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(* These marks will be awarded at the end of semester VI based upon the performances in both semester V & VI.)

CT- Cumulative Test    TA - Teacher's Assessment    ESE- End Semester Examination
ENVIRONMENTAL BIOTECHNOLOGY

TBT 501

Unit I
Introduction to Environment: Concept of ecology and ecosystem, environmental pollution (Water, soil and air) noise and thermal pollution, their sources and effects. Environmental laws and policies.

Unit II
Sewage and waste water treatments anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacterial-technical process and conditions, emerging biotechnological processes in waste – water treatment.

Unit III
Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues. Biodegradation of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

Unit IV
Bioremediation and Biorestoration: Reforestation through micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

Unit V
Environmental Biotechnology in Agriculture: Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides Biofuel: Plant derived fuels, Energy crops, Biogas, Bioethanol, biohydrogen Environmental genetics: degradative plasmids, release of genetically engineered microbes in environment.

Text / Reference Books:
1. Environmental Biotechnology by Alan Scrugg (1999); Longman.
2. Determination of fluoride in water/soil/biosamples.
3. Determination of LD$_{50}$ for common pesticides/weedicides.
5. Demonstration of Biosensors, Principle & Application, eg. BOD, Nitrite, sulfite on the basis of availability.
ENZYMEOLOGY
TBT 502

Unit I
Introduction to enzymes: Brief history of enzymes, nomenclature and classification of enzymes. Chemical nature of Enzymes: amino acids, the building blocks of protein, Levels of protein Structure: Primary, secondary, tertiary and quaternary structure. Specificity of Enzymes: Types of specificity, the Koshland “induced fit” hypothesis, Strain or transition – state stabilization hypothesis.

Unit II
Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of uncatalyzed chemical reactions, kinetics of enzyme-catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reactions, nature of enzyme catalysis, inhibition of enzyme activity.

Unit III
The Investigation of Active Site Structure and Chemical nature of Enzyme Catalysis: The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal-activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions.

Unit IV

Unit V

Text / Reference Books:
1. To prepare a sample of enzyme extract.
2. To determine activity of acid phosphatase from peas/moong seedlings.
3. Purification of an enzymatic protein by salt precipitation.
4. Determination of kinetic properties ($K_m$ and $V_{max}$ values) of an enzyme.
5. To check time and protein linearity of an enzymatic reaction.
6. To obtain standard curve of p-nitrophenol solution.
7. Immobilization of an enzyme.
UNIT ONE
Historical background and terminology used cell & tissue culture. Basic techniques of cell and tissue culture, surface sterilization, aseptic tissue transfer, concept of totipotency. Nutritional requirement of cell in vitro, various types of nutrient media. Basic aseptic techniques.

UNIT II
Physical Environment: Surface, PH Temperature. Chemical Environment – Properties of media, balanced salt solutions, Natural media, synthetic Media (with Serum & Serum free media), complex media. Primary Cell Culture: Disaggregation Techniques, Isolation, Propagation, Immortalization of cell lines, Routine maintenance.

UNIT III
Somatic embryogenesis and organogenesis in plants. Variability in tissue cultures, somaclonal and other variations. Isolation of cells, single cell cultures and cloning. Zygotic embryo culture, Micropropagation and cloning of plants, applications of micro propagation in agriculture, horticulture & forestry.

UNIT IV
Protoplast Isolation and culture, fusion of protoplast. Haploid Production: Introduction, Techniques, factors affecting embryogenesis, plant regeneration from poller embryo, gynogenesis diphedization to raise homozygous diploids applications, limitation.

UNIT V
Contamination and cytotoxicity: Sources and types of microbial contamination, Monitoring: Viability assay, Survival assay and transformation assay. Preservation of cell lines: cryopreservation, cell banks, transporting cells. Somatic Hybridization: Fusogens, basis of somatic hybridization technology, storage of hybridoma cells, Productions of monoclonal antibodies. Large scale animal cell culture, culture Parameters, scale-up of ancharge-dependent cell, Suspension culture.

Recommended Books:

8. Animal or Animal cell & tissue culture techniques 5th freshness.
CELL AND TISSUE CULTURE
PBT 503

1. Tissue culture, media preparation-MS/White media, Slant preparation
2. Sterilization techniques
3. Culture of axillary meristems for clonal multiplication.
4. Embryo culture.
5. Artificial seeds.
6. Shoot tip culture.
7. Isolation of protoplasts.
Unit I
Introduction and Tools for Genetic Engineering:
Introduction of RDT, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors: Plasmids, Lambda phage, Phagemids, Cosmids, Artificial chromosomes (BACs, YACs), Shuttle vectors, virus based vectors.

Unit II
Gene Transfer Technology

Unit III
Polymerase Chain reaction (PCR) and applications:
Basic principles, modifications, applications. Gene libraries: cDNA synthesis, Genomic DNA libraries, Amplification of gene libraries, Identifying the products of cDNA clones.

Unit IV
Analysis and expression of cloned gene in host cells:
Expression vectors, Restriction enzyme analysis, Southern blotting, Northern blotting, Western blotting, In-situ hybridization. Colony and plaque hybridization, Factors affecting expression of cloned genes, Reporter genes, Fusion proteins.

Unit V
Application of recombinant DNA in biotechnology:
Antisense and ribozyme technology, Human genome project and its application, Gene therapy prospect and future, DNA vaccine, Transgenic plants.

Text/References Books:
UNIT I
Energy, energy flow cycle, energy conversion; Structure and properties of ATP; High energy compounds, Thermodynamic considerations, Coupling reactions of ATP and NDP (nucleotide di phosphate); photosynthesis.

UNIT II
Biological membrane: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of \( \text{Na}^+ / \text{K}^+ \), glucose and amino acid transport.

UNIT III
Metabolism and bioenergetics; Generation and utilization of ATP; Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides.

UNIT IV
Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH); Stoichiometry and energetic analysis of Cell Growth and Product Formation - elemental Balances, Degree of reduction concepts; available-electron balances; yield coefficients; Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth.

UNIT-V

Text books:
1. Introduction to Chemical Engineering thermodynamics by Smith and Vannes (Mcgraw Hill).
2. Chemical engineering thermodynamics by Y.V.C. Rao (New age international)

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(* These marks will be awarded on the basis of performance of both semesters V & VI.)

(Note: The students will go for 4 weeks practical training in summer vacation after semester VI. The presentation & examination will be conducted in semester VII.)

CT - Cumulative Test

TA - Teacher's Assessment

ESE - End Semester Examination
Unit I: Introduction to Genomics
Genome evolution and phylogenetics, Origin of genomes, Acquisition of new genes, DNA sequencing – chemical and enzymatic methods, The origins of introns, DNA and RNA fingerprinting, The human genome.

Unit II: Structural and Functional Genomics
Technology, Sequences Comparison Techniques [BLAST], Genome, Annotation, ESTs, Digital Northern, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Microarray Chips, Cancer and genomic microarrays, Application of Microarrays with examples, Microarray Data Analysis; Gene finding tools.

Unit III: Introduction to proteomics
How to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, MALDI-TOF mass spectrometry

Unit IV: Protein Structure and Function
Structure function relationship, Protein-protein interactions – Large molecular complexes – RNA polymerase II, ribosome; Unstructured proteins – Current concepts and examples, the fly-casting mechanism; Current Degradation Concept.

Unit V: Application of Genomics and Proteomics
Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases. Study of Post translational Modifications: Methods of applications, Aspects of Clinical Proteomics; Protein micro arrays and MS Imaging

Recommended books:
1. Genomes II, T.A. Brown
2. Biotechnology and Genomics by P.K. Gupta
3. A Primer of Genome Science, Greg Gibson and Spencer V. Muse
4. Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk
5. DNA: Structure and Function, Richard R. Sinden
6. Recombinant DNA (Second Edition), James D. Watson and Mark Zoller
8. Genes & Genomes, Maxine Singer and Paul Berg
GENOMICS AND PROTEOMICS LAB

PBT 601

1. To study DNA sequencing methods
2. To study gene finding tools and Genome annotation
3. To study comparison of two given genomes
4. To study the analysis of 2D – IEF data
5. To study Two-hybrid methods
Unit I
Microbial growth, Mass balance, Maintenance coefficient and yield concept, Volumetric mass transfer coefficient, Kinetics of Batch, Continuous and Fed-batch processes, isolation, preservation and maintenance of Industrial important microorganism.

Unit II
Bioreactors: components and control of process parameters, Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor, Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, importance of pH, fluid vs. solids, fluid static’s mass and energy balance in fluid flow, Bernoulli’s equation, flow past immersed bodies and drag coefficient. Sterilization of process fluids, recovering and purifying products, integration of reaction and separation.

Unit III
Downstream processing: Introduction, removal of microbial cells and solid matter, Foam separation, precipitation, filtration, centrifugation, cell disruption, liquid liquid extraction and Chromatography, recovery and purification of fermentation products, Up scaling of bioprocess

Unit IV
**Diffusion and Mass Transfer:** Biological production consideration, large scale production, Enzyme kinetics, cell growth, energetics and mass transfer. Production of Penicillin, Streptomycin, Tetracycline and other Antibiotics.

Unit V
Fermentative production, Organic solvents, acetone, ethanol, butanol, Organic acids: lactic acid, citric acid and acetic acid, Enzymes (Proteases, Lipases and alpha-amylase), Amino acids (L-glutamic acid, phenylalamine and L-lysine)

Recommended Books:
2. Bioprocess Engineering: M. Shuler and F. Kargi, Pretice Hall.
3. Comprehensive Biotechnology: M. MooYoung, Editor.
4. Biotechnology: H.J. Rehm and G. Reed, VCH.
1. Isolation of Pure culture
2. Maintenance of Pure culture
3. Preservation of Industrial important microorganism by different method
4. Amylase activity
5. Antibiotic production by Fungi
6. Wine production
INTELLECTUAL PROPERTY RIGHT, BIOETHICS AND BIOSAFETY
TBT 603

Unit I

Unit II

Unit III

Unit IV
Bioethics: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc., The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

Unit V
Biosafety concepts and issues: Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. Role of patent in pharmaceutical industry, computer related innovations, Case studies: Rice, Haldi, neem, etc. and challenges ahead.

Text / Reference Books:
2. Intellectual property rights – Ganguli – Tata McGrawhill
Unit I: Bioremediation
Introductory concept, Bioremediation principles, mechanism for Bioremediation of air, water and soil pollutants, bioremediation examples, commercial application of bioremediation techniques, recombinant DNA technology and bioremediation, bioremediation models, bioremediation software

Unit II: Genetically modified organisms
Genetically modified food crops, food animals – examples and mode of production, future goals in GM food crops and animals, scientific evaluation of public concerns, legal requirements in production of GMO, current trends and consumer acceptance.

Unit III: Molecular medicine
Gene mutation, point mutation, allele specific oligonucleotides, ARMS, oligonucleotide ligation, disease diagnosis with linked genetic markers, fluorescently labeled DNA sequencing.

Unit IV: Nano-biotechnology
Introduction, definition, hybrid nanopracticles, smart drug delivery, gene sensors, biomolecule control, nanofluids, nanotechnology in medicine.

Unit V: Stem cells technology
Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

References:

Bio Reactor Analysis and Design
TBT 605

Unit I
Bioreactor: Types of reactor: Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, bubble column, air lift fermenter, mechanical design of bioreactors.

Unit II
Concept of ideal and non ideal reactors, residence time distribution, models of non ideal reactors – plug flow with axial dispersion, tanks-in-series model, chemostat model with cell growth kinetics.

Unit III
Plug flow reactor: For microbial processes, optimization of reactor systems. Multiphase bioreactors: Packed bed with immobilized enzymes or microbial cells, three phase fluidized bed trickling bed reactor, design and analysis of above reactor systems.

Unit IV
Unconventional bioreactors: Gas liquid reactors, hollow fiber reactor, membrane reactor and perfusion reactor for animal and plant cell culture.

Unit V

Text/Reference Books:
DOWNSTREAM PROCESSING
TBT 606

Unit I
Introduction: History and scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and Downstream processing. Characteristics of biotechnology products, classes of bioproducts, physicochemical basis of bioseparation.

Unit II
Cell disintegration: Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction, sorption, precipitation, ultra filtration and reverse osmosis.

Unit III
Purification methods: Fractional precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

Unit IV
Emerging separation techniques: Dynamic immobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation. Separation of intracellular, extracellular, heat and photosensitive materials. Product recovery trains - a few examples.

Unit V
Downstream processes and effluent treatment: applications of Unit Operations in Downstream with special reference to membrane separations & extractive ermentation, anaerobic and aerobic treatment of effluents. Typical examples for downstream Processing and effluent disposal in process industries.

Text/Reference Books: