KUMARAGURU COLLEGE OF TECHNOLOGY

(Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

CURRICULUM AND SYLLABUS

(REGULATIONS 2013)

3rd - 8th Semesters

B.Tech - BIOTECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE - 49
(An Autonomous Institution Affiliated to Anna University, Chennai)

B.Tech - BIOTECHNOLOGY

CURRICULUM 2013

SEMESTER-III

Code No.	Course Title	L	T	P	C
THEORY					
U13MAT305	Probability and Applied Statistics	3	1	0	4
U13BTT301	Metabolism of Biomolecules	3	0	0	3
U13BTT302	Microbiology	3	0	0	3
U13BTT303	Concepts of Industrial Biotechnology	3	0	0	3
U13BTT304	Cell Biology	3	0	0	3
U13BTT305	Stoichiometry and fluid mechanics	3	1	0	4
PRACTICAL					
U13BTP301	Biochemistry Lab	0	0	4	2
U13BTP302	Microbiology Lab	0	0	4	2
U13GHP301	Human Excellence-Family Values	1	0	1	1
				Total	**25**

Total Periods: 30

SEMESTER-IV

Code No.	Course Title	L	T	P	C
THEORY					
U13GST001	Environmental Science and Engineering	3	0	0	3
U13BTT401	Instrumental methods of analysis	3	0	0	3
U13BTT402	Bioorganic Chemistry	3	0	0	3
U13BTT403	Molecular Biology	3	0	0	3
U13BTT404	Mechanical operations and Heat Transfer	3	1	0	4
U13BTT405	Chemical Engineering Thermodynamics	3	1	0	4
PRACTICAL					
U13BTP401	Instrumental methods of analysis Lab	0	0	4	2
U13BTP402	Bioorganic Chemistry Lab	0	0	4	2
U13BTP403	Industrial Biotechnology Lab	0	0	4	2
U13GHP401	Human Excellence-Professional Values	1	1	1	1
				Total	**27**

Total Periods: 34

SEMESTER-V

Code No.	Course Title	L	T	P	C
THEORY					
U13BTT501	Genetic Engineering	3	0	0	3
U13BTT502	Enzyme Engineering and Technology	3	0	0	3
U13BTT503	Bioprocess Principles	3	0	0	3
U13BTT504	Mass transfer operations	3	1	0	4
U13BTT505	Food Biotechnology	3	0	0	3
U13BTE--	Elective- I	3	0	0	3
PRACTICAL					
U13BTP501	Chemical Engineering Lab	0	0	4	2
U13BTP502	Enzyme Technology Lab	0	0	4	2
U13BTP503	Molecular Biology Lab	0	0	4	2
U13GHP501	Human Excellence- Social Values	1	0	1	1
				Total	**26**

Total Periods: 35

* Students should carry out Technical skill development course during the 2rd year summer vacation

SEMESTER-VI

Code No.	Course Title	L	T	P	C
THEORY					
U13BTT601	Biopharmaceutical Technology	3	0	0	3
U13BTT602	Bioprocess Engineering	3	1	0	4
U13BTT603	Protein Engineering	3	0	0	3
U13BTT604	Chemical Reaction Engineering	3	1	0	4
U13BTE--	Elective-II	3	0	0	3
U13BTE--	Elective-III	3	0	0	3
PRACTICAL					
U13BTP601	Genetic Engineering Lab	0	0	4	2
U13BTP602	Bioprocess Lab	0	0	4	2
U13ENP401	Communication Skill Lab	0	0	3	1
U13GHP601	Human Excellence- National Values	1	0	0	1
				Total	**26**

Total Periods: 33

SEMESTER-VII

Code No.	Course Title	L	T	P	C
THEORY					
U13BTT701	Bioinformatics	3	0	0	3
U13BTT702	Downstream Processing	3	0	0	3
U13BTT703	Immunology	3	0	0	3
U13BTT704	IPR, Biosafety and Bioethics	3	0	0	3
U13BTE--	Elective-IV	3	0	0	3
U13BTE--	Elective V	3	0	0	3
PRACTICAL					
U13BTP701	Bioinformatics Lab	0	0	4	2
U13BTP702	Downstream Processing Lab	0	0	4	2
U13BTP703	Immunology Lab	0	0	4	2
U13BTP704	Mini Project*	0	0	1	2
U13BTP705	Project (Phase I)	0	0	2	1
U13GHP701	Human Excellence- Global Values	1	0	0	1
				Total	**28**

* Students should conduct mini project during the 3rd year summer vacation

Total Periods: 34

SEMESTER-VIII

Code No.	Course Title	L	T	P	C
THEORY					
U13BTE----	Elective-VI	3	0	0	3
U13GST---	General Elective	3	0	0	3
PRACTICAL					
U13BTP801	Project (Phase II)	0	0	18	6
				Total	**12**

For the * and ** courses, students who prefer Fast Track to complete the course work, can opt for these courses in 6th and 7th semester respectively as self study courses.

Total Periods: 24

Total Credits: 190

LIST OF ELECTIVES

Course code	Course title	L	T	P	C
Semester V- Elective –I					
U13BTE101	Plant and Animal Biotechnology	3	0	0	3
U13BTE102	Molecular and Microbial Pathogenesis	3	0	0	3
U13BTE103	Bioprocess Control and Dynamics	3	0	0	3
Semester VI- Elective –II					
U13BTE201	Nanobiotechnology	3	0	0	3
U13BTE202	Medical Biotechnology	3	0	0	3
U13BTE203	Evolution and Biodiversity	3	0	0	3
U13TTX216	Medical Textiles	3	0	0	3
Semester VI- Elective – III					
U13BTE301	Environmental Biotechnology	3	0	0	3
U13BTE302	Molecular spectroscopy	3	0	0	3
U13BTE303	Cancer Biology	3	0	0	3
Semester VII – Elective – IV					
U13BTE401	Computational methods in Molecular Biology	3	0	0	3
U13BTE402	Genomics and Proteomics	3	0	0	3
U13BTE403	Bioprocess Economics and Plant Design	3	0	0	3
U13BTE404	Bioenergy engineering	3	0	0	3
Semester VII- Elective V					
U13BTE501	Introduction to Biomedical Instrumentation	3	0	0	3
U13BTE502	Practical computing for biologists	2	0	1	3
U13BTE503	Stem cells and Tissue engineering	3	0	0	3
Semester VIII – Elective – VI					
U13BTE601	Neurobiology and cognitive science	3	0	0	3
U13BTE602	Clinical Research & Management	3	0	0	3
U13BTE603	Immunotechnology	3	0	0	3
Semester VIII – General Elective					
U13GST002	Total Quality management	3	0	0	3
U13GST004	Operations research	3	0	0	3
U13GST005	Engineering economics and financial management	3	0	0	3
U13GST006	Product design and development	3	0	0	3

SEMESTER III

U13MAT305 PROBABILITY AND APPLIED STATISTICS 3 1 0 4
(COMMON TO BT, FT & TXT)

OBJECTIVES

- Have a fundamental knowledge of statistical measures of central tendency and dispersion
- Have knowledge of basic probability concepts and random variables.
- Know about certain standard distributions.
- Test hypothesis regarding large samples and small samples
- Know about design of experiments and quality control

Course Outcomes:
By studying Probability and Applied Statistics students can be able to

CO1 – Compute measures of central tendencies, dispersions and correlate the variables.
CO2 – Analyze random or unpredictable experiments and investigate important features of random experiments.
CO3 – Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.
CO4 – Analyze sample data and interpret the same for population.
CO5 – Sketch the control charts and outline the process capability.

STATISTICAL MEASURES **5**

Measures of central tendency: Mean, Median and Mode – Measures of variation: Range, Mean deviation, standard deviation and coefficient of variation.

CORRELATION AND REGRESSION **4**

Karl Pearson's coefficient of correlation – Spearman's Rank Correlation – Regression lines.

PROBABILITY AND RANDOM VARIABLE **9**

Axioms of probability - Conditional probability – Total probability – Baye's theorem - Random variable – Distribution function – properties – Probability mass function – Probability density function – moments and moment generating function – properties.

STANDARD DISTRIBUTIONS **9**

Binomial, Poisson and Normal distributions – Moments, Moment Generating functions and properties for the above distributions - Fitting of Binomial, Poisson and Normal distributions.

TESTING OF HYPOTHESIS **9**

Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportions) – Small samples tests based on t and F distributions (single mean, difference of means, paired *t*- test and variance ratio test) – Chi-square test for independence of attributes and goodness of fit.

DESIGN OF EXPERIMENTS **4**

Analysis of Variance (ANOVA) – Completely Randomized Design (CRD) – Randomized Block Design (RBD) – Latin Square Design (LSD).

STATISTICAL QUALITY CONTROL **5**

Concept of process control - Control charts for variables – $\overline{X}$, R – charts – Control charts for attributes – p, np, c – charts – Tolerance limits.

L: 45 + T: 15 = 60

REFERENCES

1. Veerarajan T., "Probability and Statistics", Tata McGraw-Hill, New Delhi, 2007 & 2nd Reprint 2004.
2. Gupta S. P, "Statistical Methods", Sultan Chand & Sons Publishers, 2004.
3. Johnson R. A., "Miller & Freund's Probability and Statistics for Engineers", Sixth Edition, Pearson Education, Delhi, 2000.
4. Gupta S.C, and Kapur, J.N., "Fundamentals of Mathematical Statistics", Sultan Chand, Ninth Edition, New Delhi, 1996.
5. Walpole R. E., Myers S.L. & Keying Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Inc, 2002.

U13BTT301 METABOLISM OF BIOMOLECULES 3 0 0 3

OBJECTIVE(S):

- To teach the students the basics of Biochemistry with special emphasis on the metabolism of carbohydrates, proteins, lipids and nucleic acids
- To learn certain metabolic disorders associated with these biomolecules.

COURSE OUTCOME(S):

CO1 – Describe the metabolic pathways related to carbohydrates and associated metabolic disorders.
CO2 – Illustrate the metabolic pathways of polysaccharides and discuss the principles of bioenergetics
CO3 – Demonstrate the metabolic pathways of aminoacids and associated disorders.
CO4- Outline the metabolism of lipids and associated disorders
CO5- Schematize the pathway for the metabolism of nucleic acids and related disorders.

METABOLISM OF MONOSACCHARIDES 9 h

Metabolic pathways - glycolysis, TCA cycle, Pentose phosphate pathway, gluconeogenesis, Calculation of ATP production during glycolysis and TCA cycle. Metabolic disorders of carbohydrate metabolism (pathophysiology, clinical symptoms and treatment) – Diabetes mellitus

METABOLISM OF POLYSACCHARIDES AND BIOENERGITICS 9 h

Biosynthesis and degradation of starch and glycogen. Glycogen storage diseases – Von Grieke's disease, Biological oxidation –reduction reactions – reduction potentials. Respiratory chain and oxidative phosphorylation, Energy budget

METABOLISM OF AMINOACIDS 9 h

Oxidative- and non-oxidative deaminations, transamination and urea cycle. Biosynthesis of Gly, Ser and Cys; Biosynthesis of essential aminoacids (Met, Thr, Lys), Biosynthesis of aromatic aminoacids (structures optional). Metabolic breakdown of amino acids derived from phosphoglycerate and oxaloacetate family.
Metabolic disorders of amino acid metabolism: Phenyl ketonuria, Maple syrup urine disease

METABOLISM OF LIPIDS 9 h

Biosynthesis and degradation of Lipids: Fatty acid synthesis and oxidative degradation, Triacylglycerol and phospholipids biosynthesis and degradation; Cholesterol biosynthesis and degradation (hormones and bile acids)
Metabolic disorders of lipid metabolism: familial hypercholesterolemia

METABOLISM OF NUCLEIC ACIDS 9 h

Structure of purines and pyrimidines, Biosynthesis of nucleotides, *de novo* and salvage pathways for purines and pyrimidines (structures optional), degradation of purines and pyrimidines. Metabolic disorders of nucleic acid metabolism: Lesch-Nyhan syndrome

TOTAL: 45h

REFERENCE(S):

1. David L. Nelson and Michael M.Cox (2007) *Lehninger's Principles of Biochemistry*. 4th Edition, New York ,W.H Freeman & Co.
2. Lubert Stryer (2003) *Biochemistry*, 5th Edition, New York,W.H Freeman & Co.
3. Sathyanarayana. U (2008).*Biochemistry*, Kolkata, Books and Allied (P) Ltd.
4. Voet and Voet (2004) *Biochemistry*, 3rd Edition, John Wiley & Sons Inc.
5. Murray, R.K., Granner, B.K., Mayes,P.A., Rodwell , V.W.(2003) *Harper's Biochemistry*, 29th edition, Prentice Hall International.
6. Mathews, C.K. and van Holde, K.E. (2000) *Biochemistry*, 3rd edition, Benjamin / Cummings Publishing Co. Inc.
7. Salway,J.G. (2000). *Metabolism at a Glance*, 2nd edition, Blackwell Science Ltd.

U13BTT302 MICROBIOLOGY 3 0 0 3

OBJECTIVE(S)

- To disseminate information on the basics of microbiology, particularly to identify microbes, their structure, metabolism and industrial applications
- This course is prerequisite for other courses offered in Bioprocess Technology, Fermentation technology, industrial biotechnology, and molecular pathogenesis

COURSE OUTCOME(S)

CO1 Comprehend knowledge about historical perspective of microbiology and its developments
CO2 Recognize the fundamental concepts in the structure and functioning of a cell
CO3 Demonstrate the microbial nutritional requirements for growth and metabolism
CO4 Understand the controlling of microbes using physical and chemical methods
CO5 Acquire knowledge about industrial and environmental microbial applications

HISTORICAL PERSPECTIVE OF MICROBIOLOGY AND MICROSCOPY 9 h

An overview of microbiology including a historical perspective of microbiology, Origin of Leeuwenhoek's Animalcules, Germ theory of fermentation and disease, Development of laboratory techniques to study microorganisms, Developments in disease. Classification and Nomenclature of microorganisms; Basics of Microscopy - light and electron microscopy; Principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining and fungal staining

MICROBIAL STRUCTURE AND MULTIPLICATION 9 h

Morphology, Structure and Functional anatomy of Prokaryotic- and Eukaryotic Cells. Multiplication of bacteria, viruses, algae, protozoa and fungi with a special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophage.

MICROBIAL NUTRITION, GROWTH AND METABOLISM 10 h

Nutritional requirements of bacteria and different media used for bacterial culture; Screening and isolation of organisms- Pure culture techniques (spread plate, pour plate, streak plate) Preservation methods, Maintenance of strain improvement (mutant selection, recombinant DNA methods). Microbial growth and factors affecting growth. Growth curve and different methods to quantify bacterial growth, Aerobic and Anaerobic; Overview of microbial metabolism of carbohydrates, proteins and fats; Entner–Doudoroff and Phosphoketolase pathway. Introduction to chemosynthesis.

CONTROL OF MICROORGANISMS AND ANTIMICROBIALS 9 h

Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents. Host-microbe interactions, Chemotherapy and antibiotics- anti-bacterial, anti-fungal agents, anti-viral agents, mode of action and resistance to antibiotics.

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY 8 h

Production of commercial products: Preservation of food using metabolites, edible mushrooms, Enzyme from microbial sources; Microbial bioremediation: leaching of ores by microorganisms; Microorganisms and pollution control, Bio-indicators of the environment.

TOTAL: 45 h

REFERENCE(S):

1. Michael J. Pelczar (Author), E.C.S. Chan (Author) Microbiology (An Application Based Approach) 2010 Tata McGraw Hill; 1st edition
2. Talaron K, Talaron A, Casita, Pelczar and Reid (2005).Foundations in Microbiology, W.C.Brown Publishers
2. Ray B.(2003) "Fundamental Food Microbiology", Third Edition, CRC Press LLC, 2003.
3. Prescott M., Harley J.P. and Klein D.A.(2005)"Microbiology", Seventh Edition, W.C.Brown Publishers
4. Lim D.(2001), "Microbiology", Second Edition, WCB-Mc Graw Hill,

U13BTT303 CONCEPTS OF INDUSTRIAL BIOTECHNOLOGY 3 0 0 3

OBJECTIVE(S)

- To introduce various types of fermentation
- To learn about the production of primary- and secondary metabolites
- To understand the production of modern biotechnology products

COURSE OUTCOME(S)

CO1.Understand about the various industrial bioprocessess.
CO2.Learn the basics of industrial bioprocesses for the production of various primary and secondary metabolites.
CO3.Apply various modern biotechniques for producing several value added products.
CO4.Understand the production of biotechnological products.

INTRODUCTION TO INDUSTRIAL BIOPROCESS 9 h

Introduction to Industrial Biotechnology : Basic principles of fermentation technology- Fermentation media – natural and synthetic; Introduction to types of fermenters / bioreactors; Types of fermentation – Solid state, submerged, batch, continuous, fed batch fermentation methods; Immobilized enzymes and reactors.

PRODUCTION OF PRIMARY METABOLITES 9 h

A brief outline of processes for the production of some commercially important organic acids - Citric acid, lactic acid ,acetic acid; amino acids - glutamic acid, phenylalanine; ethanol.

PRODUCTION OF SECONDARY METABOLITES 9 h

Study of production processes for various classes of secondary metabolites: Antibiotics: beta lactams – penicillin and cephalosporin; aminoglycosides – streptomycin; macrolides - erythromycin, vitamin - B_9, B_{12}

PRODUCTS THROUGH MODERN BIOTECHNIQUES 9 h

Production of industrial enzymes - proteases, amylases, lipases; Production of single cell protein from wastes; biopreservatives – Bacterosin; biopolymers - xanthan gum and PHA. Industrial uses of enzymes in detergents, beverage and food.

BIOTECHNOLOGICAL PRODUCTS 9 h

Introduction to biopesticides, uses, advantages, disadvantages; biofertilisers:definition, types, benefits; Biogas -production, applications; Biofuels: first and second generation biofuels; bioenergy: definition, uses, case study on electricity generation ; biosurfactants-definition,applications;bioleaching-definition,process,advantages;biosensors:definition, applications, case study: biosensors in food industry; biosafety : definition, four levels of biosafety.

REFERENCE(S):

1. Casida, L.E., "Industrial Microbiology", New Age International (P) Ltd, 2005
2. Crueger, W and Anneliese Crueger, Biotechnology: "A Textbook of Industrial Microbiology", Panima Publishing Corporation, Edition 2, 2003
3. Sathyanarayana, U., "Biotechnology", Books and Allied (P) Ltd. Kolkata, 2005.
4. Ratledge C and Kristiansen B. "Basic Biotechnology", Cambridge University Press, second Edition, 2001.
5.Michael J. Waites. "Industrial Microbiology: An Introduction", Blackwell Publishing,2001.
6. Stanbury PF, Whitaker A, and Hall SJ, "Principles of Fermentation Technology", Elsevier Science Ltd., 1995.

U13BTT304 CELL BIOLOGY 3 0 0 3

OBJECTIVE(S)

- To inculcate basic knowledge to the students in different areas of Cell Biology, including signal transduction.
- This course is a prerequisite for other subjects like Molecular Biology and Cancer Biology.

COURSE OUTCOME(S)

CO1. Recognize the fundamental concepts in the structure and functioning of a cell
CO2. Acquire knowledge of cell culture techniques and instrumental methods in cytology
CO3. Describe the membrane transport processes and proteins facilitating them
CO4. Interpret precisely the diversified roles of cytoskeletal filaments
CO5. Infer the cascade of events in signal transduction and their significance

CELL STRUCTURE AND FUNCTIONS 9 h

Prokaryotic and eukaryotic cells – Introduction; Intracellular organelles of eukaryotic cells – Structure and functions (Nucleus, Mitochondria and Golgi apparatus); Plasma membrane – structure, composition (carbohydrates, proteins and lipids), properties (fluidity and asymmetry) and functions; Cell cycle.

CYTOLOGICAL TECHNIQUES 9 h

Cell disruption and fractionation of cell contents – Centrifugation techniques; Flow cytometry; Cytochemical methods in the study of cell and cell organelles, cell culture.

MEMBRANE TRANSPORT 9 h

Passive transport - channel and carrier proteins; Active transport - Sodium - Potassium ATPase, Ca^{2+} ATPase, P-type, V-type and F-type ATPase, ATP dependent proton pumps; Endocytosis - pinocytosis, phagocytosis and receptor mediated endocytosis; Exocytosis;

CELLULAR INTERACTIONS AND CYTOSKELETAL FILAMENTS 9 h

Cell-cell and cell-extracellular matrix interactions - Tight junctions, Adherens junctions and desmosomes, Gap junctions, Hemidesmosomes, Plasmodesmata; Cytoskeletal filaments and their role in cellular organization and functions - Microtubules (Polymerization dynamics and dynamic instability), Actin filaments (Muscle contraction),

SIGNAL TRANSDUCTION 9 h

Cell - cell signaling - Autocrine, endocrine and paracrine models; Signal transduction - Cell surface receptors (G protein coupled receptors), Second messengers (cAMP, cGMP, calcium ions, nitric oxide, membrane lipid derivatives), Protein kinases (PKA, PKG and PKC). cAMP as an example

TOTAL: 45 h

REFERENCE(S)

1 Harvey Lodish, Arnold Berk, S.L Zipursky, Paul Matsudaira, David Baltimore and James Danell (2002). *Molecular Cell Biology*, 4thEdition, New York: W.H Freeman and company.

1. De Robertis, E.D.P and De Robertis E.M.F (2001). *Cell and Molecular Biology*, 8th Edition, New York: Lippincott Williams and Wilkins.
2. Rastogi, S.C. (2004). *Cell Biology*, 2nd Edition, New Delhi: New Age International Publishers.
3. Geoffrey M. Copper (2000). *The Cell: A Molecular Approach*, 2nd Edition, Washington: ASMPress.
4. Ranga, M.M. (2002). *Animal Biotechnology*, 2nd Edition, India: Agrobios.
5. Benjamin Lewin (2004). *Genes VIII*, International Edition, New Delhi: Pearson Prentice Hall.

U13BTT305 STOICHIOMETRY AND FLUID MECHANICS 3 1 0 4

OBJECTIVE(S)

- To make the students understand the concepts of process calculations and fluid flow operations with relevance to bioprocess engineering

COURSE OUTCOME(S):

CO1. Outline the applications of units and basic chemical calculations involved in basic engineering
CO2. Understand the principles of material balances and their applications in process engineering
CO3. Explain the principles of energy balances and their applications in process engineering
CO4. Describe the basics of fluid flow and their applications in industrial biotechnology
CO5. Explain the different fluid flow operations and their applications in industrial biotechnology

UNITS AND DIMENSIONS **12 h**

Units and Dimensions - Introduction, Dimensions and System of units, Fundamental and derived quantities, Unit conversions, Representation of units, Dimensional consistency, Dimensional equations; Basic chemical calculations - Introduction, Composition of solid mixtures, solutions and gaseous mixtures, Ideal gas law and its application, Dalton's law, Amagat's law, Raoult's law, Henry's law.

MATERIAL BALANCES **12 h**

Material balances without chemical reactions - Process flow-sheet, Material balances problems, Material balances in distillation towers, extractors, dryers, evaporators, crystallizers and leaching equipments, Recycle, bypass and purge streams; Material balances with chemical reactions - Concept of limiting and excess reactants, selectivity, percentage conversion and yield.

ENERGY BALANCES **12 h**

Fuels and combustion - Introduction, Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid and gaseous fuels, Air requirement and flue gases, Combustion calculations; Thermophysics - Law of conservation of energy, Components of energy balance equations, Heat capacity of solids, liquids, gases and gaseous mixtures, Sensible and latent heat.

FLUID MECHANICS **12 h**

Fluid statics - Introduction, Nature of fluids, Hydrostatic equilibrium, Manometers, Reynolds experiment and its significance; Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Flow of incompressible fluids in conduits - Hagen-Poiseuille equation; Friction factor and losses - Darcy-Weisbach equation.

FLUID FLOW **12 h**

Flow measurements - Orificemeter, Venturimeter, Rotameter and Gas flowmeters; Pumps - Classification, Principles, construction, working and applications of centrifugal and reciprocating pumps, Pumping of slurries.

TOTAL: 60 h

REFERENCE(S)

1. B. I. Bhatt and Vora. (1996). *Stoichiometry*, 3rd edition, New Delhi: Tata McGraw Hill.
2. Warren L.Mc Cabe., Julian C.Smith., & Peter Harriot (2005). *Unit Operations of Chemical Engineering*, 7th edition, New Delhi: Tata McGraw Hill.
3. David M. Himmelblau., (2007). *Basic Principles and Calculations in Chemical Engineering*, 6th Edition, New Delhi: Prentice-Hall of India Private Limited.
4. K. V. Narayanan and B. Lakshmikutty. (2012). *Stoichiometry and Process Calculations*, New Delhi: Prentice-Hall of India Private Limited.
5. J.F. Richardson, J. H.Harker and J. R. Backhurst. (2002). *Coulson & Richardson's Chemical Engineering Volume-1*, 4th edition, United Kingdom: Elsevier.
6. S. K. Ghosal, S. K. Sanyal & S. Datta. (1993). *Introduction to Chemical Engineering*, New Delhi: Tata McGraw Hill.

U13BTP301 BIOCHEMISTRY LAB 0 0 4 2

OBJECTIVE(S):

- To provide hands-on-training to students on lab procedures in Biochemistry particularly on the quantitative determinations of essential biomolecules of the living system and
- Use of various routine lab equipments.

COURSE OUTCOME(S):

CO1 – Outline the general Lab guidelines and lab safety rules.
CO2- Estimate the amount of monosaccharide and polysaccharides by standard methods
CO3 – Evaluate the amount of aminoacids and proteins by standard methods
CO4 – Analyze the level of nucleic acids by known standard methods

1. General Lab guidelines, units of measurements, accuracy, precision, sensitivity and specificity.
2. Estimation of free reducing sugars by 3, 5 –dinitrosalicylic acid method.
3. Estimation of starch by Anthrone method
4. Estimation of protein by Lowry method and Bradford method
5. UV-spectroscopic method of analysis of proteins.
6. Estimation of amino acids by ninhydrin method
7. Estimation of cholesterol by kit method
8. Estimation of DNA by Diphenylamine method
9. Estimation of RNA by orcinol method
10. Determination of amylase activity
11. Isolation of casein from milk – case study
12. Determination of select metabolites in a tissue sample (animal or plant)

REFERENCE(S):

1. Sadasivam.S and Manickam.A (2005) *Biochemical methods*, 3rd edition, New Age International (P) Limited Publishers
2. David T.Plummer (1987). *An Introduction to Practical Biochemistry*, 3rd edition, London ; New York: McGraw-Hill

U13BTP302 MICROBIOLOGY LAB 0 0 4 2

OBJECTIVE

The course aims to develop the skills in microbial techniques.

COURSE OUTCOME(S)

CO1. Understand and demonstrate the working principles, procedures of microbiology Lab experiments and equipments
CO2. Observe and practice different types of culture media and broth for microbial cultivation
CO3. Differentiate microbes using different staining methods
CO4. Estimate and evaluate the microbial screening, identification and characterization

EXPERIMENT(S):

1. Lab safety , Sterilization techniques and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow
2. Preparation of culture media – Nutrient broth and Nutrient agar, Potato Dextrose Agar
3. Culturing of microorganisms – in broth and in plates (pour plates, streak plates, isolation and preservation of bacterial cultures)
4. Staining Techniques: Smear preparation, Simple, Negative, Gram Endospore and Fungal staining
5. Quantification of microorganisms by turbidometry
6. Effect of disinfectants on microbial flora
7. Isolation and identification of microorganisms from different sources – soil, water and milk
8. Antibiotic sensitivity assay
9. Biochemical tests – IMVIC test
10. Effect of different parameters on bacterial growth (pH, temperature & UV irradiation)
11. Isolation and identification microbes from environment or food samples

REFERENCE(S)

1. T.Palvannan, S.Shanmugam and T.Sathish Kumar (2005) Lab Manual on Biochemistry Bioprocess & Microbiology- Scitech Publishers, Chennai
3. Paul A. Ketchum (2001) Microbiology – Concepts and application, Wiley Publications,USA

U13GHP301 FAMILY VALUES -I 1 0 1 1

OBJECTIVES

- To inculcate the basic need for family life and peace in it.
- To lead spiritual development through good family life.
- To respect womanhood and live disease free life.
- To live with sound health.
- To reach Intuition.

COURSE OUTCOMES

- Develop skills in maintaining harmony among the family members.
- Acquire skills in traditional yogasanas leading to sound health.
- Behaves as a family member and leading to a blissful family life.
- Learnt Food is Medicine.

Restraint in family **4 h**

Definition - Greatness of life force & mind. Introduction - Kayakalpa yoga -aim - maintaining youthfulness – sex & spirituality – ten stage of mind – mental frequency-method of concentration – kayakalpa philosophy - physical body – sexual vital fluid – life force – bio-magnetism - mind –food transformation into seven minerals – postponing the ageing process – death – importance of kayakalpa training.

Spiritual development through good Family life **4 h**

Kayakalpa exercise – methods –aswinimudhra – ojus breathing – explanations – benefits – practices – Responsibility of men and women – introduction a good education – need of morality – spiritual development.Revision of previous physical exercises. Introduction – hints & caution – body massaging – accu-pressure –relaxation.

Peace in Family **4 h**

Family value – meaning – Introduction – values – benefits of blessings – effect of vibrations – make blessings a daily habit – greatness of friendship – individual & family peace – reason for misunderstanding in the family – no comment – no command – no demand – no ego – peace of mind.

Greatness of womanhood & Food is Medicine **4 h**

Good–cultured behavioral patterns – love and compassion - Greatness of womanhood – Food is medicine (healthy food habits)

Simplified physical exercises **7 h**

Simplified physical exercises – Kaya Kalpa Yoga (Benefits related to the Patient, Tolerance, Sacrifice)

Meditation & Yogasanas **7 h**

Thuriya meditation – introduction – practice – benefits. Asanas– ashtanga yoga – pathanjali maharishi –hints & cautions – posture - movement – involvement – standing asanas: thadasana – ekapathasana – chakrasana(side) – uthkatasana – trikonasana. Sittingasanas: thandasana – padmasana – vajrasana – suhasana – siddhasana – parvathasana – yogamudhra.Downward lying asanas: makkarasana – bhujangasana – salabhasana – navukasana– dhanurasana. Upward lying asanas: savasana - arthapavanamukthasana– pavanamukthasana – utthanapathasana – navasana& Surya namaskara.

Total: 30 h

REFERENCE(S)

1. Yoga for Modern Age ---- Vethathiri Maharishi
2. The Man making Messages ---- Swami Vivekananda
3. Manavalakalai Part- 1&2&3 ---- Vethathiri Maharishi
4. Value Education for Health & Happiness and Harmony. ---- Vethathiriyam

SEMESTER IV

U13GST001 ENVIRONMENTAL SCIENCE AND ENGINEERING (common to all branches) 3 0 0 3

OBJECTIVES

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve biodiversity.

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 10 h

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

ECOSYSTEMS AND BIODIVERSITY 14 h

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION 8 h

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT **7 h**

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – Consumerism and waste products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

HUMAN POPULATION AND THE ENVIRONMENT **6 h**

Population growth, variation among nations – Population explosion – Family Welfare Programme – Environment and human health – Human Rights – Value Education – HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies.

FIELD WORK

Visit to local area to document environmental assets- river / grassland / hill / mountain, visit to local polluted site- urban / rural / industrial / agricultural, study of common plants, insects, birds, study of simple ecosystems-pond, river, hill slopes etc.,

Total : 45 h

REFERENCE(S)

1. Deswal.S and Deswal.A, " A basic course in Environmental studies" Dhanpat Rai & Co, 2006.
2. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
3. Miller T.G. Jr., Environmental Science – Sustaining the earth, Wadsworth Publishing Co., 1993
4. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India., 2002
5. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media. 1996
6. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
7. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
8. Townsend C., Harper J and Michael Begon, "Essentials of Ecology", Blackwell science Publishing Co., 2003
9. Trivedi R.K and P.K.Goel "Introduction to Air pollution" Techno-science Pubications. 2003
10. Yamuna R.T "Environmental Science" Inter Publications, 2008

U13BTT401 INSTRUMENTAL METHODS OF ANALYSIS 3 0 0 3

OBJECTIVE

- To provide the students an ability to understand the principles of instrumentation and biotechnology oriented techniques and their applications in the field of biology

COURSE OUTCOME(S):

CO1- Understand the basics of measurements and their applications in industrial biotechnology
CO2- Describe the molecular spectroscopic techniques and their applications in industrial biotechnology
CO3- Explain the principles of thermogravimetric methods and their applications in industrial biotechnology
CO4- Describe the various separation methods and their applications in industrial biotechnology
CO5 - Understand the various other methods and their applications in industrial biotechnology

MEASUREMENT BASICS AND EXTRACTION METHODS 9 h

Classification of instrumental methods; Signal to noise ratio (S/N)- introduction; Solvent extraction – introduction and principle; Extraction techniques – batch, stripping or back, continuous and counter-current-current; Principle of solid extraction (Soxhlet); Types - Temperature assisted, pressurized hot water and supercritical fluids based extraction.

SPECTROSCOPIC TECHNIQUES 9 h

Beer-Lambert's law & it's deviations; Principle, instrumentation and applications - UV-Vis Spectroscopy, atomic absorption spectroscopy, x-ray emission spectrometry, spectrofluorimetry and Electron Paramagnetic Resonance; Principle and applications - IR, FT-IR and Raman Spectroscopy.

CHROMATOGRAPHY & ELECTROANALYTICAL METHODS 9 h

Chromatography – introduction, principle and types; Thin layer, gel filtration, ion exchange, affinity, hydrophobic interaction, HPLC and GC – principle, instrumentation and applications; Oxygen and pH electrodes – principle, instrumentation and applications.

Case study – Gel filtration. ion exchange chromatography and HPLC.

ELECTROPHORESIS & THERMAL METHODS 9 h

Electrophoresis – introduction & trouble shooting parameters; Paper, agarose gel, polyacrylamide gel (PAGE), SDS-PAGE – principle, instrumentation and applications; Immuno and capillary electrophoresis, isoelectric focusing – principle and applications; Thermo gravimetric analysis (TGA) – principle, instrumentation and applications.

Case study – PAGE and SDS PAGE.

MASS SPECTROMETRY AND STRUCTURAL ELUCIDATION METHODS **9 h**

Mass spectrometry – principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI] and applications; MALDI-TOF – principle and instrumentation; x-ray diffraction, Nuclear magnetic resonance (NMR) and Scintillation counters – principle, instrumentation and applications.

TOTAL : 45 h

REFERENCE(S)

1. Gurdeep R. Chatwal and Sham K. Anand. (2012). Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India.
2. B.K.Sharma. (2005). Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India.
3. Keith Wilson and John Walker. (2000). Principles and Techniques of Practical Biochemistry. 5th Edition. Cambridge University Press, U.K.
4. Douglas A. Skoog, F.James Holler and Stanley R. Crough. (2007). 6th Edition. Brooks Cole Publishing Company. USA.
5. Hobart H. Willard, Lynne L. Merritt, John A. Dean and Frank A. Settle. (1988). 7th Edition. Wadsworth Publishing Company.

U13BTT402 BIOORGANIC CHEMISTRY 3 0 0 3

OBJECTIVE(S)

- To develop an understanding of concepts in organic chemistry with relevance to biology

COURSE OUTCOME(S):

CO1. Understand chemical principles as applied to biological phenomena
CO2. Understand the orchestration of events during enzyme catalysis and the role of coenzymes
CO3. Learn some strategies used by the bioorganic chemist to synthesize molecules.
CO4. Understand drug design considerations and combinatorial chemistry.

CONCEPTS IN BIORGANIC CHEMISTRY 9 h

Classification of Organic reactions; Mechanisms of SN1, SN2, E1 and E2 reactions; Concepts of acids, bases and buffers, Henderson–Hasselbalch equation; Isoelectric points of amino acids; Chemical kinetics and catalysis- orders of reactions, Equilibrium, free energy, activation energy.

ORGANIC CHEMISTRY OF BIOMOLECULES 9 h

Chemical synthesis of alpha aminoacids, Solid phase peptide synthesis; Peptide sequencing- Edman's degradation; Oligonucleotide chemical synthesis, Chemical methods of DNA sequencing, Carbohydrate stereochemistry, Fischer- and DL notation; Chemical reactions of sugars, Reactions of Fatty acids- Saponification and transesterification reactions of fatty acids.

MECHANISM OF ENZYME CATALYSIS 9 h

Coenzymes in catalysis, Mechanism and role of: pyridoxal phosphate (aminotransferases), NAD/NADP (dehydrogenases), Thiamine pyrophosphate (carboxylases)
Case studies of structure and mechanism- Horse Liver alcohol dehydrogenase, alpha - chymotrypsin, hen egg white lysozyme, Ribonuclease A.

Case study- engineering an enzyme- subtilisin; Case study- allostery ATPase.

SYNTHETIC STRATEGIES AND MOLECULAR MODELS FOR BIOMOLECULES 9 h

Enzymes in organic transformations- hydrolysis of amide bond, esters; reduction of aldehydes and ketones using enzymes and whole cells. Enzymes in organic solvents- ester, lactone and peptide synthesis. Artificial- and modified enzymes – chemically modified enzymes; Enzyme-analog polymers. Molecular recognition- morphine derivatives, host-guest complexes-crown ethers, Cyclodextrins.

MOLECULAR INTERACTIONS AND DRUG ACTION **9 h**

Drug design strategies, Lead modification –pharmacore identification, functional group modification, structure activity relationships, Mechanism of enzyme inhibitors and DNA interactive drugs, Combinatorial chemistry.

TOTAL : 45 h

REFERENCE(S)

1. A. R. Fersht (1999) *Structure and Mechanism In Protein Science: A Guide To Enzyme Catalysis and Protein Folding*;, New York :W.H. Freeman.
2. H. Dugas, H (1999) *Bioorganic Chemistry (1999),* Berlin: Springer Verlag.
3. John McMuray, Second edition (2011) *Organic chemistry with biological applications*, Texas, Thomson Brooks/Cole.
4. Richard Silvermann B *The organic chemistry of drug design and drug action*, Second edition, United Kingdom, Norfolk
3. Trevor Palmer (2001) *Enzymes: Biochemistry*, *Biotechnology and Clinical Chemistry*, New York, United States.
4. Nicholas C. Price and Lewis Stevens (1999) *Fundamentals of Enzymology*, Third edition, United Kingdom, Oxford University Press.
5. Dobson, C. M., Gerrard J. A, Pratt, A. J. *Foundations of chemical biology*, (1995) USA: Oxford University Press

U13BTT403 MOLECULAR BIOLOGY 3 0 0 3

OBJECTIVE(S)

- To learn the fundamental aspects of nucleic acids
- To understand the principle and process of DNA replication, transcription and translation
- To study the basics of regulation of gene activity, mutation and DNA repair

COURSE OUTCOME(S):

CO1. Understand nucleic acids as genetic materials
CO2. Discuss and distinguish the replication of prokaryotic and eukaryotic DNA s
CO3. Explain the synthesis of RNA and post-transcriptional modifications.
CO4. Describe genetic code, and protein synthesis
CO5. Understand the operon, mutations and DNA repair mechanisms

NUCLEIC ACIDS AND DNA REPLICATION 9 h

DNA as genetic material – Griffith; Hershey and Chase; Avery McLeod & McCarty experiments. Conformation of DNA and RNA; Cot value; Prokaryotic replication; Replication in eukaryotic chromosomes; Replication of telomeres in eukaryotes. Bacterial transformation, conjugation and transduction.

TRANSCRIPTION 9 h

Features of promoters and enhancers; Transcription factors; Classes of RNA molecules; Types of RNA polymerases; Transcription in prokaryotes and eukaryotes. Introns and Exons; Post-transcriptional modifications; RNA Splicing, Polyadenylation and Capping, SnRNA & hnRNAs; Antisense RNA and RNA Interference (RNAi), ribozymes.

TRANSLATION 9 h

Elucidation of genetic code, Wobble hypothesis, Codon-anticodon interaction - redundancy, Polycistronic mRNA; Protein synthesis in prokaryotes and eukaryotes (Initiation, Elongation, and Termination); Inhibitors of Translation; Post-translational modifications.

REGULATION OF GENE ACTIVITY 9 h

Principles of Regulation; Transcriptional Regulation (*Lac* Operon; Galactose Operon; Arabinose Operon; Tryptophan Operon; Attenuation; Autoregulation; Constitutively Expressed Genes, Case study- lambda gene regulation in lytic and lysogenic cycles.

MUTATIONS AND DNA REPAIR 9 h

Introduction to Mutations; Transition; Transversion, Addition; Deletion; Physical, Chemical and Biological Mutagens; Reversion; DNA Repair Mechanisms (Direct Reversal; Excision Repair; Recombinational Repair; The SOS Response).

REFERENCE(S)

1. Friefelder, D. (2009), "Molecular Biology", 2nd Edition, Narosa Publishing House, New Delhi.
2. Lewin B. (2008), "Genes IX" Jones and Bartlett
3. Weaver, R.F. (2005), "Molecular Biology", 3rd Edition, McGraw Hill.
4. Waston, J.D. (2004) "Molecular Biology of the Gene", 5th Edition, Pearson Education.
5. Walker, J.M. and R. Rapley (2002), "Molecular Biology and Biotechnology" 4th Edition, Panima publishers
6. Gerald, K. (1999), "Cell and Molecular Biology: Concepts and Experiments." 2nd Edition, John Wiley & Sons.

U13BTT404 MECHANICAL OPERATIONS AND HEAT TRANSFER 3 1 0 4

OBJECTIVE(S)

- To make the students to understand the concepts of particle and heat flow operations with relevance to bioprocess engineering

COURSE OUTCOME(S):

CO-1 – Understand the principles of comminution and its application in industrial biotechnology
CO2 – Understand the principles of agitation and separation techniques and its applications
CO3 –Describe the principles of Heat transfer methods.
CO4 –Learn the principles of Heat exchangers and its applications
CO5 –Understand the principles of evaporators and its applications

PARTICLE FLOW AND COMMINUTION 12 h

Particle flow: Flow through packed beds - Principle, Ergun's equation and its applications, Flow through fluidized beds - Principle, types, applications, merits and demerits; Comminution: Principles of comminution, Particle size measurement, Energy and power required in size reduction, Size reduction equipments, Screening equipments, Comparison of ideal and actual screens, Screen effectiveness

MIXING AND SEPARATION 12 h

Agitation: Purposes of agitation, Agitation equipments, Flow patterns in agitation, Standard design of agitator, Dimensional analysis for power correlation, Agitator scale-up, Flow number, Special agitation systems; Filtration: Introduction, Filter media and filter aids, Constant pressure filtration, Filtration equipments - Leaf filter, Plate and frame filter press and rotary drum filter; Fundamental principles of sedimentation and settling: Mechanism, settling velocity

HEAT TRANSFER 12 h

Modes of heat transfer; Conduction: Fourier's law, Conductivity, Conduction through flat slab, cylinder and sphere, Heat transfer through multilayer cylinders, Conduction through materials in series and parallel; Insulating materials: General properties and applications; Convection – Dimensional analysis applied to natural convection and forced convection, Heat transfer coefficients; Dimensionless numbers in heat transfer - Prandtl Number, Nusselt Number, Grashof Number, Graetz Number & Peclet Number

HEAT EXCHANGERS 12 h

Heat Exchangers: Types of flow, LMTD, Fouling, Construction, working and design of double pipe and shell & tube heat exchangers, Construction and working of compact heat

exchangers – Plate type and spiral heat exchangers; Extended surface heat exchangers, Condensers – filmwise and dropwise condensation

EVAPORATORS **12 h**

Evaporation: Effect of processing variables on evaporator operation, Boiling point elevation, Mechanisms of boiling, Evaporation equipments and operation methods – forward feed and backward feed conditions, Overall heat transfer coefficients in evaporators, Calculation methods for single effect evaporator, Overview of Multiple effect evaporator, Evaporation of biological materials

TOTAL: 60 h

REFERENCE(S)

1. Christie John Geankoplis., *(*2003*), Transport process and separation process principles*, 4th edition, New Delhi: Prentice-Hall of India Private Limited.
2. Donald, Q.Kern .,(2003). *Process Heat Transfer*,New Delhi:Tata McGraw Hill.
3. Warren L. McCabe, Julian C. Smith, Peter Harriot.,(2005).*Unit Operations of Chemical Engineering*, 7th edition , New Delhi:Tata McGraw Hill.
4. Coulson, J.H., and Richardson.,*Chemical Engineering*, Vol. II,Paragon Press and ELBS.
5. C. M. Narayana and B.C.Bhattacharyya,(2005), *Mechanical Operations for Chemical Engineers*, New Delhi: Khanna Publishers.
6. K. A. Gavhane,(1992), *Heat Transfer*, Pune: Nirali Prakashan

U13BTT405 **CHEMICAL ENGINEERING THERMODYNAMICS** **3 1 0 4**

OBJECTIVE(S)

- To make the students to understand the concepts thermodynamics with examples from bioprocess industries

COURSE OUTCOME(S):

CO1. Understand the applications of thermodynamic laws and functions
CO2. Enumerate equations of state and the difference between steady-state and transient processes, open and closed systems
CO3. Describe the meaning of specific volume, enthalpy, and internal energy, and how to obtain them from thermodynamic tables and diagrams.
CO4. Explain the principles of phase equilibria problems and their applications in industrial biotechnology
CO5. Describe the principles of chemical reaction equilibria problems and their applications in industrial biotechnology

BASIC CONCEPTS OF THERMODYNAMICS **12 h**

Review of basic concepts – systems, surroundings, processes, properties (extensive/intensive), components (single/multi), phases (G/L/S), ideality, zeroth, first, second laws and their consequences (T, U, S), Thermodynamic functions H, A and G, concept of chemical potential, equations for a closed system, Maxwell's relations, thermodynamic analysis of processes – lost work, irreversibility.

THERMODYNAMIC PROPERTIES OF PURE FLUIDS **12 h**

Review of ideal gas, non-ideal gas, PVT behaviour, Virial and cubic equations of state, generalized correlations, residual properties, estimation of thermodynamic properties using equations of state.

SOLUTION THERMODYNAMICS **12 h**

Partial molar properties, fugacity, ideal and non-ideal solutions, excess properties of mixtures, activity coefficient, Gibbs-Duhem equation

PHASE EQUILIBRIA **12 h**

Phase rule, criteria for phase equilibrium, VLE for pure component, VLE for multi-component system

REACTION EQUILIBRIA **12 h**

Equilibrium criteria for homogenous reactions, evaluation of equilibrium constant, effect of temperature and pressure on equilibrium constant, calculation of equilibrium conversion and yields for single and multiple reactions.

TOTAL: 60 h

REFERENCE(S)

1. Smith J.M., Van Ness H.C., and Abbot M.M., (2003). *Introduction to Chemical Engineering Thermodynamics*, 6th Edition, New Delhi:Tata McGraw Hill.
2. Sandler S.I., (1989). *Chemical and Engineering Thermodynamics*, Hoboken/New Jersey:John Wiley.
3. Donald T. Haynie., (2008). *Biological Thermodynamics,Second edition,* United Kingdom: Cambridge University Press.
4. Narayanan K.V., (2003). *A Text Book of Chemical Engineering Thermodynamics*, New Delhi: Prentice-Hall of India Private Limited.
5. Denbigh K., (1955). *The Principles of Chemical Equilibrium with Applications in Chemistry and Chemical Engineering*, London: Cambridge University Press.

U13BTP401 INSTRUMENTAL METHODS OF ANALYSIS LAB 0 0 4 2

OBJECTIVE

- To provide hands-on training in bioanalytical techniques and related instruments which enable the students solve the engineering issues

COURSE OUTCOME(S):

CO-1 – Demonstrate spectrophotometry for wide range of applications in industrial biotechnology
CO-2 – Demonstrate pH metry for wide range of applications in industrial biotechnology
CO-3 – Demonstrate fluorimetry for wide range of applications in industrial biotechnology
CO-4 – Demonstrate flame photometry for wide range of applications in industrial biotechnology

EXPERIMENTS:

1. Precision and Validity (using Excel program) in an experiment using absorption spectroscopy
2. Preparation of buffers and determination of pH of an unknown solution (Biological fluids can be used)
3. Estimation of Iron by 1,10-phenonthroline method (spectrophotometry)
4. Estimation of sodium and potassium by flame photometry
5. Estimation of Aluminum by alizarin red S method using fluorimetry
6. Determination of iso-electric point of an amino acid by pH metric titration with a weak acid/ weak base
7. Extraction of leaf pigments and its identification through paper chromatography
8. Identification of molecules by thin layer chromatography (TLC)
9. Isolation of molecules using preparative thin layer chromatography (PTLC) (Demonstration)
10. Separation of molecules using column chromatography
11. Isolation of molecules using HPLC (Demonstration)
12. **Case study** - TLC

TOTAL : 45 h

REFERENCE(S):

1. David T.Plummer. (1987). An Introduction to Practical Biochemistry. 3rd Edition and 33rd reprint (2008). Tata McGraw-Hill Publishing Company Ltd., India.
2. S.Sadasivam and A.Manickam. (2007). Bichemical Methods. 3rd Edition (reprint, 2010). New Age International Pvt. Ltd., Publishers, India.
3. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford and P.W.G. Smith. (1996). Vogel's Textbook of Practical Organic Chemistry. 5th Edition. Prentice Hall Pvt. Ltd., India.

U13BTP402 BIOORGANIC CHEMISTRY LAB 0 0 4 2

OBJECTIVE(S)

To offer hands on training in the area of isolation and synthesis of molecules using bioorganic techniques.

COURSE OUTCOME(S):

CO1. Carry out synthesis of bioactive molecules
CO2. Isolate biomolecules using chemical principles
CO3. Carry out enzymatic synthesis of biomolecules
CO4. Learn computed aided analysis of biomolecules

EXPERIMENTS:

1. Synthesis of aspirin, acetaminophen
2. Extraction of caffeine
3. Isolation of lycopene from tomato paste
4. Determination of logP of Organic compounds (eg. Succinic acid)
5. Saponification reactions of vegetable oils
6. Essential oil isolation by steam distillation
7. Preparation of organic dyes and fabric dyeing
8. Enzymatic reduction of ethyl acetoacetate to chiral alcohol by yeast cells
9. Preparation of cholesterol epoxide
10. Chemical structure drawing using software tools
11. Analysis of molecular structure and properties using molecular modeling tools

TOTAL : 45 h

REFERENCE(S):

1. Fummis B.S., Hannaford A.J., Smith P.W.G., (1995) "Text Book of Practical Organic Chemistry", Longman Edition.
2. Vogel's Text book of Practical organic chemistry (2004). Low price Edition.
3. Advanced practical medicinal chemistry – Ashutosh Kar (New Age international publishers)

U13BTP403 INDUSTRIAL BIOTECHNOLOGY LAB 0 0 4 2

OBJECTIVES

The course aims to impart skills on the basic techniques like fermentation, production of primary and secondary metabolites, enzymes.

COURSE OUTCOME(S)

CO1. Demonstrate about the production of various metabolites
CO2. Explain the production and estimation of *Spirulina*
CO3. Choose the materials required for immobilization of cells
CO4. Explain the isolation of degraders.

EXPERIMENTS:

1. Algal Culture- S*pirulina*
2. Production and estimation of citric acid from *Aspergillus* culture
3. Production and estimation of lactic acid and lactose
4. Immobilization of yeast cells
5. Preparation of wine
6. Estimation of alcohol by specific gravity method
7. Immobilization of enzymes (Invertase)
8. Isolation of cellulose degraders
9. Isolation of pesticide degraders
10. Production of Gibberellic acid

REFERENCE(S)

1. Sullia S and Shantharam,S (2001) General Microbiology, Oxford & IBH Publishing Co, Pvt. Ltd.
2. Glaser A N & Nilaido H (2000) Microbial Biotechnology, W H Freeman & Co.

U13GHP401 PROFESSIONAL VALUES 1 0 1 1

(Common to all branches of Engineering and Technology)

Objective:

- To know the 5 Cs (Clarity, courage, confidence, commitment, compassion)
- To Know the 5 Es(Energy, Enthusiasm, Efficiency, Enterprise, Excellence)
- To Practice the IQ Questions and given to the result
- To Learn about Professional Ethics
- To know the examples for Self Control

COURSE OUTCOMES

- Acquire knowledge on the Clarity, courage, confidence, commitment, compassion for a good Professionalize
- Demonstrate Skills of IQ test
- Contribute to the better Management of Time
- Behave a good Professionalism from Quality Enhancement

Personality concepts - 5C's & 5E's **5 h**

Personality-concepts, definition,-types of personality-personality development activities- how to develop a good personality factors affecting personality development tools of improve personality-steps to a dynamic personality-5 C's and 5 E's

Time Management **5 h**

Self-development – importance of self development – how to develop oneself – continuous learning – laser focus +persistence – working a plan – sound mind follows sound body – complete responsibility – practice – those who make it, made it – never give-up – meditation – ten commandments of self development – self control technique for teenagers.

Leadership traits **5 h**

Leadership traits – style – factors of leadership – principles of leadership - time management – importance of time management – benefits – top five time sucks of the average Human – time management for college students. Passion for excellence – what is passion? – Why passion? – Value of life – index of life – fuel for fulfillment – secret of physical & spiritual fitness – improves learning ability.

Empowerment of Mind **5 h**

IQ, - Factors affecting the intelligence quotient – IQ and the brain – sex – race – age – relationship between IQ & intelligence – how to develop good intelligence quotient power – exercise can improve IQ – food plan to increase IQ – meditation – reading – playing – try right with opposite hands – learn new things - the IQ tests. EQ – emotional Intelligence – list positive & negative emotions. SQ – spiritual quotients – definition – basic science of spiritual quotient – how to build SQ? – Relationship between IQ, EQ, SQ.

Meditation **3 h**

Panchendhriya meditation – Introduction – practice – benefits.

Simplified Physical Exercise& Yogasanas **7 h**

Asanas – revision of previous asanas–standing asanas: natarasana –virabhadrasana – pathangusthasana– ardhachandrasana–utthithatrikonasana–parsvakonasana.

Total : 30 h

REFERENCE(S)

- Personality & Self Development –ICFAI University
- Leadership-Dr.A Chandra Mohan
- Intelligence-Swami Vivekananda
- Ways to make every second valuable- Robert W. Bly
- Manavalkkalai Part-II-Vethathiri Maharishi
- Professional Ethics& Human Values-D.R Kiran & S.Bhaskar
- Extraordinary performance from ordinary people- Keith Ward& Cliff Bowman,
- Mind-Vethathiri Maharishi.
- Manavalkkalai Part-I-Vethathiri Maharishi,
- Self Cotrol-Russell Kelfer

SEMESTER V

U13BTT501 GENETIC ENGINEERING 3 0 0 3

OBJECTIVES

- To learn the fundamentals of recombinant DNA technology
- To know about vectors and their uses in recombinant DNA construction
- To understand various molecular techniques and their applications in rDNA research

COURSE OUTCOME(S):
The students will be able to
CO1. Understand the steps in recombinant DNA preparation.
CO2. Explain the features of various types of gene cloning vectors.
CO3. Discuss and distinguish genomic and cDNA libraries.
CO4. Describe various molecular techniques and their applications.
CO5. Demonstrate the different applications of transgenic plants and animals.

BASICS OF RECOMBINANT DNA TECHNOLOGY 9h

Genetic elements that control gene expression; Promoter-operator-attenuator-enhancer, restriction and modifying enzymes, construction of recombinant DNA molecules, transformation of r-DNA molecules into target host organisms; Calcium chloride mediated-electroporation- microinjection- gene gun, selection methods for recombinants; antibiotic resistance - blue & white selection.

CLONING AND EXPRESSION VECTORS 9h

Cloning vector; properties of a cloning vector, Plasmid Vectors; pBR322-pUC18, Lambda phage vectors, phagemid, cosmid, shuttle vector, expression vectors; *E.coli* based- yeast vector- insect vector- mammalian vectors, plant transformation vector; binary vector, high capacity vectors.

GENE ISOLATION AND EXPRESSION METHODS 9h

Construction of gene and cDNA libraries, PCR based cloning, library screening methods; nucleic acid Probe preparation-radioactive and non-radioactive labeling of probe, library screening methods; nucleic acid hybridization based screening-PCR based screening-immunochemical screening, over-expression and purification of recombinant proteins.

Case study: Discussion on gene cloning from a research paper

MOLECULAR TECHNIQUES IN rDNA RESEARCH 9h

Blotting techniques; Southern-northern-western blotting, PCR; principle- types- applications of PCR, molecular markers; RAPD-RFLP-application in plant variety characterization,

Nucleic acid sequencing methods; Sangers method -automated DNA sequencing, submitting gene sequence in DNA banks, patenting of gene sequences and its issues.

Case study: Use of PCR and RFLP in forensic field.

APPLICATION OF rDNA TECHNOLOGY **9h**

Application of genetically modified organisms; medicine-recombinant therapeutic proteins-recombinant vaccines- disease diagnosis, agriculture – Transgenic Bt cotton- round-up ready soybean transgenic crops, RNAi and gene knock-out techniques, safety guidelines and release procedure for GMOs in India, effect of GMOs on environment.

TOTAL : 45h

REFERENCE(S):

1. Brown T.A., (2006) Gene Cloning and DNA Analysis: An *Introduction*, 5th Edition, Blackwell Science, Cheltenham,
2. Glick B. and J.J. Pasternick (2003) Molecular biotechnology: Principles and Applications of recombinant DNA, 3rd Edition, Washington, ASM press.
3. Primrose S.B. and R.M.Tywman, (2006) Principles of Gene manipulation and Genomics, 7th edition, Blackwell Science.

U13BTT502 ENZYME ENGINEERING AND TECHNOLOGY 3 0 0 3

OBJECTIVE

- To provide a broad knowledge to the students in the area of enzymes, enzyme engineering and to impart its applications in various industries

COURSE OUTCOMES:

Students will be able to
CO1. Learn the basics of enzymes, nomenclature and classification

CO2. Apply the knowledge to derive the kinetics for enzymes

CO3. Learn and apply the different techniques for immobilization of enzymes

CO4. Explain the production and purification techniques of enzymes

CO5. Discuss the applications of enzymes in different industries , Biosensors and its different types

INTRODUCTION TO ENZYMES 9 h

Introduction and definition of enzymes; Nomenclature and Classification of enzymes; concept of active site and energetics of enzyme substrate complex formation; Mechanisms of enzyme action, – General catalysis and acid base catalysis principles of catalysis – collision theory and transition state theory; Enzymes in organic solvents; Introduction to enzyme activity and specific activity.

ENZYME KINETICS 9 h

Kinetics of single substrate reactions - Michelis – Menten equation and Briggs Haldane equation; Estimation of Michelis – Menten parameters – Lineweaver-Burk plot, Eadie-Hofstee plot and Hanes plot; Bisubstrate reactions – single displacement and ping pong mechanism; multi substrate reactions- King and Altmann equation; types of inhibition– Competitive, Uncompetitive, non competitive and substrate; Allosteric regulation of enzymes - Monod-Changeux-Wyman model, Koshland–Nemethy-Filmer model.

ENZYME IMMOBILIZATION 9 h

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking and covalent binding; Applications of immobilized enzymes.

PRODUCTION OF INDUSTRIAL ENZYMES & ENZYME ENGINEERING 9 h

Alpha amylase; Cellulase; Xylanase; Lipase; Protease; Laccase, Enzyme engineering – introduction, different strategies; Synzymes, abzymes and ribozymes– introduction.

ENZYME APPLICATIONS AND BIOSENSORS 9 h

Application of enzymes in industries– Food, detergent, leather and wool, brewery and environment, chemicals processing ; Enzyme electrodes and their application as biosensors in various industries – Calorimetric, potentiometric, amperometric, optic and immunosensors.

Case study – development of sensors for management of diabetes mellitus

TOTAL: 45 h

REFERENCE(S):

1. Trevor Palmer (2007) *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry,* 2nd Edition, Horwood Publishing Limited, United Kingdom
2. S. Shanmugam, T. Sathishkumar and M. Shanmugaprakash (2012) *Enzyme Technology,* 2nd Edition, IK International Publishers, India
3. Ashok Pandey, Collin Web, Carlos Ricard and Christian Larroche (2006) *Enzyme Technology,* 2nd Edition, Springer Science + Business Media Inc. and Asiatech Publishers, Netherlands
4. NIIR Board of Consultants and Engineers (2004) *Enzymes Biotechnology Handbook,* 1st Edition, Asia Pacific Business Press Inc. India
5. Nicholas Price and Lewis Stevens (2009) *Fundamentals of Enzymology,* 3rd Edition, Oxford University Press, India
6. Andreas S. Bommarius and Bettina R. Riebel (2004) *Biocatalysis,* 1st Edition, Wiley-VCH GmbH & Co.

U13BTT503 BIOPROCESS PRINCIPLES 3 0 0 3

OBJECTIVES

- To learn the basic principles of fermentation process
- To understand microbial growth kinetics in batch, fed-batch and continuous mode
- To study the basics of stoichiometry and energetics

COURSE OUTCOMES:

The students will be able to

CO1. Understand the types fermented products and bioreactors
CO2. Discuss and distinguish the medium requirements and optimization methods.
CO3. Explain the sterilization kinetics of medium and equipments.
CO4. Describe various microbial cultivation and their kinetics
CO5. Understand the stoichiometry of cell growth and energy

OVERVIEW OF FERMENTATION PROCESSES 9 h

Historical development of fermentation industry, general requirements of fermentation processes, industrially important microbes and their products, basic configuration of stirred tank reactor and ancillaries, Types of bioreactors, main parameters to be monitored and controlled in fermentation processes.

RAW MATERIALS AND MEDIA OPTIMIZATION METHODS 9h

Criteria for good medium, Various carbon, nitrogen, minerals, vitamins and other complex nutrients for fermentation industry, Simple and complex media for microbial, plant and animal cells, oxygen requirements, medium formulation for optimal growth and product formation, medium optimization methods-Plackett-Burman design, simplex design and response-surface methodology.

Case study: Enzyme production using Plackett-Burman design

STERILIZATION KINETICS 8h

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, sterilization of air, design of sterilization equipment for batch and continuous process.

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 10h

Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth – Monod model, Growth of filamentous organisms and yeast, Product formation kinetics – Leudeking-Piret models, substrate and product inhibition on cell growth and product formation.

Case study: Production of penicillin by fed-batch cultivation

METABOLIC STICHIOMETRY AND ENERGITICS 9h

Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass and available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients, energetic analysis of microbial growth and product formation, Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth.

REFERENCE(S):

1. Shuler M.L. and Kargi F., (2002) "Bioprocess Engineering: Basic Concepts", 2nd Edition, New Delhi, Prentice-Hall of India.
2. Stanbury P. F., Hall S. and Whitaker A., (2003), "Principles of Fermentation Technology", 2nd Edition, Butterworth-Heinesmann
3. Blanch H. W. and Clark D. S., (2007) "Biochemical Engineering" , 2nd Edition, CRC Press.
4. Pauline M. Doran, (2012), "Bioprocess Engineering Principles, 2nd Edition, Academic Press
5. Bailey and Ollis, (2010), "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill
6. Rajiv Dutta, (2008) Fundamentals of Biochemical Engineering, Ane Books India

U13BTT504 MASS TRANSFER OPERATIONS 3 1 0 4

OBJECTIVE(S)

To make the students to understand the concepts of mass transfer operations with relevance to bioprocess industries

COURSE OUTCOME(S):

CO-1 – Explain the principles of diffusion and mass transfer coefficient.
CO2 – Understand the principles of gas liquid operations
CO3 – Describe vapour liquid operations in biotech industries
CO4 – Learn the concept of liquid – liquid extraction operations
CO5 – Understand the solid fluid operations and its equipments with application

DIFFUSION AND INTERPHASE MASS TRANSFER 12 h

Introduction to mass transfer operations, Molecular and Eddy Diffusion in fluids: Fick's first law, Steady state molecular diffusion in fluids at rest and in laminar flow, Diffusivity of gases, Diffusivity of liquids, Interphase Mass Transfer: Concept of overall mass transfer coefficient for liquids and gases, Theories of Mass Transfer – Film, Penetration and Surface renewal theories

ABSORPTION 12 h

Concept of stage and cascade, equipments for gas liquid operations (plate and packed towers), Principles of gas absorption, equilibrium solubility of gases and liquids, choice of solvent, one component absorption in single and multistage operation, HTU and NTU concepts

DISTILLATION 12 h

Vapor-liquid Equilibria, P-x-y and T-x-y diagrams, Ideal solutions, Deviation from ideality, Minimum and maximum boiling azeotropes, Flash and differential distillation, continuous rectification, Determination of number of stages by McCabe-Thiele method, Concept of minimum, total and optimum reflux ratio, Steam distillation, Azeotropic Distillation and Extractive Distillation

EXTRACTION AND LEACHING 12 h

Ternary liquid- liquid equilibrium and tie line data, choice of solvent, Single stage & multistage extraction, Co-current and cross current extraction, Continuous counter current multistage extraction without reflux, Single stage & multistage equipments, Single stage leaching, Multistage cross current and counter current leaching, Leaching equipments, Overview of bioleaching.

Case study: Bioleaching of metal sulphides by Thiobacillus

ADSORPTION **12 h**

Types of adsorption, Nature of adsorbents, adsorption isotherms – Langmuir, Freundlich and BET, adsorption of single gas/vapour from gaseous mixture, dilute and concentrated liquid solutions, Adsorption equipments, fixed bed and moving bed adsorption, Overview of biosorption

Case study: Biosorption of dye on microbial surfaces

TOTAL: 60 h

REFERENCE(S):

1. Geankoplis C.J.(2002) *Transport Processes and Unit Operations*, 3rd Edition, New Delhi: Prentice-Hall of India Private Limited.
2. Warren L.Mc Cabe., Julian C.Smith.,& Peter Harriot., (2005), *Unit Operations of Chemical Engineering*, 7th edition ,New Delhi: Tata McGraw Hill.
3. Treybal R.E.(1981), *Mass Transfer Operations*,3rd Edition ,New Delhi: Tata McGraw Hill.
4. Coulson and Richardson, (1998)*Chemical Engineering*. Vol I & II, New Delhi:Asian Books Pvt Ltd.
5. N. Anantharaman and K.M. Meera Sheriffa Begum. (2011). *Mass Transfer - Theory and Practice.* New Delhi: PHI Learning Private Limited

U13BTT505 FOOD BIOTECHNOLOGY 3 0 0 3

OBJECTIVES

- To learn about food and nutrients.
- To obtain knowledge about the expanding role of functional foods and nutraceuticals in the promotion of human health and nutrition
- To enable students pursue higher studies in food processing
- To learn the strategies to produce specific food ingredients

COURSE OUTCOMES

CO1. The students will be able to recognize the relationship between food and health.
CO2. The students will be able to describe the need and use of functional foods and nutraceuticals
CO3. The students will be able to compare probiotics and prebiotics.
CO4. The students will be able to explain the biotechnological approaches to modify food
CO5..The students will be able to sketch food safety, toxicity & security.

RELATIONSHIP BETWEEN FOOD AND HEALTH 9h

Food : definition;five food groups; Nutrition : Definition , classification of nutrients, relationship between food and health: obesity and energy regulation , nutritional deficiencies – Diabetes mellitus, marasmus,Kwashiokar, scurvy,Beri-beri,Rickets.

FUNCTIONAL FOODS AND NUTRACEUTICALS 9h

Functional foods: categories of functional foods, processed foods,GM foods ,role of biotechnology in functional foods, Nutrition related diseases and relavent functional foods : Atherosclerosis, cardiovascular disease, cancer, obesity,osteoporosis, Nutraceuticals: definition,major nutraceuticals and their applications, case study on prevention of cancer using phytochemicals.

PROBIOTICS AND PREBIOTICS 9h

Probiotics – definition , potential benefits , strains, advantages and disadvantage, genomics of probiotic lactic acid bacteria : impact on functional foods ; prebiotics: definition, types of new prebiotics and their bifidogenic effects, health effects of prebiotics and synbiotics .

BIOTECHNOLOGICAL APPROACHES TO MODIFY FOOD 9h

Biofortification of food crops : rice, wheat , maize; Modern biotechnology for the production of dairy products; Modification of poultry and egg : genetic modification of the birds for meat and egg types birds, Bacterial food additives and dietary supplements ; biotechnological modification of *Saccharomyces cerevisiae.*

FOOD SAFETY, TOXICITY & SECURITY 9h

Food safety: definition , hazardous substances in foods :microbial contamination , environmental contamination, natural toxins , agricultural residues, regulatory agencies, introduction to food laws in force in India; food security; case study on nutritional consequences of poverty & food security in developed countries.

TOTAL 45h

REFERENCE(S):

1.Shankuntala Manay N and Shadaksharaswamy M ,2009. Foods : facts and principles – 3rd edition , New Age International Publishers , India.
2. Sri Lakshmi B ,2007. Food Science, New Age International Publishers , India.
3. Potter N.N. 1996. Food science. CBS publishers & distributors, Delhi.
4. Food microbiology - Adams, M.R. and Moss M.O.
5.Jim Mann & Stewart A Truswell, 2007.Essentials of human nutrition,3rd edition.Oxford university press.
6. Shubhangini Joshi,2010.Nutrition and dietetics with Indian case studies,3rd edition,Tata McGraw Hill publication.

U13BTP501 CHEMICAL ENGINEERING LAB 0 0 4 2

OBJECTIVE

To provide extensive knowledge on various unit operations and flow measuring equipments involved in bioprocess industries

COURSE OUTCOME(S):

CO1. Understand the important of fluid mechanics applications.
CO2. Experiment and learn the mechanical operations.
CO3. Understand the heat transfer concept and its applications.
CO4. Experiment the mass transfer concepts applicable in biotech industries.

LIST OF EXPERIMENTS

1. Flow measurement – Venturimeter / Orificemeter / Rotameter
2. Flow through pipes – Straight / Annular
3. Pressure drop studies – Packed / Fluidized beds
4. Size Reduction Equipment – Jaw Crusher
5. Screening Equipments – Rotap / Gyratory
6. Filters – Plate and Frame / Rotary Drum / Vacuum Leaf
7. Heat Losses in Pipes
8. Heat Exchangers – Shell and Tube / Double Pipe
9. Evaporator – Film Type Long Tube
10. Distillation – Simple / Steam / Packed
11. Extraction / Adsorption / Leaching
12. Batch Sedimentation

TOTAL : 45 h

REFERENCE(S):

1. Geankoplis C.J.(2002) *Transport Processes and Unit Operations*, 3rd Edition, New Delhi: Prentice-Hall of India Private Limited.
2. Warren L.Mc Cabe., Julian C.Smith.,& Peter Harriot., (2005), *Unit Operations of Chemical Engineering*, 7th edition ,New Delhi: Tata McGraw Hill.
3. S. K. Ghosal, S. K. Sanyal & S. Datta,(1993), *Introduction to Chemical Engineering*, New Delhi: Tata McGraw Hill.

U13BTP502 ENZYME TECHNOLOGY LAB 0 0 4 2

OBJECTIVES:

- Provide hands-on training on the assay of different enzymes and kinetics
- To familiarize the students with solid state fermentation and its applications
- To expose the students to the proper handling of fermenters

COURSE OUTCOMES:

The students will be able to

CO1. Understand the important microbes as source of enzymes

CO2. Experiment to determine enzyme kinetics and properties of enzymes

CO3. Explain the production and applications of enzymes

LIST OF EXPERIMENTS:

1 Isolation of industrially important microbes
2 Enzyme assay - α-Galactosidase / protease / laccase / xylanase / cellulase
3 Partial purification of enzymes by acetone precipitation
4 Enzyme kinetics – Michaelis-Menten parameters
5 Enzyme inhibitions
6 Effect of temperature and pH on enzyme activity
7 Enzyme immobilization – Gel entrapment / cross-linking
8. Hydrolysis of raffinose and stachyose by immobilized α-galactosidase
9. Production of enzymes by SSF using agriculture residues
10. Degradation of recalcitrant dyes with immobilized enzymes / cells

REFERENCE(S):

1. Sadasivam.S and Manickam, A (2008), 3rd Ed, New Age International Publishers, India
2. Ninfa. A.J, and Ballou. D.P (1998) Fundamental Lab approaches for biochemistry and biotechnology, 2nd Edn, Oxford University press, UK.

U13BTP503 MOLECULAR BIOLOGY LAB 0 0 4 2

OBJECTIVES

- To develop practical skills related to preparation of reagents for molecular biology experiments, handling equipments in molecular biology lab
- To impart hands-on training to handle DNA and protein related molecular techniques
- To understand DNA mutation and repair pathway in bacteria

COURSE OUTCOMES:

The students will be able to

CO1. Estimate and prepare reagents for molecular biology experiments.
CO2. Experiment to isolate DNA and RNA from various biological tissues.
CO3. Analyse and interpret DNA and RNA.
CO4. Explain the activity of restriction enzymes on DNA

LIST OF EXPERIMENTS

1. Preparation of reagents, handling equipments and Lab safety in molecular biology lab
2. Isolation of genomic DNA from bacteria/plant
3. Agarose gel electrophoresis of DNA
4. Purification of DNA by PCI method
5. Quantification of DNA using UV spectrophotometer
6. Molecular weight determination of DNA using agarose gel electrophoresis
7. SDS-PAGE of proteins
8. Demonstration of bacterial conjugation
9. Phage titration
10. Understanding DNA mutation using UV light exposure of bacteria

.

REFERENCE(S):

1. Sambrook et al., (2001) Molecular Cloning: A Lab Manual, 3rd ed., Cold Spring Harbour, NY: Cold Spring Harbour Lab Press

U13GHP501 SOCIAL VALUES 1 0 1 1

(Common to all branches of Engineering and Technology)

Course Objectives

- To produce responsible citizens to family and society
- To uplift society by pure politics and need education
- To realize the value of unity, service
- To immunize the body
- To get divine peace through inward travel

Course outcomes

After successful completion of this course, the students should be able to

CO1: Learn knowledge on the Duties and Responsibilities. (20%)
CO2: Demonstrate skills required for the Disparity among human being (20%)
CO3: Behave as a responsible Politics and Society & Education and Society (30%)
CO4: Analyze Impact of Science in Society (30%)

Course Content

1. Evolution of man – Man in society.
2. Duties and Responsibilities, Duty to self, family, society and the world.
3. Disparity among human beings.
4. Social welfare – Need for social welfare – Pure mind for pure society.
5. Politics and society – Education and society-Case study and live examples.
6. Impact of science in society - social development & society upliftments by science.
7. Economics & society – role of economics in creating a modern society.
8. Central message of Religions.
9. Yogasanas-I
10. Meditation-II [Thuriatheetham]

References

1. World peace plane ---- Vethathiri Maharishi
2. Prosperous India ---- Swami Vivekananda
3. Samudhaya chikkalukkana nala Aaivugal ---- Vethathiri Maharishi
4. World Community Life ---- Vethathiriyam

SEMESTER VI

U13BTT601 BIOPHARMACEUTICAL TECHNOLOGY 3 0 0 3

OBJECTIVES

- To learn basic concepts of Drug manufacture
- To understand Drug action and Drug metabolism
- To enable students to take up research and development projects in the area of Biotechnology and Biopharmaceutical in the industry.

COURSE OUTCOME(S)

CO1. Outline drug standards and pharmacopoeia commission
CO2. Describe the principles of drug action and mechanism of action
CO3. Discuss and obtain knowledge on the drug development and manufacture process
CO4. Explain the principles and materials involved during the drug manufacture in pharmaceutical industries
CO5. Discuss the clinical uses of biopharmaceutical therapeutics

OVERVIEW OF PHARMACEUTICALS 7h

Introduction to drugs and pharmacy: History of pharmacy & pharmaceutical industry, age of biopharmaceutical, drug standards (United States Pharmacopeia & Indian Pharmacopeia), Drug regulation and control- Food and Drug Administration (FDA), New Drug Application (NDA), Indian Pharmacopoeia commission (IPC).

PHARMACOKINETICS AND PRINCIPLES OF DRUG ACTION 9h

Route of drug administration - Enteral and parenteral, Pharmacokinetics - Drug Absorption, Distribution, Metabolism and Elimination (ADME); factors influencing ADME process; Pharmacodynamics – basic principles of drug action, Mechanism of drug action, through enzymes, drug receptor interactions; radiopharmaceutical.

DRUG DEVELOPMENT AND MANUFACTURE PROCESS 9h

New Drug development: Drug discovery, patenting, preclinical and clinical trials, and regulatory authorities; Manufacturing process: special manufacturing facilities, sources of biopharmaceuticals, production of final product and analysis of the final product. Good Manufacturing Practice (GMP).

PRINCIPLES OF DRUG MANUFACTURE IN PHARMACEUTICALS 10h

Dosage form design: Need for dosage forms, General considerations in Dosage form design; Solid dosage forms – powders, granules, capsules and tablets; Semisolid dosage forms – ointments, creams and gels; transdermal drug delivery system; Pharmaceutical inserts – suppositories and inserts; Liquid dosage forms – solutions; Sterile dosage forms – parenteral (injections), Biologics (vaccine).

BIOPHARMACEUTICAL THERAPEUTICS AND CLINICAL USES 10h

Various categories of therapeutics and uses: Cytokines – interferon, interlukins, tumour necrosis factor. Heamopoietic growth factors – Colony stimulating factor (granulocyte, macrophage), erythropoietin. Hormones – insulin, glucagons . Antibodies – polyclonal and monoclonal. Vaccine – attenuated and inactivated bacteria, viral vaccine. Gene therapy – basic approach, vectors used in gene therapy and clinical uses of gene therapy.

TOTAL : 45h

REFERENCE(S):

1. Gary Walsh. (2005) Biopharmaceutical technology-biochemistry and biotechnology, 1st Edition, John Wiley and Sons, Ltd.
2. Ansel H.C., et al. (2007) Pharmaceutical dosage forms and drug delivery systems- 8th edition, Lippincott Williams & Wilkins.
3. Richard D. Howland. (2007) Lippincott's illustrated reviews: Pharmacology. 7th Edition, Lippincott Williams & Wilkins.
4. Remington (2000) Pharmaceutical sciences, 20th edition, Mack publishing and Co., PA
5. Troy, D. B (2006) Remington: the Science and practice of Pharmacy, 21st edition. Vol I & II., Lippincott Williams & wilkins., New york.
6. Katzung B.G. (2000) Basic and Clinical Pharmacology, Prentice Hall Intl.

U13BTT602 BIOPROCESS ENGINEERING 3 1 0 4

OBJECTIVES

- To learn basics of designing of stirred tank reactors and configuration of various bio-reactors
- To learn to modeling and simulation in bioprocesses
- To learnt the various process strategies for recombinant cell cultivation methods

COURSE OUTCOMES:

CO1. Illustrate the various models used for analysis of bioreactor stability

CO2. Explain the importance of mass transfer coefficient in bioprocess

CO3. Illustrate the various physico-chemical and biochemical parameters monitored in bioprocess

CO4. Explain the various modern biotechnology process

CO5. Describe the various structured models used in bioprocess engineering

OPERATIONAL MODES OF BIOREACTORS 10+3 h

Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment,
two stage cultivation, packed bed reactor, airlift reactor, fluidized bed reactor, bubble column reactors

BIOREACTOR SCALE-UP 8+3 h

Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS 8+3 h

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

MODELLING AND SIMULATION OF BIOPROCESSES 12+3 h

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism. Introduction to simulation packages.

RECOMBINANT CELL CULTIVATION 7+3 h

Different host vector system for recombinant cell cultivation strategies and advantages. *E.coli*, yeast *Pichia pastoris/ Saccharomyces cereviseae*, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system

TOTAL: 45+15=60 h

REFERENCES:

1. Lee, James M. "*Biochemical Engineering*", Prentice Hall India,1992.
2. Shuler, M.L. and Kargi, F. "*Bioprocess Engineering: Basic Concepts*", 2nd Edition, Prentice Hall India,2002.
3. Bailey, J.E. and Ollis, D.F. "*Biochemical Engineering Fundamentals*" 2nd Edition, McGraw– Hill, 1988.
4. Blanch, H.W. and Clark, D.S. "*Biochemical Engineering*", Marcel Decker Inc., 1997.
5. Moser, Anton. "*Bioprocess Technology : Kinetics and Reactors*", Springer – Verlag, 1988.
6. Stanbury, P.F. etal. "*Principles of Fermentation Technology*", 2nd Edition, Butterworth – Heinemann / Elsevier, 1995.

U13BTT603 PROTEIN ENGINEERING 3 0 0 3

OBJECTIVES

- To learn basic concepts of properties of amino acid, peptides and proteins
- To understand the relationship between protein structure and function
- To learn methods that are used to modify the protein for intended applications

COURSE OUTCOMES

CO1. Describe high-throughput techniques in protein characterization (2-D, MS)
CO2. Understand various secondary and tertiary structures of proteins
CO3. Learn methods to engineer the proteins

AMINOACIDS, PEPTIDES & THEIR CHARACTERSTICS 10 h

Amino acids, peptides and their molecular properties, Post-translational modification of proteins- involving amino, carboxyl, hydroxyl, thiol & imidazole groups; Covalent and non-covalent interactions in proteins; Ramachandran plot, peptide mapping, Solid phase peptide synthesis. Protein separation techniques- 1-D and 2-D gel electrophoresis.

PROTEIN ARCHITECTURE-I 8 h

Primary structure- Peptide mapping, Peptide sequencing – automated Edman method & mass-spectrometry, High-throughput protein sequencing setup (MALDI-TOF, MS-MS), Circular dichroism; Secondary structure- Alpha, beta and loop structures, Methods to determine super- secondary (motif)) structure, Helix-turn-helix, hairpin β motif, Greek key motif, Beta-alpha-beta motif, topology diagrams, up and down, & TIM barrel structure; nucleotide binding folds, Prediction of substrate-binding sites.

PROTEIN ARCHITECTURE-II 9 h

Tertiary structure- Domains (α, β and α / β), Protein folding; denaturation and denaturation, Overview of methods to determine 3D structures of proteins (NMR and X-ray diffraction). Quarternary structure- Modular nature, formation of complexes

PROTEIN STRUCTURE-FUNCTION RELATIONSHIP 9 h

DNA-binding proteins- Prokaryotic transcription factors, helix-turn-helix motif of trp-repressor & cro protein in DNA binding; Eukaryotic transcription factors- TATA box-binding proteins, TFIIA, TFIIB; Homeodomain, Zn-fingers, Lecucine zippers. Membrane Proteins: General characteristics, K-Channel, Bacteriorhodopsin, and Photosynthetic reaction center; Immunoglobulins- IgG Light chain and heavy chain architecture, Abzymes; Enzymes- Serine proteases-Understanding catalytic design by engineering trypsin, chymotrypsin and elastase, Substrate-assisted catalysis, other commercial applications of engineered proteins.

PROTEIN ENGINEERING AND APPLICATIONS 9 h

Advantages and purpose - Overview of methods, Underlying principles with specific examples - Thermal stability of T4-lysozyme, *de novo* protein design, *In silico* engineering of proteins, Recombinant insulin, HIV and aspartate protease

Case study: Design and expression of heterologous protein (insulin) in *Pichia pastoris*

REFERENCE(S):

1. Branden C and Tooze J, (1999), Introduction to Protein structure, 2nd Edition, Garland Publishing.
2. Garland Publishing, NY, USA.Voet D., Voet G (2008), Biochemistry, 3rd edition, John Wiley & Sons.
3. Pravin Kaumaya (2012), Protein Engineering, InTech Publishers, Open Access Book.
4. Moody P.C.E. & Wilkinson AJ, (1990), Protein Engineering, IRL press, 2ND Edition Oxford, UK.
5. Creighton T.E., (2002), Proteins, Freeman, WH, 2nd Edition
6. Schulz, G.E.and Schirmer, RH, (2003), Principles of protein structure, 3rd edition, Springer.
7. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2763986/

8.www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijbt/ijbt2k6/ijbt_july06.asp

U13BTT604 CHEMICAL REACTION ENGINEERING 3 1 0 4

OBJECTIVE(S)

To make the students to understand the concepts of reaction mechanism and kinetics and reactor design for biochemical and microbial reactions

COURSE OUTCOME(S):

CO-1 – Understand the basic laws on chemical kinetics and its application on different types of reactions.
CO2 – Learn the various ideal reactors and their design equations
CO3 – Describe the non ideal behavior of reactors
CO4 – Understand the basic of heterogeneous reacting systems
CO5 – Explain the various multiphase reactors and their applications in biotech industries

CHEMICAL REACTION KINETICS **12 h**

Classification of chemical reactions, order and molecularity, rate equation, rate constant; Activation energy, Concentration and temperature dependence; Search for reaction mechanism, Methods of analyzing batch reactor data - Integral and differential, Analysis of total pressure data obtained in constant volume system

IDEAL REACTORS **12 h**

Performance equations - batch, plug flow and mixed flow reactors; Space time and Space velocity; Size comparison of single reactors, multiple reactor systems, Recycle reactor and autocatalytic reactions, Case examples in bioprocess engineering

NON-IDEAL REACTORS **12 h**

Reasons for non-ideality in reactors; RTD function and measurement; RTD in plug flow and mixed flow reactor ;conversion in non ideal flow, relation among E,F and C curve, non - ideal flow models- tank in series and dispersion models.

HETEROGENEOUS REACTING SYSTEM **12 h**

Introduction to heterogeneous reacting systems, Ideal contacting patterns, Solid catalysed reactions - Surface kinetics and pore resistance, Kinetics of non catalytic fluid particle systems - Progressive conversion model and shrinking core model, Determination of rate controlling step

INDUSTRIAL REACTORS **12 h**

Reactors to carry out G/L reactions on solid catalysts - Trickle bed, slurry, three phase fluidized bed, fluid-fluid and fluid-particle reactors

TOTAL: 60 h

REFERENCE(S):

1. Levenspiel, Octave (1999),*Chemical Reaction Engineering*, 3rd Edition, Hoboken/New Jersey:John Wiley & Sons.
2. Fogler, H.S.(1999), *Elements of Chemical Reaction Engineering*, 2nd Edition, New Delhi: Prentice Hall of India.
3. Richardson, J.E .,D.G. Peacock,Coulson & Richardson *Chemical Engineering*", Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, United Kingdom: Butterworth – Heinemann/ Elsevier.
4. Nauman, E. Bruce (2002), *Chemical Reactor Design, Optimization, and Scaleup*, New Delhi: Tata McGraw Hill.

U13BTP601 GENETIC ENGINEERING LAB 0 0 4 2

OBJECTIVES

- To develop practical skills related to gene cloning
- To impart practical knowledge on use of rDNA techniques

COURSE OUTCOME:

The students will be able to

CO1. Design primers for PCR and analyse PCR product.

CO2. Reconstruct and analyse a recombinant DNA from cloned DNA fragment.

CO3. Analyse recombinant protein using SDS-PAGE separation.

LIST OF EXPERIMENTS

1. PCR amplification of DNA fragment
2. Elution of DNA from agarose gel
3. Isolation of plasmid vector (pUC19)
4. Restriction digestion of vector DNA
5. Ligation of PCR product and vector
6. Preparation of competent cells of *E.coli*
7. Transformation of competent cells by heat-shock method
8. Selection of recombinant clones using blue & white selection
9. Confirmation of presence of insert in the recombinant clone by restriction digestion
10. DNA fingerprinting by RAPD analysis

REFERENCES:

1. Sambrook et al., (2001) Molecular Cloning: A Lab Manual, 3rd ed., Cold Spring Harbour, NY: Cold Spring Harbour Lab Press

U13BTP602 BIOPROCESS LAB 0 0 4 2

OBJECTIVES:

- Provide hands-on training on the operation of fermenters
- To familiarize the students with microbial growth kinetics
- To know mass transfer in fermenters and production of metabolites

COURSE OUTCOMES:

The students will be able to

CO1. Experiments to estimate the growth kinetics of bacteria in batch, fed-batch and continuous fermentation

CO2. Analyze and interpret mass transfer in bioreactors

CO3. Explain the production of various microbial products

LIST OF EXPERIMENTS:

1. Batch sterilization design
2. Batch cultivation - calculation of μ and product formation rate (Yp/s)
3. Fed-batch cultivation - calculation of μ and product formation rate (Yp/s)
4. Continuous cultivation – pulse and shift method and & Yp/s
5. Medium optimization by Plackett-Burman design
6. Estimation of K_La – sulfite oxidation method
7. Estimation of K_La – power correlation method
8. Residence Time Distribution (RTD)
9. Production of microbial metabolites (enzymes / antibiotics)
10. Production of biofertilizer / biopesticides / mushroom

REFERENCE:

1. Ninfa. A.J, and D.P. Ballou (1998) Fundamental Lab approaches for biochemistry and biotechnology, 2st Edition, Oxford University press, UK.

U13ENP401 COMMUNICATION SKILLS LAB 0 0 3 1

(Common to all branches of Engineering and Technology)

(Method of End Semester Evaluation : Practical : 60 marks, Online Exam : 40 marks)

OBJECTIVE:

- To impart communicative ability to exhibit the individual's subject knowledge
- To achieve the desirable communicative competence by the students to meet the expectation of corporate
- To show the need for a comprehensive link language to share subject expertise
- To offer adequate exposure to soft skills needed for the corporate.
- To sensitize towards corporate culture.

GRAMMAR IN COMMUNICATION 9 periods

Grammar and Usage – Building Blocks, Homonyms, Subject and Verb Agreement, Error Correction - Grammar Application, Framing Questions – Question words, Verbal Questions, Tags, Giving Replies –Types of Sentences, Listening Comprehension –Listening and Ear training.

ASSERTIVE COMMUNICATION 9 h

Listening Comprehension in Cross–Cultural Ambience, Telephonic Conversations/Etiquette, Role Play Activities, Dramatizing Situations- Extempore – Idioms and Phrases.

CORPORATE COMMUNICATION 9 h

Video Sensitizing, Communicative Courtesy – Interactions – Situational Conversations, Time Management, Stress Management Techniques, Verbal Reasoning, Current Affairs – E Mail Communication / Etiquette.

PUBLIC SPEAKING 9 h

Giving Seminars and Presentations, Nuances of Addressing a Gathering - one to one/ one to a few/ one to many, Communication Process, Visual Aids & their Preparation, Accent Neutralization, Analyzing the Audience, Nonverbal Communication.

INTERVIEW & GD TECHNIQUES 9 h

Importance of Body Language –Gestures & Postures and Proxemics, Extempore, Facing the Interview Panel, Interview FAQs, Psychometric Tests and Stress Interviews, Introduction to GD, Mock GD Practices.

TOTAL: 45 h

REFERENCES:

1. Bhatnagar R.P. & Rahul Bhargava, "English for Competitive Examinations", Macmillian Publishers, India, 1989, ISBN: 9780333925591
2. Devadoss K. & Malathy P., "Career Skills for Engineers", National Book Publishers, Chennai, 2013.
3. Aggarwal R.S., "A Modern Approach to Verbal & Non–Verbal Reasoning", S.Chand Publishers, India, 2012, ISBN : 8121905516

U13GHE601 NATIONAL VALUES 1 0 0 1

(Common to all branches of Engineering and Technology)

Course Objectives

- To produce responsible citizens
- To uphold our culture and spiritual life
- To realize the value of unity, service
- To immunize the body
- To get divine peace through inward travel

Course Outcome

After successful completion of this course, the students should be able to

CO1: Acquire knowledge on the Enlightened Citizenship.(30%)
CO2: Demonstrate skills required for the Indian Culture and it's greatness. (20%)
CO3: Behave as a responsible Great spiritual Leaders. (20%)
CO4: Analyze National Values identification and practice. (30%)

Course Content

1. Citizenship- its significance-Enlightened citizenship.
2. Emerging India-it's glory today- Global perspective-other view about India.
3. Indian culture and it's greatness.
4. India and Peace.
5. India and Spirituality- Great spiritual leaders.
6. India's message to the world – it's role in global peace.
7. Service and sacrifice-Unity in diversity – case studies-live examples.
8. National values identification and practice.
9. Yogasanas -II
10. Meditation III [Nithyanandam& Nine Centre Meditation]

References

1. World peace plane ---- Vethathiri Maharishi
2. Prosperous India ---- Swami Vivekananda
3. Samudhaya chikkalukkana nala Aaivugal ---- Vethathiri Maharishi
4. World Community Life ---- Vethathiriyam

SEMESTER VII

U13BTT701 BIOINFORMATICS 3 0 0 3

OBJECTIVE(S)

- To learn the fundamentals of network models and protocols
- To understand dynamic programming and heuristics methods in sequence alignment
- To learn the basics of phylogenetic, microarray analysis

COURSE OUTCOME(S):

Students' would be able to:

CO1. Quote various type of network protocols and topology
CO2. Classify the biological databases and apply the dynamic programming for sequence analysis
CO3. Apply, solve and interpret pairwise and multiple sequence analysis of macromolecules
CO4. Demonstrate and construct the phylogenetic tree
CO5. Describe the structure prediction methods and microarrays

NETWORK PROTOCOLS AND TOPOLOGY 9 h

Operating systems- types; Basic MSDOS and UNIX commands; Network types; Network Hardware (Media); Network topology – Star, bus, tree & ring; Network Protocols – TCP/IP and ftp; basic concepts of search engines.

DATABASES AND DYNAMIC PROGRAMMING 9 h

Introduction to database technology – Biological databases; Primary nucleotide databases (EMBL, GeneBank and DDBJ) – Primary protein databases (SwissProt, TrEMBL and PIR) - Dot matrix analysis; Pairwise sequence alignment – local vs. global alignment; Dynamic programming – Needleman –Wunsch algorithm & Smith – Waterman algorithm.

HEURISTICS METHODS 9 h

Substitution matrices – PAM & BLOSUM; Heuristics methods – FASTA & BLAST; Multiple sequence alignment – Sums of pairs method (SP), CLUSTAL W, SAGA, applications; Machine learning – Hidden Markov models.

PHYLOGENY ANALYSIS 9 h

Introduction to mutations – Substitution, insertion and deletion mutations; Molecular Clock theory; Jukes-Cantor and Kimura's model- Phylogenetic tree construction – distance matrix method – Unweighted pair group method of arithmetic mean (UPGMA), Fitch-Margoliasch algorithm (FM), Neighbor – Joining method (NJ); Character based methods – Maximum parsimony and maximum likelihood - Bootstrapping technique

ADVANCED TOPICS IN BIOINFORMATICS 9 h

Micro array analysis – Spotted and oligonucleotide arrays; Clustering gene expression profiles – Hierarchical clustering, Nearest neighboring clustering, Unweighted pair group clustering; Protein secondary structure prediction – Chow-Fasman method, Systems biology – Introduction to metabolic pathways; Introduction to computer aided drug design (CAD)

TOTAL : 45 h

REFERENCE(S):

1. Bergeron.B (2009). “Bioinformatics Computing”, Second Edition, India, Prentice Hall of India Learning Pvt (Ltd).

2. Attwood, T.K & ParrySmith.D.J (2002). “Introduction to Bioinformatics”, First Edition, India, Pearson Education Asia.

3. Rastogi,S.C, Mendiratta.N and Rastogi.P (2006). “Bioinformatics – Methods & Applications: Genomics, Proteomics and Drug Discovery”, Second Edition, India, Prentice Hall of India Learning Pvt (Ltd).

4. Gibas.C & Jambeck.P (2001). “Developing Bioinformatics Skills”, First Edition, USA, O'Reilly Media.

5. David W.Mount. (2004). “Bioinformatics – Sequence & Genome Analysis”, Second Edition, USA, Cold Spring Harbor Lab.

RELEVANT WEB ADDRESSES (subject to change):

1. http://mally.stanford.edu/~sr/computing/basic-unix.html
2. http://www.networktutorials.info/topology.html
3. http://bioinfo.ernet.in/s-star/downloads/tutorial/t1b.pdf
4. http://www.avatar.se/molbioinfo2001/seqali-dyn.html
5. http://www.clcbio.com/index.php?id=1046
6. http://www.ncbi.nlm.nih.gov/Education/BLASTinfo/BLAST_algorithm.html
7. http://www.ncbi.nlm.nih.gov/About/primer/phylo.html

U13BTT702 DOWNSTREAM PROCESSING 3 0 0 3

OBJECTIVES

To learn about the various purification methods available to obtain the biomolecules

COURSE OUTCOME:

CO1. Describe the importance of downstream processing in biotechnology

CO2. Illustrate the solid-liquid unit operation involved in downstream processing

CO3. Explain the various enrichment operations applied for protein purification

CO4. Describe the various methods of chromatography used in protein purification

CO5. Explain the principle involved in product polishing and formulation

ROLE OF DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 7h

Introduction to Downstream processing principles, Economics of downstream processing in Biotechnology, Characteristics of Biomolecules and bioprocesses. Cell disruption methods for intracellular products release: Mechanical methods, Chemical and Enzymatic methods

PRIMARY SEPARATION AND RECOVERY PROCESSES 9h

Unit operations for solid-liquid separation-Filtration (General theory for filtration, Types of equipments, batch-continuous, pretreatment methods) and Centrifugation (General theory for Centrifugation, Types of centrifuges, Scale-up of centrifugation, centrifugal filtration)

ENRICHMENT OPERATIONS 12h

Adsorption, Extractive separation: Solvent extraction, Aqueous Two Phase and Three Phase Extractions, Riverse Micelle Extraction, Super Critical Extraction. Precipitation methods: Salts, Organic solvents and polymers, Membrane Based Separation: Ultrafiltration, Reverse Osmosis, Dialysis and Electrodialysis.

PRODUCT PURIFICATION 10h

Chromatographic Principles: Distribution coefficients, retention parameters, qualitative and quantitative aspects of chromatography-Column Efficiency, Selectivity and Resolution. Size exclusion Chromatography, Ion exchange chromatography, Reverse phase chromatography, hydrophobic chromatography, Affinity chromatography, isoelectric focusing and its applications.

PRODUCT POLISHING AND FORMULATION 7h

Crystallization: Methods of super saturation, types of nucleation and crystal growth, Material and energy balance, yield of crystal, Types of crystallization. Drying: types of moistures, batch drying process, mechanism of drying, drying time calculation, Industrial dryers, Lyophilization and product formulation.

Total:45h

REFERENCE(S):

1. BIOTOL series-(1995) '*Product recovery in Bioprocess Technology*', VCH publications.
2. Belter P.A, Cussler,E.L and Wei-Houhu (1988)'*Bioseparations- Downstream Processing for Biotechnology*', Wiley Interscience Publications, USA
3. Roger G.Harrison, Paul Todd, Scott R.Ruger and Demetri P. Petrides. (2009) '*Bioseparation Science and Engineering*', oxford University Press, 2nd ed. NewYork.
4. Sivashankar, B (2005) '*Bioseparation : Principles and Techniques*' Prentice Hall of India, New Delhi.
5. Jansons. J.C and Ryden L. (Ed) (1989)-'*Protein purification-Principles, High Resolution Methods and Application*'. VCH Publications
6. Scopes, R.K., (2005) *Protein Purification – Principles and Practice*, 2nd ed. Narosa Publications.

U13BTT703 **IMMUNOLOGY** **3 0 0 3**

OBJECTIVES:

- To learn about the basic molecules and mechanisms by which a human body fights with a pathogenic microbe
- To study about the various immunological techniques and their applications

COURSE OUTCOME:

CO1 – Outline the general concepts of immune system and describe the cells and organs of the immune system
CO2 – Describe the properties of antigens and antibodies with special emphasis on haptens
CO3 - Demonstrate various antigen-antibody interactions and techniques
CO4- Explain the concept of cell mediated immunity and complement system
CO5- Illustrate the mechanisms behind hypersensitivity and transplantation immunology

CELLS AND ORGANS OF IMMUNE SYSTEM **9h**

Historical background, general concepts of the immune system. Innate and adaptive immunity. Structure, properties and functions of the immune cells & organs: Hematopoeisis, T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils Mast cells and dendritic cells. Thymus and bone marrow; Lymph nodes, spleen, MALT, GALT and CALT.

ANTIGENS AND ANTIBODIES **9h**

Antigens and haptens; Properties; Adjuvants. B and T cell epitopes. T-dependent and T-independent antigens. Antibodies: Classification, Structure, function and properties of the antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype).

TECHNIQUES OF ANTIGEN-ANTIBODY INTERACTIONS **9h**

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA - types , Western Blotting. Hybridoma technology-Monoclonal antibodies production and applications.

Case study - Applications of monoclonal antibodies as immunodiagnostics.

CELL MEDIATED IMMUNITY & COMPLEMENT **9h**

Major histocompatibility gene complex: Organization of MHC- Types and Functions, Structure and cellular distribution of HLA antigens. Cell mediated immunity: Cell types (CTLs, NK cells, macrophages and TDTH cells), effector mechanisms and effector molecules of cell mediated reactions. Cytokines – interleukins and interferons (outline only).Complement system: Components of the complement activation - classical, alternative and lectin pathways. Biological consequence of complement activation and complement deficiencies.

HYPERSENSITIVITY & TRANSPLANTATION IMMUNOLOGY 9h

Hypersensitivity: Types and mechanism of hypersensitive reactions Autoimmunity: Mechanisms of induction of organ specific and systemic, autoimmune diseases. Therapeutic approach. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, properties and types of rejection, tissue typing, immunosuppressive therapy. Immunity and tumors: Types of tumors, tumor antigens (TSTA and TATA), immune response to tumors.

Case study - Tumor immunology

REFERENCE(S):

1. Kuby, J. H. (2007). *Immunology*, 6th Edn., New York, USA,W. H. Freeman Publication,
2. Abbas, K. A., Litchman, A. H. and Pober, J. S. (2007). *Cellular and Molecular Immunology*, 4th Edn., Pennsylvania, USA, W. B. Saunders Co.
3. Roitt, I., Brostoff, J. and David, M. (2008). *Immunology*, 11th Edn., New York, USA Mosby publishers Ltd.
4. Tizard, R.I. (2007). *Immunology*, 4th Edn., Chennai ,Saunders college publishing, Microprint Pvt. Ltd., Chennai.

U13BTT704 IPR, BIOSAFETY AND BIOETHICS 3 0 0 3

OBJECTIVE

- To provide knowledge on various aspects of intellectual property
- To learn procedures for patenting
- To learn concepts of bioethics and biosafety

COURSE OUTCOME:

CO1. Students able to understand different forms of Intellectual property.

CO2. Students should understand types of patents and patenting system in India.

CO3. Students should learn International patenting procedures and Patent infringements

CO4. Students can able to learn different institutional biosafety guidelines and Biosafety levels of infectious agents,

CO5. Students should understand GMO's and their Environmental release.

INTRODUCTION TO INTELLECTUAL PROPERTY 9h

Types of IP- Patents, Trademarks, Copyright, Industrial Designs, Trade Mark, Trade secret and Geographical Indications; International framework for the protection of IP; Objective and functions of GATT, WTO, WIPO and TRIPS; Farmers rights.

BASICS OF PATENTS AND PATENT DATABASES 9h

Indian Patent Act 1970- Recent Amendments; Types of patents; Role of a Country Patent office; Patent applications-Forms and guidelines, fee structure, time frames;Types of patent application-provisional and complete specification; Concepts of Prior art; Patent databases-India, USPTO, and EPO.

NATIONAL AND INTERNATIONAL PATENT AND INFRINGEMENT 9h

PCT-Procedure for filing a PCT application; International patenting-requirement and cost; Publication of patents- India, Europe and US; Patent infringement- Introduction, Type of patent infringement- Case study with examples.

BIOSAFETY 9h

Introduction to Biological safety cabinets; Primary and secondary containments; Biosafety levels of specific Microorganisms, Infectious Agents and infected animals; Biosafety guidelines- GOI; Role of biosafety committee- RCGM, GEAC.

GMOs AND BIOETHICS **9h**

Definition of GMOs- GMO applications in food and agriculture; Environmental release of GMOs- Risk analysis, Risk assessment, Risk management and Communication; Overview of national regulation and international agreement - Cartagena protocol.

Total: 45h

REFERENCE(S):

1. Singh. K, (2010) "Intellectual Property Rights in Biotechnology" BCLI, New delhi.
2. Shaleesha A. Stanley, (2007) 'Bioethics' Wisdom educational service, Chennai.
3. Erbisch,F H and Maredia,K M (1998) Intellectual property rights in agricultural biotechnology Universities Press (India) Ltd.
4. Rajiv Jain and Rakhee Biswas,(1999) Law Of Patents, Procedure & Practice,Vidhi Publication.

U13BTP701 BIOINFORMATICS LAB 0 0 4 2

OBJECTIVE(S)

- To understand the methodology of sequence analysis, gene prediction, and programming
- To learn and have hands-on training in the basic techniques of Bioinformatics

COURSE OUTCOME(S):

CO1. Students learn to retrive biological sequence and structure files and do analysis using them
CO2. Design primers and conduct insilico pcr experiments
CO3. Write simple programs and carry out ligand-protein docking

LIST OF EXPERIMENTS

1. Biological Databanks - Sequence and structure databases and Database file formats
2. Sequence analysis using EMBOSS – Dynamic programming
3. Sequence similarity searching by Heuristics method
4. Multiple sequence alignment (CLUSTAL W) and Molecular phylogeny
5. Protein sequence analysis using ExPAsY
6. Gene function prediction
7. Molecular visualization of protein structure using RASMOL
8. DNA rational probe design and analysis
9. Insilico Primer design and PCR
10. Protein – ligand docking
11. Sequence analysis using Perl programming

TOTAL : 45 h

REFERENCE(S):

1. Mani.K and Vijayaraj.N (2004). Bioinformatics a Practical Approach, Aparna Publications, India.

U13BTP702 DOWNSTREAM PROCESSING LAB 0 0 4 2

OBJECTIVES

To develop skills of students perform in various purification techniques used in separation of biomolecules.

COURSE OUTCOME(S):

CO1. Separate the bacterial cells using membrane based separation
CO2. Demonstrate the cell disruption techniques
CO3. Purify and quantify the protein using chromatography
CO4. Demonstrate freeze drying experiments

LIST OF EXPERIMENTS:

1. Solid liquid separation by microfiltration
2. Cell disruption techniques by homogenization
3. Cell disruption techniques by ultrasonication
4. Partial purification of enzymes by ammonium Sulphate Fractionation
5. Enzyme concentration by ultra filtration
6. Aqueous two phase extraction of biological samples
7. Affinity chromatography
8. Ion exchange chromatography
9. Gel filtration chromatography
10. Lyophilization
11. HPLC demonstration

REFERENCE(S):

1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri Petrides (2002) *Bioseparations Science and Engineering*, Oxford University Press, USA

2. Robert K.Scopes, (2010) *Protein Purification: Principles and Practice*, IIIrd edition, Springer-verlag New York, USA

3. Rosenberg (Ian M) (2003) *Protein Analysis and Purification, Bench top techniques*, IInd edition, Springer International, New Delhi, India

U13BTP703 **IMMUNOLOGY LAB** **0 0 4 2**

OBJECTIVE(S)

1. To develop skills of students in Immunological techniques by performing simple experiments in the Lab
2. To perform techniques like blood grouping, ELISA, & identification of T-cell
3. To study the applications of immunotechniques

COURSE OUTCOMES:

CO1. Students understand various techniques related to immunology, like agglutination and precipitation reactions.
CO2. Understand and learn immuno cell sorting techniques.
CO3. Understand qualitative and quantitative immune-detection techniques.

LIST OF EXPERIMENTS:

1. Serum separation and storage
2. Blood smear identification of leucocytes by Giemsa stain
3. Identification of blood group
4. Separation of leucocytes by dextran method
5. Separation of mononuclear cells by Ficoll-Hypaque
6. Ouchterlony Double Diffusion Test and Single radial diffusion test
7. Immunoelectrophoresis & Rocket Immunoelectrophoresis
8. Widal test
9. Enzyme Linked Immuno Sorbent Assay (ELISA)
10. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)

REFERENCE(S):

1. Hudson L. and Hay H. C (2008) *Practical Immunology*. Blackwell Scientific Publications.
2. Frank C. Hay, F. C., Westwood, O. M. R., Nelson, P. N., and Hudson, W. L., (2006) *Practical Immunology*, Wiley-Blackwell Publications.

U13BTP704	MINI PROJECT	0 0 0 2

OBJECTIVES

1.To obtain research proficiency in biotechnology

COURSE OUTCOME

CO1. Develop skills for independent & team oriented research and process innovation
CO2. Analyze, evaluate, interpret and justify an experimental data
CO3. Write a dissertation report
CO4. Scientific Presentation skills

GUIDELINESS:

- Students should do mini project during the 3rd year summer vacation
- Evaluation will be done by an internal panel

U13BTP705	PROJECT (Phase1)	0 0 2 1

OBJECTIVES

1. To formulate a research problem and collect relevant literature

COURSE OUTCOME

CO1. Formulate an experimental design to solve biological problems
CO2. Conduct survey of literature
CO3. Scientific Presentation skills

GUIDELINESS:

1. Students should do carry out Project (Phase 1) under the guidance of a faculty member of the department
2. Evaluation will be done by an internal panel

U13GHE701 **GLOBAL VAUES** **1 0 0 1**

(Common to all branches of Engineering and Technology)

Course Objectives

- To realize global brotherhood and protect global
- To know the youths participation in politics
- To know importance of retain of our culture and maintain
- To know impact of global terrorism
- To know the current economic status among the youths

Course Content

After successful completion of this course, the students should be able to

CO1: Acquire knowledge on the complex patterns involved in maintaining world's peace and ecological balance. (20%)

CO2: Demonstrate skills required for the emergency of mono-culture at the global level. (30%)

CO3: Behave as a responsible human beings respecting the global values. (20%)

CO4: To learn about Man is the cause and Man is the solution.(30%)

Course Content

1. Global values – understanding and identification – its importance.
2. Racial discrimination and solution – Ecological imbalance and solution.
3. Political upheavals and solution – Social inequality and solution – live case discussions and debate.
4. Cultural degradation and solution – live case discussions and debate.
5. Emergence of monoculture – solution.
6. Global terrorism – it's cause and effect – solution.
7. Economic marginalization and solution – it's impact in the globe.
8. Man is the cause and man is the solution.
9. All Meditations.
10. All Yogasanas.

Practical: 30 Hrs Tutorial: 00 Hr **Total Hours: 30 Hrs**

References

1. World peace plane ---- Vethathiri Maharishi
2. Prosperous India ---- Swami Vivekananda
3. Samudhaya chikkalukkana nala Aaivugal ---- Vethathiri Maharishi
4. World Community Life ---- Vethathiriyam

SEMESTER VIII

U13BTP801	PROJECT (Phase 2)	0	0	18	6

OBJECTIVES

1. To obtain research proficiency in biotechnology

COURSE OUTCOME

CO1. Formulate an experimental design to solve biological problems
CO2. Develop skills for independent & team oriented research and process innovation
CO3. Analyze, evaluate, interpret and justify an experimental data
CO4. Write a dissertation report

GUIDELINESS:

1. Evaluation will be via continuous review followed by an external members panel

ELECTIVE SUBJECTS
(Semesters 5-8)

ELECTIVE I

U13BTE101 PLANT AND ANIMAL BIOTECHNOLOGY 3 0 0 3

OBJECTIVES

- To learn the fundamentals of plant and animal tissue culture
- To study plant and animal transgenesis
- To learn gene transfer techniques.

COURSE OUTCOMES

The students will be able to

CO1. Outline and learn the basics of plant tissue culture and requirements to setup the lab
CO2. Distinguish the direct and indirect gene transfer techniques in plants
CO3. Apply the techniques for development of transgenic plants
CO4. Outline and learn the basics of animal cell cultures and medium for growth
CO5. Distinguish and apply the techniques for development of transgenic animals

PLANT TISSUE CULTURE **9h**

Introduction to plant tissue culture; General requirements for plant tissue culture Lab; Preparation of tissue culture media; Callus culture; Suspension culture; Cell culture; Batch culture; Continuous culture; Protoplast culture; Hardening ; Somatic embryogenesis; Transfer and establishment of whole plants into greenhouse and field; Advantages of plant tissue culture.

GENE TRANSFER TECHNIQUES **9h**

Transformation techniques- Direct gene transfers - Electroporation, particle gun method, Lipofection, Microinjection, Fibre mediated DNA delivery; Laser induced DNA delivery; Biological gene transfer-*Agrobacterium tumefaciens* mediated gene delivery; Germplasm preservation and cryopreservation.

TRANSGENIC PLANTS **9h**

Genetic engineering of plants and applications; Development of Disease resistance Plants; Inset resistance plants; virus resistance plants; Stress and senescence tolerant plants; Herbicide resistance in plants; Fungus and bacterium resistant plants; Modification of seed protein quality- Guidelines and safety regulations for transgenic plants.

ANIMAL CELL CULTURE **9h**

Basic animal cell culture techniques; chemically defined medium and serum free media; types of cell lines; primary culture and establishment of cell line; characterization of cell lines; Maintenance and preservation of animal cell lines; suspension cultures; Continuous – Flow cultures; Immobilized cultures.

TRANSGENIC ANIMALS **9h**

Transgenic mice- Methodology and applications, retroviral method, DNA microinjection method, Engineered embryonic stem cell method; Transgenic cattle- Cloning by nuclear transfer, yeast artificial chromosome transgenesis; Transgenic pig; Embryo sex determination; Artificial insemination; Ethical issues related to transgenic animals.

REFERENCES

1. Sandy B. Primrose, Richard Twyman, Bob Old (2002), *Principles of gene manipulation*, sixth edition, John wiley and sons

2. Bernard R. Glick, Jack J. Pasternak (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM press, U.S.A.

3. Singh,B.D. (2008) *Text book of Biotechnology*, fourth Edition, Kalyani Publishers, New Delhi.

4. Ranga,M.M (2007), *Animal Biotechnology*, fourth Edition, Agrobios Indialimited, Jodhpur.

5. Ian R Freshney (2011) *Animal cell culture: A manual of basic technique and specialized applications*, Wiley and sons.

6. Smith, H.R(2006) *Plant Tissue Culture*, Fourth edition, Academic Press,California, USA.

7. Rama Dass,P.and Meera Rani S (2007) *Text Book of Animal Biotechnology*, Akshara Printers, New Delhi.

8. Masters, J.R.W(2007) *Animal Cell culture. Practical Approach*, Oxford University Press, UK

U13BTE102 MOLECULAR AND MICROBIAL PATHOGENESIS 3 0 0 3

OBJECTIVE

- To learn about principles of microbial pathogenesis, clinical importance of specific pathogens
- To understand - Host defense mechanisms and pathogen adaptation
- To understand molecular mechanisms involved in Pathogenesis of diseases caused by *E.coli*, Vibrio, Shigella, Salmonella, malarial parasite and Influenza virus.

COURSE OUTCOME:

CO1. Students understand principles of microbial pathogenesis, clinical importance of specific pathogens.
CO 2. Students can learn importance of Host defense mechanisms and pathogen adaptation against host defense.
CO3. Students understand molecular mechanisms involved in Pathogenesis of diseases caused by *E.coli*, Vibrio, Shigella, Salmonella, malarial parasite and Influenza virus.
CO4. Students understand host-pathogen interaction with respect to pathological damage of pathogens.
CO5. Students understand different diagnostic techniques like ELISA, RIA etc.,

INTRODUCTION TO MICROBIAL PATHOGENESIS 9h

Introduction to the infectious diseases - Molecular Koch postulates; Clinical importance of pathogenic bacteria, fungi, virus and parasite with Examples; Principles of microbial pathogenesis- Microbial modes of entry mechanism and colonization; Components of microbial pathogenesis; Inflammation process.

HOST-DEFENSE AGAINST PATHOGENS AND PATHOGENIC STRATEGIES 9h

Virulence, virulence factors, virulence-associated factors and virulence lifestyle factors; Introduction to host defense- First line and second line defense mechanisms; Antimicrobial compounds; Mechanism of killing by humoral and cellular defense mechanisms; Pathogenic adaptations to overcome the above defenses; complement system - types of complement system.

MOLECULAR MICROBIAL PATHOGENESIS (SPECIFIC EXAMPLES) 9h

Clinical features and molecular mechanism of pathogenesis: Enteric pathogens- *E.coli* pathogens- Enteropathogenic (EPEC), Enterotoxicgenic (ETEC), Enteroinvasive *E.coli* (EIEC); Shigella ; Salmonella; Vibrio - PAI; Superficial mycoses- Dermatophytes, Candidiasis*;* Malaria – Plasmodium life cycle; Influenza virus: Intracellular stage-H1N1 ; HIV.

EXPERIMENTAL STUDIES ON HOST-PATHOGEN INTERACTIONS 9h

Virulence assay: Adherence, cytopathic, cytotoxic; Criteria and tests in identifying virulence factors- Classical, biochemical, genetic and genome approaches; Molecular characterization of virulence factors.

MODERN DIAGNOSIS TO CONTROL PATHOGENS 9h

Modern diagnosis based on highly conserved virulence factors – Immuno and DNA-based techniques- Precipitation, agglutination, ELISA, RIA, PCR, Blotting techniques- Southern and Western blotting; Vaccines – types, applications and their advantages and disadvantages.

TOTAL: 45h

REFERENCE(S):

1.David Greenwood, Richard C. B. Slack and John. F. Peutherer (2007) "*Medical Microbiology- A guide to microbial infections: Pathogenesis, Immunity, Lab Diagnosis and Control".* Edn. 16. Churchill Livingstone- An imprint of Elsevier.

2. Peter Williams, Julian Ketley & George Salmond, (1998) "*Methods in Microbiology: Bacterial Pathogenesis",* Vol. 27, Academic Press.

3. Camille Locht and Michel Simonet (2012) "Bacterial *Pathogenesis- molecular and Cellular Mechanisms".* Caister Academic Press.

4. Eduardo A. Groisman (2001) "*Principles of Bacterial Pathogenesis"*, Academic Press, USA/UK.

5. Kathleen Park Talaro and Arthur Talaro, (2002) "*Microbiology"*, 4th edition, Mc Graw Hill.

U13BTE103 BIOPROCESS CONTROL AND DYNAMICS 3 0 0 3

OBJECTIVE(S)

To make the students to understand the concepts of control systems, process dynamics and process instrumentation with relevance to bioprocess industries

COURSE OUTCOME(S):

CO1. students would have attained knowledge on control systems, process dynamics and process instrumentation with relevance to bioprocess industries

9 h

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application, Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for bioreactors and dynamics.

9 h

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

9 h

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings

9 h

Controller mechanism, Introduction to advanced control systems, cascade control, feed forward control, control of distillation towers and heat exchangers, introduction to microprocessors and computer control of chemical processes.

9 h

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, pH and concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties.

TOTAL: 45 h

REFERENCE(S):

1. Coughnowr and Koppel,(1986), *Process Systems Analysis and Control*, New Delhi: Tata McGraw Hill.
2. Eckman, D.P.,(1978), *Industrial Instrumentation*, Hoboken/New Jersey:John Wiley.
3. Stephanopolous, George.(1990), *Chemical Process Control*. Prentice-Hall of India.
4. Emenule, S.Savas,(1965), *Computer Control of Industrial Processes* , New Delhi: Tata McGraw Hill.

ELECTIVE II

U13BTE201 **NANOBIOTECHNOLOGY** **3 0 0 3**

OBJECTIVES

- To impart knowledge to the students in the area of nanobiotechnology and its wide applications.
- To gain extensive knowledge in nanobiotechnology, involvement of macromolecules in nanobiotechnology
- To study the application in drug delivery, and cancer treatment.

COURSE OUTCOME:

CO1. Students understand the basics of nanotechnology and nanobiotechnology
CO2. Understand the synthesis and characterization of nanoparticles
CO3. Understand about nanodevices, its fabrication.
CO4. Understand about the nanomolecules in biosystems the orchestration of events during enzyme catalysis and the role of coenzymes
CO5. Learn and understand the applications of nanobiotechnology

INTRODUCTION TO NANOBIOTECHNOLOGY 9h

Introduction to Nanobiotechnology-micro and nanosystems and technologies; overview of nanodevices and techniques. Synthesis and characterization of nanoscale materials- strategies for nanoarchitecture; top down and bottom up approaches – self assembly systems.

SYNTHESIS OF NANOPARTICLES 9h

Inorganic nanoscale systems for biosystems-nanostructure materials –fullerness: properties and characterization – carbon nano tubes: characterization and application-quantum dots and wires. Synthesis of gold, silver and silica nanoparticles – nanopores.

NANOMOLECULES IN BIOSYSTEMS 9h

Nanomolecules in biosystems -proteins, lipids, RNA and DNA-nanoscale elements for delivery of materials into cells - DNA based artificial nanostructures – proteins as components in nanodevices, lipids in self assembly structures.

USE OF MICROORGANISMS IN NANOBIOTECHNOLOGY 9h

NanoBiotechnology and Microorganisms – PHA in nanoBiotechnology – cyaophycin inclusions- magnetosomes- alignates- bacteriophages-bacterial spores-bacterial protein complexes-s-layer proteins-bacteriorhodopsin.

APPLICATION OF NANOBIOTECHNOLOGY 9h

NanoBiotechnology in drug delivery - nanoscale devices for drug delivery -micelles for drug delivery – targeting, microarray and genome chips - nanobiosensors and nanobiochips. Nanotechnology for cancer diagnosis and treatment. NanoBiotechnology for cell destruction.

TOTAL : 45 h

REFERENCE(S):

1. Jain, K. K (2006) *NanoBiotechnology in molecular diagnostics –current techniques and applications*, First edition, Taylor and Francis
2. Niemeyer, C. M., and CA Mirkin, C. A., (2010) *NanoBiotechnology II – More concepts, and applications.* First edition, Wiley –VCH publications
3. Rosenthal, S.J., and Wrigh, D.W., (2010) *Nanobiotechnology Protocols*, First Edition, Humana Press
4. Niemeyer, C.M and Mirkin, C.A, (2010) *NanoBiotechnology – concepts, applications and perspectives.* First edition, Wiley –VCH publications

U13BTE202 MEDICAL BIOTECHNOLOGY 3 0 0 3

OBJECTIVES

To develop an understanding of molecular basis of genetic diseases, skills required for their diagnosis and possible therapeutic interventions.

COURSE OUTCOME

CO1. Students understand and apply skills and knowledge in the area of medical biotechnology to meet the necessary needs in bio-based issues such as health and medicine.

CLASSIFICATION OF GENETIC DISEASES 9h

Chromosomal disorders – Numerical disorders, trisomies, monosomies; Chromosomal instability syndromes; Gene controlled diseases – Autosomal and X-linked Disorders; Candidate gene approach – Marfan's syndrome, Alzeimer's disease; Gene Hunting-schizophrenia, bipolar disorder**.**

MOLECULAR BASIS OF GENETIC DISEASES 9h

Molecular basis of human diseases - Pathogenic mutations, Gain of function mutations – Oncogenes; Huntingtons Disease; lethal bleeding diathesis - Pittsburg variant of alpha 1 antitrypsin; Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, Mitochondrial diseases-MELAS, LHON, MERRF; Immuno Pathology,

MOLECULAR & MEDICAL DIAGNOSTICS 9h

Conventional methods of diagnosis – amniocentesis, ultrasonography; G-banded chromosomal preparations for detection of autosomes of autosomal/sexchromosomal disorder - Down's syndrome; PCR bases diagnosis – fragile-X syndrome; mutation detection by PCR-SSCP - sickle cell anemia; SNP analysis for known SNPs; PAGE- band detection of enzyme variants, Microarray technology- genomic and cDNA arrays, application to diseases

MOLECULAR THERAPEUTICS 9h

Gene therapy- *Ex vivo, Inv ivo, In situ*; Strategies of gene therapy - gene Augmentation, antisense therapy; Viral vectors - retrovirus, adenoviruses, Herpes simplex virus; non viral methods - liposomes, receptor mediated gene transfer. Stem cell therapy - Embryonic and adullt Stem Cells, Totipotent, Pluripotent and Mulltipotent Cells; Potential use of stem cells – Cell based therapies; Nanomedicine – Basic approach and clinical application

GENE PRODUCTS IN MEDICINE 9h

Functional cloning – anti-haemophilic factor; Positional cloning- Dystrophin; Gene products in medicine – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon; Vaccines-DNA based vaccines, subunit vaccines, Attenuated Vaccines

REFERENCE(S):

1. Judit Pongracz, Mary Keen. (2009) *Medical Biotechnology*, Churchill Livingstone
2. Pamela Greenwell, Michelle McCulley, (2008) *Molecular therapeutics*: 21st-century medicine, John Wiley and Sons,
3. U.Sathyanarayana (2010) *Biotechnology*, Books and Allied (P) Ltd.
4. Gary Walsh. (2005) Biopharmaceutical technology-biochemistry and biotechnology, Wiley & Sons.

U13BTE203 EVOLUTION AND BIODIVERSITY 3 0 0 3

OBJECTIVES:

- To understand the concepts in evolution and biodiversity
- To gain an in-depth understanding of evolution and biodiversity
- To learn about conservation of biodiversity and to develop an awareness on IPR, to thwart bio piracy and also to comprehend the impact of our policy decisions on the biodiversity conservation.

COURSE OUTCOME:

- CO1. Students understand the concepts in evolution and biodiversity.
- CO2. Understand in depth about evolution and biodiversity.
- CO3. Gain knowledge about conservation and get awareness on IPR, and learn to comprehend the impact of legislation pertaining to biodiversity and conservation.

EVOLUTION **9h**

Origin of life on Earth, biological evolution, fossil record, mechanisms that drive evolution, Darwinian Natural Selection, Stabilizing Selection, Disruptive Selection, Directional Selection. Limits to adaptation, Microevolution and macroevolution,.The case of the Peppered Moths.

EVOLUTION AND BIODIVERSITY **9h**

Gene Flow and Genetic Drift, Speciation, coevolution: Interaction Biodiversity, Niches-pollenpeeper evolution, Competition and Community Diversity, Extinction, Factors Affecting Extinction Rates, Extinction in the Context of Evolution, using evolution and genetics to inform conservation, national and International Legislations.

BASIS OF BIODIVERSITY **9h**

Historical and geographical causes for biodiversity, classes of biodiversity - genetic diversity, molecular taxonomy, species and population biodiversity. Quantifying biodiversity. Endemic and pandemic species-Hotspots, endangered species, loss of biodiversity.

Case study: On-campus flora and fauna..

UNDERSTANDING ABOUT ORGANISMS DIVERSITY **9h**

Principles of microbial diversity- basics of structural, biochemical and molecular phylogenetic relationships of microorganisms. Diversity of plants- classification, characteristics and life cycle, modification of plant form as adaptation to environment, Diversity of animals- classification, characteristics and the phylogenetic relationship.

ECONOMIC VALUES AND POLICY CONCERNS **9h**

Uses and values of biodiversity, intellectual property rights relating to biological resources, Biopiracy, indigenous system of knowledge, national policies, legislation and instruments

relating to the protection of wild and domesticated flora and fauna as well as habitats, biodiversity conservation and management.

Case Study: on Biopiracy.

TOTAL: 45 h

REFERENCE(S):

1. Campbell, N.A., and Reece, J.B., (2005) Biology, 7th ed. Pearson Education, India, New Delhi. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D.B., Patel, N.H., (2007) Evolution, Cold spring Harbour Lab press, New York.
2. Bull, A.T., (2007) *Microbial Diversity and Bioprospecting*. American Society for Microbiology
3. Atlas, R.M., and Bartha R. (2008) *Microbial Ecology: Fundamentals and Applications* 6th ed. Benjamin Cummings.
4. Strikberger, M. W., (2000) Evolution, 3rd Ed, Jones & Bartlett Learning, London UK.
5. Arunachalam. A and Arunachalam, K., (2008) *Biodiversity utilization and conservation*, First edition, Aavishkar Pulications.
6. Meffe, G. K. and Carroll C.R., (2007) *Principles of Conservation Biology*, fourth edition Sinauer Associates Inc., Sunderland, Mass.

U13TTX216 MEDICAL TEXTILES 3 0 0 3

OBJECTIVES

At the end of the course the students would be exposed to

- Market scenario of medical textile industry.
- Bio polymers and tissue engineering.
- Wound dressing concepts.
- Knowledge on tissue engineering, smart textiles and legal issues.

COURSE OUTCOME:

CO1. The students will understand various aspects related to the emerging field of medical textiles

INTRODUCTION 9h

Medical textiles — classification, current market scenario in international and national level – government initiatives; antimicrobial fibres and finishes; nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non-wovens in medicine; textiles in infection prevention control.

BIOPOLYMERS, TESTING AND TISSUE ENGINEERING 9h

Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests – direct contact, agar diffusion & elution methods – in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds- relationship between textile architecture and cell behavior – applications of textile scaffolds in tissue engineering.

IMPLANTABLES, NON-IMPLANTABLES AND DRUG DELIVERY 9h

Bandages-types, properties and applications; compression garments-types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh – vascular prostheses – stents; Extra corporeal materials: Cartilage nerves – liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification – mechanism various fabrication methods – characterization – applications.

WOUND CARE AND REUSABLE MEDICAL TEXTILES 9h

Wound: types and healing mechanism- textile materials for wound dressing – bio active dressing – anti microbial textiles dressing – composite dressing –- testing of wound care materials; Wound compression textiles; Reusable medical textiles: types, advantages, physical properties and performance — reusable processing methods.

SMART MEDICAL TEXTILES AND LEGAL ISSUES 9h

Smart textiles – types, characteristics – smart textiles in wound care ; applications of phase change and shape memory materials – monitoring pregnancy, children and cardio patients – mobile health monitoring ; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare ;legal and ethical values involved in the medical textile materials.

TOTAL HOURS: 45h

CASE STUDY:

1. Study about the various wound care materials on fabric particulars.
2. Analysis on market potential of medical textiles in national and international level.
3. Study of various bandages available in market.

REFERENCE(S):

1. Rajendran.S, "Advanced Textiles for Wound Care", Wood Head publishing in Textiles: Number 85, 2009.
2. Bartel.V.T, "Handbook of medical textiles", Wood Head publishing, 2011.
3. Van Langenhove, "smart textiles for medicine and health care – materials, systems and applications", Wood Head publishing, 2007.
4. Ray smith, "Biodegradable polymers for industrial application", CRC press, 2005.
5. Buddy D.Ratner and Allan S. Hoffman, "Biomaterials science – An introduction to materials in medicine", Academic press, 1996.

ELECTIVE III

U13BTE301 ENVIRONMENTAL BIOTECHNOLOGY 3 0 0 3

OBJECTIVES:

1. To learn the environmental fate of xenobiotic compounds.
2. To explore the role of Biotechnology in finding innovative solutions to environmental problems such as designing GEMs for tackling recalcitrant pollutants.

COURSE OUTCOMES

CO1. Identify the key concepts in Environmental Biotechnology
CO2. Review the biodegradation pathways for xenobiotic compounds
CO3. Summarize wastewater characteristics and treatment protocols
CO4. Construct systems for biotreatment of domestic / industrial effluents and solid wastes
CO5. Devise problem specific bioremediation or biomonitoring schemes

MICROBIOLOGY OF SOIL 9 h

Soil characteristics; soil microbial communities - their growth and ecological adaptations; interactions among soil microorganisms – mutualism, commensalism, cooperation, parasitism, predation, antagonism, competition, and neutralism; biogeochemical role of soil microorganisms – Carbon, Nitrogen, Sulfur and Phosphorus cycles.

BIODEGRADATION OF XENOBIOTICS 9 h

Xenobiotics - persistence and biomagnification; factors causing molecular recalcitrance; microbial pathways for biodegradation of petroleum hydrocarbons – aliphatic, alicyclic and aromatic (simple and polycyclic) hydrocarbons, polychlorinated aromatics; biodegradation of pesticides and synthetic detergents.

WASTEWATER TREATMENT 9 h

Physical, chemical and biological characteristics of wastewater; wastewater treatment – overview of physical and chemical methods; biological methods - suspended growth and biofilm processes; design of activated sludge process; ponds and lagoons; trickling filters; anaerobic wastewater treatment; sludge digestion - design of anaerobic sludge digesters; nutrient removal – nitrogen and phosphorus.

INDUSTRIAL AND SOLID WASTE MANAGEMENT 9 h

Leather, pulp, pharmaceutical, dairy, textile and dye industries – production process, origin and characteristics of waste, waste minimization and treatment options; solid waste management; hazardous waste management.

Case study – municipal solid waste management practices in Indian cities.

APPLICATIONS OF ENVIRONMENTAL BIOTECHNOLOGY 9h

Biomonitoring; bioleaching and biomining; biofertilizers; biopesticides; biodiversity – values and threats faced, biodiversity conservation and role of biotechnology in it; bioremediation – types and applications, use of genetically engineered microorganisms in bioremediation.
Case study – bioremediation of recalcitrant pollutants.

TOTAL: 45 h

REFERENCE(S):

1. Michael J. Pelczar, Chan E.C.S., Noel R. Krieg, (2006). *Microbiology*, 5th edition, New Delhi: Tata McGraw Hill Publishing Company.
2. Bruce Rittman, Perry L Mac Carty (2007). *Environmental Biotechnology: Principles and Applications*, New York: McGraw Hill.
3. Atlas R.M., and Bartha R. (2008). *Microbial Ecology: Fundamentals and Applications*, 6th edition, Benjamin / Cummings Publishing Company.
4. Metcalf and Eddy (2007). *Wastewater Engineering: Treatment and Reuse*, 5th edition, New Delhi: Tata McGraw Hill Publishing Company.
5. Bernard R. Glick, Jack. J. Pasternak (2007). *Molecular Biotechnology*, 4th edition, ASM Press.

U13BTE302 MOLECULAR SPECTROSCOPY 3 0 0 3

OBJECTIVES:

- To enable students understand the principles behind various analytical techniques
- To study the methods employed in the analysis of biomolecules

COURSE OUTCOMES

- CO1. To understanding of spectroscopic methods currently in use in research
- CO2. To develop skills of application of the spectroscopic method to research problems

INTRODUCTION 9h

Electromagnetic spectrum; Quantum mechanics of molecules; Vibrational transitions; Rotational transitions; Electronic transition; chirality.

IR SPECTROSCOPY 9h

Infrared spectroscopy- basic concept of IR spectroscopy, IR spectrophotometer - principle and instrumentation, sampling technique; FTIR- principle and working, interpretation of data.

FLUORESCENCE AND PHOSPHORESCENCE SPECTROSCOPY 9h

Luminescence and nature of light; Fluorescence and phosphorescence; light scattering- Raleigh Tyndall effect, Raman effect; factors affecting sensitivity and accuracy; instrumentation and interpretation of data.

NUCLEAR MAGNETIC RESONANCE (NMR) 9h

Chemical shifts; spin spin coupling; relaxation mechanisms; nuclear overhauser effect; multidimensional NMR; MRI.

MASS SPECTROMETRY 9h

Ion sources; sample introduction; mass analyzers and ion detectors; analysis of biomolecules- carbohydrate, proteins, lipids; specific applications- MALDI-ToF

Total: 45 hours

REFERENCES:

1. Keith Wilson and John Walker (2010) *Principles and Techniques of Biochemistry and Molecular Biology*, Ed., 7th Edition, Cambridge University Press.
2. M.L. Srivatsava, Ed., (2007) *Bioanalytical Techniques*, Alpha Science International Ltd.
3. Douglas A. Skoog, Brooks Cole (2006) Principles of Instrumental Analysis, 6th Edition
4. Hobarth Willard, Lynne Merritt, John Dean, Frank Settle., (1998) Instrumental methods of Analysis; 7 Subedition, Wadsworth Pu

U13BTE303 CANCER BIOLOGY 3 0 0 3

OBJECTIVE

- To offer the students a broad education about cell cycle, cancer pathogenesis, diagnosis and therapeutics in the area of cancer biology

COURSE OUTCOMES:

- CO1. Understand the mechanism of proto-oncogene's in the regulation of cell cycle
- CO2. Attained the knowledge in the fundamentals of carcinogenesis and its role in cancer
- CO3. Enriched capacity to comprehend the basics of cancer diagnosis and therapeutics

ONCOGENES AND PROTO ONCOGENES 9 h

Mechanism of oncogene and proto oncogene – epidermal growth factor (EGF), platelet derived growth factor (PDGF), transforming growth factor (TGF), src and myc; RAS cycle; Oncogenes – Identification and detection; Apoptosis – intrinsic and extrinsic pathways.

CELL CYCLE REGULATION 9 h

Regulation of cell cycle - *S. pombe*, *S. cerevesiae* and mammalian system; Types of mutations that cause changes in signal molecules; Effects on receptor; Tumor suppressor genes -p53 and Rb proteins; Modulation of cell cycle in cancer; Mechanism of action of telomerase.

MECHANISM OF CARCINOGENESIS 9 h

Carcinogenesis – introduction and types; Chemical carcinogenesis – Direct acting and indirect acting carcinogens; Metabolism of carcinogens - CYP450 reductase mechanism; Mechanism of radiation carcinogenesis – ionizing and non ionizing radiation; Retroviruses - RSV life cycle and its role in cancer; Identification of carcinogens- Long and short term bioassays.

MECHANISM OF CANCER METASTASIS 9 h

Metastasis – Introduction and cascade; Clinical significances and three step theory of invasion; Significance of proteases in basement membrane disruption; Properties of cancer cell; Oral, lung, uterus, breast & blood – etiology, diagnosis and treatment.

Case study – oral, breast and blood cancers.

CANCER DIAGNOSIS AND THERAPY 9 h

Action of cancers – biochemical assays; Tumor markers; Molecular tools for early diagnosis of cancer; Prediction of aggressiveness of cancer; Different forms of therapy – Chemotherapy, Radiation therapy and Immunotherapy; Role of antioxidants in preventing cancer .

TOTAL: 45 h

REFERENCE(S):

1. Ian F.Tannock, Richard P. Hill, Robert G. Bristow and Lea Harrington (2005) *The Basic Sciences of Oncology*, 4th Edition, The McGraw-Hill Companies, Inc. New Jersey.
2. R.A. Weinberg (2007) *The Biology of Cancer*, 1st Edition, Taylor and Francis, Garland Science. United Kingdom.
3. S. Pelengaris and M. Khan (Eds). (2006) *The Molecular Biology of Cancer,* Wiley - Blackwell Publishing, USA.
4. Gareth Thomas (2004) *Medicinal Chemistry – An Introduction*, 1st Edition, John Wiley and Sons, USA
5. Benjamin Lewin (2004) *Genes VIII,* International Edition, Pearson Prentice Hall, New Delhi.
6. Eugene Braunwald, Anthony S. Fauci, Dennis L. Kasper, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Braunwald, Fauci and Isselbacher (2008) *Harrison's Principles of Internal Medicine*, 17th Edition, McGraw Hill Medical Publishing Division. NewYork.

ELECTIVE IV

U13BTE401 COMPUTATIONAL METHODS IN MOLECULAR BIOLOGY 3 0 0 3

OBJECTIVE(S)

- To understand the underlying principles of various bioinformatics applications
- To obtain a strong foundation for higher studies/research in bioinformatics
- To expose students to various approaches of problem solving in bioinformatics

COURSE OUTCOME(S):

CO1. Understand the algorithms of protein prediction,
CO2. Understand the methods of modeling, genome analysis
CO3. Learn basics of programming as applied to biology

PROTEIN STRUCTURE PREDICTION AND MODELING 9 h

Levels of protein structure, Conformational parameters of secondary structures, secondary structure prediction methods- Chou Fasman, GOR, Neural networks, Limitations of secondary structure prediction methods, Methods of protein modeling- Comparitive homology modeling, De Novo, Threading.

MODELING OF BIOMOLECULAR SYSTEMS 9 h

Molecular dynamics and simulations, Mone carlo Methods, Molecular dynamics, Energy minimization methods, HMM, Application of HMM for gene finding and secondary structure prediction. Metabolic pathway databases- KEGG, MetaCyc, Biosilico, Modeling Reaction networks.

GENE PREDICTION 9 h

Predictive methods using DNA sequences- GRAIL, FGENEH/FGENES, MZEF, GENSCAN, HMMgene. Predictive methods based on protein composition- AACompldent, AACompSim, PROPSEARCH, MOWSE, Predictive methods based on protein sequence-ExPASy tools, TGREASE, BLOCKS, CDD, PREDATOR, SOPMA, PSIPRED, PHDtopology.

GENOME ANALYSIS 9 h

Genome mapping- map elements, Types of maps, Complexities and pitfalls, Databases-GDB, Genome mapping projects. Sequence assembly and finishing methods-Global assembly, Assembly software requirements, Preparing readings for assembly,GAP4 program, Large scale genome analysis- Technologies, Computational tools.

APPLICATION OF PROGRAMMING IN BIOLOGY 9 h

Basic concepts of programming, Perl programming, Advantages of perl as applied to molecular biology, Perl basic usage, Application of Java, Python and R in biology.

TOTAL : 45 h

REFERENCE(S):

1. Zhumur Ghosh and Bibekanand Mallick, (2008) "Bioinformatics Principles and Applications", 1st Edition, Oxford University Press.

2. Dan Krane, Michael Raymer (2003) "Fundamental concepts of Bioinformatics", 1st India Reprint, Pearson Press.

3. Andreas Baxevanis, Francis Quellettei, (2002) "Bioinformatics – A practical guide to the analysis of genes and proteins", 2nd Edition, John Wiley and Sons,

4. Shui Qing YE, (2008) "Bioinformatics a practical approach" 1st edition, Chapman & Hall/CRC.

5. David W.Mount, (2001) "Bioinformatics – Sequence & Genome Analysis", 1st Edition, Cold Spring Harbor Lab.

U13BTE402 GENOMICS AND PROTEOMICS 3 0 0 3

OBJECTIVES

- To provide solid foundation in concepts of genome mapping and genome sequencing
- To expose the students to the concept of large scale analysis of proteins and their applications.

COURSE OUTCOME:

The students will be able to

CO1. Discuss and distinguish prokaryotic and Eukaryotic genome organization in relation to Human genome project.

CO2. Understand the steps involved in different genome mapping methods.

CO3. Describe genome sequencing methods and genome sequence assembly.

CO4. Demonstrate the use of expression profiling methods and the gene finding from prokaryotic genome sequence.

CO5. Explain the steps involved in analyzing proteome and protein modifications.

GENOME MAPPING **9h**

History and mile stones of human genome project, Genome organization; prokaryote-eukaryote, complexity of genomes, classical chromosome mapping using recombination frequency, genome mapping; FISH- optical mapping- STS content mapping.

GENOME SEQUENCING **9h**

Automated DNA sequencing methods; capillary electrophoresis based- pyrosequencing, genome sequencing mehods; top-down approach-bottom- up approach, genome sequence assembly, comparative study on the genome sequencing methods, genome annotation, Genscan for gene finding, UTR scan for functional element prediction.

Case study: ORF finding using NCBI tool.

TRANSCRIPTOMICS **9h**

EST database, differential gene expression analysis; DDRT- PCR- subtractive hybridization-representational display analysis, quantitative gene expression using Serial Analysis of Gene Expression, Microarray; principle-fabrication of cDNA based array-DNA chip - application microarray in gene expression analysis.

Case study: Analysis and interpretation of microarray data

PROTEOMICS **12h**

Introduction to proteomics methods, two dimensional gel electrophoresis: pI -Isoelectric focusing of proteins- principle and steps- 2D gel image acquisition and analysis, high throughput protein identification by peptide mass fingerprinting (PMF), protein sequencing using MS, application of proteomics for biomarker identification and disease diagnosis.

SYSTEMS BIOLOGY **6h**

Introduction to systems biology, biological networks, protein interaction networks- computational prediction of protein interactions, network topology analysis; bus- star - ring networks.

TOTAL: 45h

REFERENCE(S):

1. T.A .Brown (2002)Genomes, 2nd Edition, Oxford: Wiley-Liss
2. J.Pevsner (2009) Bioinformatics and Functional genomics, 2nd Edition, John Wiley
3. I.Rigoutsos, G. Stephanopoulos (2007) "Systems Biology: Genomics", Oxford University Press.

U13BTE403 BIOPROCESS ECONOMICS AND PLANT DESIGN 3 0 0 3

OBJECTIVE(S)

To make the students to understand the concepts of bioprocess economics and plant design

COURSE OUTCOME(S):

CO1. The students would have attained knowledge on conducting economic study of bioprocess plant and design equipments of bioprocess industries

PROCESS ECONOMICS AND BUSINESS ORGANIZATIONS 9 h

Definition of Bio Process, Bio Process Economics, Importance of various M-inputs-Globalization concept-Competition by Dumping-It's effect on Plant size-Status of India with adjoining ASEAN countries (Singapore, Malaysia, Indonesia etc)-Project profile concept-details; Structure and Types of Organizations

PROJECT DESIGN AND DEVELOPMENT 9 h

Choosing a Project, Market Survey, Utility requirements, Waste generation and management; Regulatory factors, Competition factors, Importance of Techno-Economic-Viability Studies, Sourcing of Processes, Process alternatives, Fixing most economic processes, Technology-Scanning, Plant Location Principles, Plant Lay out, Process Flow sheets/diagrams, Preparation of Budgetory investment and production costs.

COST ESTIMATION, PROFITABILITY AND ACCOUNTING 9 h

Capital investment, Concept of time-Value of money, Source Sink concept of Profitability, Capital Costs, Depreciation, Estimation of Capital costs, Manufacturing Costs, Working Capital; Profitablity Standards, Project profitability evaluation, Alternative investments and Replacements; Annual reports, Balance Sheets, Performance Analysis.

DESIGN OF BIOREACTORS AND ITS ACCESSORIES 9 h

Mechanical design of bioreactors, Materials of construction, Valves: Gate, Globe and Butterfly Valves, Piping design

HEAT AND MASS TRANSFER EQUIPMENTS 9 h

Design of single pass shell and tube heat exchanger, Design of single pass double pipe heat exchanger, Design of single and multi effect evaporators, Design of Plate and Packed Extraction Towers; Design of Plate and Packed Distillation Towers

TOTAL: 45 h

REFERENCE(S):

1. Brownell I.E., Young E.H.(1985) *Chemical Plant Design*.
2. R. K. Sinnott. *Coulson & Richardson's Chemical Engineering Volume-6*,United Kingdom: Elsevier.
3. Peters, M.S., and D. Klaus.(1992),*Plant Design and Economics for Chemical Engineers*, New Delhi: Tata McGraw Hill.
4. Senapathy, R. (2001) *Textbook of Principles of Management and Industrial Psychology*.New Delhi:Lakshmi Publications.
5. Rudd.,& Watson.,(1987) *Strategy for Process Engineering*,Hoboken/New Jersey:John Wiley.

U13BTE404 BIOENERGY ENGINEERING 3 0 0 3

OBJECTIVE(S)

To make the students to develop basic understanding of bioenergy sources and technologies

COURSE OUTCOME(S):

After completion of this course, the students are expected to learn about:
CO1. The current energy challenges and the importance biofuels in achieving energy security and minimizing greenhouse gases emissions;
CO2. The overview of available renewable and alternative energy sources;
CO3. Biomass resources, types of biofuels and the bio-refinery concept;
CO4. Mass and energy balances, biomass characterization techniques, unit operations, and thermodynamics in biomass conversion process;
CO5. The concept of 1^{st} generation, 2^{nd} generation and advance biofuels;
CO6. Techno-economic analysis of various biofuel conversion technologies and their environmental attributes; and
CO7. The increasing role of renewable energy engineers to address growing energy needs.

INTRODUCTION TO BIOENERGY 9 h

Energy: Sources, classification, energy security, influence of energy on environment and economy; Biomass - Introduction, types, chemical composition, properties, availability; Energy crops: Size reduction, Briquetting, Drying, Storage and handling.

THERMAL CONVERSION TEHNOLOGIES 9 h

Bioenergy technologies: Thermochemical and biochemical conversion technologies; Thermochemical conversion technologies: Incineration/Combustion, pyrolysis, liquefaction and gasification; Biomass gasification followed by Fischer-Tropsch synthesis for liquid fuels.

BIOGAS TECHNOLOGY 9 h

Biochemical technologies - Anaerobic digestion, fermentation and transesterification; Biogas: Sources, microbial and biochemical aspects, operating parameters for biogas production, kinetics and mechanism, high rate digesters; Wood Gasifier System: Wood gas, operation of spark ignition and compression ignition engines with wood gas, operation and maintenance.

BIOETHANOL AND BIODIESEL TECHNOLOGIES 9 h

Bioethanol: Sources, microbial and biochemical aspects, operating parameters for bioethanol production, kinetics and mechanism, high throughput reactors; Biodiesel: Sources, microbial and biochemical aspects, operating parameters for biodiesel production, kinetics and mechanism.

ADVANCED BIOENERGY 9 h

Advanced bioenergy: Overview of microbial fuel cells, biohydrogen, biopower, biocoal; Biofuels: Economics, policies, life cycle analysis, challenges, R&D.

TOTAL: 45 h

REFERENCE BOOK(S):

1. Chakraverthy A,(1989) *Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes*, New Delhi: Oxford & IBH publishing Co.
2. Mital K.M,(1996) *Biogas Systems: Principles and Applications*, New Delhi :New Age International publishers (P) Ltd.
3. Nijaguna, B.T.,(2002), *Biogas Technology*, New Delhi :New Age International publishers (P) Ltd.
4. Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", Tata Energy Research Institute, 1996.
5. Rezaiyan. J and N. P. Cheremisinoff, "Gasification Technologies, A Primer for Engineers and Scientists", Taylor & Francis, 2005
6. Khandelwal. K. C. and Mahdi S. S.,(1986) "*Bio-Gas Technology*", New Delhi: Tata McGraw Hill.

ELECTIVE V

U13BTE501	INTRODUCTION TO BIO-MEDICAL INSTRUMENTATION	3 0 0 3

OBJECTIVE(S)

- To understand concepts of biosignals and measurements
- To study working principles of various biomedical instruments.

COURSE OUTCOME(S):

CO1**.** Students will understand the working and instrumentation associated with a variety of biomedical devices
CO2. Understand the origin an nature of biomedical signals

PHYSIOLOGICAL SYSTEMS, SIGNALS AND TRANSDUCERS 9 h

Sources of Physiological signals, Working of the brain, resting and action potential, working of the heart and muscular system, Transducers- principles, Active, Passive, Inductive passive transducers, Transducer types- Force, Temperature, Pressure, Biopotential electrode.

ELECTRO-PHYSIOLOGICAL MEASUREMENTS 9 h

Basic components of a biomedical system – Electrodes – Micro, needle and surface electrodes – ECG – EEG – EMG – Lead systems and recording methods – Typical waveforms. Plethysmography – Measurement of blood pressure and blood flow – Cardiac output – Cardiac rate – Heart sound.

MEDICAL LAB INSTRUMENTATION 9 h

pH of blood, pCO_2, pO_2, ESR, GSR measurements –spectrophotometry, Automated chemical analysis, chromatography, electrophoresis, blood cell count .

MEDICAL IMAGING AND PATIENT MONITORING SYSTEMS 9 h

X-ray machine; Radio graphic and fluoroscopic techniques – Computer tomography, MRI, Ultrasonography, Endoscopy, Thermography; Biotelemetry systems and patient monitoring.

ASSISTING AND THERAPEUTIC EQUIPMENTS 9 h

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers.

TOTAL : 45 h

REFERENCE(S):

1. Leslie Cromwell, Fred J.Weibell, Erich A. Pfeiffer, (2006) 'Bio-Medical Instrumentation and Measurements', 2nd Edition, Pearson Education, PHI.
2. Sawhney, G.S. (2007) Fundamentals of Biomedical Engineering, New Age International
3. R.S.Khandpur, (2005) 'Hand book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd..
4. Joseph J.Carr,John M.Brown, "Introduction to Biomedical Equipment Technology" 4th edition, Pearson Education, 2001
5. M.Arumugam, (2007) 'Bio-Medical Instrumentation', Anuradha Agencies.
6. L.A. Geddes and L.E.Baker, (1989) Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons.
7. J.Webster, (2007) 'Medical Instrumentation', John Wiley & Sons.
8. C.Rajarao and S.K. Guha, (2005) 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman Ltd.

U13BTE502 PRACTICAL COMPUTING FOR BIOLOGISTS 2 0 1 3

OBJECTIVE(S)

This course aims at providing basic knowledge of computer and operating systems and their application in biological sciences such as packages related to data analysis, data processing and generating graphs.

COURSE OUTCOME(S):

CO1. Learn fundamentals of operation of : UNIX/Linux operating systems,
CO2. Learn to build databases and do statistical analysis
CO3. Learn to model biochemical pathways,
CO4. Write programs
CO5. Work with image files

UNIX WORKSTATIONS 9 h

Flavours of UNIX, Linux OS's distros and installation; Command line operations: the shell; Handling text in shell; scripting within the shell; File permissions; sharing resources in multiuser environment- process management, scheduling, creating archive.

BUILDING BIOLOGICAL DATABASES 9 h

Types of databases; database software; anatomy of a database; introduction to SQL, MYSQL DBMS, basics of good database design; web based front end for databases; database user management and security.

BIOLOGIAL DATA AND STATISTICAL ANALYSIS 9 h

Data analysis tools- excel and SPSS packages; Graphing 2d and 3D using calc and origin. Design of experiments-using minitab; modelling chemical and biochemical reaction network pathways using gepasi; Introduction to R statistical programming language.

PROGRAMMING FOR THE BIOLOGIST 9 h

Compiled versus interpreted programs; variables, arrays and lists; Flow control- If, for, while; using lists and dictionaries; input and output; libraries and modules; Basic syntax of perl and python programming languages.

GRAPHICAL CONCEPTS 9 h

Vector versus pixels; image resolutions and dimensions; color schema and their interconversion- CMYK, RGB; Working with layers; vector art and pixel image manipulations; image processing tools.

TOTAL : 45 h

REFERENCE(S):

1. Cynthia Gibas and Per Jambeck (2001) *Developing bioinformatics computer skills*, O'Reilly books, Indian edition, Shroff Publishers and Distributers Ltd
2. Shui Qing Ye (2007) *Bioinformatics: A Practical Approach;* Chapman and Hall/ CRC
3. Steven Haddock and Casey Dunn (2010) Practical computing for Biologists, MA, USA, Sinauer Associates

U13BTE503 STEM CELLS AND TISSUE ENGINEERING 3 0 0 3

OBJECTIVES:

- To learn the basics of stem cells and their differentiation
- To understand the concept of tissue engineering, scaffold materials and deigning.
- To study the applications of tissue engineering in tissue repair and dysfunction.

COURSE OUTCOME:

CO1. The student must have attained the knowledge of stem cells, concept of tissue engineering and their role in regenerative medicine.

STEM CELLS **9h**

Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Examples- mesenchymal, liver and neuronal stem cells; telomeres and self renewal; stem cell plasticity

STEM CELL DIFFERENTIATION **9h**

Culture media for human embryonic and adult stem cells; growth factors
Characterization and Differentiation of human embryonic stem cells - hematopoietic, neural and germ cell differentiation; conceptual and dynamic models of stem cell proliferative behavior

CONCEPTS IN TISSUE ENGINEERING **9h**

Cells as therapeutic agents- examples; cell numbers and growth rates; Tissue organization – components and types; Tissue dynamics – dynamic states, homeostatsis and tissue repair. Tissue Morphogenesis.

BIOMATERIALS IN TISSUE ENGINEERING **9h**

Microscale patterning of cells and their environment. Cell interactions with polymers, Matrix effects, polymer scaffold fabrication, Biodegradable polymers, Micro and nano fabricated scaffolds, three dimensional scaffolds.

REGENERATIVE MEDICINE **9h**

Medical and surgical therapies for tissue dysfunction; Tissue engineered therapies –Artificial Blood, Tissue Engineering of Bone Marrow .Wound healing process and angiogenesis.
Case study – mesodermal (articular cartilage), ectodermal (skin), endodermal (liver).

TOTAL :45h

REFERENCE(S):

1. Thomas C.G.Bosch (2008). *Stem cells – From Hydra to Man.* First Edition, New Delhi, Springer International.
2. Bernhard Palsson and Sangeeta N Bhatia (2009). *Tissue Engineering, 2nd Edition*, New Delhi, Prentice Hall.
3. Robert Lanza, Robert Langer, Joseph Vacanti (2007*).Principles of Tissue Engineering*, Academic Press.
4. Yoshito Ikada (2006).*Tissue Engineering: Fundamentals and applications*, Elsevier International ProjectsLtd.

ELECTIVE VI

U13BTE601 NEUROBIOLOGY AND COGNITIVE SCIENCES 3 0 0 3

OBJECTIVES:

- To learn about the human nervous system, neurophysiology and neuropharmacology.
- To understand the mechanism of neurological behaviour.
- To study about the disorders associated with nervous system.

COURSE OUTCOMES

CO1 – Outline the basis of central and peripheral nervous system and describe the structure of neurons and supporting cells.
CO2- Explain the mechanism of action potential conduction and working of voltage dependent channels
CO3 – Illustrate the concept of synaptic transmission and mechanism of action of neurotransmitters
CO4 – Explain the basic mechanisms of sensations with special emphasis on skeletal muscle muscle contraction.
CO5- Enumerate the mechanisms associated with motivated and describe the disorders associated with nervous system

NEUROANATOMY 9h

Overview of central and peripheral nervous system, Neurons – structure, types and functions; Glial cells – types ; Synapses – types and functions ; myelination ; Blood Brain barrier ;Neural Development; Cerebrospinal fluid – origin and compostion ; Spinal cord - functions.

NEUROPHSIOLOGY 9h

Resting and action potential; Mechanism of action potential conduction; Voltage dependent channels – sodium and potassium channels; Electrical transmission; information representation and coding by neurons. A

Case study - information representation by neurons

NEUROPHARMACOLOGY 9h

Synapse formation; Synaptic transmission, neurotransmitters and their mechanism of action – acetyl choline, serotonin and dopamine; fast and slow transmission; hypothalamic control of neuronal function.

APPLIED NEUROBIOLOGY 9h

Basic mechanisms of sensations – touch, pain, smell, taste; neurological mechanisms of vision and audition; skeletal muscle contraction

BEHAVIOURAL SCIENCE 9h

Basic mechanisms associated with motivation; regulation of feeding, sleep, hearing and memory; Disorders associated with nervous system – Parkinson's disease, Alzheimer's disease, Schizoprenia, Anxiety and mood disorders – depression , Agrophobia.

Case study - Parkinsons and Alzeimer's disease.

TOTAL : 45h

TEXTBOOKS:

1. Mark F. Bear, Barry W. Connors and Michael A. Paradiso, (2001) *Neuroscience – Exploring the Brain*, 2nd edition, USA, Lippincott Williams & Wilkins..

2. Mathews G G (2000) *Neurobiology*, 2nd edition, UK, Blackwell Science.

U13BTE602 CLINICAL RESEARCH & MANAGEMENT 3 0 0 3

OBJECTIVES

- To develop the knowledge of the students in the area of clinical research and management
- To know the ethical guidelines, and clinical researches.
- To study the types of clinical trials

COURSE OUTCOME(S)

CO1. Distinguish and express the ethical guidelines for doing biomedical research on animals and humans
CO2. Understand the ethical theories and process in clinical research
CO3. Explain the delivery model and design contract research in clinical trial environment
CO4. Describe the clinical trial protocol for approval and responsibility of sponsor
CO5. Understand the depth of clinical research education and training in India

ETHICAL GUIDELINES 9h

General guidelines and principles in biomedical research involving human participants; Specific principles for clinical evaluation involving drug trials and vaccine trials; Statement of specific principles – Human Genome Project (HGP) ; Ethical guidelines in - DNA banking, prenatal diagnosis, principles in transplantation.

ETHICS IN CLINICAL RESEARCH 9h

Ethical Theories and Foundations; Ethics Review Committee – Institutional Ethical Committee (IEC), Ethics Review Board (ERB); Informed Consent Process; Integrity & Misconduct in Clinical Research; Conflicts of Interest (COI).

CONTACT RESEARCH 9h

Contact research – delivery model – CR Business environment – CR Information research – Contact research – Regulatory affairs and contact research – schedule Y1 – contact research and clinical trial environment.

CLINICAL TRIALS 9h

Clinical trial – protocol approval – Informed consent – responsibility of sponsor – investigator – ethics committee – types of clinical trials – structure & contents of clinical report. Data blinding & randomization – data management – trial subjects – recruiting.

TECHNICAL PRESENTATION 9h

Technical presentation – clinical research, regulation affairs – clinical trials laboratories in India – present status – setting up clinical trial company – clinical research education and training in India – India as a site for conducting clinical – outsourcing trends.

Total hours :45h

REFERENCE(S):

1. Bengt D. Furberg , Curt D. Furberg, (2007) "Evaluating Clinical Research: All That Glitters is Not Gold" 2nd edition , Springer publications
2. Stephen B Hulley, Steven R Cummings, Warren S Browner, Deborah G Grady, Thomas B Newman,(2008) Designing clinical research, Second edition Lippincott Williams & Wilkins Publishers
3. John I. Gallin and Fredrick P.Ognibene (2007). Principles and Practice of Clinical Research , Second Edition, Academic press
4. Antonella Bacchieri, Giovanni Della Cioppa (2007). Fundamentals of Clinical Research , First edition, Springer publishers

U13BTE603 IMMUNOTECHNOLOGY 3 0 0 3

OBJECTIVES:

- To learn the advanced mechanisms by which a human body fights with a pathogenic microbe
- To know about the various methods in immunodiagnosis.
- To study the basic techniques in immunopathology and molecular immunology.

COURSE OUTCOME:

CO1. The student should have understood the basic immune mechanisms and also demonstrate various methods in immunodiagnosis, immunopathology and molecular immunology.

ANTIGENS & ANTIBODIES 9h

Types of antigens, their structure, preparation of antigens for raising antibodies, handling of animals, adjuvants and their mode of action. Antibodies: Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype).

IMMUNODIAGNOSIS 9h

Monoclonal and polyclonal antibodies – their production and characterization, western blot analysis, immunoelectrophoresis, SDS-PAGE, purification and synthesis of antigens, ELISA-principle and applications, radio immuno assay (RIA) principles and applications, non isotopic methods of detection of antigens-enhanced chemiluminescence assay.

Case Study - Applications of ELISA in cancer and AIDS detection

ASSESMENT OF CELL MEDIATED IMMUNITY 9h

Identification of lymphocytes and their subsets in blood. T cell activation parameters, estimation of cytokines, macrophage activation, macrophage microbicidal assays,– a case study.

Case study - in-vitro experimentation-application of the above technology to understand the pathogenesis of infectious diseases

IMMUNOPATHOLOGY 9h

Preparation of storage of tissues, identification of various cell types and antigens in tissues, isolation and characterization of cell types from inflammatory sites and infected tissues, functional studies on isolated cells, immuno cytochemistry – immuno fluoresecence, immuno enzymatic and immuno ferrtin techniques, immuno electron microscopy.

MOLECULAR IMMUNOLOGY 9h

Preparation of vaccines, antibody engineering, production of antidiotypic antibodies, catalytic antibodies, application of PCR technology to produce antibodies and other immunological reagents, immuno therapy with genetically engineered antibodies – recombinant

vaccines.Trends in immunology of infectious diseases (tuberculosis and influenza) and tumours.

TOTAL : 45h

REFERENCES:

1. Kuby, J. H. (2007). *Immunology*, 6th Edn., New York, USA,W. H. Freeman Publication, ,
2. Asim K.Chakravarthy (2008). *Immunology & Immunotechnology*. Oxford University Press.
3. Roitt, I., Brostoff, J. and David, M. (2008). *Immunology*, 11th Edn., New York, USA.,Mosby publishers Ltd.,
4. Tizard, R.I. (2007).*Immunology*, 4 th Edn., Chennai , Saunders college publishing, Microprint Pvt. Ltd.

GENERAL ELECTIVE

U13GSS002 TOTAL QUALITY MANAGEMENT 3 0 0 3

OBJECTIVES

- Acquire knowledge on TQM concepts
- Acquire knowledge on quality systems
- Develop skills to use TQM tools for domain specific applications

INTRODUCTION 9h

Definition of Quality, Dimensions of Quality, Quality costs, Top Management Commitment, Quality Council, Quality Statements, Barriers to TQM Implementation, Contributions of Deming, Juran and Crosby, Team Balancing

TQM PRINCIPLES 9h

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Continuous Process Improvement,5S, Kaizen, Just-In-Time and TPS

STATISTICAL PROCESS CONTROL 9h

The seven tools of quality, New seven Management tools, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Concept of six sigma.

TQM TOOLS 9h

Quality Policy Deployment (QPD), Quality Function Deployment (QFD), Benchmarking, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), FMEA

QUALITY SYSTEMS 9h

Need for ISO 9000 and Other Quality Systems, ISO 9001:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, ISO 14001:2004

TOTAL : 45h

REFERENCE(S):

1.Dale H.Besterfiled, “Total Quality Management”, Pearson Education

2.James R.Evans & William M.Lidsay, “The Management and Control of Quality”, South-Western (Thomson Learning), 2008.

3.Feigenbaum.A.V. “Total Quality Management”, McGraw Hill
4.Oakland.J.S. “Total Quality Management”, Butterworth – Hcinemann Ltd., Oxford
5.Narayana V. and Sreenivasan, N.S. “Quality Management – Concepts and Tasks”, New Age International 2007.
6.Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers

U13GSS004 OPERATIONS RESEARCH 3 0 0 3

OBJECTIVES

- Apply knowledge of OR techniques to domain specific industrial situations to optimize the quality of decisions
- Conduct investigations by the use of OR techniques

LINEAR MODEL **9h**

The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique (Big M method, two phase method), duality in simplex

TRANSPORTATION AND ASSIGNMENT MODELS **9h**

Transportation model – Initial solution by North West corner method – least cost method – VAM. Optimality test – MODI method and stepping stone method
Assignment model – formulation – balanced and unbalanced assignment problems

PROJECT MANAGEMENT BY PERT & CPM **9h**

Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT cost

REPLACEMENT AND SEQUENCING MODELS **9h**

Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies) Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem

INVENTORY AND QUEUING THEORY **9h**

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management
Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ -
M/M/1: FCFS/n/m

Total: 45h

REFERENCES

1. Taha H.A., "Operation Research", Pearson Education
2. Hira and Gupta "Introduction to Operations Research", S.Chand and Co.2002
3. Hira and Gupta "Problems in Operations Research", S.Chand and Co.2008
4. Wagner, "Operations Research", Prentice Hall of India, 2000
5. S.Bhaskar, "Operations Research", Anuradha Agencies, Second Edition, 2004

U13GSS005 ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT 3 0 0 3

OBJECTIVES

- Acquire knowledge of economics to facilitate the process of economic decision making
- Acquire knowledge on basic financial management aspects
- Develop the skills to analyze financial statements

Course Outcomes

1. Evaluate the economic theories, cost concepts and pricing policies
2. Understand the market structures and integration concepts
3. Understand the measures of national income, the functions of banks and concepts of globalization

ECONOMICS, COST AND PRICING CONCEPTS: 9h

Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual cost and opportunity cost – Incremental cost and sunk cost – Fixed and variable cost – Marginal costing – Total cost – Elements of cost – Cost curves – Breakeven point and breakeven chart – Limitations of break even chart – Interpretation of break even chart – Contribution – P/V-ratio, profit-volume ratio or relationship – Price fixation – Pricing policies – Pricing methods

CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES: 9h

Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger – Horizontal integration

NATIONAL INCOME, MONEY AND BANKING, ECONOMIC ENVIRONMENT: 9h

National income concepts – GNP – NNP – Methods of measuring national income – Inflation – Deflation – Kinds of money – Value of money – Functions of bank – Types of bank – Economic liberalization – Privatization – Globalization

CONCEPTS OF FINANCIAL MANAGEMENT: 9h

Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital

ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS: 9h

Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations

REFERENCE(S):

- Prasanna Chandra, " Financial Management (Theory & Practice) TMH
- Weston & Brigham, " Essentials of Managerial Finance"
- Pandey, I. M., "Financial Management"
- Fundamentals of Financial Management- James C. Van Horne.

- Financial Management & Policy -James C. Van Horne
- Management Accounting & Financial Management- M. Y. Khan & P. K. Jain
- Management Accounting Principles & Practice -P. Saravanavel

U13GSS005 PRODUCT DESIGN AND DEVELOPMENT 3 0 0 3

OBJECTIVES

- Acquire knowledge on the various stages of a product development process
- Develop skills for using the various tools and techniques for developing products
- Acquire knowledge on project management techniques

Course Outcomes

After successful completion of this course, the students should be able to

1. Understand the process to plan and develop products
2. Understand the process of collecting information and developing product specifications
3. Understand the concept generation, selection and testing processes
4. Understand the concepts of product architecture, industrial design and design for manufacture
5. Understand the basics of prototyping, economic analysis and project planning and execution processes

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS PRODUCT PLANNING: 9h

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development.

A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization.

The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 9h

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING 9h

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process. Overview of methodology, concept screening, concept scoring, caveats.

Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING 9h

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.
Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design.

Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING - PRODUCT DEVELOPMENT ECONOMICS MANAGING PROJECTS 9h

Prototyping basics, principles of prototyping, technologies, planning for prototypes. Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.
Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

REFERENCE(S):

1. **Product Design and Development:** Karl. T. Ulrich, Steven D Eppinger,. Irwin McGrawHill.
2. **Product Design and Manufacturing:** A C Chitale and R C Gupta, PHI
3. **New Product Development:** Timjones. Butterworth Heinmann,, Oxford. UCI.
4. **Product Design for Manufacture and Assembly:** Geoffery Boothroyd, Peter Dewhurst and Winston Knight.

DEPARTMENT OF BIOTECHNOLOGY

VISION

Create a strong teaching base in the area of biotechnology through technical knowledge dissemination to the students, and to scale new heights in research by combining the concepts of professionalism, social justice, environmental impact and human ethics for the welfare of the general public.

MISSION

- Disseminate a blending of knowledge acquisition and its application in real-life situations to the students
- Equip the students adapt to changing global and local needs through well designed curriculum and syllabus
- Groom students to uphold professional ethics and develop leadership qualities
- Train students on issues related to social welfare.