DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

PROPOSED SCHEME AND DETAILED SYLLABUS OF ME BIOTECHNOLOGY

JUNE 2012
**Proposed Teaching / practical / Examination scheme for 2012-2013 for M.E. (Biotechnology Engg.)**

### 1st Year semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subjects</th>
<th>Teaching scheme Hours per week</th>
<th>Examination scheme-Marks</th>
<th>Total Marks</th>
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<tbody>
<tr>
<td>MEBT-111</td>
<td>Molecular Cell Biology (MCB)</td>
<td>4:2:6</td>
<td>100:25:125</td>
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<tr>
<td>MEBT-112</td>
<td>Biological Engineering</td>
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<td>MEBT-113</td>
<td>Bioinformatics and Research Methodology</td>
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<td>MEBT-114</td>
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<td>MEBT-115</td>
<td>Bioreactor design, operation and control</td>
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### 1st Year semester 2

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<td>Genetic Engineering and Bioinformatics</td>
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<td>MEBT-122</td>
<td>Advances in biological engineering</td>
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<td>MEBT-123</td>
<td>Protein, cell and tissue engineering</td>
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<td>MEBT-124</td>
<td>Synthetic biology design and engineering—1</td>
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### 2nd Year Semester 1

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Dissertation—It includes review of literature, project planning, synopsis submission, Pre-project presentation, every 15 days project progress report submission

Term work Include
Bioinformatics learning, research methodology learning

Note: Project viva with two external examiners, pre-project report should submit to department head sign

### 2nd Year Semester 2

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Grand Total 1700

****
Dissertation
Execute proper experimental and project planning
Every 15 days project progress report should submit to HOD
After completion of project, there is viva on it with three external examiners

Course Code detail:

MEBT—M.E. Biotechnology
111------ 1-year 1—semester 1---subject code
### 1st Year semester 1

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MEBT-111 Molecular Cell Biology

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Chemical Foundations, Covalent Bonds, Noncovalent Bonds, Chemical Equilibrium, Biochemical Energetics, Activation Energy and Reaction Rate

Protein Structure and Function, Hierarchical Structure of Proteins, Folding, Modification, and Degradation of Proteins, Functional Design of Proteins, Membrane Proteins, Purifying, Detecting, and Characterizing Protein, PERSPECTIVES for the Future, PERSPECTIVES in the Literature


Biomembranes and the Subcellular Organization of Eukaryotic Cells, Microscopy and Cell Architecture, Purification of Cells and Their Parts, Biomembranes: Structural Organization and Basic Functions, Organelles of the Eukaryotic Cell, PERSPECTIVES for the Future, PERSPECTIVES in the Literature


Unit 2

Genetic Analysis in Cell Biology, Mutations: Types and Causes, Isolation and Analysis of Mutants, Genetic Mapping of Mutations, Molecular Cloning of Genes
Defined by Mutations, Gene Replacement and Transgenic Animals, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Molecular Structure of Genes and Chromosomes, Molecular Definition of a Gene, Chromosomal Organization of Genes and Noncoding DNA, Mobile DNA, Functional Rearrangements in Chromosomal DNA, Organizing Cellular DNA into Chromosomes, Morphology and Functional Elements of Eukaryotic Chromosomes, Organelle DNAs, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Regulation of Transcription Initiation, Bacterial Gene Control: The Jacob-Monod Model, Bacterial Transcription Initiation, Eukaryotic Gene Control: Purposes and General Principles, Regulatory Sequences in Eukaryotic Protein-Coding Genes, Eukaryotic Transcription Activators and Repressors, RNA Polymerase II Transcription-Initiation Complex, Molecular Mechanisms of Eukaryotic Transcriptional Control, Other Transcription Systems, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

RNA Processing, Nuclear Transport, and Post-Transcriptional Control, Transcription Termination, Processing of Eukaryotic mRNA, Regulation of mRNA Processing, Signal-Mediated Transport through Nuclear Pore Complexes, Other Mechanisms of Post-Transcriptional Control, Processing of rRNA and tRNA, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

DNA Replication, Repair, and Recombination, General Features of Chromosomal Replication, The DNA Replication Machinery, The Role of Topoisomerases in DNA Replication, DNA Damage and Repair and Their Role in Carcinogenesis, Recombination between Homologous DNA Sites, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Regulation of the Eukaryotic Cell Cycle, Overview of the Cell Cycle and Its Control, Biochemical Studies with Oocytes, Eggs, and Early Embryos, Genetic Studies with S. pombe, Molecular Mechanisms for Regulating Mitotic Events, Genetic Studies with S. cerevisiae, Cell-Cycle Control in Mammalian Cells, Checkpoints in Cell-Cycle Regulation, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Gene Control in Development, Cell-Type Specification and Mating-Type Conversion in Yeast, Cell-Type Specification in Animals, Anteroposterior Specification during Embryogenesis, Specification of Floral-Organ Identity in Arabidopsis, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Transport across Cell Membranes, Diffusion of Small Molecules across Phospholipid Bilayers, Overview of Membrane Transport Proteins, Uniporter-Catalyzed Transport, Intracellular Ion Environment and Membrane Electric
Potential, Active Transport by ATP-Powered Pumps, Cotransport by Symporters and Antiporters, Transport across Epithelia, Osmosis, Water Channels, and the Regulation of Cell Volume, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cellular Energetics: Glycolysis, Aerobic Oxidation, and Photosynthesis, Oxidation of Glucose and Fatty Acids to CO₂, Electron Transport and Oxidative Phosphorylation, Photosynthetic Stages and Light-Absorbing Pigments, Molecular Analysis of Photosystems, CO₂ Metabolism during Photosynthesis, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Protein Sorting: Organelle Biogenesis and Protein Secretion, Synthesis and Targeting of Mitochondrial and Chloroplast Proteins, Synthesis and Targeting of Peroxisomal Proteins, Overview of the Secretory Pathway, Translocation of Secretory Proteins across the ER Membrane, Insertion of Membrane Proteins into the ER Membrane, Post-Translational Modifications and Quality Control in the Rough ER, Protein Glycosylation in the ER and Golgi Complex, Golgi and Post-Golgi Protein Sorting and Proteolytic Processing, Receptor-Mediated Endocytosis and the Sorting of Internalized Proteins, Molecular Mechanisms of Vesicular Traffic, PERSPECTIVES for the Future, PERSPECTIVES in the Literature


Cell-to-Cell Signaling: Hormones and Receptors, Overview of Extracellular Signaling, Identification and Purification of Cell-Surface Receptors, G Protein–Coupled Receptors and Their Effectors, Receptor Tyrosine Kinases and Ras, MAP Kinase Pathways, Second Messengers, Interaction and Regulation of Signaling Pathways, From Plasma Membrane to Nucleus, PERSPECTIVES for the Future, PERSPECTIVES in the Literature


Cell Interactions in Development, Dorsoventral Patterning by TGFβ-Superfamily Proteins, Tissue Patterning by Hedgehog and Wingless, Molecular Mechanisms of Responses to Morphogens, Reciprocal and Lateral Inductive Interactions, Overview of Neuronal Outgrowth, Directional Control of Neuronal Outgrowth, Formation of Topographic Maps and Synapses, Cell Death and Its Regulation, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cancer, Tumor Cells and the Onset of Cancer, Proto-Oncogenes and Tumor-Suppressor Genes, Oncogenic Mutations Affecting Cell Proliferation, Mutations Causing Loss of Cell-Cycle Control, Mutations Affecting Genome Stability, PERSPECTIVES for the Future

Reference

5. Molecular and Cell Biology For Dummies by René Fester Kratz
6. Molecular Cell Biology (Lodish, Molecular Cell Biology) by Harvey Lodish, Arnold Berk, Chris A. Kaiser and Monty Krieger
7. Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser and Monty Krieger
8. Cell and Molecular Biology: Concepts and Experiments (Karp, Cell and Molecular Biology) by Gerald Karp
9. Molecular Cell Biology Solutions Manual by Harvey Lodish

Practicals: with reference to theory syllabus

Theory Examination

Theory Examination is like other ME courses

Practical Examination
Lab Experiment with viva on it
MEBT-112 Biological Engineering

<table>
<thead>
<tr>
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What Is Bioengineering? Engineering versus Science, Bioengineering, Career Opportunities, Further Consideration of the Ethical Dimension of Bioengineering

Cellular, Elemental, and Molecular Building Blocks of Living Systems--Origins and Divergence of Basic Cell Types, Elemental and Molecular Composition of a Cell, Molecules That Contain Information, Unique versus Interchangeable Parts Leads to Molecular-Based Classification, Cellular Anatomy, Cellular Physiological Lifestyles, Viruses, Prions


Requirements and Features of a Functional and Coordinated System--Chemical Reaction Rate Acceleration, Energy Investment to Provide Driving Forces for Nonspontaneous Processes, Control and Communication Systems

Molecular Basis of Catalysis and Regulation, Binding in the Biological Context, Binding Is Dynamic, Different Venues in Which Binding Operates

Analysis of Molecular Binding Phenomena--General Strategy for Problem Formulation and Solution, Analysis of a Single Ligand-Single Binding Site System, How to Decide What the Free Ligand Concentration Is, Examples of Binding Calculations, Analysis of Binding When Enzyme Catalysis Occurs, A Protein with Multiple Binding Sites, Further Thoughts on How Living Systems Are Designed and Function

Applications and Design in Biomolecular Technology

Binding Applications, Enzyme Catalysis Application, Using Enzymes in Food Processing, Bioresource Engineering, Immobilized Enzymes in Chemical Weapon Defense and Toxic Chemical Destruction 139

Cellular Technologies and Bioinformatics Basics-Microbial Metabolic Engineering, Tissue Engineering, Gene Therapy and DNA Vaccines, An Experimental Facet of
Bioinformatics, Computational Component to Bioinformatics: Eigenvalue-Based
Methods, Future Studies

Primer on Organs and Function--Basic Parameters and Inventories in the Human
Body, Digestive System, Circulatory Systems, Heart Structure and Function, Removal
versus Preservation of Substances in the Blood, Activity Coordination: Endocrine
System, Follow-On Biomedical Engineering Considerations 188

Biomechanics--Power Expenditure in Walking, Optimization Illustration: Least
Power Expenditure, Stride Length, Scaling the Result in an Ergonomic Analysis,
Using the Solution to Solve a Larger Problem

Much Force Is Needed to Inject a Drug? Example: How Does the Heart Compare to a
Cell? Operation and Design of the Circulatory System, Biomedical Engineering
Applications, Accomplishments, and Challenges

Biomaterials--Three Basic Quantifiable Features of Biomaterials, Body Response to
Wounding, Immune System Defense, Examples of the Role of Mechanical Properties
of Biomaterials, Examples of Biomaterials Engineering Strategies That Attempt to
Minimize Clotting Through Surface Modification, Examples of Immune System
Links to Biomaterials 246

Pharmacokinetics--Pharmacokinetic Modeling Basics, Limits of Pharmacokinetic
Models and Gaining, More Predictive Power, Solution of Pharmacokinetic Model
Noninvasive Sensing and Signal Processing--Physics of NMR, Signal Processing:
Converting Raw Signal into Useful, Information, NMR Applications
References

1. Introduction to Biomedical Engineering, Third Edition by John Enderle and Joseph Bronzino


3. An Introductory Text to Bioengineering (Advanced Series in Biomechanics) by Shu Chien, Peter C Y. Chen and Y C. Fung

4. Introduction to Bioengineering by S. A. Berger, W. Goldsmith and E. R. Lewis

5. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB (Cambridge Texts in Biomedical Engineering) by Michael R. King and Nipa A. Mody


8. Handbook of Bioengineering by Richard Skalak and Shu Chien

9. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach


11. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach

Practicals: with reference to theory syllabus

Theory Examination
Theory Examination is like other ME courses

Practical Examination
Lab Experiment with viva on it
MEBT-113 Bioinformatics and Research Methodology

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Bioinformatics and Research methodology

Sequence-alignment methodologies.---Sequence databases; Similarity matrices; Pairwise alignment: Features of dynamic Programming, alignment by Bayesian Statistical Methods, multiple sequence alignment: local multiple sequence alignment: MEME, PSSM, HMM( algorithms and applications) Progressive methods for global multiple sequence alignment: CLUSTALW, PILEUP, T COFFEE; Statistical significance of alignment results.

Pattern analysis in sequences--- Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Pattern analysis in sequences and Phylogenetic tree construction methods

Motif representation, Markov models; .Distance Based methods: clustering based methods, optimality based methods: Fitsch -Margoliash and Minimum evolution methods, Neighbor joining and related neighbor methods Character Based methods: Maximum parsimony methods, Maximum likely hood method, , genetic algorithm, Phylogenetic tree evaluation: Boot strap analysis; dendrogram and applications.
Structure-Prediction of Biomolecules with applications in Bioinformatics----

Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein categories (e.g. transmembrane proteins and helical proteins), RNA secondary structure prediction methods. Patterns, motifs and Profiles in sequences: Derivation and search methods; Derived Databases of patterns, motifs and profiles e.g Prosite, Blocks, Prints- S, Pfam. Overview of tertiary structure prediction methods; algorithms for modeling protein folding; algorithms for 3D structure prediction with representative examples. Protein structure prediction by comparative modelling approaches (homology modeling and foldrecognition); ab initio structure prediction methods. Bioinformati

Molecular Modelling and drug design

Force fields and their evaluation (e.g MM2, AMBER) Monte Carlo and molecular dynamics simulations (e.g. GROMACS); simulation approaches towards protein and nucleic acid conformation determination; Energy minimization techniques; Structure comparison using database formalisms (DALI, VAST etc.); CASP for dry-wet structure comparisons. Classification of drug targets, Target discovery and validation methodologies Types of drug targets and characterization of drugs, Structure based drug design methods including computer-aided drug design (pharmacophore development) and recent technology developments; Target selection, Ligand (lead compound) design, optimization and analysis; Protein-ligand docking; QSAR; physico-chemical molecular descriptors; ADME parameters and their optimization; drug deliverability, metabolism, toxicity and pharmacokinetics; molecular diversity and Combichem;, discussion of drug design to drug discovery to drug development with pharmaceutical/biotech drug case studies.
Introduction to Research methodology: Development of hypothesis. Logical reasoning and analytical thinking. Planning and scientific strategy. Designing research methods. Setting up of scientific goals. Introduction to scientific statements Dimensions and properties Comparison and Models of research.

Critical reading of scientific paper Outline of scientific paper – planning of parts. Title, Introduction and Summary/abstract Materials and methods – importance of measurements, reproducibility, statistics, confidence. Results: Text, data presentation, methodology: Tables, graphs, histograms, photographic plates, legends. Discussion: Logical presentation and critical analysis of ideas and data, conclusions Citations: How to find references from journals, books etc

Testing of Hypothesis and Experimental design Specific search for similar hypothesis. Designing methods in order of simple to complex methodologies. Reverse testing of data by alternative methods. Double blind and randomization of protocol. Unbiased analysis. Data interpretation at multiple levels and integrating the broad idea. Reproducibility of data. Significance and correlation analysis.

Practicals: with reference to theory syllabus

Theory Examination

Theory Examination is like other ME courses

Practical Examination
Lab Experiment with viva on it

Texts/References:


2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a


7. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education


DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD
FACULTY OF ENGINEERING AND TECHNOLOGY
First Year Engineering
Semester-I

MEBT-114 Biomaterial Science

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Materials for Biomedical Applications, Chemical Structure of Biomaterials, Physical Properties of Biomaterials, Mechanical Properties of Biomaterials, Biomaterial Processing, Surface Properties of Biomaterials, classes of materials used in Medicine,

The role of adsorbed proteins in tissue response to biomaterials, cells and cell injury, Tissues- the extracellular Matrix and cell- Biomaterial interactions, mechanical forces on cells, Protein Interactions with Biomaterials, Cell Interactions with Biomaterials, Biomaterial Implantation and Acute Inflammation, Wound Healing and the Presence of Biomaterials, Immune Response to Biomaterials, Biomaterials and Thrombosis, Infection, Tumorigenesis and Calcification of Biomaterials, the complement system, systemic toxicity and hypersensitivity, blood coagulation and blood- materials interaction

Testing Biomaterials-introduction, in vitro assessment of tissue compatibility, in vivo assessment of tissue compatibility, testing of blood- materials interaction, large animal models in cardiac and vascular biomaterials research and testing, microscopy for biomaterials science
Degradation of materials in the biological environment—introduction, degradation of materials in the biological environment, degradation effects of the biological environment on metals and ceramics, pathological calcification of biomaterials

The world wide burden of diseases, global population aging and the burden of disease, the global economic impact of disease, the role of novel biomaterials in alleviating disease, practical consideration for modern biomaterials, coronary artery disease—historical perspective on coronary artery disease, pathology of coronary artery disease, biomaterials as bioactive stents, biomaterials as degradable stents, biomaterials for cardiac regeneration, stroke—pathology of stroke, biomaterials for brain imaging, biomaterials for nerve regeneration, pneumonia—historical perspective on pneumonia, pathology of pneumonia, biomaterials as novel antibiotic carriers


Traumatic injuries—clinical necessity for wound closure technologies, fibrin based biomaterials for wound closure, cyanoacrylate-based biomaterials as tissue glues, crosslinked protein-based biomaterials as tissue glues, polyethylene glycol (PEG)-
based biomaterials for wound closure, emerging biomaterials for wound closure, perinatal lung surfactant and respiratory distress in infants, biomaterials as synthetic surfactants for the lung

Artificial red blood cell substitute, extracorporeal artificial organs, clinical aspects of orthopedic biomaterial performance, dental implantation, adhesives and sealants, ophthalmological applications, intraocular lens implant—a scientific perspective, burn dressings and skin substitutes, sutures, drug delivery systems, bioelectrodes, cochlear implants, biomedical sensors and biosensors, diagnostics and biomaterials and medical applications of silicones

**Practicals: with reference to theory syllabus**

**Theory Examination**

**Theory Examination is like other ME courses**

**Practical Examination**
Lab Experiment with viva on it

**References**

1. Biomaterials: The Intersection of Biology and Materials Science by Johnna S. Temenoff and Antonios G. Mikos
3. Biomaterials: An Introduction by Joon Park and R. S. Lakes
4. Biomaterials by Joyce Y. Wong and Joseph D. Bronzino
5. Advanced Biomaterials: Fundamentals, Processing, and Applications by Bikramjit Basu, Dhirendra S. Katti and Ashok Kumar
8. Biomaterials: A Nano Approach by Seeram Ramakrishna, Murugan Ramalingam, T.S. Sampath Kumar and Winston O. Soboyejo
10. A Laboratory Course in Biomaterials by Wujing Xian
11. An Introduction to Tissue-Biomaterial Interactions by Kay C. Dee, David A. Puleo and Rena Bizios

12. An Introduction to Biomaterials, Second Edition (Biomedical Engineering) by Jeffrey O. Hollinger

13. Biomaterials for Clinical Applications by Sujata K. Bhatia

14. Integrated Biomaterials in Tissue Engineering (Biomaterials Science, Engineering and Technology) by Murugan Ramalingam, Ziyad Haidar, Seeram Ramakrishna and Hisatoshi Kobayashi
Inoculums development

Introduction to fermentation process, Microbial growth kinetics and media for Industrial fermentation, design of industrial nutrient media. Sterilization: Thermal death kinetics of micro –organisms – Batch and continuous Heat sterilization of liquid media – filter sterilization of liquid Media and Air. Inocula Development:
Introduction – criteria for the transfer of inoculums – Development of inocula for:
Yeast processes, Bacterial processes and mycelial processes – The Aseptic inoculation of plant fermenters.

Bioreactors

a. Batch and continuous culture: Chemostat: General principle, Balance equations critical dilution rate, Biomass productivity, comparison with batch cultures, residence time distribution, Test of validity, imperfect mixing, wall growth Transient state analysis,

Turbidostat, Chemostat in series Applications. Fed batch operation, Perfusion system, Bioreactor consideration in immobilized cell system.

b. Advanced Bioreactor: Stirred vessel reactors, Bubble column reactors, biochemical
loop reactors and its applications, Biological wastewater treatment in reciprocating jet bioreactors, tower-shaped reactors for aerobic biological wastewater treatment. Membrane bioreactors.

c. Modeling and Scale Up of Bioreactor: Introduction, Modeling of bioreactors, the model cycles, kind of models, complexity of the model, solving equations, parameter sensitivity, experimental design / parameter optimization / testing of the model. Scale up of bioreactors: Introduction, scale up methods in use, fundamental methods, semifundamental methods, dimensional analysis, Rules of thumb, trial and error, Mechanistic background of dimensional analysis, the use of dimensionless groups for scaling up, heterogeneous systems, generation of dimensionless groups and some examples, regime analysis, method of regime analysis. Power input requirement, scale translation, types of fermenter, scale up of CSTR, design correlations, bulk mixing, scale up methods.

Bioreactor Instrumentation and Control

a. Measurement of physical and chemical parameters in bioreactors: monitoring and control of dissolved oxygen, pH, impeller speed and temperature in stirred tank fermenter.

b. Transport Phenomenon in Bioreactor: Oxygen demand, solubility, measurement of D.O.T. Redox potential, oxygen transfer, measurement of KLa (different methods). Agitation and mixing, Baffled, vortex and airlift systems, Effect of stirring, sparging and other parameters, Power requirements for gassed and ungassed system, Rheology, O2 Transfer.
Biochemical aspects of production


b. Effect of Inhibition and Activation of Growth: Competitive and noncompetitive inhibition, Product and substrate inhibition, activators, Effect on batch and continuous systems.

Plant and Animal Cell Bioreactor

Plant cell bioreactors: characteristics of plant cell suspensions, plant cell bioreactor requirements, plant cell bioreactor design, plant cell bioreactor operation, alternative cultures for plant cells. Animal cells: Animal cell bioreactors, animal cell bioreactor operation, and animal cell bioreactor design.

Practicals: with reference to theory syllabus

Theory Examination

Theory Examination is like other ME courses

Practical Examination
Lab Experiment with viva on it

Texts/References:

1964 Pauling M. Doran, Bioprocess engineering principles
5. Biotechnology Series edited by H. Bauer,
6. Biochemical Engineering, S.Aiba
### 1st Year semester 2

<table>
<thead>
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MEBT-121 Genetic Engineering and Bioinformatics

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Basics tools of Genetic Engineering

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions- Electromobility shift assay; DNaseI footprinting; Methyl interference assay; Chemical Synthesis of oligonucleotides.

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-can be omitted vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies;
Baculovirus and pichia vectors system.

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression.

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test), Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing.

Applications of Genetic Engineering

Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy-
in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting;
Transgenics; cDNA and intragenic arrays; Differential gene expression and protein
array.

Practicals=== with reference to theory syllabus

Theory Examination ===Theory Examination is like other ME courses

Practical Examination===Lab Experiment with viva on it

Text/References


11. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual,

12. J. D. Watson et al.; Recombinat DNA, W.H. Freeman and Company

13. B. R. Glick and J.J. Pasternak ; Molecular Biotechnology: Principles and
   Applications of Recombinant DNA, ASM press

14. D. M. Glover and B.D. Hames; DNA cloning: A Practical Approach, IRL
   Press.


16. Selected papers from scientific journals.

17. Technical Literature from Stratagene, Promega, Novagen, New England
   Biolab etc.
MEBT-122 Advances in Biological Engineering

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**TRANSCRIPTION NETWORKS, BASIC CONCEPTS.** Introduction, The Cognitive Problem of the Cell, Elements of Transcription Networks, Dynamics and Response Time, of Simple Gene Circuits

**AUTO-REGULATION, A NETWORK MOTIF.** Introduction, Patterns, Randomized, Networks and Network Motifs, Auto regulation is a Network Motif, Negative Auto, Regulation Speeds the Response Time of Gene Circuits, Negative Auto-Regulation, Promotes Robustness to Fluctuations in Production, Positive auto-regulation speeds responses and widens cell-cell variability, Summary

**THE FEEDFORWARD LOOP NETWORK MOTIF**—Introduction, The Number of Appearances of a Sub graph in Random Networks, The Feed forward Loop (FFL) is a Network Motif, The Structure of the Feed forward Loop Circuit, Dynamics of the, Coherent FFL with AND-Logic, The C1-FFL is a Sign-Sensitive Delay Element, The, Incoherent FFL: a pulse generator and response accelerator, Why Are Some FFL Types Rare? Convergent Evolution of FFLs, Summary


ROBUSTNESS OF PROTEIN CIRCUITS, THE EXAMPLE OF BACTERIAL CHEMOTAXIS--The Robustness Principle, Bacterial Chemotaxis, or How Bacteria, 'Think', The Chemotaxis Protein Circuit of E. coli, Two Models Can Explain Exact, Adaptation, One is Robust and the Other Fine Tuned, The Barkai-Leibler model Individuality and Robustness in Bacterial Chemotaxis

ROBUST PATTERNING IN DEVELOPMENT--Introduction to Morphogen Gradients, Exponential Gradients Are Not Robust, Increased Robustness by Self-Enhanced Morphogen, Degradation, Network Motifs That Provide Robust Patterning, The Robustness Principle Can Distinguish Between, Mechanisms of Fruit Fly Patterning
KINETIC PROOFREADING—Introduction, Kinetic Proofreading of the Genetic Code Can Reduce Error, Rates of Molecular Recognition, Recognition of Self and Non-Self by the Immune System, Kinetic Proofreading May Occur in Diverse Recognition, Processes in the Cell

OPTIMAL GENE CIRCUIT DESIGN—Introduction, Cost and Benefit Analysis of Gene circuits, Optimal Expression Level of a Protein Under Constant, Conditions To Regulate or Not to Regulate: Optimal Regulation in Variable, Environments, Environmental Selection of the Feedforward Loop Network Motif, Summary

RULES FOR GENE REGULATION BASED ON ERROR MINIMIZATION,
Introduction, The Savageau Demand Rules, Rules for Gene Regulation Based on Minimal Error Load, Demand Rules for Genes with Multiple Regulators, Summar

Practicals===with reference to theory syllabus

Theory Examination ==Theory Examination is like other ME courses

Practical Examination===Lab Experiment with viva on it

Text /References
1. Introduction to Biomedical Engineering, Third Edition by John Enderle and Joseph Bronzino


3. An Introductory Text to Bioengineering (Advanced Series in Biomechanics) by Shu Chien, Peter C Y. Chen and Y C. Fung
4. Introduction to Bioengineering by S. A. Berger, W. Goldsmith and E. R. Lewis

5. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB

6. (Cambridge Texts in Biomedical Engineering) by Michael R. King and Nipa A. Mody


9. Handbook of Bioengineering by Richard Skalak and Shu Chien

10. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach


12. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach
**MEBT-123Protein, Cell and Tissue Engineering**

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The History and Scope of Tissue Engineering

The Challenge of Imitating Nature

Moving into the Clinic, Future Perspectives

BASIS OF GROWTH AND DIFFERENTIATION - Molecular Biology of the Cell, Organization of Cells into Higher-Ordered Structures, Dynamics of Cell-ECM, Interactions, Matrix Molecules and Their Ligands, Morphogenesis and Tissue, Engineering, Gene Expression, Cell Determination and Differentiation

IN VITRO CONTROL OF TISSUE DEVELOPMENT

Engineering Functional Tissues, Principles of Tissue Culture and Bioreactor Design

R, Regulation of Cell Behavior by Extracellular Proteins, Growth Factors, Mechanochemical Control of Cell Fate Switching

IN VIVO SYNTHESIS OF TISSUES AND ORGANS, In Vivo Synthesis of Tissues and Organs, MODELS FOR TISSUE ENGINEERING - Models as Precursors for, Prosthetic Devices, Quantitative Aspects, PBIMATERIALS IN TISSUE ENGINEERING -- Micro-Scale Patterning of Cells and Their Environment, Cell Interactions with Polymers, Matrix Effects, Polymer Scaffold Fabrication, Biodegradable Polymers, Micro- and Nanofabricated, Scaffolds, Three-Dimensional Scaffolds,
TRANSPLANTATION OF ENGINEERED CELLS AND TISSUES

Tissue Engineering and Transplantation in the Fetus
Immunomodulation, Immunoisolation,
Engineering Challenges in Immunobarrier Device Development, STEM CELLS,
Embryonic Stem Cells, Adult Epithelial Tissue Stem Cells, Embryonic Stem Cells as a Cell Source for Tissue Engineering, Postnatal Stem Cells, GENE THERAPY, Gene Therapy
Ronald, Gene Delivery into Cells and Tissues, BREAST-Breast Reconstruction, CARDIOVASCULAR SYSTEM-Progenitor Cells and Cardiac Homeostasis, Cardiac-Tissue Engineering, Blood Vessels, Heart Valves


MUSCULOSKELETAL SYSTEM--Mesenchymal Stem Cells, Bone Regeneration, Bone and Cartilage Reconstruction, Regeneration and Replacement of the Intervertebral Disc, Articular Cartilage Injury, Tendons and Ligaments Francine, Mechanosensory Mechanisms in Bone, Skeletal-Tissue Engineering, NERVOUS SYSTEM, Neural Stem Cells, Spinal Cord Injury, Protection and Repair of Audition,
OPHTHALMIC APPLICATIONS--Stem Cells in the Eye, Corneal-Tissue Replacement, Vision Enhancement Systems

ORAL/DENTAL APPLICATIONS--Biological Tooth Replacement and Repair, Oral and Maxillofacial Surgery, Periodontal-Tissue Engineering, RESPIRATORY SYSTEM--Progenitor Cells in the Respiratory System, Lungs, SKIN--Cutaneous Stem Cells, Wound Repair, Bioengineered Skin Constructs


REGULATION AND ETHICS--The Tissue-Engineering Industry, The Regulatory Path From Concept to Market, Ethical Issues

Practicals==with reference to theory syllabus

Theory Examination ==Theory Examination is like other ME courses

Practical Examination==Lab Experiment with viva on it

Text / Reference

1. Tissue Engineering by Bernhard O. Palsson and Sangeeta N. Bhatia
2. Tissue Engineering (Academic Press Series in Biomedical Engineering) by Clemens van Blitterswijk, Peter Thomsen, Jeffrey Hubbell and Ranieri Cancedda
3. Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues by W. Mark Saltzman
4. Stem Cell and Tissue Engineering by Song Li, Nicolas L'Heureux and Jennifer Elisseeff
7. Fundamentals of Tissue Engineering and Regenerative Medicine by Ulrich Meyer, Thomas Meyer, Jörg Handschel and Hans Peter Wiesmann
9. Tissue Engineering: From Lab to Clinic by Norbert Pallua and Christoph V. Suschek
10. Nanotechnology in Tissue Engineering and Regenerative Medicine by Ketul Popat
12. Tissue Engineering by M. Owen and John P. Fisher
13. Culture of Cells for Tissue Engineering (Culture of Specialized Cells) by Gordana Vunjak Novakovic and R. Ian Freshney
14. Integrated Biomaterials in Tissue Engineering (Biomaterials Science, Engineering and Technology) by Murugan Ramalingam, Ziyad Haidar, Seeram Ramakrishna and Hisatoshi Kobayashi
MEBT-124 Synthetic biology design and engineering

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High-Throughput Technologies and Functional Genomics, Predicting the Lymph Node Status of Breast Cancer Tumors Using Gene Expression Patterns and Genomic Signal Processing, From Recombinant Genes to Recombinant Genomes for Systems Biology


Self-replication in Chemistry and Biology, The Synthetic Approach for Regulatory and Metabolic Circuits, Synthetic Genetic Networks

The theory of biological robustness and its implication to cancer, Nucleic Acid Engineering

Potential Applications of Synthetic Biology in Marine Microbial Functional Ecology and Biotechnology, On fundamental implications of systems and synthetic biology, Outstanding Issues in systems and synthetic biology

Practicals==with reference to theory syllabus

Theory Examination ==Theory Examination is like other ME courses

Practical Examination==Lab Experiment with viva on it

Text /References

1. Chemical Synthetic Biology by Pier Luigi Luisi and Cristiano Chiarabelli
2. The Emergence of Life: From Chemical Origins to Synthetic Biology by P. L. Luisi
3. An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical & Computational Biology) by Uri Alon
4. Creating Life in the Lab: How New Discoveries in Synthetic Biology Make a Case for the Creator (Reasons to Believe) by Fazale Rana
5. Systems Biology and Synthetic Biology by Pengcheng Fu and Sven Panke
6. Systems Biology by Edda Klipp, Wolfram Liebermeister, Christoph Wierling and Axel Kowald
8. Synthetic Biology: the technoscience and its societal consequences by Markus Schmidt, Alexander Kelle, Agomoni Ganguli-Mitra and Huib de Vriend
9. Synthetic Biology by Markus Schmidt
10. Synthetic Gene Networks: Methods and Protocols (Methods in Molecular Biology) by Wilfried Weber and Martin Fussenegger
11. Designing Human Practices: An Experiment with Synthetic Biology by Paul Rabinow and Gaymon Bennett
12. Synthetic Biology: A Primer by Paul S. Freemont and Richard I. Kitney
14. Biology for Engineers by Arthur T. Johnson
15. Synthetic Biology by A.K. Sethi
MEBT-125 Upstream and down stream Processing

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Upstream and downstream processing—introduction, solids and liquids handling, gas compression, selection criteria for fermentation air filters, media sterilization, heat management in fermentation processes, Disruption of microbial cell

Centrifugation, filtration of fermentation broths, cell processing using tangential flow filtration, cell separation with hollow fiber membrane, ultrafiltration, ultrafiltration processes in biotechnology,

Liquid-liquid extraction of antibiotics, liquid-liquid extraction of biopolymers, Ion exchange recovery of antibiotics, ion exchange recovery of proteins, affinity chromatography, hydrophobic chromatography, high performance liquid chromatography, recovery of biological products of distillation, supercritical fluid extraction, electrodialysis

Case studies—penicillins, Tylosin, peptide antibiotics, anticancer agents, product from Recombinant DNA, siderophores, traditional fermented soybean foods, bacterial biomass, fermented dairy products, tryptophan, citiric acid, lactic acid, ethanol, acetone / butanol, microbial insecticide, enzymes in food technology
Practicals===with reference to theory syllabus

Theory Examination ==Theory Examination is like other ME courses

Practical Examination===Lab Experiment with viva on it

Texts/References:

4. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
8. Chromatographic and Membrane Processes in Biotechnology” by C.A. Costa and J.S. Cabral, Kluwer, Academic Publisher
9. Downstream Processing” by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
10. Protein Purification” by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag
12. Physical Biochemistry: David Friefelder, 5th Ed, PHI
### 2\textsuperscript{nd} Year Semester 1

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Dissertation—It includes review of literature, project planning, synopsis submission, Pre-project presentation, every 15 days project progress report submission

Term work Include
Bioinformatics learning, research methodology learning

Note: Project viva with two external examiners, pre-project report should submit to department head sign

### 2\textsuperscript{nd} Year Semester 2

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Grand Total 1700

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Dissertation
Execute proper experimental and project planning
Every 15 days project progress report should submit to HOD
After completion of project, there is viva on it with three external examiners

Course Code detail:

MEBT—M.E. Biotechnology
111------ 1-year 1—semester 1---subject code