PANJAB UNIVERSITY CHANDIGARH

Scheme and Syllabus of
MASTER OF ENGINEERING
M.E. (Biotechnology)
1\textsuperscript{st} to 4\textsuperscript{th} semester

2016-2017

University Institute of Engineering and Technology,
Panjab University, Chandigarh
# Scheme and Syllabus of M.E. (Biotechnology) 1st to 4th Semester

## Scheme of Examination of M.E. Biotechnology

**First Year - First Semester**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Subject Name</th>
<th>L-T-P</th>
<th>Contact hrs/week</th>
<th>Credits</th>
<th>Marks Total</th>
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* Practical marks are for continuous and end semester evaluation

**Total Hrs/wk = 25 Total Credits = 23**

## Elective I

- Stem Cell Biology
- Cell & Cell Technology
- Food Processing and Biotechnology
## SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

### First Year - Second Semester

<table>
<thead>
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<th>S. No.</th>
<th>Subject Code</th>
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### Total

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<th>L-T-P</th>
<th>Contact hrs/week</th>
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## ELECTIVE II

- Advances in Biomaterials
- Biopharmaceutical Technology
- Protein Engineering

**Total Hrs/wk = 23  Total Credits = 21**
## SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

### Second Year – Third Semester

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<th>S. No.</th>
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**Total Hrs/wk = 26  Total Credits = 16**

**ELECTIVE III**

- Nano Biotechnology and Nano Devices
- Agriculture Biotechnology
- Bioprocess Control & Instrumentation

**ELECTIVE IV**

- Biological Waste Water Engineering
- Biostatistics & Computer Applications
- Polymer Science & Engineering
SCHEME OF EXAMINATION OF M.E. BIOTECHNOLOGY

Second Year – Fourth Semester

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<th>S. No.</th>
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Total Hrs/wk = 30 Total Credits = 15

ME Thesis will be graded as follows for internal evaluation from session 2016-2017

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<td>A+</td>
<td>Publication in SCI/SCIE indexed journal</td>
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<td>A</td>
<td>Scopus / ESCI indexed journal</td>
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<td>B+</td>
<td>Paper presented International / National conference</td>
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Total Marks: 1700
Total Credits: 75
SYLLABUS OF M.E. (BIOTECHNOLOGY) 1ST SEMESTER

Paper Title: Advances in Biochemistry

Paper Code: ME BIO 101 L T P 4 0 0 Credits: 4

Internal Assessment: 50

University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Microbial Biochemistry: Glycolysis, fate of pyruvate under aerobic and anaerobic conditions, TCA cycle and its industrial products, Energy from oxidation of inorganic electron donors; Iron oxidation; Methanotrophy and methylotrophy; Nitrate and Sulfate reduction; Acetogenesis; Methanogenesis; Anaerobic respiration; Chlorophylls and other pigments involved in microbial photosynthesis; Anoxygenic and oxygenic photosynthesis; Autotrophic CO2 Fixation: Calvin cycle, Nitrogen fixation. (18)


SECTION-A

Medical Biochemistry:

Biosynthesis of Sphingomyelins, cholesterol and their regulation, lipid metabolism and related genetic disorders, Signal transduction and diseases, diabetes and cancer, targets of drug design. (8)

Antisense technology: Comparisons of different antisense strategies (antisense oligo nucleotides, ribozymes and siRNAs). RNA interference induced by siRNA molecules. Applications and challenges of antisense strategies (antisense oligo nucleotides and RNAi) in gene silencing, prostaglandins, thromboxane, cox1 and cox2 inhibitors. (12)

Recommended books:

1) Prescotts Microbiology, 8th Ed. by Joanne Willey, Linda Sherwood, Chris Woolverton, McGraw Hill Publishers,


Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

Flow cytometry and cell sorting, Techniques for Protein-Protein and receptor-ligand interaction (FRET, SPR, and ITC) Two hybrid system

Advances and applications of Chromatographic and mass spectrometric techniques, 2D-DIGE, Qualitative and quantitative Proteomics (ICAT, ITAQ, SILAC approaches), protein-based microarrays, Organelle/tissue/plasma proteomics

TIRF and confocal microscopy, and their applications for fixed and live-cell imaging, Dynamic analysis using photobleaching and photoactivation, FRAP and FLIP

SECTION B

Principle, sample preparation and applications of Electron microscopy (TEM, SEM, Cryo, Field Emission, Environmental SEM/TEM, Electron Tomography) and Atomic force microscopy

History of sequencing, Next generation sequencing, RNA sequencing and transcriptome analysis, FISH, Luminex Multiplex assays, RACE, RFLP, RAPD, chromatin analysis using ChIP, designing, handling and use of siRNA, miRNA techniques, DNA and RNA microarrays.

Use of radioactive and stable isotopes and their detection; Applications of radioisotopes in advanced research

Recommended books:
5. Protein–Ligand Interactions: Methods and Applications, edited by G. Ulrich Nienhaus, 2005
Paper Title: Microbial Biotechnology

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

Bioprospecting of microbial diversity- scope and techniques (2)

Process technology for the microbial production of:
- Organic acids- itaconic acid, propionic acid
- Enzymes: Inulinase, peroxidases, chitinase
- Microalgal pigments- β carotene from algae (14)

Large scale production of Bio- therapeutics from recombinant microorganism
- Insulin, antibodies (6)
Development and use of next generation antibiotics (2)

SECTION B

Bioleaching of ores (3)
Microbial fuels (Methane, Hydrogen) (5)
Fermentation technology for waste stabilization (4)
Role of microbial biotechnology in agriculture: microbes as biocontrol agents and as biofertilizers (4)
GMP for production of antibiotics and vaccines (2)
Microbial biotechnology of the extreme environments- thermo and cold adapted enzymes, use of halophilic microbes in biotechnological applications (3)

Recommended books:
Paper Title: Bioseparation and Bioprocess technology

Paper Code: ME BIO 104  L T P  4  0  0  Credits: 4

Internal Assessment: 50  University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

INTRODUCTION TO BIOSEPARATION: Characterization of biomolecules and fermentation broth.
Guidelines to recombinant protein purification. (4)


CONCENTRATION AND PURIFICATION: Liquid- liquid extraction – theory and practice with emphasis on Aqueous two phase extraction. Solid liquid extraction. Precipitation techniques using salt and solvent.
Separation by ultrafiltration, Dialysis, Electrophoresis. (10)

SECTION-B

BLACK BOX MODEL: Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries. (5)

DESIGN OF FERMENTATION PROCESSES: Kinetics of substrate utilization, biomass growth and product formation, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation. (12)

CASE STUDIES IN FERMENTATION DERIVED PRODUCTS: Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc. (5)

Recommended books:
Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

1. Basic biology of stem cells; Types & sources of stem cell with characteristics: amniotic fluid, cord blood haematopoetic, placenta, bone marrow, embryonic, adult, primordial germ cells, cancer stem cells, Induced Pluripotent Stem cells. (8)
2. Stem cell Characterizations: isolation & characterizations, Markers & their identification, growth factor requirements and their maintenance in culture. feeder and feeder free cultures. (10)
3. Cell cycle in stem cells (5)

SECTION-B

4. Molecular basis of stem cell renewal and differentiation, Metaplasia and transdifferentiation. (7)
5. Molecular basis of pleuripotency and stem cell niche. (7)

Recommended Books:

1. Essential of Stem Cell Biology” by R. Lanza, J. Gearhart etal (Eds), Essentials of Stem Cell Biology, Third Edition 2013, by Robert Lanza (Editor), Anthony Atala (Editor)
2. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms, 2014 by CRC Press, Federico Calegari (Editor), Claudia Waskow (Editor)
SECTION-A

History and Introduction of Animal Cell Culture - Past, present and future of animal cell culture, terminology of cell and tissue culture, normal and transformed cells, culture types (cell culture, organ culture, explant), their advantages and limitations, Biology and characteristics of cultured cells (cell adhesion molecules, intercellular junctions, extracellular matrix, cytoskeleton).

Animal Cell Culture Laboratory and Facilities - Infrastructure, equipments and culture vessels.

Component of Cell Culture Environment - Media (basal media, serum media and serum replacement media, specialized media and choice of media.), conditioned medium, feeder cells, physiochemical factors.

Primary Culture and Cell Lines - Establishment of Primary culture from various sources, isolation of cells (mechanical disaggregation, enzymatic disaggregation), Secondary cell culture (subculturing and establishment of continuous cell lines, cell cloning and selection, cell Sorting and separation techniques).

SECTION-B

Growth and Scale up of Cell Culture - Growth characteristics and kinetics, growth in suspension (stirrer culture, continuous flow culture, air-lift fermentor culture), growth in monolayer (roller bottle culture, multisurface culture, multiarray disks, spirals and tubes).

Genetic Engineering of Animal and Animal Cells - Transfection techniques, development of transgenic animals (xenotransplantation, knockout, human disease models, reproductive and therapeutic cloning).

Mammalian Cell Expressin System - Methodology and production of medical/pharmaceutical products using mammalian culture (tissue plasminogen activator, Factor-VIII) their transport and cellular therapies.

GLP and Quality Control of Cell Line - Testing for microbial contamination, regulatory aspects of GLP, authentication of cell line (isoenzyme analysis, DNA fingerprinting, multiplex PCR).

Recommended books:
SYLLABUS

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Historical developments in food processing, World and Indian food processing scenario, food processing industries-types, technology of processing. (4)
Effect of processing on nutritive value of foods, Quality control and assurance, Sensory evaluation of foods (4)
Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing. (7)

Manufacture of Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages. (8)

SECTION-B

Post Processing Technology: coating and enrobing; functions of a package, types of containers, package design considerations, packing materials- properties and testing procedures, packing of fresh and processed foods. (6)
Aseptic packaging, retort pouch processing technology, RFID/smart tag in labeling of foods, recent trends in packaging. (3)
Present scope of food technology, setting up of food processing units, selection of processing technology, marketing concept. Foods of increasing sophistication: Newer foods, GM foods, organic foods. (5)
Food safety and regulations: FDA, Codex Alimentarius, PFA, FPO, BIS, ISO, Agmark, Overview of Food Safety and Standards Act, 2006, HACCP, Food Safety Management System, Process Control, Food plant sanitation, personal hygiene, hygienic water for processing; Food Industry waste: types, disposal and management. (8)

Recommended books:
Paper Title: Biotechnology Lab I

Paper Code: ME BIO 106 L T P 0 0 3 Credits: 2

Internal Assessment: 50

SYLLABUS

List of Experiments:

1) Production of microbial inoculants.
2) Assay of biocontrol activity of microorganisms.
3) Preparation of Plasma from blood and estimation of glucose.
4) Estimation of total cholesterol/ lipid profile in blood.
5) Estimation of plant secondary metabolite.
6) Hemolytic activity assay of bacteria
7) Isolation of nitrogen fixing bacteria from environment
8) Analysis of transfection efficiency
9) Determination of the phenol coefficient of a given disinfectant
10) Estimation of chemical oxygen demand (COD) of given sample

Paper Title: Biotechnology Lab II

Paper Code: ME BIO 107 L T P 0 0 3 Credits: 2

Internal Assessment: 50

SYLLABUS

List of Experiments:

1) Separation and identification of compounds using Column Chromatography.
2) Proteomic analysis of bacterial cell lysate using 2D Gel electrophoresis.
3) Synthesis of Gold nanoparticles and their characterization using SEM/TEM.
4) Virtual designing of siRNA using bioinformatics tools.
5) Determination of growth curves for microbial cultures and liquid-liquid extraction of metabolites from fermentation broth.
6) Cell disruption methods and their effect on the extracted lipid composition.
7) Chromatographic separation of metabolites/drugs/bio molecules.
8) Estimation of Monods Kinetic Parameters.
9) Evaluate the temperature and pH effect on culture growth.
Paper Title: Research Methodology

Paper Code: ME BIO 201

Internal Assessment: 50

University Examination: 50

Credits: 4

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction to Educational Research: Concept, types-basic, applied and action, Need for educational research. (4)

Reviewing Literature: Need, Sources-Primary and Secondary, Purposes of Review, Scope of Review, Steps in conducting review. (4)

Identifying and defining research problem: Locating, Analyzing stating and evaluating problem, Generating different types of hypotheses and evaluating them. (4)

Method of Research: Descriptive research design-survey, case study, content analysis, Ex-post Facto Research, Corelational and Experimental Research. (6)

Sampling Techniques: Concept of population and sample’ sampling techniques-simple random sampling, stratified random sampling, systematic sampling and cluster sampling, snow ball sampling, purposive sampling, quota sampling techniques determining size of sample. (6)

SECTION-B

Design and development of measuring instruments, Tests, questionnaires, checklists, observation schedules, evaluating research instruments, selecting a standardized test. (8)

Procedure of data collection: Aspects of data collection, coding data for analysis. (4)

Statistical Methods of Analysis: Descriptive statistics: Meaning, graphical representations, mean, range and standard deviation, characteristics and uses of normal curve.

Inferential statistics: t-test. Chi-square tests. Correlation (rank difference and product moment), ANOVA (one way) (4)

Procedure for writing a research proposal; Purpose, types and components of research proposal. (2)

Procedure for writing a research report: Audiences and types of research reports, Format of Research report and journal Strategies for evaluating, research, disseminating and utilizing research- An Overview. (3)

Recommended books:
3. CPSC: Developing Skills in Technician Education Research Modules 1 to 11 Singapore, Colombo
   Plan Staff College for Technician Education
Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A
1. Overview: biological systems, media design, media sterilization and ideal reactor types. (5)
2. Scale-up of bioreactors: introduction, scale-up methods, correlations and illustrations. (8)
3. Heat transfer: heat transfer equipment, heat transfer between fluids, design equations for heat transfer systems, applications of design equations. (10)

SECTION-B
4. Mass transfer: molecular diffusion, diffusion and film theories, oxygen uptake in cell cultures oxygen transfer in fermenters, measurement of dissolved oxygen concentrations, mass-transfer correlations, measurement of $k_{l,a}$. (8)
5. Design and analysis: Reactor dynamics and stability, reactors with non-ideal mixing. (6)
6. Bioreactor system supplies: water, steam, air and gases. (8)

Recommended books:
INTRODUCTION
Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes Biocatalysis: Definition of Biocatalysis, advantages and disadvantages of Biocatalysis over chemical catalysis. Stereo selective biocatalysts for the synthesis of chiral pharmaceutical intermediate such as synthesis of ACE inhibitors, definition, mode of action of inhibitors. (10)


IMMOBILIZED ENZYMES: Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization. (7)

MODELLING OF DIFFUSION SYSTEMS
External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models, the effectiveness factor concept. (8)

DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS
Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions, reactor dynamics and stability. (7)

Recommended books:
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Scope of Genetic Engineering- Milestones in Genetic Engineering, genetic code, genetic elements that control gene expression. (2)

Molecular Tools in Genetic Engineering – Restriction and DNA Modifying enzymes (Polymerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc.), Vectors for E. coli (Plasmids, Phages, Cosmids, Fosmids, Phagemids, BAC), Vectors for Eukaryotes (YEPS, YIPs, YRPs, YAC), Vectors for plants (Ti and Ri plasmids, caulimoviruses, geminiviruses), Vectors for animals (P-elements, baculovirus, adenovirus, papillomavirus and retrovirus). (10)

Nucleic Acid Amplification and Gene Cloning Strategies- PCR analysis, their types and applications, prokaryotic and eukaryotic transformations, Creating and screening DNA libraries (Genomic library and cDNA library preparations). (6)

Directed Mutagenesis and Protein Engineering- in-vitro mutagenesis, in-vivo mutagenesis, error-prone PCR, adding disulphide bond, increasing enzymatic activity, modifying metal cofactor requirement etc. (5)

SECTION-B

Molecular Markers and Diagnostic Systems- Molecular Markers (RFPL, AFLP, RAPD, SSR, SNP, CAPs, SSR and their applications), Human molecular genetics (genetic linkage and genetic mapping), Detection of microbes (radioactive, non-radioactive hybridization procedure, molecular beacons, DNA fingerprinting, bacterial biosensor), Diagnosis of genetic diseases (cystic fibrosis, sickle cell anemia, PCR/OLA). (10)

Application of Genetic Engineering in Plants, Animals and Microbes- Transgenic plants (Disease resistant, insect resistance, herbicide tolerance and biopharming), in Animals (hormones and pharmaceutical protein production, generation of transgenic animal, Gene therapy, to fight AIDS), Transgenic Microbes (Production of restriction endonucleases, small biological molecules such as ascorbic acid, indigo, antibiotics and enzymes, insulin, growth hormones, monoclonal antibodies/magic bullets, humanized monoclonal antibodies, biopolymers such as xanthum gum, animal adhesive biopolymer, bioremediation i.e. degradation of xenobiotics, clearing oil spills, starch and cellulose utilization and case studies. (10)

Regulation and Patenting in Molecular Biology- importance of regulation, regulating food and food ingredients, GMOs release and controversy, Human gene therapy. (2)

Recommended books:
CLASSIFICATION OF BIOMATERIALS AND THEIR PROPERTIES:

- **Metals**: crystal structure, properties, processing, oxide formation and corrosion. Examples: Stainless steel, Ti and Ti-based alloys.
- **Ceramics**: classification - inert, bioactive and resorbable ceramics, structure and processing. Examples: Alumina, Carbon, hydroxyapatite.
- **Composite material**: basic concept, matrix phase, particle reinforcement - organic and inorganic, fibre reinforcement. Synthesis techniques. Example: Ceramic-Polymer composites.
- **Polymers**: natural and synthetic polymers - structure - property relationship

CHARACTERIZATION OF BIOMATERIALS:

- atomic bonding, crystal lattice. Methods of material characterization: Thermal analysis, TGA, DTA, DSC, basic principle. Mechanical properties: stress strain curve, tensile strength) optical properties, surface properties, tribology

SECTION B

TESTING OF BIOMATERIAL: In vitro assessment of cell and tissue compatibility. In vivo assessment of tissue compatibility

HOST RESPONSE TO BIOMATERIALS: Biomaterial-Blood interaction, blood coagulation, foreign body reaction, inflammation, wound healing process

APPLICATIONS OF BIOMATERIALS:

- **Soft tissue application**: cardiovascular, skin and facial implants.
- **Hard tissue application**: orthopedic and dental implants. **Tissue engineering scaffolds**: scaffolds for bone and skin tissue engineering. **Drug delivery**: Targeted drug delivery. Coating on implant surface

IMPLANT FAILURE:

- Wear, cracks, fatigue, degradation of material in the biological environment.

Recommended books:


Paper Title: Pharmaceutical Biotechnology (Elective -II)

Paper Code: BIO 205 L T P 3 0 0 Credits: 3
Internal Assessment: 50 University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

History of pharmacy, pharmaceutical industry & development of drugs, economics and regulatory aspects, quality management, GMP, drug kinetics and bio-pharmaceutics, mechanism of drug absorption, distribution, metabolism and excretion, factors affecting ADME process, advance drug delivery systems, controlled release, transdermals, liposomes and drug targeting. (23)

SECTION-B

Factors contributing to immunogenicity (product related factors, host related factors), consequences of immunogenicity to biopharmaceuticals, drug design, principles and applications of SAR and PAR (QSAR), study of artificial enzymes, computer-aided drug design (CADD) and molecular modeling. (22)

Recommended books:

SYLLABUS

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SECTION-A

Biology of Proteins
Basic constituents, hierarchical arrangements, over-view of protein preparation, modification, maturation; protein protein interactions, Heat shock proteins, their structure and functions in cells, protein mimicry, assisted protein maturation processes in cells, Protein trafficking and dislocation, protein secretion from cell, biomarker discovery, ribosome profiling.

Protein folding and assembly
Protein folding pathways in prokaryotes and eukaryotes; Single and multiple folding pathways; Protein folding of single domain and multi-domain proteins; Inclusion bodies and recovery of active proteins; Osmolyte assisted protein folding; Structure of chaperones and role of chaperones in protein folding, kinetics and thermodynamics of protein folding and unfolding reactions.

SECTION-B

Protein modifications
Strategies for protein engineering, Random and site directed mutagenesis, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Antibody engineering.

Prediction and design of protein structures
Similar structure and function of homologous proteins, Role of multiple alignment, Homology and ab-initio method for protein structure prediction, Phage display systems; Structure based drug design, Rational protein design.

Proteomics Technologies:
Protein Arrays/ Protein Chips and their application, 2D Gel Electrophoresis and its application Mass Spectrometry and Protein Identification, Proteomics Databases Proteomics Analysis Tools at ExPaSy.

Recommended books:
1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
SYLLABUS

List of Experiments:

1. Media optimization (pH, Temperature, Carbon & Nitrogen sources) for enzyme production.
2. Enzyme immobilization by various methods.
3. Kinetic study of free enzyme and immobilized enzyme.
4. Determination of the parameters of oxygen transport in water.
5. To study the mass and energy balance during cell-growth.
6. Determination of reaction kinetics of a substrate in a fed-batch system.
7. To determine residence time distribution for reactors.
8. Determination of characteristics parameters for the design of stirred vessels.

SYLLABUS

List of Experiments:

1. Analysis of protein by gel electrophoresis under denaturing conditions (SDS-PAGE).
2. Amplification of DNA using PCR and detection of amplified fragment using agarose gel electrophoresis.
3. Digestion of plasmid DNA by restriction endonuclease.
5. Induction and expression of a gene cloned in an expression vector in *E.coli*.
6. Western blot analysis.
SYLLABUS OF M.E. (BIOTECHNOLOGY) 3rd SEMESTER

Paper Title: Nanobiotechnology and Nanodevices (Elective - III)

Paper Code: ME BIO 301                  L T P  3 0 0  Credits: 3

Internal Assessment: 50  University Examination: 50

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION A

INTRODUCTION TO NANOBIOТЕХНОLOGY: Basic concept, recent advances and applications of nanobiotechnology (2)

NANOFABRICATION TECHNIQUES FOR BIOLOGICAL APPLICATIONS: Top down techniques- electron beam lithography, nanoimprint lithography. Bottom up approaches-block copolymer micelle nanolithography, sol gel process. (7)

HYBRID BIO NANODEVICES: Fabrication and applications (4)

NANO FLUIDIC DEVICES: Basic theory, construction of nanofluidic devices, lab on a chip (4)

NANOSTRUCTURED SURFACE AND CELLULAR BEHAVIOUR: Creation of cell interactive surfaces by chemical and topographical nanopatterning, surface functionalization of nanoparticles, cellular response to the nanostructured surfaces (5)

SECTION B

DNA BASED NANOSTRUCTURES: DNA based nanowires and network – fabrication and their applications, self assembled DNA nanostructures and nanodevices, DNA programmed organization of nanostructures (5)

PROTEIN NANOTEХНОLOGY: Protein based self-assembly nanostructures – s layers, nanopores. Protein nanoarrays- construction and application (5)

NANOTEХНОLOGY AND DIAGNOSTICS: Quantum dots, Surface plasmon resonance based nanosensors, nanowires, SERS active nanoparticles, nanoparticles as contrast agents for MRI (5)

NANOTEХНОLOGY AND THERAPEUTICS: Nanodiamonds, carbon nanotubes, virus based nanoparticles, dendrimers, gold nanoparticles (5)

NANOTEХНОLOGY IN TISSUE ENGINEERING: Nanofabrication techniques to develop scaffolds for tissue engineering (3)

Recommended Books

Introduction and History of Plant Biotechnology

General Concept and Methodology- Nutrition of cell and organ culture, PGRs and their use in micropropagation, totipotency, cloning (isolation and culture of single cells, propagation from non-meristematic tissues-non zygotic embryogenesis and organogenesis, transfer and establishment of whole plants in soil, shoot tip culture (clonal propagation and production of virus free plants), embryo rescue..

Hybrid Plants- Protoplast isolation, culture and fusion, selection and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid.

Production of Haploid/Double Haploid Plants- Andereogenesis and gynogenesis, homozygous lines.

In-vitro Pollination and Fertilization: Ovular, ovary and stigmatic pollination, techniques for in-vitro fertilization, chemical, physical and electoral fusion.

SECTION-B

Plant Transformation, Productivity And Performance- Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors (binary and co-integrate), use of 35S and other promoters, selection markers, reporter genes, viral vectors and their application, transformation methods – biological, physical and chloroplast transformation. Herbicide resistance, insect resistance, virus resistance, thionins, PR proteins, nematode resistance, abiotic stress, post harvest losses, product shelf life improvement, male sterile lines, bar and barnase systems.

Plant Metabolic Engineering - control mechanisms, manipulation for Plant secondary metabolic pathways and their commercial relevance.

Recent Advances in Agricultural Biotechnology: Use of enzymes as biopesticides, nanopesticides, management of agro waste, phytoremediation of heavy metals, biodegradable plastics, therapeutic proteins, edible vaccines.

Recommended Books

Course Duration: 45 lectures of one hour each.

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SECTION-A

Introduction, need for process control, design elements of a control system, Difference between feedback and feed forward control configuration, Hardware for a process control system. (5)

Block Diagrams, Laplace transforms and transfer functions, difference between lumped and distributed parameter system. (4)

Dynamic behavior of first and higher order systems, interacting and non-interacting systems, dead time. (8)

Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve. (6)

SECTION-B

Stability Analysis of Feedback Systems-Notion of Stability, characteristic equation, Routh- stability criterion. (8)

Root Locus Analysis

Introduction to Advanced Control Systems- Cascade control, Over-ride Control, feed forward control, Ratio control, Inverse response, Control system design concepts. (7)

Physical and Chemical Sensors, on line sensors for cell properties, off line analytical methods. (7)

Recommended books:

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SECTION-A

Measurement of Organic Pollutant: Parameters - BOD, COD & TOC, Factors affecting on BOD, BOD equations, methods of estimating BOD, Biological v/s Physicochemical analysis. (5)

Microbial Growth Kinetics: Microbial Growth Kinetics terminology, rate of utilization of soluble substrates, other rate expression for the utilization of soluble substrate, rate of soluble substrate production from biodegradable particulate organic matter, rate of biomass growth with soluble substrate, rate of oxygen uptake, effects of temperature, total volatile suspended solids and active biomass, net biomass yield and observed yield. (7)

Biological Treatment: Overview of biological wastewater treatment, objectives of the treatment, role of Micro-organisms, Types of biological processes for wastewater treatment, suspended and attached growth systems, Municipal wastewater treatment, Unit operations of Pre and primary treatment. (10)

SECTION-B

Aerobic Suspended Growth Biological Treatment Systems: Aerobic biological oxidation, process description, stoichiometry, environmental factors, plug flow activated sludge, Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Intermittently aerated and decanted systems, Oxygen activated sludge, Principles of aeration, factors affecting oxygen transfer, Oxygenation and mixing requirements, Final clarification. Aerobic attached Growth Biological Treatment systems, Introduction to attached growth systems, Mass transfer limitations, trickling filtrations, Oxygen transfer and utilization, Applications rotating biological contactors, Bio-Towers, Process design considerations. (13)

Anaerobic Decomposition: Mechanism of anaerobic fermentation – a multistep process, Microbiology and biochemistry of anaerobic processes, substrate inhibition, optimal anoxic environment, kinetic constants, stuck reactors, standard rate, high rate and multistage anoxic digesters. (10)

Recommended Books

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SECTION-A

Introduction to biostatistics: Basic definitions and applications, sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: types of data, methods of collection of primary and secondary data, methods of data collection, graphical representation by histogram, polygon, ogive curves and pie diagram.


Tests of significance: Tests of significance: small test (Chi-square t-test, F-test), large sample test (Z-test) and standard error. Introduction to probability theory and distribution (concept without deviation) binomial poison and normal (only definitions and problems) computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot. Computation of mean, variable and standard deviations, t test, correlation coefficient.

SECTION-B

Computer: Introduction and application: Introduction to computers and computer applications: Introduction to computers, Computer applications in research, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.

Scientific writing in research: Research: Definition, importance and meaning of research, characteristics of research, types of research, steps in research, identification, selection and research problems, formulation of hypothesis. Scientific writing - characteristics. Logical format for writing thesis and papers. Essentials features of abstract, introduction, review of literature, materials, methods, and discussion. Effective illustration - table and figures. Reference styles- Harvard and Vancouver systems.

Recommended Books

1. Elements of Mathematical statistics” by V.C.Kapoor and Gupta.
4. Biostatistical methods by Lachin
Course Duration: 45 lectures of one hour each.

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SECTION-A

Introduction to polymers: Basic concept, classification of polymers, molecular weight and its distribution, preparation of polymeric materials and their characterization. Step growth and chain polymerization, copolymerization, kinetics and molecular weight distribution in polycondensation and free radical addition polymerization, control of molecular weight. (15)

Dilute Solution viscometry, conformation and molecular dimensions of polymer chains, Thermodynamics of polymer solutions. Rubber elasticity, flow curve and its determination. (10)

SECTION-B

Polymerization processes (6)

Polymeric materials with discussion on electrical, optical, transport and mechanical properties. (4)

Viscoelasticity, linear viscoelastic models. (5)

Bio-polymer materials, applications in bio-technology and controlled drug delivery system. (5)

Recommended Books

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<tbody>
<tr>
<td>1.</td>
<td>Polymer Science and Technology</td>
<td>J.R.fried</td>
<td>Prentice Hall</td>
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<tr>
<td>2.</td>
<td>Polymer Science and Engineering</td>
<td>D.J.Williams</td>
<td>Prentice Hall</td>
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Paper Title: Thesis Work – I

Paper Code: ME BIO 303  
L T P  0 0 0  
Credits: 10

Internal Assessment: 100

SYLLABUS OF M.E. (BIOTECHNOLOGY) 4th SEMESTER

Paper Title: Thesis Work – II

Paper Code: ME BIO 401  
L T P  0 0 0  
Credits: 15

Internal Assessment: 100  
University Examination: 100