drug delivery mechanism in therapeutics.
5. To strengthen the concept of protein drug interactions.
6. Integrate the knowledge of clinical and regulatory aspects on different engineered tissues in medical human tissue products and pharmaceutical sector

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	2	-	-	-	-	-	-	-	3	1	-
CO 3	3	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 4	3	2	3	-	2	-	-	-	-	-	-	1	3	1	1
CO 5	2	2	2	-	2	-	-	-	-	-	-	1	3	1	-
CO 6	2	2	2	3	2	-	-	-	-	-	-	1	1	1	-

UBT624E	ANIMAL BT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Cell lines

Primary culture – Mechanical and enzymatic mode of desegregation, establishment of primary culture. Subculture -passage number, split ratio, seeding efficiency, criteria for subculture. Cell lines -definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines. Contamination -bacterial, viral, fungal and mycoplasma contaminations, detection and control, cell transformation – normal vs. transformed cells, growth

Cell culture

Scale-up of animal cell culture – Factors to be considered. Scale-up of suspension cultures Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, microcarrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

UNIT–II	10 Hrs.

Invitro fertilization & cloning

Conventional methods of animal improvement, predominantly selective breeding and crossbreeding. Embryo biotechniques for augumentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation Oestrus synchronization. Embryo collection, evaluation and transfer. Invitro maturation of oocytes. Invitro fertilisation and embryo culture. Embryo preservation. Micro manipulation and cloning. Artificial insemination, preparation of foster mother, surgical and non-surgical methods of embryo transfer, donor and recipient aftercare. Cloning -concept of nuclear transfer, nuclear reprogramming and creation of Dolly. Stem cells -embryonic and adult stem cells, plasticity and concept of regenerative medicine.

UNIT 3	10 Hrs.

Human genome

Human genome complexicity of the genome, outlines of human genome project, human disease genes. Molecular biological techniques for rapid diagnosis of genetic diseases. Chemical carcinogenesis, transfection, oncogenes and antioncogenes. Cryo preservation and transport of animal germ plasm (i.e. semen, ovum and embryos). Genetherapy -ex vivo and in vivo gene therapy methods, applications.

Transgenics

Transgenic animals -retroviral, microinjection, and engineered embryonic stem cell method of transgenesis. Application of transgenic animals -biopharming, disease models, functional knockouts.

UNIT–IV	10 Hrs.

Other applications

Application of animal cell culture -Vaccine production, specialized cell types. Concepts of tissue engineering -skin, liver, kidney, bladder and heart. Principles and species suitable for aquaculture (Indian major carps and prawns). Genetic status of culture stocks. Chromosome manipulations -Production of all male and sterile populations, Hypophysation in fishes and prawns. Pearl culture -pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls. Probiotics and their significance in aquaculture. Molecular tools for the identification of diseases in aquatic species.

Reference Books *

1. Ian Fredhney. Culture of Animal Cells, (3rd Edn) R Wiley-Liss Animal Cell Biotechnology, - Spier, RE and Griffith, JB Academic Press, London 1990
2. Animal Biotechnology by Murray Moo-Young (1989), Pergamon Press, 2000
3. Oxford Animal Cell Technology, Principles and practices, 1987, Butter, M Oxford press
4. Molecular Biotechnology by Primrose.
5. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press Fish and Fisheries India VG Jhingram
6. Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop (1990), cambridge University Press, cambridge.
7. Animal Cell Culture – Practical Approach, Ed. John RW. Masters, Oxford Animal
8. Cell Culture Techniques Ed Martin Clynes, Springer Cell Culture Lab Fax. Eds. M
9. Butler & MDawson, Bios Scientific Publications Ltd. Oxford

Course Outcomes**

After completion of the course student will be able to

1. Study cell lines and cell culture
2. Study Invitro fertilization & cloning.
3. Study human genome and Transgenic animals
4. Know Application of animal cell culture
5. Understand transgenic science
6. Understand and analyse cell culture applications.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	-	-	-	-	-	-	2	-	3	1	2
CO 3	3	2	2	-	-	-	-	-	-	-	2	1	3	1	-
CO 4	3	2	3	-	-	-	-	-	-	-	2	1	3	1	2
CO 5	2	2	2	-	-	-	-	-	-	-	-	1	3	1	1
CO 6	2	2	2	3	-	-	-	-	-	-	-	1	1	1	1

UBT626E	PERL PROGRAMMING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

An overview of Perl: Getting started, interpreted vs compiled source code, documentation in perl, statement blocks, ASCII and Unicode, Escape sequences, whitespaces, numerical data type, strings in perl, alternative delimiters, conversion between numbers and strings, Arithmetical operators, bitwise operators, Boolean operators, string operators, string comparison, operator precedence, variables, modifying a variable, autoincrement and autodecrement operators, multiple assignments, scoping, special variables, regular expression variables, input/ output variables, filehandle / format variables, error variables and system variables variable interpolation .

Lists, Arrays and Hashes

Introduction to lists, simple lists, complex lists, accessing list values, list slices, ranges, combining ranges and slices, arrays, assigning arrays, scalar vs list context, adding elements to an array, accessing single and multiple elements from an array, running through arrays, array functions (pop, push, shift, unshift, and sort, Introduction to Hashes, creating a hash, working with hash values, adding, changing and taking values from a hash, accessing multiple values.

UNIT–II	10 Hrs.

Loops and Decisions

Introduction, Changing Array Size, Interacting Over an Array by Reference, Extracting Unique Elements from a List, Computing Union, Intersection, or Difference of Unique Lists, Appending One Array to Another, Reversing an Array, Processing Multiple Elements of an Array, Finding All Elements in an Array Matching Certain Criteria, Sorting an Array Numerically

Regular Expression

Introduction to regular expressions, patterns, interpolation, escaping special characters, anchors, character classes, word boundaries, posix and Unicode classes, detecting repeating words, well defined repetition, back reference variables, match operator, substitution operator and transliteration operator, binding operators, meta characters, changing delimiters, modifiers, usage of split and join keywords, inline comments and modifiers, grouping and alternation, grouping with back references.

UNIT 3	10 Hrs.

Files and References

Introduction to Filehandles, STDIN, STDOUT, STDERR file handles, reading lines, creating filters, line separator, reading paragraphs, reading entire files, writing to files, writing on a file handle, accessing filehandle, writing binary data, selecting a filehandle, buffering, file permissions, opening pipes, piping in, piping out, file tests, reading directories and globbing, introduction to references, lifecycle of a reference, anonymous reference, dereferencing, reference modification, array and hash referencing, reference counting and destruction.

Subroutines and Modules

Introduction to subroutines, difference between subroutines and modules, defining subroutines, order of declaration, subroutines for calculations, return values, caching, context, subroutine prototypes, scope, global variables, lexical variables, runtime scope, aliases, passing references, arrays, hashes and filehandles to a subroutine, modules, usage of keywords do, require and use, changing @INC, package hierarchies, exporters, standard modules in perl.

UNIT–IV	10 Hrs.

Running and Debugging Perl

Examining syntax errors, runaway strings, brackets around conditions, missing semicolons, braces, commas

and barewords. Diagnostic modules, use warnings, scope of warnings, use strict, strict on variables, references, subroutines, use diagnostics, perl command line switches, usage of–e, -n, -p, -c, -l, -M, -s, -I, @INC, -a, -F and –T switches, Debugging techniques, usage of print, comments, context, scope and precedence in debugging, Defensive programming.

Bioperl

Overview, Bioperl Objects, Brief descriptions (Seq, PrimarySeq, LocatableSeq, RelSegment, LiveSeq, LargeSeq, RichSeq, SeqWithQuality, SeqI), Location objects, Interface objects and implementation objects, Representing large sequences (LargeSeq), Representing changing sequences (LiveSeq), Using Bioperl: Accessing sequence data from local and remote databases, Accessing remote databases (Bio::DB::GenBank, etc), Indexing and accessing local databases Bio::Index::*, bp_index.pl, bp_fetch.pl, Bio::DB::*), Transforming sequence files (SeqIO), Transforming alignment files (AlignIO);

Reference Books *

1. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 1st Edition,2003.
3. D. Curtis Jamison, Perl Programming for Bioinformatics & Biologists, John Wiley & Sons, INC., 2004
4. Michael Moorhouse, Paul Barry, Bioinformatics Biocomputing and Perl, Wiley, 1st Edition 2007.

Course Outcomes**

After completion of the course student will be able to

1. Study the over view of perl
2. Study about loops and decisions.
3. Study of regular expression paterns.
4. Study of files and references.
5. Understand the subroutines and modules.
6. Understand the concept of running and debugging perl.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	1	2	-	-	-	-	-	-	-	-	-	3	1	1
CO 2	2	2	2	3	-	-	-	-	-	-	2	-	3	1	2
CO 3	3	2	2	-	-	-	-	-	-	-	2	1	3	1	-
CO 4	3	2	3	-	-	-	-	-	-	-	2	1	3	1	2
CO 5	2	2	2	-	-	-	-	-	-	-	-	1	3	1	1
CO 6	2	2	2	3	-	-	-	-	-	-	-	1	1	1	1

UBT628E	TRANSPORT PHENOMENA	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Momentum Transfer and Overall Balances

Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes.

Momentum transfer – Principles and Applications: Flow past immersed objects, packed beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion).

UNIT–II	10 Hrs.

Steady State Heat Transfer

Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, natural convection heat transfer, boiling and condensation, heat exchangers.

Unsteady State Heat Transfer: Derivation of basic equation, simplified case for systems with negligible internal resistance.

UNIT 3	10 Hrs.

Mass Transfer:

Mass transfer and diffusion, molecular diffusion in gases, liquids and solids. Mass transfer coefficients. Separation Processes - Evaporation, Drying, Humidification, and Absorption.

UNIT–IV	10 Hrs.

Separation Processes:

Distillation, Adsorption, Ion Exchange, Leaching, Crystallization, Membrane processes.

Reference Books *

1. Transport Processes and Separation Process Principles – C. J. Geankoplis, 4th Edition
2. Momentum, Heat and Mass Transfer – Bennett and Myers
3. Welty, Wicks and Wilson Fundamentals of momentum, heat and mass transfer,2000.
4. Sawhney Gs Fundamentals of Fluid Mechanics IK Publishers ,2008

Course Outcomes**

After completion of the course student will be able to

1. Define the units, dimensions and dimensional analysis
2. Analyze the dimensional analysis methods
3. Define the fluid, property and types of fluid
4. Apply the Hydrostatic and Bernoulli's theorem
5. Apply the applications of Bernoulli's theorem in venture meter, Orifice meter, etc
6. Evaluate the working of size reduction equipments and mixing equipments

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 2	3	3	3	-	-	-	1	-	-	-	-	-	3	1	-
CO 3	2	3	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 4	3	2	2	-	-	-	1	-	-	-	-	-	3	1	-
CO 5	2	3	3	-	-	-	1	-	-	-	-	-	2	1	-
CO 6	3	2	2	-	-	-	1	-	-	-	-	-	2	1	-

UBT622E	GENOMICS AND PROTEOMICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases, c) potential revenue in the area diagnostic and biomedical applications, d) biosimilars market and implications.

Sequencing & genome projects

Early sequencing efforts, Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on *E.coli*, Arabidopsis and rice; Human genome project .

UNIT–II	10 Hrs.

Genomics

Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans.

Genome management in eukaryotes

Cell differentiation and gene regulation. Inheritance pattern in eukaryotes, Mutations, organization of eukaryotic genome within the nucleus, translation and post-translational modification in eukaryotes. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics- definition & concept.

UNIT 3	10 Hrs.

Functional genomics

Hargobhind Khorana discovery the first artificial gene, C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking. Molecular markers – RFLP, RAPD and AFLP, Microsatellites and telomerase as a molecular markers. Methods of molecular mapping, Marker assisted selection, map based cloning, T-DNA tagging, Transposon tagging. Bioinformatics analysis- clustering methods. Approaches to physical mapping, FISH – DNA amplification markers.

UNIT–IV	10 Hrs.

Proteomics

Introduction to proteins, Methods of protein isolation, purification, quantification, Large scale preparation of proteins, use of peptides in biology, Proteomics databases and proteins as drugs.

Proteome analysis

Mass-spec based analysis of protein expression and post-translational modifications. "Protein Chip" - interactions and detection techniques. Methods of measurement of mRNA expression, DNA array hybridization Non-DNA array hybridization, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas.

Reference Books *

1. Introduction to Genomics – Arthur M Lesk, Oxford University Press, 2007.
2. Plant Genome Analysis – Peter M Gresshoff, CRC Press.
3. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science,1994.
4. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics–,Pearson Education, 2007.
5. Albala J S & I Humprey-Smith Protein Arrays, Biochips and Proteomics–CRC Press, 2003.
6. 3.Sabesan, Genomics & Proteomics – , Ane Books, 2007.
7. Pennington S. R. and M J Dunn Proteomics –, 2004.
8. Richard J Simpson Purifying Proteins for Proteomics, IK International, 2004.
9. Richar.d J Simpson Proteins and Proteomics –, IK International, 2003.

Course Outcomes**

After completion of the course student will be able to

1. Ability to describe how genomic DNA contains long stretches non-coding regions.
2. Ability to describe how a single gene can give rise to multiple proteins.
3. Ability to harness the emerging genomic, transcriptomics and proteomics.
4. Ability to understand bioinformatics information to build novel paradigms of biological importance.
5. Ability to understand how modern genomics tools are useful in functional genomics.
6. Ability to understand the importance of proteomics in modern biology.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	-	-	2	2	-	-	-	-	1	-	2	3
CO 2	3	3	1	-	-	2		-	-	-	-	2	1	-	3
CO 3	3	2	2	1	2	-		-	-	-	-	1	1	2	2
CO 4	2	2	2	2	2	2	2	2	-	-	-	1	1	2	2
CO 5	2	1	2	-	1	-	2	-	-	-	-	1	1	2	2
CO 6	3	1	2	2	2	1	-	-	-	-	-	1	1	2	2

UBT625E	BIOFUELS TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Biochemistry of biofuels and energy resources

Basic principle of light energy conversion to chemical energy & carbon fixation. Biochemistry involved in conversion of sugars to alcohols. Renewable and non-renewable resources.

Biofuels

Introduction to Biofuels - definition, advantages and disadvantages. Biofuel life cycle. Biomass as an energy core and its different mode of utilization. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biofuel energy content. World scenario of biofuel production and use.

UNIT–II	10 Hrs.

Biofuel feed stocks

Starch feed stocks-cereal grains, tubers & roots; Sugars feed stocks-sugarcane & sugarbeet; cellulosic feed stocks - forest residues, agricultural residues, Agricultural processing by-products, dedicated energy crops, municipal solid waste and paper waste. Lipid feed stocks :-Oilseed crops with examples, Algae, Waste oil, Animal fats. Next generation feed stocks. Environmental impacts of feed stocks.

Types of biofuels

First generation biofuels-vegetable oil biodisel, bioalcohols, bioethers, biogas syngas, solid biofuels. Second generation and third generation biofuels

UNIT–III	12 Hrs.

Technologies for biofuels

Historical background. Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Innovations in 2G technology. Thermochemical platforms - biodiesel production, Innovations in Biodiesel productions, standardization, properties and emissions of biodiesel. Biomethanation-AD technology and innovations in Biomethanation process. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Microbial fuel cells. Blending of biofuels.

UNIT–IV	10 Hrs.

Biofuels in perspective

Integrated refining concepts with reference to ethanol production. Economic feasibility of producing biodiesel, Issues with biofuel production & use. Impact of biofuel in global climate change & food production. 1st versus 2nd generation biofuels. Strategies for new vehicle technologies. Current research on biofuel production. Market barriers of biofuels.

Reference Books *

1. Environmental Biotechnology by Foster C. F., John ware D.A., Ellis Horwood Limited, 1987.
2. Fuels from Waste by Larry Anderson and David A Tillman. Academic Press, 1977.
3. Biofuels by Ayhan Demirbas publ. Springer
4. Biofuels (Series - Energy For The Future And Global Warming)
5. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.
6. Environmental Biotechnology by Pradipta Kumar Mahopatra, 2007.

Course Outcomes**

1. After completion of the course student will be able to
2. Ability to understand the basic principle involved in bioconversion process in energy and to

differentiate the conventional fuels with biofuels .

3. Able to diagnose the types of feed stocks used for biofuels.
4. Able to produce the biofuels (biodiesel, bioalcohol biogas and biohydrogen) using current technologies and innovations involved
5. Able to understand and recall current issues related with production and use of biofuels, Research opportunities, economic feasibility of the biofuels

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	2		1	-	-	-	-	1	3	2	-
CO 2	3	3	-	3			2	-	-	-	-	1	2	-	-
CO 3	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 4	3	3	-	3			2	-	-	-	-	3	-	1	-
CO 5	3	3	-	3	3		2	-	-	-	-	3	-	2	-
CO 6	3	3	-	3			2	-	-	-	-	3	-	1	-

UBT632N	ENVIRONMENTAL TECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction:
Current Environmental Issues and scope of Environmental science and technology biogeochemical role of soil microorganisms, Bioconcrete, Environment Impact Assessment

Bioaccumulation of toxicants
Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation

Sustainable future: Green building concept, Carbon foot print, crediting, trading and its calculation, Water foot print Rain water harvesting .

UNIT–II	10 Hrs.

Waste water treatment: Waste water characteristics BOD, COD, Primary & Secondary treatment, nanofiltration. ultrafiltration and microfiltration Microbial removal of phosphorous and Nitrogen Wastewater treatment of industries like sugar factories, food industries, beverages industries, and distilleries.

Solid waste management
Basic aspects, general composition of municipal solid wastes, aerobic treatment, anaerobic treatment biogas generation Solid waste management. Hazardous wastes, Biomedical Wastes E waste management, MoEF rules.

UNIT–III	10 Hrs.

Bioleaching & Biomining:
Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of phosphate, petroleum.

Bioremediation:
Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation

UNIT–IV	10Hrs.

Biofuels:
Definition, Renewable and nonrenewable resources Advantages and disadvantages of biofuels Biofuel feed stocks-sugar starch, cellulose, lipid Types of biofuel- first, second and third generation Technologies for bio-fuel production-transesterification, gasification 2G technology, Biomethanation, Issues of biofuel production and its use. Microbial fuel cells.

Biodiversity: Value of biodiversity, threats to biodiversity approaches of biodiversity conservation.

Reference Books *

1. Pradipta Kum Mahopatra, 2006, Text Book of Environmental Biotechnology, I K Publishers.
2. R C Dubey and D K Maheshwari,2013 Text book of Microbiology,
3. M Y Young ,2004 ,Comprehensive Biotechnology Vol 1-4 (Eds). Pergamon Press
4. EJ Dasilva, C Ratledge & A Sasson, 2003, Biotechnology, Economic & Social Aspects Cambridge Univ Press.
5. Indu Shekhar Thakur,2012,Environmental Biotechnology Basic concepts and applications, Second Edition, I K international Publishing House, Pvt, Ltd.

Course Outcomes**

1. Able to analyse the current environmental issues, scope of environmental Technology and understand the various sustainable future concepts.
2. Able to analyse the methods used in treatment of waste water and solid waste.
3. Able to understand the concept of bioleaching process and biomining activity
4. Able to analyse the types and methods used in cleaning of the environment by bioremediation.
5. Able to define the sources of biofuels and produce various biofuels
6. Able to analyse the need of conservation of biodiversity

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	2	1	-	-	-	-	-	-	-	1	1
CO2	2	3	1	-	1	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	-	1	-	-	-	-	-	-	-	2	3	2
CO4	2	2	1	-	-	-	1	-	-	-	-	-	2	3	1
CO5	2	1	-	-	-	-	3	-	-	-	-	2	2	2	2
CO6	2	-	1	-	2	-	1	-	-	-	-	2	2	3	2

UBT615L	BIOKINETICS & ENZYME TECHNOLOGY LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN BIOKINETICS & ENZYME TECHNOLOGY LABORATORY

1. Isolation of alpha-amylase from sweet potato or saliva
2. Maltose calibration curve by DNS method
3. Determination of activity of Salivary alpha-amylase
4. Determination of Specific activity of an enzyme
5. Effect of pH and temperature on enzyme activity
6. Determination of Kinetics constants (Km & Vmax)
7. Urea calibration curve
8. Determine the activity of enzyme Urease
9. Effect of inhibitors on enzyme activity
10. Immobilization of enzyme and determination of immobilized enzyme activity
11. (Prediction of error percentage, standard deviation need to be calculated from expt. no 5 and 6)

Reference Books *

1. Laboratory manual of Biochemistry by Pattabiraman, 4th Edition, International book publishers , India, 2017.
2. Sadasivam and Manickam, "Biochemical Methods", 2nd Edition, New age international Publishers, 2017.

Course Outcomes**

After completion of the course student will be able to

1. Understand the preparation of enzymes.
2. Determine the activity of enzymes.
3. Estimate the effect of external condition on enzyme activity.
4. Evaluate the action of inhibitors on the enzyme activity.
5. Analyze the kinetic of enzymes.
6. Apply knowledge of immobilization of enzymes

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	1	3	1	-	2		-	-	-	-	1	3	2	-
CO2	3	3	2	2	-	3	2	-	-	-	-	-	3	1	-
CO3	3	2	-	2	-	2	-	-	-	-	-	-	3	3	-
CO4	2	3	1	1	-	2	4	-	-	-	-	-	3	1	-
CO5	2	3	-	1	-	-	-	-	-	-	-	-	3	2	-
CO6	2	3	3	2		3	2	-	-	-	-	1	3	-	-

UBT614L	UPSTREAM PROCESSING LAB	Credit: 01
L:T:P – 0:0:2		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS IN UPSTREAM PROCESSING LABORATORY

1. Callus Induction Technique- Stock preparation, Media preparation.
2. Explants preparation and inoculation technique.
3. Development of suspension culture from callus
4. Animal cell culture techniques
5. Artificial seed production (Auxiliary buds)
6. Production of secondary metabolite by shake flask studies; Comparison of yield in various media
7. Fed batch culture – Assessment of yield
8. Development of inocula; lag time effect
9. Study of operational functions of the fermentor
10. Production of Ethanol in fermentor – Study of Growth, product formation
11. Kinetics and end substrate utilization
12. Single Cell Protein (SCP) production by continuous culture.

Reference Books *

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995
2. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3nd Edition, 2018.
3. Culture of Animal cells-3rd Edition-R. Ian Freshney. Wiley 2010.
4. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth- Heinemann; 3rd Edition, 2016.

Course Outcomes**

After completion of the course student will be able to

1. Prepare/reproduce the protocols for the experiments
2. Produce callus using plant tissue culture techniques
3. Prepare the industrial media and inoculum for the fermentation process
4. Operate lab fermenter and prepare the fermentation process to study growth kinetics, substrate utilization and product formation
5. Record/observe the experimental data and interpret them in the graph/table
6. Calculate the result and to write the conclusion at the end of the experiment

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	-		2	-	1	-	-	-	-	1	3	2	-
CO2	3	3	-	3	-	-	2	-	-	-	-	1	2		-
CO3	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-
CO5	3	3	-	3	3	-	2	-	-	-	-	3	-	2	-
CO6	3	3	-	3	-	-	2	-	-	-	-	3	-	1	-

VIII SEMESTER

Sl. No.	Subject Code	Subject Title		Hours/Week			Examination Marks		
			Credits	Lecture	Tutorial	Practical	CIE	SEE	Total
1	UBT805P	Project	15	0	0	15	50	50	100
2	UBT8XXE	Elective-6	3	3	0	0	50	50	100
3	UBT8XXE	Elective-7	3	3	0	0	50	50	100
Total			**21**	**6**	**0**	**15**	**150**	**150**	**300**

Elective-6

UBT823E: Chemical plant utilities & safety
UBT824E: Metabolic engineering
UBT825E: Industrial waste water treatment
UBT827E: Pharmaceutical BT

Elective-7

UBT830E: Clinical research
UBT832E: Health diagnostics
UBT833E: Validation & quality control
UBT834E: Product development

UBT827E	PHARMACEUTICAL BIOTECHNOLOGY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:

Introduction to pharmaceutical biotechnology, Pharmaceutical Industry. Drug design, development and Economics, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescription and Non-prescription drugs. Regulations & guidelines for pharma ,CDSCO, fda, ichq7, usfdA21 cfr part11.

Drug metabolism:

Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway). Pharmacodynamics and Pharmacokinetics of drugs.

UNIT–II	10 Hrs.

Toxicology:

Basic concepts in toxicology, the mechanism of toxin action, biotransformation of toxins, their inactivation and removal from the body, Reactive intermediates.

Manufacturing principles and formulations:

Definitions, applications, composition, preparation, physicochemical considerations, Preformulation Testing, Tablets, compressed tablets, tablet granulation, Coatings, Pills, Parental preparations, herbal extracts, Oral liquids, Ointments, short study of current biotech products, herbal medicines. Quality control, storage and stability of biotech products.

UNIT–III	10 Hrs.

Stem cells in health care:

Introduction to Stem Cell Biology, Fate Mapping of Stem Cells, Mesenchymal Stem Cells, Stem Cells and Neurogenesis and its application , Epidermal Stem Cells, Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon. Application of epidermal stem cell in Tissue engineering, Hematopoietic Stem Cells, Classification and clinical manifestations of hematopoietic stem cell disorders.

Drug delivery system:

Advanced Sustained Release Drug Delivery System, Advanced drug Delivery Systems, Liposomes and Nanoparticles Drug Delivery System, Biodegradable Drug Delivery System, Hydrogel based Drug Delivery System.

UNIT–IV	10 Hrs.

Analysis of biologicals & pharmaceuticals:

Vitamins Cold remedies Laxatives Analgesics, NSAIO, External antiseptics, Antacids, Antibiotics, Biologicals, Herbal products. Packaging techniques – Glass containers, plastic containers, film wrapper, bottle seals.

Advanced pharmacology:

Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.

Reference Books *

1. Gary Walsh, (2013),Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers.
2. Bartram Katzung, (2009),Basic & Clinical Pharmacology(9th Edition), McGraw Hill.
3. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of

Industrial Pharmacy, (3 rd Edition) Publishing House Bombay.

Course Outcomes**

After completion of the course student will be able to

1. Apply and classify various biological sources of pharmaceutical products to retrieve the basic concept of pharmacology, drug metabolism .and their importance in biotechnology
2. Select and apply the toxicological studies of pharmaceutical products
3. Use knowledge of the techniques used in the manufacture of pharmaceutical products and apply in the field of Biopharmaceuticals.
4. Ability to discuss the concepts used in production of stem cells and analyse the applications and ethical issues of stem cells in the society.
5. Select and apply appropriate techniques advanced techniques in drug delivery system.
6. Demonstrate an ability to apply principles various other applications to protect the global community from various dreadful diseases.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	2	2	2	3	3	1	-	-	-	-	-	3	2	1
CO2	-	3	3	3	3	2	3	-	-	-	-	-	2	2	1
CO3	-	2	3	2	3	1	-	-	-	-	-	-	3	2	-
CO4	-	2	3	2	3	1	-	-	-	-	-	-	2	2	-
CO5	-	3	3	2	3	1	-	-	-	-	-	-	2	3	-
CO6	-	3	3	3	3	2	2	-	-	-	-	-	2	2	3

UBT833E	VALIDATION & QUALITY CONTROL	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	6 Hours

Introduction

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation &Revalidation . Validation of Water, Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non- Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). FDA and ICH guidelines.

UNIT–II	7 Hrs.

Medical Device, In-Vitro Diagnostics & Packaging Validation Issues, Validation of Analytical Methods, Computerized & Automated Systems under 21 CFR Part 11.

Standards

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001 - Environmental Management Systems.

UNIT–III	6Hrs.

Implementation **10 Hours**

The Influence of Good Automated Manufacturing Practice (GAMP); The FDA's Approach to GMP Inspections of Pharmaceutical Companies.

Quality System, Contract Review, Design Control, Document and Data Control, Purchasing,Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Control of Inspection, Measuring and Test Equipment, Inspection and Test Status, Control of Nonconforming Product, Corrective and Preventive Action, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques.

Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement

UNIT–IV	7Hrs.

Quality

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Process, Product, Procedure; Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Regrade, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation, Information, Document, Specification, Quality Manual, Quality Plan, Record; Terms Relating of Examination, Objective Evidence, Inspection, Test. Metrological Confirmation.

Reference Books *

1. Pharmaceutical Process Validation, 3rd Edition, Edited by Robert Nash and Alfred Wachter, Marcel Dekker, 2003
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From

Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000.
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2nd Ed., 1998.
4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance,2017
5. Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie,2017
6. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press, 1998.
7. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series, 2001

Course Outcomes**

1. Ability to comprehend the validation techniques, process, concepts.
2. Ability to analyse the good practices in lab, clinical and manufacturing practices
3. Capable of understanding the ISO standards and environmental management systems
4. Ability to analyse the analytical methods of validation, issues and automated system and standards
5. Ability to discuss the quality control measures used in industries
6. Ability to analyse the Quality Management System

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	-	-	-	-	2	3	1	-	-	-	-	-	1	3
CO2	2	-	-	2	-	3	3	3	-	-	-	-	2	2	3
CO3	3	-	-	-	-	3	2	2	-	-	-	3	2	3	2
CO4	2	-	-	-	-	3	1	3	-	-	-	3	2	3	3
CO5	2	-	-	-	-	2	3	3	-	-	-	2	2	2	3
CO6	2		-	2	-	2	1	2	-	-	-	2	2	3	2

UBT823E	CHEMICAL PLANT UTILITIES AND SAFETY	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment,

Air

Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system-piping and accessories. Air-water vapour system: humidification/ dehumidification and evaporative cooling-related calculations.

UNIT–II	10 Hrs.

Steam and power

Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories.

Refrigeration:

Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect-related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.

UNIT–III	10 Hrs.

Insulation

Insulation Materials & Selection-Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation.

Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards-Toxicity, Flammability, Fire , Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.

UNIT–IV	10 Hrs.

Safety devices

Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.

Process safety analysis

HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

Reference Books *

1. Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill, 8th Reprint, 1998.
2. Heat Engines, K.P. Roy, Media Promoters and Publishers, 1995.
3. Chemical Engineers Handbook, Perry, 8th Edition, 2007.
4. Chemical Engineering-Vol 6, R.K. Sinnot, Coulson and Richardson's, 3rd Edition, BH, Reprint, 2000.

Course Outcomes**
1. Ability to Storage and handling of water 2. Able to understand types of compressor 3. Able to analyze the economy of steam generation with different fuels 4. Able to study Hazard and risk assessment methods. 5. Ability to understand safety devices 6. Ability to compare HAZAN and HAZOP operations

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	2	1	-	2	-	2	-	2	-	-	-	-	1	3	1
CO6	1	2	3	2	-	3	-	1	-	-	-	-	1	3	1

UBT824E	METABOLIC ENGINEERING	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

Basic Concept of metabolic engineering overview of metabolism. Different models for cellular reactions, Mutation, mutagens mutation in metabolic studies.

Metabolic regulation

An overview of Cellular Metabolism, Transport Processes, Passive Transport, Facilitated Diffusion, Active Transport, Fueling Reactions, Glycolysis, ermentative Pathways, TCA Cycle and Oxidative Phosphorylation, Anaplerotic Pathways, atabolism of Fats, Organic Acids, and Amino Acids, Biosynthetic Reaction, iosynthesis of Amino Acids, Biosynthesis of Nucleic Acids, Fatty Acids, and Other Building Blocks, Polymerization, Growth Energetics

UNIT–II	10 Hrs.

Metabolic flux

Metabolic flux analysis and its application, Methods for experimental determination of metabolic flux by isotope dilution method.

Applications of metabolic flux analysis

Amino Acid Production by Glutamic Acid Bacteria, Biochemistry and Regulation of Glutamic Acid Bacteria, Calculation of Theoretical Yields, Metabolic Flux Analysis of Lysine Biosynthetic Network in C. glutamicum, Metabolic Flux Analysis of Specific Deletion Mutants of C. Glutamicum, Metabolic Fluxes in Mammalian Cell Cultures, Determentation of Intracellular Fluxes., Computational Networks and Systems Biology

UNIT–III	10 Hrs.

Regulation of metabolic pathways

Regulation of Enzymatic Activity, Overview of Enzyme Kinetics, Simple Reversible Inhibition Systems, Irreversible Inhibition, Allosteric Enzymes: Cooperativity, Regulation of Enzyme Concentration, Control of Transcription Initiation, Control of Translation, Global Control: Regulation at the Whole Cell Level, Regulation of Metabolic Networks, Branch Point Classification, Coupled Reactions and the Role of Global Currency Metabolites.

UNIT–IV	10 Hrs.

Metabolic engineering in practice

Enhancement of Product Yield and Productivity, Ethanol, Amino Acids, Solvents, Extension of Substrate Range, Metabolic Engineering of Pentose Metabolism for Ethanol Production, Cellulose-Hemicellulose Depolymerization, Lactose and Whey Utilization, Sucrose Utilization, Starch Degrading Microorganisms, Extension of Product Spectrum and Novel Products, Antibiotics, Polyketides, Vitamins, Biopolymers, Biological Pigments, Hydrogen, Pentoses: Xylitol, Improvement of Cellular Properties, Alteration of Nitrogen Metabolism, Enhanced Oxygen Utilization, Prevention of Overflow Metabolism, Alteration of Substrate Uptake, Maintenance of Genetic Stability, Xenobiotic Degradation, Polychlorinated Biphenyls (PCBs), Benzene, Toluene, P-Xylene Mixtures (BTX).

Reference Books *

1. P.F. Stanbury and A. Whitkar. 2008,Principle of Fermentation Technology pergaman press,
2. Wang D I C Cooney C I Demain, A L ,2008, “Fermentation and enzyme Technology” John Willey,
3. Roberts, 2007 “Metabolism of Agrochemicals in Plants” Willey Int,.
4. David L. Nelson and Michael Cox, 2016, “Lehninger Principles of Biochemistry” –6th Edition
5. Lubert Stryer, 2010 “Biochemistry” -Freeman & Co., Pub.

Course Outcomes**
1. Recall the concepts of cellular metabolism. 2. Explain the Basic concepts of metabolic engineering. 3. Explain Fundamentals of Metabolic flux analysis. 4. Apply the knowledge of metabolic flux analysis. 5. Apply the knowledge of regulatory mechanism for altering the metabolic pathways. **6.** Design the metabolic pathways for desired product.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2			2							1	1	1
CO2	2	2	2		2	3							2	1	2
CO3	3	3	2		2	2						1	1	1	2
CO4	3	3	3		2	3						1	2	1	3
CO5	2	1		2		2		2					1	3	1
CO6	1	2	3	2		3		1					1	3	1

UBT825E	INDUSTRIAL WASTE WATER TREATMENT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Water and waste water engineering an overview

Water quality, physical chemical and biological parameters of water, water quality standards,water quality indices. Waste water: terminology, impact of regulation on waste waterengineering, health and environmental concern in waste water management, waste water characteristics and treatment methods, current status and future trends, waste water reclamation and reuse, biosolids and residual management. Constituents of waste water, physical chemical and biological parameters of waste water, sampling methods, waste water effluent standards, sewage disposal methods.

UNIT–II	10 Hrs.

Primary and secondary treatment of waste water

Screens, oil traps, grit chambers, coagulation, clariflocculation, oxidation ponds and lagoons,Attached growth biological treatment : Activated sludge process and its modifications, trickling filter, biological nitrification and denitrification, anaerobic process, sludge disposal.

Advanced waste water treatment

Removal of dissolved organic, inorganic constituents and biological constituents, Filtration: modeling and backwashing for slow sand and rapid sand filters, adsorption principle and isotherms, gas stripping, ion exchange, advanced oxidation process.

Membrane filtration

RO, UF, MF, NF, electrodialysis. Disinfection: chlorine dioxide, chloramines, ozonation, UV radiation.

UNIT–III	10 Hrs.

Waste water reclamation and reuse

Waste water reuse application, need for water reuse, public health and environmental issues in water reuse, introduction to risk assessment for water reuse, different reuse options: Agriculture and landscape irrigation, industrial reuse, ground water recharge, non-potable uses with case studies.

UNIT–IV	10 Hrs.

Issues related to treatment plant performance

Need for upgrading treatment plant performance, treatment process reliability and selection of design values, odour management, introduction to automatic process control, energy efficiency, upgrading waste water treatment plant performance by process optimization, important design consideration for new waste water treatment plants: Liquid stream, solid processing, odour control.

Reference Books *

1. John C. Geyer and Daniel A Okun, Jhon Hutey,1996. Water and Waste water engineering-Vol 2, Gordon M Fair.
2. Mark J. Hammer Jr. ,1997 ,Water and waste water Technology,, 4th Edition, Prentice Hall.

Course Outcomes**

1. Define water quality and explain methods to characterize water quality.
2. Describe water quality standards and their impact.
3. Explain primary and secondary treatment methods of waste water.
4. Apply membrane filtration techniques, and disinfection methods to purify waste water.
5. Analyze the importance of reclamation and reuse of waste water.

6.	Identify various issues related to the performance of treatment plants and problems

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	-	2	-	1	1	2	2	-	-	-	1	2	1	1
CO2	1	-	2	-	-	2	2	3	-	-	-	1	2	1	2
CO3	-	-	1	1	2	-	2	2	-	-	-	1	2	1	-
CO4	2	-	2	-	-	1	2	2	-	-	-	1	2	1	-
CO5	-	-	1	2	2	-	3	3	-	-	-	1	2	1	1
CO6	1	-	1	-	-	2	2	2	-	-	-	2	2	1	-

UBT830E	CLINICAL RESEARCH	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Introduction

The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology.

Clinical pharmacology

Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development - formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.

UNIT–II	10 Hrs.

Therapeutics

Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors.

Management of drugs

Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.

UNIT–III	10 Hrs.

Healthcare marketplace

National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing.

Social, ethical issues

patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.

UNIT–IV	10 Hrs.

Clinical research

Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data **Management in Clinical Research:** General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.

Reference Books *

1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd.
2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication. ,
3. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology,
4. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.

Course Outcomes**

1. Exploit the knowledge to know the clinical importance of different therapeutic products
2. An integrated understanding of the formulations, manufacturing and supply of materials
3. Ability to study the philosophy behind organization of research Ability to understand control measures uised in drug and its control
4. Ability to elucidate the marketing strategies of pharma products
5. Ability to compare the social and ethical issues
6. Ability to inculcate the epidemiology study designs, case reports and case series

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	3	-	2	-	2	1	-	-	-	2	2	2	1
CO2	1	2	3	-	1	-	2	1	-	-	-	3	3	1	1
CO3	1	2	3	-	2	-	2		-	-	-	3	2	2	1
CO4	1	3	3	-	1	-	1	1	-	-	-	2	2	1	1
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

UBT832E	HEALTH DIAGNOSTICS	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

INTRODUCTION:

Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders chromosomal disorders, single cell disorders and complex traits. Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis.

DNA BASED DIAGNOSTICS

G-banding, in *situ* hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH). Cancer cytogenetics: spectral karyotyping. DNA diagnostics: PCR based diagnostics; ligation chain reaction, Southern blot diagnostics, array-based diagnostics, Genome sequencing and Metagenomics, DNA sequencing, genetic profiling, single nucleotide polymorphism. Haemoglobinopathies. Neuro developmental disorders. Neuro degenerative disorders. Dynamic mutations. G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (translocation, deletion, Down's syndrome, Klumefelter syndrome, Turner's syndrome, etc.) FISH for detections of: translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation).

UNIT–II	10 Hrs.

Biochemical diagnostics

Inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis

Cell based diagnostics

Antibody markers, CD Markers, FACS, HLA typing, Bioassays

UNIT–III	10 Hrs.

Immunodiagnostics

Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs.

UNIT–IV	10 Hrs.

Imaging diagnostics

Imaging Techniques (Basic Concepts), Invasive and Non-Invasive, Electrocardiography (ECG), Uses of ECG, Electroencephalography (EEG), Use of EEG, Computerized Tomography (CT), Uses of CT, Magnetic Resonance Imaging (MRI), uses of MRI, Ultrasound Imaging (US), Uses of Ultrasound, Planning and Organization of Imaging Services in Hospital, Introduction, Planning, Physical Facilities, Layout, Organization, Organization and Staffing, Records, Policies, Radiation Protection.

Reference Books *

1. Lisa Anne Shimeld.,2000 Essentials of Diagnostic Microbiology
2. Balley & Scott's. 1998 Diagnostic Microbiology, 2ND edition,
3. Burtis & Ashwood,.Tietz ,2005,Text book of Clinical Biochemistry.

Course Outcomes**

1. Ability to study Biochemical disorders, chromosomal disorders.
2. Able to study DNA based diagnostics.
3. Analyse Biochemical diagnostics.
4. Understand cell based diagnostics.
5. Analyse Immunodiagnostics
6. Understand imaging diagnostics

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	-		2	-	-	-	-	-	-	1	1	1
CO2	2	2	2	-	2	3	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	2	-	-	-	-	-	1	1	1	2
CO4	3	3	3	-	2	3	-	-	-	-	-	1	2	1	3
CO5	1	3	3	-	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	-	3	3	3	3

UBT834E	PRODUCT DEVELOPMENT	Credits: 03
L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hours

Essentials of product development

The product development process, privacy policies and Knowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies. Stability studies – Stability Testing of new Drug Substances and Products – types and stages of testing, Stress Testing, storage conditions. Manufacturing Process for Recombinant pharma Products. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Approved Biotech Drugs.

UNIT–II	10 Hrs.

Interpersonal Skills

Understand analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in Pharma industries.

Understand work output requirements, company policies, delivery of quality work on time and report any anticipated reasons for the delay, effective interpersonal communication, conflict-resolution techniques, importance of collaborative working, multi-tasking, training the team members, knowledge of project management.

UNIT–III	10 Hrs.

Reporting and formulations

Reporting – power point presentations, technical writing, Principal investigator, communication with upstream and downstream teams. Problem Solving and Decision Making. Types of adverse drug reactions (ADR) and their treatment. Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, geriatric products, veterinary products, immune boosters.

UNIT–IV	10 Hrs.

Safety and Security at workplace

Different types of occupational health hazards, knowledge of chemical substances -characteristics & safety measures. Use of safety gears, masks, gloves and accessories, evacuation procedures for workers and visitors. Health, safety and security issues – types (illness, fire accidents). Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances.

Reference Books *

1. Endrenyi, L., Declerck, D. and Chow, S. (2017).
2. Biosimilar Drug Product Development. Boca Raton: CRC Press.
3. Biochemistry and Biotechnology by Gary Walsh. (2002): John Wiley & Sons Ltd.
4. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker, 5th Ed., 2000, 723 pp.,
5. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers.

Course Outcomes**

1. Understand, analyze and apply the techniques and essentials of product development and understand the various guidelines along with techniques in pharma industry
2. Demonstrate the different inter personnel skills and project management skills
3. Ability to comprehend various techniques involved in reporting, decision making process and understand adverse effects of drugs.
4. Describe the formulation of various energy drinks and demonstrate the role of Upstream and Downstream marketing.
5. Analyze and list the various health hazards in industry.
6. Ability to understand importance of safety and implement in various industries.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3	2	2	2	3	1	-	-	-	-	1	1	2	3
CO2	1	-	-	2	1	2	1	-	-	-	-	1	1	1	1
CO3	1	3	2	1	2	1	1	-	-	-	-	1	1	2	1
CO4	1	-	3	2	1	2	2	-	-	-	-	1	1	1	2
CO5	1	2	2	1	2	3	3	-	-	-	-	1	1	2	1
CO6	1	2	2	2	1	2	3	-	-	-	-	1	1	1	-