BVVS

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOT

DEPARTMENT OF BIOTECHNOLOGY

B.E. V SEMESTER

2021-22

Sl. No	Subject Code	Subject Title	Hours/Week					Exam Marks		
			Credits	Lecture	Tutorial	Practical	Total	CIE	SEE	Total
1	UBT520C	Fundamentals of Bioinformatics	3	2	2	0	4	50	50	100
2	UBT516C	Bioprocess and Reaction Engineering	3	3	0	0	3	50	50	100
3	UBT519C	Genetic Engineering & Applications	3	3	0	0	3	50	50	100
4	UCS559L	Advanced C Programming Lab	2	0	0	2	2	50	50	100
5	UHS002N	Advanced Quantitative Aptitude and Soft Skills	1	2	0	0	2	50	50	100
6	UBT506H	Industrial Safety & Bioethics	3	3	0	0	3	50	50	100
7	UBT52XE	Elective-1	3	3	0	0	3	50	50	100
8	UXX00XN	Open Elective -1	3	3	0	0	3	50	50	100
9	UBT514L	Bioinformatics Lab	1	0	0	2	2	50	50	100
10	UBT515L	Genetic Engineering Lab	1	0	0	2	2	50	50	100
		Total	**23**	**19**	**2**	**6**	**27**	**500**	**500**	**1000**

Elective -1

UBT521E: Environmental BT
UBT522E: Biomedical Instrumentation
UBT525E: Stem cell technology
UBT527E: Nutraceuticals

UBT520C: Fundamentals of Bioinformatics

3 Credits (2-2-0)

UNIT 1

Introduction to Bioinformatics and Biological Database **12 Hours**

Introduction to bioinformatics, Components of bioinformaticsand interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG;ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file.

Tutorials: Practices on other primaryandsecondarydatabases

UNIT 2

Sequence alignment and database searches **10 Hours**

Introduction, Types of sequence alignment,Comparison between global and local alignment,Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions;Word/k-tuple method- BLAST, FASTA.

Multiple Sequence Alignment:Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles.

Tutorials: Solving problems on pairwise sequence alignment

UNIT 3

Phylogenetic analysis and predictive methods using sequences **10 Hours**

Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees,Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares.

Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan). Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling.

Tutorials: Practices on prediction of phylogenetic trees

UNIT 4

Plasmid mapping and primer designing &molecular modelling techniques **10 Hours**

Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations,Calculation of Molecular Properties,Dockingsoftwares (AUTODOCK, HEX)

Tutorials: Solving problems related to Restriction mapping and Primer designing

Total: 42 hours

Text Books

1. Bioinformatics – Andreas D Baxevanis. Wiley Interscience, 4 th Edition, 2020.
2. Bioinformatics –David W Mount, cold spring harbor, 2 nd Edition, 2005.

Reference Books

1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition,2006.
2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000.
3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
4. Computational methods for macromolecular sequence analysis – R F Doolittle. academic Press, 1996.

Course Outcomes

1. Importance of databases involved in bioinformatics along with their file formats
2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences
3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis
4. Explain various statistical tools involved in predicting the structure of genes and proteins
5. The principle behind restriction mapping and primer designing
6. Different approaches involved in silico drug design

UBT516C: Bioprocess Reaction Engineering
3Credits (3-0-0)

UNIT 1

Kinetics of Homogeneous reactions **10 Hours**

Basic Concepts of Bioreactor and bioprocess engineering, Concentration dependent term of a rate equation. Rate Constant. Representation of elementary reaction and Non elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.

UNIT 2

Interpretation of Batch Bioreactor Data **10 Hours**

Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalyzed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data and numerical

UNIT 3

Introduction to Reaction Design **10 Hours**

Introduction. Factors to be consider for designing a reactor, Types of reactors, Basic design equation, relation between Concentration and conversion, Performance equation for ideal batch reactor, MFR/CSTR and PFR, space time and space velocity for flow reactors, design of flow reactors and numerical.

UNIT 4

Design for single reactions **10 Hours**

Introduction .Size comparison of single reactors, multiple reactors CSTR in series /MFR in series, CSTR in parallel .PFR in series, in parallel, Reactors of different types in series, and numerical.

Total: 40 hours

Text Books

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3nd edn., Prentice Hall PTR.

Reference Books:

1. Bailey JE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
2. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
3. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
4. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

Course Outcomes

1. Understand the basic concept of reaction engineering.
2. Predict the order and rate of the different reactions.
3. Analyse the batch bioreactor data for different reactions.
4. Design the suitable bioreactor for different biochemical reactions.
5. Predict the residence time distribution to determine the conversion in non ideal flow reactors
6. Analyse bioreactors for various cell cultures.

UBT519C: Genetic Engineering & Applications

3 Credits (3-0-0)

UNIT 1

Introduction **10 Hours**

Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambsa vectors.

Enzymes in Genetic Engineering

Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase.

UNIT 2

Nucleic acid hybridization and amplification **10 Hours**

Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.

Construction of DNA Libraries

Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.

UNIT 3

Gene transfer techniques **12 Hours**

Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti& Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.

Transgenic Science and Genetic Improvement

Transgenic science in plant improvement, Antisense RNA technology (Flavrsavr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Btgenes(*Bacillus thuringiensis* and its mode of action), Cry proteins – mechanism of action.

UNIT 4

Gene therapy **10 Hours**

Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.

APPLICATIONS

Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.

Total: 42 hours

Text Books

1. Molecular Biotechnology, Principles and applications of Recombinant DNA by Bernard R Glick and Jack J Pasternak, CBS Publishers,2nd Edition, 2017.
2. Recombinant DNA by Watson, et al., Freeman Publishers 2nd Edition 2010.

Reference books

1. Principles of gene manipulation, Primrose S.B., Blackwell Scientific Publications, 6th Edition, 2001.
2. Biotechnology Expanding Horizon, B.D.Singh, 3rd revised edition, Kalyani Publishers, 2010
3. NPTEL Source material

Course Outcomes

1. Emphasize on the basic aspects of genetic engineering; the key areas and apply the knowledge in vectors used in genetic engineering experiments.
2. Apply the properties of various enzymes and vectors in gene and genome manipulation.
3. Acquire working knowledge on the mechanism of methods of nucleic acid detection, hybridization and amplification and their applications in the research.
4. Acquire working knowledge on the construction of genomic and cDNA libraries their applications in the research and biology of *Bacillus thuringiensis*.
5. Identify the various gene transfer techniques in plants, animals and microbes that are essential for controlled protein production in the industry and acquire knowledge on various strategies of Gene therapy and its application in therapeutics.
6. Identify and apply the current applications and advances of biotechnology and describe the steps involved in the production of biopharmaceuticals in microbial systems and industrial utilization

UCS 559L: Advanced C Programming Lab

2 Credits (2-0-0)

Unit 1

Multidimensional arrays. Self-referential structures and Unions. **Pointers:** Introduction, Pointers for inter function communication, Pointers to pointers

Unit 2

Pointer Applications: Arrays and pointers, pointer arithmetic and arrays, passing an array to a function, memory allocation functions, array of pointers, Examples.
Data Structures, Data structure Operations,
Stacks: Definition, Stack Operations, Array Representation of Stacks.

Unit 3

Stacks using Dynamic Arrays, Stack Applications: Queues: Definition, Array Representation, Queue Operations. Programming Examples.

Unit 4

Linked Lists: Definition, Representation of linked lists in Memory, Linked list operations: Traversing, Searching, Insertion, and Deletion. Applications of Linked lists. Implementation of stack and queue using linked list.

Text Books

1. Gilberg &Forouzan, DataStructur Structures: A Pseudo-code approach with C, Cengage
    a. Learning,2nd Edition, 2014
2. Yashwant Kanetkar,Data Structures through C,BPB Publications,2017

References

1. Gilberg&Forouzan, DataStructur Structures: A Pseudo-code approach with C,Cengage
    a. Learning,2nd Edition, 2014
2. Reema Thareja,Data Structures using C,Oxford press, 3rd Edition 2012
3. Jean-Paul Tremblay & Paul G,An Introduction to Data Structures with Applications,2nd Edition,2013

Course outcomes

1. Define advanced C programming concepts like pointers, data structures.
2. Apply the knowledge of advanced C programming concepts to implement given requirement specification or to solve real world problem.
3. Analyze different data structures and use suitable data structure to implement requirement specification.
4. Implement, interpret, debug and test any given advanced C program.
5. Develop software product using advanced C programming concepts to solve real world problem.

UBT506H: Industrial Safety & Bioethics

3 Credits (3-0-0)

UNIT 1

Introduction to Bioethics & Biosafety **10 Hours**

Definition and scopeof bioethics and biosafety, Ethical implications and need for biosafety, Legal and Socio-Economic impacts of Biotechnology. Convention on biological weapons. Bioterrorism-classification of biological agents with examples.

Biosafety regulation guidelines

Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety committee(IBC), Review Committee on Genetic Modification (RCGM), Genetic Engineering Approval Committee (GEAC), Biosafety guidelines-national guidelines, Cartagena Protocol on Biosafety.

UNIT 2

Biosafety Regulation **12 Hours**

Genetically modified organisms and their release in environment, Laboratory associated infections and other hazards, Good Lab Practices and Good Manufacturing Process (GLP &GMP). Biosafety levels for microorganismBL1,BL2,BL3, BL4) plants (BL1-P,BL2-P,BL3-P,BL4-P) animals (BL1-N,BL2-N,BL3-N,BL4-N).

Risk assessment during laboratory research and risk groups. Recombinant organisms and transgenic crops. Guideline for labeling GM crops. Containments; Physical, Biological. Field trial methods using transgenic plants.

UNIT 3

Food and Pharma safety **10 Hours**

Biosafety assessment procedures for biotech foods and Pharma products. Procedure to apply patent, Copy right, Plant Breeder's Right, Environmental aspects of biotech applications. Special application of patent laws in biotechnology and case studies. Flavr Savr Tomato as model case, case studies of relevance (Eg. Bt cotton, Bt brinjal). Licensing and cross licensing.

UNIT 4

Industrial safety **10 Hours**

Need for safety, importance of occupational safety, Health and safety programs, Safe and unsafe conditions.

Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention Safety policy

Fire: Fire extinguishers and fire exits, extinguishing agents. Importance of safety in food and Pharma industry. Food safety, Biological, chemical and Physical Hazards-HAACP system, Pharma safety. Food and safety act. Injuries by industrial sector

Total: 42 hours

Text Books

1. Bioethics and Biosafety by Sateesh M.K., I.K.International pub, Kindle edition, 2012
2. Biotechnology Expanding Horizon, B.D.Singh, 3rd revised edition, Kalyani Publishers, 2015

Reference Books

1. Biotechnology and Safety Assessment by Thomas, J.A., Fuch, R.L. Academic Press.3rd Edition,2002.
2. Biological safety Principles and practices,by Fleming, D.A., Hunt, D.L., ASM Press, 4th Edition,2006.
3. IPR-Biosafety and Bioethics Deepa Goel, Shomini Parashar, 2nd edition, Pearson Education India Publishers, 2010

Course outcomes: Student will be able to

1. Emphasize on the basic aspects of Biosafety and ethics; the key areas and apply the knowledge in the social, legal & ethical issues connected with BT, BWC and Bioterrorism
2. Interpret & describe biosafety regulation guidelines committees, Cartagena protocol & their relevant applications in BT
3. Identify biosafety levels as relevant to Biotechnology & apply this knowledge in maintenance of biosafety, GLP, GMP in research lab, field & industry.
4. Acquire working knowledge on the risk assessment, containment, GMO labeling and transgenic field trials in the research.
5. Identify the various forms of IPR and understand the importance of patents in modern scientific and industrial research and discuss special application of patent laws in biotechnology with case studies.
6. Identify & discuss the potential dangers in Biotechnology and gain knowledge on safety aspects in food and Pharma industry and apply precautionary measures to avoid /overcome it.

UBT521E: Environmental BT

3 Credits (3-0-0)

UNIT 1

Microorganisms **10 Hours**

Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms.

Bioaccumulation of toxicants

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

UNIT 2

Biological treatment of wastewater **12 Hours**

Waste water characteristics BOD, COD, Primary & Secondary treatment,nanofiltration, ultafilration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries.

Solid waste management

Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules.

UNIT 3

Bioleaching & Biomining **10 Hours**

Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum.

Bioremediation

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

UNIT 4

Biotechnology in biodiversity conservation **10 Hours**

Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.

Total: 42 hours

Text Books

1. Environmental Biotechnology by Pradipta Kumar Mohapatra.,I K International Publishing house,1st Edition,2007.
2. Text book of microbiology by R C Dubey and D K Maheshwari,4th Edition,2013.

Reference Books

1. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited,1987.
2. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom RIT,2000
3. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young,Pergamon Press.2nd Edition,2011
4. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
5. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 4th Edition,2006.
6. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.1st Edition, 2009.

Course Outcomes : Students will be able to

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove environmental contaminants.
5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

UBT522E: Biomedical Instrumentation
3 Credits (3-0-0)

UNIT 1

Introduction **10 Hours**

Sources of Biomedical signals, Basic medical instrumentation system, Performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems. 4 Hours UNIT 2. **BIOELECTRIC SIGNALS AND Electrode**

Origin of bioelectric signals, Recording electrodes, - Electrode-tissue interface, metal electrolyte interface, electrolyte -skin interface, Polarization, Skin contact impedance, Silver – silver chloride electrodes, Electrodes for ECG, EEG, EMG, Electrical conductivity of electrode jellies and creams, Microelectrode. Patient Safety: Electrode shock hazards, Leakage currents.

UNIT 2

ECG & EEG **10 Hours**

Electrical activity of heart, Genesis & characteristics of Electrocardiogram (ECG), Block diagram description of an Electrocardiograph, ECG Lead Systems, Multichannel ECG machine Genesis of Electroencephalogram (EEG), Block diagram description of an Electroencephalograph, 10-20 Electrode system, Computerized analysis of EEG.

Cardiac pacemakers and defibrillators

Need for Cardiac pacemaker, External pacemaker, Implantable pacemaker, Programmable pacemakers, DC defibrillator, AC defibrillator and Implantable Defibrillator.

UNIT 3

Patient monitoring system **10 Hours**

Bedside monitors, Central Monitoring System, Measurement of Heart rate -Average heart rate meter, Instantaneous heart rate meter, (Cardio tachometer), Measurement of Pulse Rate, Blood pressure measurement -direct and indirect method, Rheographic method, Oscillometric method, Ultrasonic Doppler shift method, Measurements of Respiration rate -Thermistor method, impedance puenmography, CO2 method, and Apnea detector. Blood flow meters: Electromagnetic and its types, Ultrasonic, NMR, Laser Doppler. Blood gas analyzers: Blood pH measurement, Measurement of Blood pCO2, pO2.

Physiological Transducers

Introduction, classification, performance characteristics of transducers-static and dynamic transducers, Displacement, position and motion transducers, Pressure transducer, Transducers for body temperature measurement, Optical Fiber sensor and Biosensor

UNIT 4

Recording systems **10 Hours**

Basic recoding system, general considerations for signal conditioners, preamplifiers-instrumentation amplifier, isolation amplifier, ink jet recorder, potentiometric recorder, thermal array recorder and electrostatic recorder. 4 Hours UNIT 8. ANALYSIS a) Cardiac output measurement: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of Continuous cardiac output derived from the aortic pressure waveform, Impedance technique. 4 Hours b) Pulmonary function analysis: Pulmonary function measurement, Spirometry, Puemotachometer, Measurement of Volume, Nitrogen washout technique.

Total: 40 hours

Text Books

1. Hand book of Biomedical Instrumentation – R. S. Khandpur, 2nd Edition, Tata McGraw- Hill Publishing Company Limited, 2003.
2. Introduction to Biomedical Engineering by J Enderle, S Blanchard & J Bronzino, Elsevier, 3rd Edition, 2011.

Reference Books

1. Principals of applied Biomedical instrumentation – John Wiley and sons,3rd Edition,2008.
2. Introduction to Biomedical equipment technology – Joseph J Carr, John M Brown Prentice hall 4th Edition, 2005.

Course Outcomes

1 Able to understand basic concepts of biomedical signals.
2 Able to know ECG and EEG.
3 Able to understand the patient monitoring system and recording systems
4 Able to develop recording system

UBT525E: Stem cell Technology
3 Credits (3-0-0)

UNIT 1

Stem cells and cellular pedigrees **10 Hours**

Scope of stem cells – definition of stem cells – concepts of stem cells – differentiation , maturation , proliferation , pluripolericy, self – maintainance and self – renewal –problems in measuring stem cells – preservation protocols.

UNIT 2

Stem cell concept in plants **10 Hours**

Stem cell and founder zones in plants – particularly their roots – stem cells of shoot meristems of higher plants.

UNIT 3

Stem cell concept in animals **10 Hours**

Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –Tumour stem cells, Embryonic stem cell biology - factors influencing proliferation and differentiation of stem cells – hormone role in differentiation.

UNIT 4

Haemopoietic stem cell **10 Hours**

Biology – growth factors and the regulation of haemopoietic stem cells.

Potential uses of stem cells

Cellular therapies – vaccines – gene therapy – immunotherapy – tissue engineering –blood and bone marrow – Fc cells.

Total: 40 hours

Text Books

1. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
2. Robert Lanza et al. Principles of Tissue Engineering, Academic Press; 3 edition (2007)

Reference Books

1. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual.Wiley-Blackwell; 1stEdition 2011.
2. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press,1st Edition, 2004.
3. R Lanza, Langer R and Vacanti J: Principles of Tissue Engineering. Elsevier.4th Edition, 2013.
4. JD Bronzino; Tissue Engineering and Artificial organs, Taylor and Francis, 4th Edition, 2006.

UBT527E: Nutraceuticals

Credits (3-0-0)

UNIT 1

Introduction to Nutraceutical and dietetics **10 Hours**

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

UNIT 2

Nutrition related diseases and disorders **10 Hours**

Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management.Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress.Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.

UNIT 3

Nutraceuticals of microbial, plant and animal origin **10 Hours**

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health.Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides

UNIT 4

Biotechnology in Phytonutraceuticals **10 Hours**

Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties.Golden rice, GM Tomatoes.

Total: 40 hours

Text Books

1. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA
2. L. Rapport and B. Lockwood ,Nutraceuticals,Pharmaceutical Press.,2nd Edition,2002.

Reference Books

1. M. Maffei ,Dietary Supplements of Plant Origin, Taylor & Francis,1st Edition,2003.
2. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, , American Chemical Society,1st Edition, 2004.
3. Richard Neeser& J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
4. Timotht S. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

Course Outcomes:

1 To be aware of basic concepts of nutraceuticals and nutrition
2 To have a general idea of scope of nutraceuticals and functional foods
3 To have brief idea about nutrition related health disorders and the role of nutraceuticals
4 To classify nutraceuticals and the role of nutraceuticals among different age groups
5 To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin
6 To know about the role of biotechnology in production of plant secondary metabolites

UBT514L: Bioinformatics Lab
1.0 Credits (2-0-0)

List of Experiments

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, andXenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures.

Reference Books

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience,2nd Edition,2001.
2. Discovering Genomics, Proteomics & Bioinformatics – A M Campbell & L J Heyer, Pearson Education,2nd Edition, 2007
3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
4. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
5. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 4th Edition,2013

Course Outcomes

1 Ability to Search literature and sequence databases
2 Ability to retrieve and search sequences from databases
3 Ability to align pair wise and multiple sequences
4 Ability to identify evolutionary and relationships and functional sites in genomes
5 Ability to evaluate primer designing and restriction mapping
6 Ability to docking and superimpose the structures

UBT515L: Genetic Engineering Laboratory
1.0 Credits (0-0-3)
List of Experiments in Genetic Engineering Laboratory

1. Transformation.-
2. Blue white colony screening.
3. Thermal denaturation of DNA.
4. Restriction Digestion.
5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblotting and analysis.
8. SOP for PCR
9. SOP for Gel Documentation
10. SOP for UV-Spectrophotometer
11. SOP for Lyophilizer
12. PCR (Amplification with specific primers)

Reference Books

1. Sadashiva and Manickam, "Biochemical Methods", 2nd Edition, New age international Publishers, 2017.
2. Sambrook & Russell, "Molecular Cloning", Cold Spring Harber Lab, 3rd Edition, 2002.
3. Current protocols in molecular biology-Greena Publishing Associates, NY, 1988

Course Outcomes

1. To demonstrate proficiency in Transformation and screening of transformants.
2. To apply the knowledge of thermal denaturation to calculate Tm value.
3. To evaluate the functions of restriction digestion and Ligation on DNA.
4. To demonstrate proficiency in Electro-blotting and detection.
5. To demonstrate understanding of SOP and PCR.
6. To gain knowledge in common and advanced laboratory practices in Genetic engineering lab.

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):

1. CIE comprises of 3 tests, each of 30 marks and I hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one and half unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment: quiz/ objective tests etc carries five mark

QUESTION PAPER PATTERN of SEE:

1. Total of Eight Questions with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.

Laboratory Assessment:

1) Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)

2) Allocation of 50 marks for CIE

- Performance and Journal write-up: marks for each experiment = 30 marks/No. of proposed experiments.
- One practical test, for 20 marks (5 write-up, 10 conduction, calculation, Result etc., 5 –viva-voce)

3) Allocation of 50 marks for SEE

Major and Minor	: 35 marks (Write-up 25%, conduction 50%, calculation and results 25%)
Spotting	: 08 marks
Viva-Voce	: 07 marks

B.E. VI SEMESTER

2021-22

Sl. No.	Subject Code	Subject Title	Hours/Week					Exam Marks		
			Credits	Lecture	Tutorial	Practical	Total	CIE	SEE	Total
1	UBT615C	Enzyme Kinetics and Biotransformation	3	3	0	0	3	50	50	100
2	UBT616C	Upstream processing Technology	3	2	2	0	4	50	50	100
3	UBT617C	Bioprocess Equipment Design	3	2	2	0	4	50	50	100
4	UHS003N	Career Planning and Professional Skills	1	2	0	0	2	50	50	100
5	UBT62XE	Elective – 2	3	3	0	0	3	50	50	100
6	UBT63XE	Elective – 3	3	3	0	0	3	50	50	100
7	UXX00XN	Open Elective -2	3	3	0	0	3	50	50	100
8	UBT614L	Upstream Processing Lab	1.5	0	0	3	3	50	50	100
9	UBT608L	Bio-kinetics & Enzyme Technology Lab	1.5	0	0	3	3	50	50	100
10	UBT610P	Mini Project	2	0	0	4	4	50	50	100
Total			**24**	**18**	**4**	**10**	**32**	**500**	**500**	**1000**

Elective-2

UBT621E Microbial BT
UBT623E Plant BT
UBT625E Biofuels technology
UBT627E Tissue engineering

Elective-3

UBT631E Genomics & Proteomics
UBT632E Animal BT
UBT633E Pearl programming
UBT634E Transport phenomena

UBT615C: Enzyme Kinetics and Biotransformation
3 Credits (3-0-0)

UNIT- 1

Enzyme **10 Hours**

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

Multi-Substrate Reactions:

Introduction to enzyme catalyzed reaction Ping-pong mechanism, Sequential mechanism (ordered and random), Enzyme models - Host guest complexation chemistry. Mechanism of Enzyme catalysis - Acid-Base catalysis, covalent catalysis and -entropy effect.

UNIT- 2

Enzymatic Techniques: **10 Hours**

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

Immobilization of enzymes

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

UNIT- 3

Enzymes of biological importance **10 Hours**

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

UNIT 4

Industrial uses of enzymes **10 Hours**

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

Total: 40 Hours

Text Books

1. Enzymes: Biochemistry , Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing Ltd, East-West Press, 2nd Edition, 2008
2. David L. Nelson and Michael Cox, "Lehninger Principles of Biochemistry" –7th Edition 2017
3. Nicholas C. Price and Lewis Stevens Fundamentals of Enzymology , Oxford university Press,3rd edition, 2009

Reference Books

1. U. Sathyanarayana, "Biochemistry" -Books and Allied Pub,5th Edition, 2017.
2. James R Hanson "An Introduction to Biotransformation in Organic Chemistry" Oxford university Press,1997.
3. Daniel L. Purich, Melvin I. Simon, John N. Abelson" Contemporary Enzyme Kinetics and Mechanism" Academic press, 3rd edition, 2009.

4. K. Faber" Biotransformations in Organic: Springer- Verlag.1st Edition, 1999.
5. Bailey and Ollis, "Biochemical Engineering Fundamentals", Mcgraw Hill (2nd Ed.), 2017.
6. Plowman,"Enzyme Kinetics' McGraw Hill, 2010

Course Outcomes:

1. Ability to understand mechanism of enzyme reactions.
2. Ability to understand how to characterize the enzymes.
3. Ability to apply the techniques of immobilization of enzymes and know its uses.
4. Ability to know the importance of enzymes in diagnostics.
5. Ability to know the application of enzymes in wool, leather and detergent industries.
6. Ability to apply knowledge of using enzymes in food industries.

UBT616C: Upstream Processing Technology

3 Credits (2-2-0)

UNIT 1

Fermentation process: **10 Hours**

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

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

UNIT 2

Raw materials and media sterilization: **10 Hours**

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

UNIT 3

Microbial system: **10 Hours**

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

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

UNIT 4

Plant Cell system: **10 Hours**

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

AnimalCellsystem :

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

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

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

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

Total: 40 hours

Text Books

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Butterworth-Heinemann; 3rd Edition,2016.
2. Bioprocess Engineering by Michael L. Shuler, Shuler & Kargi, Fikret Kargi, Pearson Publishers, 2nd Edition, 2012.

Reference Books

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995.
2. Introduction to plant Biotechnology by H.S. Chawla, , Oxford & IBH Publishers, 3nd Edition, 2018.
3. Introduction to Plant tissue Culture, M.K. Razdan, Oxford & IBH Publishers,3rd Edition,2019
4. Culture of animal cells by Ian Freshney , John Willey & Sons Publ. 7th Edition.2016

Course Outcomes

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

UBT617C: Bioprocess Equipment Design
3 Credits (2-2-0)

UNIT 1

Process design of double pipe heat exchanger **10 Hours**

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

UNIT 2

Process design of shell & tube heat exchanger **10 Hours**

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

UNIT 3

Process design of fermentor **10 Hours**

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

UNIT 4

Process design of plate column distillation column **10 Hours**

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

Total: 40 hours

Reference Books

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

Course Outcomes

1. Design a Double pipe Heat Exchanger as per standard procedure.
2. Design a Shell and Tube Heat Exchanger as the procedure
3. Design a Reaction Vessel Fermentor as per the Procedure
4. Design a Distillation column as per the procedure
5. Draw the Various notation of the engineering drawing
6. Draw the pipe and welded joints

UBT621E: Microbial BT
3 Credits (3-0-0)

UNIT 1

Microbial biotechnology **10 Hours**

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

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

UNIT 2

Industrial microbiology **10 Hours**

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

UNIT 3

Microbial by products **10 Hours**

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

Environmental microbiology

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

Food microbiology

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

UNIT 4

Bioremediation and bioleaching **10 Hours**

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

Total: 40 hours

Text Books

1. Microbiology by Pelczar, Chan and Kreig 7th Edition ,Mc Graw Hill Publishers,2017
2. Fundamentals of Biotechnology by Paul Prave, Uwe Faust, Wolfgang Sitig and Dieter A Sukatsch. VCH Publishers, 2000.

Reference Books

1. Principles of fermentation Technology by Peter Stanbury Allan Whitaker Stephen Hall, Aditya books (P) Ltd. 3rd Edition, 2016.
2. Alexander N Glazer, Hiroshi Nikaido by Microbial Biotechnology, W H Freeman & Company New York, 2007

UBT623E: Plant BT
3 Credits (3-0-0)

UNIT 1

Plant genetic engineering **10 Hours**

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

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

Transformation technology

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

UNIT 2

Applications **10 Hours**

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

UNIT 3

Secondary metabolites & gene markers **10 Hours**

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

UNIT 4

Nitrogen fixation **10 Hours**

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

Algae

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

Total: 40 hours

Text Books

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.2nd Edition, 1995.

2. Introduction to plant Biotechnology by H.S. Chawla, Oxford & IBH Publishers, 3nd Edition, 2018

Reference Books

1. Introduction to Plant tissue Culture, M.K. Razdan, Oxford & IBH Publishers,3rd Edition, 2019
2. P K Gupta, Elements of Biotechnology. 2nd Edition, Rastogi publication 2010

Course Outcomes

1 Study plant genetic engineering and transformation technology.
2 Study Application of plant transformation for productivity and performance
3 Study Metabolic engineering and industrial products.
4 Study nitrogen fixationandIdentification of elite species and mass production for practical application of algae.

UBT625E: Biofuels Technology

3 Credits (3-0-0)

UNIT 1

Biochemistry of biofuels and energy resources: **10 Hours**

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

Biofuels

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

UNIT 2

Biofuel feed stocks **10 Hours**

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

Types of biofuels

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

UNIT 3

Technologies for biofuels **10 Hours**

Historical background.Biochemical platform – bioethanol production, standardization, emissions and properties of bioethanol. Thermochemical platforms - biodiesel production, standardization, properties and emissions of biodiesel. BtL fuels -production, properties and emissions. Biohydrogen processing and uses. Converting solid wastes to pipeline gas. Biomethanation, Microbial fuel cells. Blending of biofuels.

UNIT 4

Biofuels in perspective **10 Hours**

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

Total: 40 hours

Text Books

1. Advances in feedstock conversion technologies for alternative fuels and bioproducts by Majid Hosseini, Academic press, 2019
2. Handbook of Biofuels Production edited by Rafael Luque, Carol Sze Ki Lin, Karen
3. Wilson, James Clark, Woodhead Publishing, 2016

Reference Books

1. Biotechnology, Economic & Social Aspects: E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge, 2000
2. Biofuels for Aviation: feedstocks, technology & implementation by Cristopher Chuck Acedemic Press, 2016
3. Second and third generation of feed stocks: The evolution of biofuels edited by Angelo Basile, Francesco Dalena, Elsevier Publication , 2019.

4. BIOFUELS: A Promising Alternate for Next Generation Fuels by B. Bharathiraja, J, Jayamuthunagai, R. Praveen Kumar , MJP Publisher, 2019
5. Biomass and Biofuels: Advanced Biorefineries for Sustainable Production and Distribution by Shibu Jose, Thallada Bhaskar CRC Press, 2015

Course Outcomes

1. Ability to understand the bioconversion process in biofuel production.
2. Able to know biofuel life cycle.
3. Able to know types of feed stocks used for biofuel.
4. Able get the knowledge about the technologies used for biofuel production.
5. Able to know the issues related with biofuels
6. Able to know first and second generation biofuels.

UBT627E- Tissue Engineering
3 Credits (3-0-0)

UNIT-I

Introduction to tissue engineering, Cell and Tissue Biology: 10Hours

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

UNIT-II

Extracellular Matrix: 10Hours

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

UNIT-III

Biomaterials & Drug Delivery Systems 10Hours

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

UNIT-IV

Tissue Engineering Bioreactors - Design and Fabrication 10Hours

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

Clinical & Regulatory Aspects of Engineered Tissues:

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

Total 40 Hours

Text Books

1. Channarayappa,Cell Biology,Universities Press,kindle Edition,2010.
2. Robert Lanza Robert Langer Joseph Vacanti Anthony Atala Principles of Tissue Engineering Academic Press 5th Edition 2020.

Reference Books

1. Patrick CW, Mikos AG, McIntire LV, Frontiers in Tissue Engineering, Pergamon Press,1st Edition,1998.
2. Bernhard O Palsson, Sangeeta N Bhatia,Tissue Engineering, Pearson Prentice Hall.1st Edition 2003.

Course Outcomes:

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

UBT631E: Genomics and Proteomics

3 Credits (3-0-0)

UNIT 1

Introduction **10 Hours**

Genes and Proteins, Polymorphisms – types of polymorphism, commercializing the Genome - Revenue opportunities: a) genome sequences and database subscriptions, b) prediction of new genes and their function by databases. Sequencing & genome projects: Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Dideoxy method, Fluorescence method, shotgun approach. Next generation sequencing Genome projects on E.coli., Arabidopsis and rice; Human genome project .

UNIT 2

Functional Genomics **10 Hours**

Gene variation and Single Nucleotide Polymorphisms (SNPs) genotyping tools -DNA Chips, comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans. Applications in Functional genomics, medicine and Gene Knockdown. Metagenomics- definition & concept. C-Value and paradox of genomes, Repetitive and coding sequences, Genetic and physical maps, chromosome walking Methods of molecular mapping, Marker assisted selection, map based cloning, Bioinformatics analysis-clustering methods. Approaches to physical mapping

UNIT 3

Structure of Proteins **10 Hours**

Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, Vanderwaal's force , salt bridges hydrophobic interactions, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions (Examples of bio-molecular interactions), fibrous proteins (structure of collagen, keratin) and Quaternary structures.

UNIT 4

Proteomics **10 Hours**

Introduction to proteomics, Sample preparation, protein extraction Denovo protein synthesis, LCMS/MS, M/Z ratio, sequencing and identification, Predictive Methods using Protein sequences: Protein Identity based on composition, Related web based software (JPRED, PROSEC, NNPREDICT and SOPMA) Proteome analysis "Protein Chip" - interactions and detection techniques, two dimensional PAGE for proteome analysis, Applications of proteome analysis to drug development and toxicology. Crisper-cas. Challenges in proteomics.

Total: 40 hours

Text Books

1. Introduction to Genomics – Arthur M Lesk, Oxford University Press, 2nd Edition,2012.
2. Plant Genome Analysis – Peter M Gresshoff, CRC Press.1st Edition,1994.

Reference Books

1. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Science,1st Edition,1994.

2. A M Campbell & L J Heyer Discovering Genomics, Proteomics & Bioinformatics –, Pearson Education, 2nd Edition, 2006.
3. Albala J S & I Humprey-Smith Protein Arrays, Biochips and Proteomics, CRC Press,1st Edition,2003.

Course Outcomes:

1. To know about genes, prediction methods, DNA sequencing methods and brief history
2. Able to be aware of Functional genomics of different organisms
3. To know about molecular markers, gene and physical mapping techniques
4. To know about Protein structure analysis and molecular interactions
5. To know about different protein database and proteome analysis
6. To know the applications of genomics and proteomics in medicine

UBT632E: Animal BT

3 Credits (3-0-0)

UNIT 1

Cell Lines **10 Hours**

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

Cell Culture

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

UNIT 2

Invitro Fertilization & Cloning **10 Hours**

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

UNIT 3

Human Genome **10 Hours**

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

Transgenics

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

UNIT 4

Other Applications **10 Hours**

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

Total: 40 hours

Text Books

1. Sudha Gangal,Principles and practice of Animal Tissue Culture, Universities press, 2007.
2. B Singh and S K Gautam,Animal Biotechnology,The energy and resources institute TERI,2015.

Reference Books

1. Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press,1st Edition,1998.
2. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 7th Edition, 2015

3. Animal Biotechnology by Murray Moo-Young , Pergamon Press,1st Edition,1989.

Course Outcomes

1 Study cell lines and cell culture
2 Study invitro fertilization & cloning.
3 Study human genome and Transgenic animals
4 Know Application of animal cell culture

UBT633 E: Perl Programming
3 Credits (3-0-0)

UNIT-I

Introduction **10 Marks**

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

Lists, Arrays and Hashes

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

UNIT-II

Loops and Decisions **10 Marks**

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

Regular Expression

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

UNIT-III

Files and References **10 Marks**

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

Subroutines and Modules

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

UNIT-IV

Running and Debugging Perl **10 Marks**

Examining syntax errors, runaway strings, brackets around conditions, missing semicolons, braces, commas and barewords. Diagnostic modules, use warnings, scope of warnings, use strict, strict on variables, references, subroutines, use diagnostics, perl command line switches, usage of–e, -n, -p, -c, -I, -M, -s, -I, @INC, -a, -F and

–T switches, Debugging techniques, usage of print, comments, context, scope and precedence in debugging, Defensive programming.

Bioperl

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

Total: 40 Hours

Text Books

1. Harshawardhan P Bal, Perl Programming for Bioinformatics, Tata McGraw Hill, 2003.
2. James Tisdall, Mastering Perl for Bioinformatics, O'Reilly, 1st Edition,2003.

Reference Books

1. D. Curtis Jamison, Perl Programming for Bioinformatics & Biologists, John Wiley & Sons, INC., 2004
2. Michael Moorhouse, Paul Barry, Bioinformatics Biocomputing and Perl, Wiley, 1st Edition 2007.

UBT634E Transport Phenomena
3 Credits (3-0-0)

UNIT 1

Momentum Transfer and Overall Balances **10 Hours**

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

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

UNIT 2

Steady State Heat Transfer **10 Hours**

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

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

UNIT 3

Mass Transfer **10 Hours**

Mass transfer and diffusion, molecular diffusion in gases, liquids and solids. Mass transfer coefficients.

Separation Processes - Evaporation, Drying, Humidification, and Absorption.

UNIT 4

Separation Processes **10 Hours**

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

Total: 40 hours

Text Book

1. Bird, Stewart and Lightfoot, Transport Phenomena, John Wiley, revised 2nd Edition,2006.
2. Biochemical Engineering Fundamentals by James E. Bailey, David F. Ollis, Publisher: Mc Graw Hill, 2nd Edition 1986.

Reference Books

1. Welty, Wicks and Wilson, Fundamentals of Momentum, Heat and Mass Transport, John Wiley,5th Edition 2008.

Course outcomes

1 Able to understand Momentum transfer – Principles and Applications.
2 Mechanisms of heat transferand Mass Transfer.
3 Separation Processes.

UBT608L: Biokinetics & Enzyme Technology Lab
1.5 Credit (0-0-3)

LIST OF EXPERIMENTS

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

Reference Books

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

Course outcomes

1 Ability to understand the preparation of enzymes.
2 Ability to determine the activity of enzymes.
3 Ability to estimate the effect of external condition on enzyme activity.
4 Ability to evaluate the action of inhibitors on the enzyme activity.
5 Ability to analyze the kinetic of enzymes.
6 Ability to apply knowledge of immobilization of enzymes

UBT614L: Upstream Processing Lab
1.5 Credit (0-0-3)

LIST OF EXPERIMENTS

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

Reference Books

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

Course outcomes

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

QUESTION PAPER PATTERN OF CIE (Continuous Internal Evaluation):

1. CIE comprises of 3 tests, each of 30 marks and I hr duration, totaling to 90 marks and later is scaled down to 45 mark
2. Each CIE will be covering one and half unit
3. Any two full questions to be answered out of three questions and each question carries fifteen marks
4. Assignment: quiz/ objective tests etc carries five mark

QUESTION PAPER PATTERN of SEE:

1. Total of Eight Questions with Two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four sub questions.
3. Any Five Full questions are to answered choosing at least one from each unit.

Laboratory Assessment:

1) Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE)

2) Allocation of 50 marks for CIE

- Performance and Journal write-up: marks for each experiment = 30 marks/No. of proposed experiments.
- One practical test, for 20 marks (5 write-up, 10 conduction, calculation, Result etc., 5 –viva-voce)

3) Allocation of 50 marks for SEE

Major and Minor	: 35 marks (Write-up 25%, conduction 50%, calculation and results 25%)
Spotting	: 08 marks
Viva-Voce	: 07 marks