PANJAB UNIVERSITY

Scheme and Syllabus of
B.E. (Biotechnology)
3rd to 8th semester

2014-2015

University Institute of Engineering and Technology,
Panjab University, Chandigarh
DEPARTMENT BIOTECHNOLOGY ENGINEERING

VISION
To nurture world-class bioengineers with a potential to innovate, invent and disseminate knowledge for the benefit of society and environment.

MISSION
a) Starting dedicated Postgraduate Programme (M.Tech, PhD, M.Tech-PhD Integrated Programme).

b) Regular updation of the course curriculum to cater to the needs of academia and industry.

c) Initiate inter-departmental and multi-institutional projects with special emphasis on implementation of bioprocess design and scale-up.

d) Academia-industry interface for product development.

e) Emphasis on recent trends in bioengineering through organization of conferences, symposia, workshops.

f) Student exposure by visits to various industries and research institutes.

g) Expert lecture series.

h) Faculty development programmes.

PROGRAMME B.E. Biotechnology (UG PROGRAMME )

EDUCATIONAL OBJECTIVES
Program Educational Objectives of the UG Biotechnology branch are:

1. Understand the concepts of engineering in the field of biotechnology and demonstrate professional attitude to expand their horizon to higher studies or bioengineering oriented profession.

2. Identify, analyze and solve the problems with novelty by implementing the engineering principles to biological systems in product/process/techniques development to meet the demands in
academia, government, industry and health related fields.
3. Facilitate multi-disciplinary approach to effectively communicate scientific and technical information facilitating collaboration with experts across different disciplines and execute multidisciplinary projects.

PROGRAMME OUTCOMES

1. Graduates will gain and apply knowledge of Biotechnology, Science and Engineering concepts to solve problems related to field of Biotechnology.
2. Graduates will be able to identify, analyze and understand problems related to biotechnology Engineering and finding valid conclusions with basic knowledge in biotechnology Engineering.
3. Graduates will be able to design and develop solution to Biotechnology Engineering problems by applying appropriate tools by keeping in mind safety factor for environmental & society.
4. Graduates will be able design, perform experiments, analyze and interpret data for investigating complex problems in biotechnology Engineering and related fields.
5. Graduates will be able to decide and apply appropriate tools and techniques in biotechnological manipulation.
6. Graduates will be able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological engineering practices
7. Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
8. Graduates will have knowledge and understanding of related norms and ethics in Biotechnology Engineering product/technique development.
9. Graduates will be able to undertake any responsibility as an
individual and as a team in a multidisciplinary environment.
10. Graduates will develop oral and written communication skills.
11. Graduates will have thorough knowledge in Biotechnology Engineering and will also be ready to engage themselves in lifelong learning.
12. Graduates will be able to demonstrate knowledge of project and finance management when dealing with Biotechnology Engineering problems.
**SCHEME OF EXAMINATION OF B.E. BIOTECHNOLOGY**

Second Year - Third Semester

<table>
<thead>
<tr>
<th>Sub Code</th>
<th>Subject</th>
<th>Scheme of Teaching</th>
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<td>BIO 311</td>
<td>Process Calculations</td>
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<td>BIO 312</td>
<td>Microbiology</td>
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* Cumulative marks for mid semester and end semester evaluation.
### SCHEME OF EXAMINATION OF B.E. BIOTECHNOLOGY

#### Second Year - Fourth Semester

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* Cumulative marks for mid semester and end semester evaluation.
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### Third Year – Fifth Semester

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<td>Bioinstrumentation</td>
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* Cumulative marks for mid semester and end semester evaluation.
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### Third Year - Sixth Semester

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<td>BIO602</td>
<td>Operation Research</td>
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<td>BIO652</td>
<td>Operation Research (Prac.)</td>
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<td>BIO603</td>
<td>Introduction to Bio-Informatics</td>
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<td>Introduction to Bio-Informatics (Prac.)</td>
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<td>Bioreactor Design and Operation</td>
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<td>BIO605</td>
<td>Down Stream Processing</td>
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<td>BIO655</td>
<td>Down Stream Processing (Prac.)</td>
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<td>Biomaterials</td>
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* Cumulative marks for mid semester and end semester evaluation.
### SCHEME OF EXAMINATION FOR B.E. BIOTECHNOLOGY

**Fourth Year Seventh Semester**

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<td>Food Biotechnology</td>
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<td>BIO752</td>
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<td>BIO703</td>
<td>Plant Tissue Culture</td>
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<td>BIO704</td>
<td>Bio-analytical Techniques</td>
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* Cumulative marks for mid semester and end semester evaluation.
SCHEME OF EXAMINATION FOR B.E. BIOTECHNOLOGY

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<td>Sessional Marks Univ. Exam. Total</td>
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<td>BIO801</td>
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<td>BIO852</td>
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<td>Enzyme catalyzed Organic Synthesis (Prac.)</td>
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<td>BIO803</td>
<td>003</td>
<td>Project Management and Entrepreneurship</td>
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<td>BIO804</td>
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<td>Modeling and Simulation of Bioprocesses</td>
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**Option 2**

| BIO806   | Industrial Training | --- --- --- --- 22 | 350 200 550 |
| **Total**|                  | --- --- --- --- 22 | 350 200 550 |

* Cumulative marks for mid semester and end semester evaluation.

Options in Elective - I*

1. Nanobiotechnology
2. Microbial Biodiversity
Conditions for choosing Option 2 in 8th Semester:

A student may opt for either Option 1 or one semester training (Option 2) in lieu of subjects of 8th Semester (option 1). The marks for six months training will be equal to the total marks of 8th Semester study. A student can opt for six semester training under following conditions:

a. The student got selected for job in campus placement and the employer is willing to take that student for the training.

b. The student got offer of pursuing training from reputed government research organization/govt. sponsored projects/govt. research institution provided that student should not be paying any money to get trained. For pursuing this training student needs the prior approval from the Coordinator of the respective branch.
Course Code: BIO 311  
Course Title: Process Calculations  
Type of Course: Core  
L T P: 4 0 0  
Credits: 4  

Course Assessment Methods:  
End Semester Assessment (University Exam.): 50  
Continuous Assessment (Sessional): 50  

Course Prerequisites: Fundamental course in physics, chemistry and mathematics.  

Course Objectives:  
1. To develop a fundamental understanding of the basic principles of process calculations.  
2. To introduce students to calculations involving material and energy balance for reaction and separation processes.  
3. To learn about the PVT relations and gaseous mixtures.  
4. To introduce students to the use of data sources for physical and chemical properties and the estimation of such data.  

Course Outcome:  
1. Define and determine properties of process streams  
2. Perform PVT calculations for ideal and non-ideal gases.  
3. Analyze and solve elementary material balances on single and multiple unit processes with recycle and bypass for reactive and non-reactive processes.  
4. Perform energy balance calculations on reactive and non-reactive processes.  
5. Perform process calculations using psychrometric charts and steam tables.  

SYLLABUS  
B.E. IN BIOTECHNOLOGY  
THIRD SEMESTER  

Note: The semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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 Engineering Calculations: Units and dimensions, mole concept, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equations and stoichiometry. Composition of mixtures and solutions: mass fractions, mole fraction.

Material Balance: Material balance with and without chemical reactions; Material balance involving multiple subsystems; recycle, bypass and purge. Concept of limiting and excess reactant, conversion and yield. Metabolic stoichiometry of growth and product formation.

SECTION-B

P-V-T relations for gas and gas mixtures, calculations using ideal gas law, vander waal’s equation of state. Liquid and liquid mixtures, vapor pressure, saturation, partial saturation and humidity.

Enthalpy changes, energy balance for simple flow process, calculation of heat capacity, mean heat capacity, application of the energy balance to systems with and without reactions. Use of Hess’s law for calculation of heats of formation, heats of combustion, heats of reaction. Kirchhoff’s equation for calculating heats of reaction at different temperatures.

RECOMMENDED BOOKS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
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<tbody>
<tr>
<td>1</td>
<td>Elementary Principles of Chemical Processes</td>
<td>R.M.Felder, R.W.Rousseau</td>
<td>John Wiley &amp; Sons</td>
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<tr>
<td>2</td>
<td>Basic Principles and Calculations in Chemical Engineering</td>
<td>D.M.Himmelblau, D.M.Riggs</td>
<td>PHI Learning</td>
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<td>3</td>
<td>Stoichiometry</td>
<td>B.I.Bhatt, S.M.Vora</td>
<td>Tata McGraw Hill</td>
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Course Code: BIO-312  
Course Title: Microbiology (Theory)

Type of Course: Core  
L T P: 4 0 0 
Credits: 4

Course Assessment Methods: 
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: 
Knowledge of the prokaryotic and eukaryotic cell structure and the nature and function of different bio-molecules

Course Objectives: 
1. To familiarize the students with the discipline of Microbiology, historical developments and various extensions of Microbiology
2. To understand different structural and functional aspects of microorganisms
3. To understand different methods and approaches of microbial classification and techniques of working with microorganisms
4. To understand the role of microorganisms in different scenarios

Course Outcome:
1. The course would enable the students to understand the importance and scope of Microbiology as a discipline.
2. The students would attain knowledge about the structure, function and diversity of different microorganisms
3. The students would be empowered to handle and maintain microbial cultures and understand different microbial interactions at various levels
4. The course would enable them to realize the scope to engineer microorganisms for greater use

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

Brief history of microbiology. Scope and application of microbiology to (3) biotechnology (in agriculture, food, health, environment, industry)

Microbial diversity- Fine structure of bacteria, fungi, algae, virus (8)
Methods in microbiology - cultural characteristics and cultivation of microorganisms, pure culture technique, enumeration and preservation of microorganisms, principles of microbial nutrition, construction of culture media, theory and practice of sterilization, control of microorganisms by physical, chemical and biological agents, methods of bacterial staining (simple, differential and special stains).
Microbial growth - definition, expression, measurement, Growth curve, synchronous and asynchronous growth. Transport of nutrients across the cell membrane

SECTION-B
Microbial metabolism - Energy generation and biosynthesis in prokaryotes
Microbial genetics - Mutations, recombination in bacteria, conjugation, transduction, transformation
Microbes as geochemical agents – nitrogen, phosphorous, carbon and sulphur cycles; microbial interactions

RECOMMENDED BOOKS

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Course Code: BIO 362  
Course Title: Microbiology (Practical)  
Type of Course: Core  
L T P: 0 0 3  
Credits: 2  

Course Assessment Methods:  
End Semester Assessment (University Exam.): 00  
Continuous Assessment (Sessional): 50  

Course Prerequisites: Microbiology (Theory)  
Course Objectives:  
1. To impart to students skills to work with microorganisms and familiarize them with different techniques used in a microbiology lab  

Course Outcome:  
1. The students learn to isolate, grow, identify and maintain different microbial cultures  
2. Become proficient to use microbial techniques in different scenarios pertaining to biotechnology  

List of Experiments:  
1. To prepare different culture media-broth and agar  
2. To learn the culturing of microorganisms by simple streaking and pure culture technique  
3. To learn the preservation of microorganisms on agar slants  
4. To isolate microorganisms from soil/ milk/food sample by dilution plate method.  
5. To study the working of a compound microscope  
6. To perform Gram staining of a given microbial sample  
7. To perform endospore staining of endospore forming microorganisms  
8. To perform motility test on the given bacterial sample
Course Code: BIO 313
Course Title: Biochemistry (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites
Knowledge of cell structure and functions of different cell types, organ system. Knowledge of mammalian, plant and microbial systems in Biotechnology.

Course Objectives
1. To study the structures and functions of various biomolecules like carbohydrates, lipids, nucleic acids, proteins and vitamins in biosystem.
2. To understand the structure-function relationship in proteins, purification and sequencing of proteins/enzymes.
3. To study the anabolic and catabolic pathways of carbohydrates and fats and its significance.
4. To understand the biochemical pathways of nucleic acid biosynthesis and degradation.
5. To study the biochemical pathways of photosynthesis and nitrogen fixation in plants and microbes respectively.

Course Outcome
1. Students learn the basic concepts of biochemistry such as structural and functional aspects of biomolecules, necessary for biotechnology studies and applications.
2. Students understand how biomolecules function as a unit to build a complex multicellular organism, undergoing diverse functions and cellular metabolic pathways in mammals, plants and microorganisms.
3. Students learn the role of enzymes and other molecules in metabolic pathways and how regulation of biochemical pathways is attained in a cell.

SYLLABUS
Note: The Semester question paper will be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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
Structure, function and biological role of following Biomolecules:
a) amino acids b) proteins c) carbohydrates d) lipids
e) nucleic acids, f) water soluble vitamins.

Proteins: Primary, secondary, tertiary and quaternary structures, methods for isolation and purification of proteins and enzymes, amino acid sequence determination.

Carbohydrate metabolism: Glycolysis, glycogenolysis, glycogenesis and their regulation, citric acid cycle.

SECTION-B

Fat metabolism: Oxidation of fatty acids, synthesis of fatty acids (fatty acid synthase complex), ketone bodies.

Amino acid metabolism: General reactions of amino acid metabolism such as transamination, decarboxylation, deamination. Urea cycle.

Nucleic acid metabolism: Biosynthesis of purines and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides, their regulation, catabolism.

Mitochondria: Structure of mitochondria, organization of respiratory chain, oxidative phosphorylation.

Plant and microbial biochemistry: Photosynthesis and Nitrogen fixation.

RECOMMENDED BOOKS

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<td>Course Assessment Methods</td>
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<tr>
<td>End Semester Assessment (University Exam.)</td>
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<td>Continuous Assessment (Sessional)</td>
<td>50</td>
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<tr>
<td>Course Prerequisites</td>
<td>Understanding of biomolecules and biochemistry.</td>
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<td>Course Objectives</td>
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<tr>
<td>1. To give practical training of the analysis of various biochemical parameters having clinical and industrial relevance.</td>
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<td>2. To have an understanding of the principle of each determination by biochemical reactions using UV –visible spectroscopy.</td>
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<td>3. To resolve biomolecules by chromatographic technique.</td>
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<tr>
<td>Course Outcome</td>
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<tr>
<td>1. Students have hands on training of quantitations related to biomolecules in biochemistry.</td>
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<td>2. Students learn quality control in clinical biochemistry by performing blood analysis.</td>
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**SYLLABUS**

**List of Experiments:**
1. To study Beer-Lambert Law and to determine $\lambda$ max of a colored dye.
2. To estimate carbohydrate content in a given sample by Anthrone method.
3. To determine total amount of proteins in serum by Biuret method.
4. To estimate proteins by Lowry method.
5. To identify the amino acids in a mixture by ascending paper chromatography.
6. To determine the content of nucleic acids by UV method.
7. To quantitate RNA/DNA in the given sample by colorimetric method.
8. To determine cholesterol/ urea/uric acid in blood.
Course Code  
BIO 314

Course Title  
Cell Biology and Genetics (Theory)

Type of Course  
Core

L T P  
4 0 0

Credits  
4

Course Assessment Methods
End Semester Assessment (University Exam.)  
50
Continuous Assessment (Sessional)  
50

Course Prerequisites  
Knowledge of eukaryotic cell structure along with some genetics concepts like about DNA and chromosomes

Course Objectives
1. The topics in this subject would help students in understanding various characteristics of cell that are important in cell behavior.
2. The emphasis has been laid to provide students with cells architectural as well as structure assortment that are important to its normal functions.
3. The information regarding how cells transfers its characters to next generation have been comprehensively discussed and elaborated in topics covering cell genetics.
4. It is hoped that students understanding about various intricacies of cell, structure and function would be sorted out.

Course Outcome
1. Student would be able to understand about various characteristics of cell that are important in cell behavior
2. Student would be able to understand various intricacies of cell, its structure, function
3. The course also enable them to understand that how cell transfers its characters to next generation

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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
**Biological membranes:** models, structure and function, membrane proteins

**Cytoskeletal elements:** microtubules, intermediate filaments and microfilaments, their structure and functions

**Extracellular matrix interactions:** Types of ECM, interaction of cell with the ECM, malfunctions in ECM signaling

**Chromosomes structure and organization:** Chemical composition of DNA, structural organization of nucleosomes, chromosomal organization, polytene and lampbrush chromosomes, human chromosomes, centrosome, telomere

**Types of DNA sequence:** unique and repetitive DNA, heterochromatin

**Cell cycle:** Phases in cell cycle, regulation and control of cell cycle

**Cell division:** Detail of different stages in Mitosis and meiosis, their importance

**Molecular genetics:** C value paradox, cot curve, transposons (bacterial, eukaryotic, retrotransposons, viral), gene families, homologus gene, pseudogene

**Extensions of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy

**Chromosome Theory of Inheritance** The chromosome theory of heredity, Sex Chromosomes and sex determination, Genetic linkage and Genetic mapping, sex linkage, sex limited and sex influenced characters

**Extra chromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance

**Cytogenetics:** Human Karyotype, chromosome banding, ploidy, chromosome aberrations

**SECTION-B**

**Molecular genetics:** C value paradox, cot curve, transposons (bacterial, eukaryotic, retrotransposons, viral), gene families, homologus gene, pseudogene

**Extensions of Mendelian principles:** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy

**Chromosome Theory of Inheritance** The chromosome theory of heredity, Sex Chromosomes and sex determination, Genetic linkage and Genetic mapping, sex linkage, sex limited and sex influenced characters

**Extra chromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance

**Cytogenetics:** Human Karyotype, chromosome banding, ploidy, chromosome aberrations

**RECOMMENDED BOOKS**

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<th>NAME</th>
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<td>Page</td>
<td>Title</td>
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<tr>
<td>7</td>
<td>Genetics</td>
<td>Strickberger</td>
<td>Prentice Hall, (2002) 3(^{rd}) edition</td>
</tr>
</tbody>
</table>
Course Code: BIO 364

Course Title: Cell Biology and Genetics (Practical)

Type of Course: Core
L T P: 0 0 2
Credits: 1

Course Assessment Methods:
End Semester Assessment (University Exam.): 00
Continuous Assessment (Sessional): 50

Course Prerequisites: Cell Biology and Genetics (Theory)

Course Objectives:
1. To develop skills in observing cell structure and its genetic material through microscope by preparing slides in different ways

Course Outcome:
1. Students would be able to develop skills in preparing slides for observing cell structure and its genetic material through microscope.
2. Student would also learn methods for determination of bacterial cell density or their viable/ non viable no.

SYLLABUS

List of Experiments:
1. Observation of cell cycle and cell division related permanent slides
2. Determination of bacterial cell density by counting of bacterial cells using hemocytometer
3. Determination of cell no. (viable/nonviable) in bacterial cell population
4. To study structure of cell from onion leaf peels
5. Extraction of collagen ECM using glacial acetic acid
6. Chromosomal preparation of mitotic cell division using onion root tip and observation under simple microscope
7. Staining of DNA and RNA using methyl green and pyronin stains
8. Identification of Barr Body in human Buccal smear
Course Code: AS-301
Course Title: Engineering Mathematics – III (Theory)

Type of Course: Core
L T P: 3 1 0
Credits: 4

Course Assessment Methods:
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites:
Differential and integral calculus of one and more than one variable (as studied in Engineering Mathematics – I), basic knowledge of matrices, operations on matrices, number system and fundamentals of complex numbers (as studied in senior secondary classes).

Course Objectives:
This course is designed to provide an introduction to Sequences and Series, Linear algebra and Complex functions. Particularly, this course will:

1. Present basic concepts of sequences and series, namely limit of sequence, convergence and divergence of an infinite series, error estimates.
2. Present an introduction to the fundamental concepts of Linear algebra, namely linear dependence and independence of vectors, rank of matrix, solution of a system of linear equations by Gauss elimination method and inverse of a matrix by Gauss-Jordan elimination method, eigen value problem, Cayley-Hamilton theorem, similarity of matrices etc.
3. Present an introduction to the basic concepts of complex functions, namely continuity, differentiability of complex functions, analytic function, Cauchy-Riemann equations, Taylor and Laurent series, concept of residue, conformal mappings and linear fractional
transformations etc.

**Course Outcome**

After completion of the course, the students will:

1. Demonstrate ability to deal with sequence and series.
2. Demonstrate ability to deal with matrix manipulations for example finding eigen values and eigen vectors, solution of system of linear equations.
3. Demonstrate ability to deal complex function theory. It will help the students to solve various problems which cannot be solved or very difficult to tackle in real variable theory.

**SYLLABUS**

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**SECTION-A**

**Sequences and Series:** Sequences, Limits of sequences, Infinite series, series of positive terms, Integral test, Comparison test, Ratio test, Root test. Alternating series, Absolute and Conditional Convergence, Leibnitz test. Power series: radius of convergence of power series, Taylor’s and Maclaurin’s Series, Formulae for remainder term in Taylor and Maclaurin series, Error estimates. (Scope as in Chapter 8, Sections 8.1 – 8.10 of Reference 2).

**Linear Algebra:** Concept of linear independence and dependence, Rank of a matrix: Row – Echelon form, System of linear equations: Condition for consistency of system of linear equations, Solution by Gauss elimination method. Inverse of a matrix: Gauss – Jordan elimination method (Scope as in Chapter 6, Sections 6.3 – 6.5, 6.7 of Reference 1).

Eigen values, eigen vectors, Cayley – Hamilton theorem (statement only). Similarity of matrices, Basis of eigenvectors, diagonalization (Scope as in Chapter 7, Sections 7.1, 7.5 of Reference 1).
SECTION-B

Complex Functions: Definition of a Complex Function, Concept of continuity and differentiability of a complex function, Cauchy – Riemann equations, necessary and sufficient conditions for differentiability (Statement only). Study of complex functions: Exponential function, Trigonometric functions, Hyperbolic functions, real and imaginary part of trigonometric and hyperbolic functions, Logarithmic functions of a complex variable, complex exponents (Scope as in Chapter 12, Sections 12.3 – 12.4, 12.6 – 12.8 of Reference 1).

Laurent Series of function of complex variable, Singularities and Zeros, Residues at simple poles and Residue at a pole of any order, Residue Theorem (Statement only) and its simple applications (Scope as in Chapter 15, Sections 15.1 – 15.3 of Reference 1).

Conformal Mappings, Linear Fractional Transformations (Scope as in Chapter 12, Sections 12.5, 12.9 of Reference 1).

RECOMMENDED BOOKS

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<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Advanced Engineering Mathematics</td>
<td>E. Kreyszig</td>
<td>John Wiley (8th edition)</td>
</tr>
<tr>
<td>2</td>
<td>Calculus</td>
<td>G. B. Thomas, R. L. Finney</td>
<td>Pearson Education(9th edition)</td>
</tr>
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</table>
### COURSE OUTLINE

**Course Code**  
BIO 411  

**Course Title**  
Molecular Biology (Theory)  

**Type of Course**  
Core  

**L T P**  
4 0 0  

**Credits**  
4  

**Course Assessment Methods**  
- End Semester Assessment (University Exam.)  
- Continuous Assessment (Sessional)  
  - 50  
  - 50  

**Course Prerequisites**  
Student should have prior knowledge of structure, functions and importance of basic biomolecules such as DNA, RNA and proteins.  

**Course Objectives**  
1. To understand the chromosomal organization of DNA, its replication, transcription and translation process  
2. To understand the process of cell cycle regulation  
3. To understand about signal transduction process  
4. To understand application of cell and molecular biology in medicine  

**Course Outcome**  
1. Student learn the basics of DNA, its packaging, its replication, transcription and translation process  
2. Student learn the process of cell cycle regulation  
3. Student learn about signal transduction process  
4. Student learn about application of cell and molecular biology in medicine  

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**SECTION-A**  

**Introduction**-Chromosome, chromatin, gene for understanding molecular processes  

**DNA replication**-Unit of replication, enzymes involved, replication process (initiation, elongation and termination) in Prokaryotes and Eukaryotes, fidelity of replication, extrachromosomal replicons
DNA repair and recombination mechanism—Importance of DNA repair and recombination, various types of DNA damages and repair mechanisms in Prokaryotes and Eukaryotes, homologous and site-specific recombination, DNA transposition.

RNA metabolism in eukaryotes and prokaryotes—structure, function and types of RNA, Transcription factors and machinery, formation of transcriptional initiation complex, elongation and termination.

Post transcriptional modifications—splicing, capping and polyadenylation, RNA editing.


SECTION-B

Protein metabolism in eukaryotes and prokaryotes—small and large Ribosomal subunits in eukaryotes and prokaryotes, various translational factors, translation initiation, (aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading), elongation and termination, translational inhibitors, Post-translational modifications.

Regulation of gene expression—Operons in prokaryotes (lac and galactose operons), Regulatory elements in eukaryotes (enhancers, activators, mediators), Control of gene expression at translation level (such as si-RNA), regulation through epigenetic mechanism.

Signal Transduction—Cell surface receptor, second messenger molecules, signaling through G-protein coupled receptors, signal transduction pathways, bacterial chemotaxis and quorum sensing.

Basic Molecular biology Techniques and their applications—Principle, general and specialized electrophoretic techniques, gel electrophoresis (types of gels, modes of gel electrophoresis) Distcontinuous gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, pulse field gel electrophoresis, PCR, molecular hybridization and their applications.

Role of molecular biology in molecular medicine.
## RECOMMENDED BOOKS

<table>
<thead>
<tr>
<th>S No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
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<tbody>
<tr>
<td>1</td>
<td>Basic Molecular and Cell Biology</td>
<td>Latchman, D., 2006</td>
<td>Black Well pub</td>
<td>3rd edition</td>
</tr>
<tr>
<td>3</td>
<td>Schaum’s Outline of Theory and Problems of Molecular and Cell Biology,</td>
<td>Stansfield, W. D.,</td>
<td>Tata McGraw Hill</td>
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<td></td>
<td></td>
<td>Colome, J.S. and</td>
<td></td>
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<td></td>
<td></td>
<td>Cano, R. J., 2004</td>
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</table>
**Course Code**  BIO 461
**Course Title**  Molecular Biology (Practical)
**Type of Course**  Core
**L T P**  0 0 2
**Credits**  1
**Course Assessment Methods**
- End Semester Assessment (University Exam.)  00
- Continuous Assessment (Sessional)  50
**Course Prerequisites**
Student should have knowledge about structure, function and regulation of DNA, RNA and proteins biomolecules in eukaryotic and prokaryotic systems

**Course Objectives**
1. To understand basic techniques used for isolation of RNA, DNA and protein
2. To understand the process of transformation and selection of clones in recombinant DNA technology

**Course Outcome**
1. Student learn the basic techniques used for isolation of RNA, DNA and protein
2. Student learn the technique of clones selection used during recombinant DNA technology

**SYLLABUS**

**List of Experiments:**
1. Genomic DNA extraction from yeast cells using mechanical disruption and resolution of DNA on agarose gel.
2. Total RNA extraction from yeast cells.
3. Resolution of isolated RNA on formaldehyde agarose gel.
4. To study cell cycle arrest in onion root tip cells by treatment with colchicines.
5. Study of bacterial lac operon regulation in bacterial cells using IPTG as an inducer
6. Generation of auxotrophic markers in yeast by UV induced mutagenesis
7. Extraction and separation of total proteins from bacterial cells/animal cell using one-dimensional SDS gel electrophoresis method
Course Code: BIO 412
Course Title: Thermodynamics
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Process Calculations, Physical Chemistry, Mathematics and Biochemistry

Course Objectives
1. To learn the fundamentals of thermodynamics, understand various forms of energy including heat and work.
3. Study different refrigeration cycles.
4. Understand the criteria of phase equilibrium for a pure substance and mixtures.
5. Understanding of the quantitative aspects of chemical reaction equilibrium

Course Outcome
1. Able to calculate changes in enthalpy, internal energy and entropy for ideal gases.
2. Calculating heat and work requirements for different processes.
3. Estimation of thermal efficiency and work for refrigeration cycles.
4. Able to make phase equilibrium calculations.
5. Able to calculate the composition at equilibrium for single reactions in a single phase as a function of temperature and pressure.

SYLLABUS

Note: The semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

Review: state functions, types of systems, internal energy, heat and work, reversible and irreversible processes, first laws of thermodynamics and its application, Heat capacities, Heat effects during phase change, reaction, formation, combustion and mixing.
Throttling process, Joule Thompson coefficient, liquefaction of gases.


SECTION-B


Chemical Equilibrium: chemical reaction equilibrium; standard free energy change and equilibrium constant, effects of temperature on free energy change; equilibrium constant; equilibrium conversion.

Applications of thermodynamics to bio-systems.

RECOMMENDED BOOKS

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<tr>
<td>2</td>
<td>Chemical Engineering Thermodynamics</td>
<td>Y.V.C.Rao</td>
<td>University Press</td>
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<tr>
<td>3</td>
<td>Introductory Chemical engineering Thermodynamics</td>
<td>J.R.Elliott and C.T. Lira</td>
<td>Prentice Hall</td>
</tr>
<tr>
<td>Course Code</td>
<td>BIO 413</td>
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<tr>
<td>Course Title</td>
<td>Chemical Reaction Engineering (Theory)</td>
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<td>Type of Course</td>
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<td>Course Assessment Methods</td>
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<td>Continuous Assessment (Sessional) 50</td>
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<tr>
<td>Course Prerequisites</td>
<td>Knowledge of material balance equation and mathematical equations.</td>
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<tr>
<td>Course Objectives</td>
<td>1. To understand the characteristics of kinetics of chemical reactions.</td>
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<td>2. To study different types of ideal reactors.</td>
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<td>3. To gain understanding of single and multiple reactions.</td>
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<td>4. To follow various aspects of biochemical kinetics.</td>
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<td>Course Outcome</td>
<td>1. Understanding of the data analysis.</td>
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<td>2. To implement various types of reactor configuration at appropriate conditions.</td>
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<td>3. Knowledge of design of single and multiple reactions and their product distribution.</td>
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<td>4. Understanding of various components of microbial and enzymatic fermentations.</td>
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**SYLLABUS**

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**SECTION-A**

Kinetics: Types of reactions, Rate Equation, Analysis of Mechanism and Rate equations for archetypal models of reactions, Intermediates, Data Analysis. (8)
Ideal Reactors: Batch, Plug Flow Reactor, CSTR (Constant Volume & Variable Volume). (5)
Multiple Reactor system for Single Reactions. (6)
Biochemical reaction systems: Michaelis-Menten kinetics, Kinetic of competitive and Non-competitive inhibition, evaluation of M-M equation parameters, enzyme fermentation in batch, plug-flow and mixed flow fermenters. (4)

**SECTION-B**

Thermal Characteristic of Reactors: Optimum temperature progression, Adiabatic Operations. (6)
Design for Multiple Reactions: Qualitative and Quantitative Product distribution for (10)
Parallel and Series reaction. Qualitative product distribution of Series-Parallel reactions.
Biochemical kinetics: Microbial Fermentation, Monod Growth Model, qualitative treatment in Batch and Mixed-flow fermenter, Kinetics of availability of food and harmful wastes.

RECOMMENDED BOOKS

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Course Code: BIO463
Course Title: Chemical Reaction Engineering (Practical)
Type of Course: Core
L T P: 002
Credits: 1

Course Assessment Methods:
- End Semester Assessment (University Exam.): 00
- Continuous Assessment (Sessional): 50

Course Prerequisites: Knowledge of concepts of chemical reaction engineering theory.

Course Objectives:
1. To provide students with hands on training of different types of chemical reactors.
2. To compare performances of different reactors under different conditions.

Course Outcome:
1. Students learn to operate different types of reactors.
2. Students learn to analyze data generated as a result of various reactor operations.

SYLLABUS

List of Experiments:
1. Kinetics studies for a non-catalytic reaction in a shake-flask using Integral method.
2. Kinetic studies in a batch reactor at a) constant temperature b) different temperatures.
4. Kinetic studies in a CSTR at a) constant temperature b) different temperatures.
5. RTD studies in CSTR.
6. Dispersion number for packed bed reactor.
Course Code: BIO 414
Course Title: Industrial Biotechnology
Type of Course: Core
L T P: 4 0 0
Credits: 4
Course Assessment Methods
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50
Course Prerequisites: Students should have done basic courses in Microbiology and Biochemistry

Course Objectives
1. To make the students understand the role of diverse organisms in industrial productions, their growth requirements and culture preservation.
2. To learn the methods applied for strain development.
3. To understand the microbial production process for a wide range of products having varied applications.
4. To learn the stabilization methods of industrial enzymes, immobilization of enzymes and their role in biotransformations.

Course Outcome
1. The students will get knowledge of the role of large number of organisms in processes for microbial productions.
2. Students will learn the strain development and culture preservation techniques applied in industry.
3. Students will understand the intricacies of the production process for each class of compounds and the applications of a range of products.
4. Knowledge of enzyme applications, stability and immobilization methods required in industry.

SYLLABUS
Note: The Semester question paper should be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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
Industrially important microbes (E. coli, Bacillus, Actinomycyes, Saccharomycyes). 4
Preparation of an ideal growth medium for production of biomass and a microbial product, synthetic and crude media, prerequisites for preparation of a media. 4
Strain improvement by genetic means 5
Culture preservation  2
Classifications of microbial products.  2
Microbial fermentations, Introduction to design of fermenters.  5

SECTION-B

Microbial production processes and applications of the following industrially important classes of products
  a) Organic acids and solvents: citric acid, lactic acid, acetone and butanol  4
  b) Antibiotics: Classification and production of penicillin, streptomycin  4
  c) Enzymes: Amylases, proteases  3
  d) Flavoring agents: nucleosides and nucleotides.  2
  e) Other upcoming productions such as dextran and carotene.  4

Microbial enzymes, their stability and enzyme immobilization methods.  4

Microbial biotransformations and role of enzymes in bio-conversions of industrially important compounds.

RECOMMENDED BOOKS

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<th>NAME</th>
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<tbody>
<tr>
<td>1.</td>
<td>Industrial Microbiology</td>
<td>L.E. Casida</td>
<td>John Wiley &amp; Sons</td>
</tr>
<tr>
<td>3.</td>
<td>Industrial Microbiology</td>
<td>M.J. Waites et al</td>
<td>Blackwell Science Ltd.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>London 2002</td>
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Course Code: BIO 464
Course Title: Industrial Biotechnology (Practical)
Type of Course: Core
L T P: 0 0 2
Credits: 1

Course Assessment Methods
- End Semester Assessment (University Exam.): 00
- Continuous Assessment (Sessional): 50

Course Prerequisites: Experience of handling microbial cultures and biochemical analysis.

Course Objectives
1. To have practical training of the concepts and topics done in theory.
2. To get practical training in studying the growth curve and utilization of carbon source in media by bacterial/yeast cultures.
3. To get practical training in media preparation, cell counting and product formation in bacteria/yeast.

Course Outcome
1. Practical Exposure in handling/ culturing of microorganisms, cell counting, measurement of product formation with respect to time of growth and by biochemical assay of product formation.
2. Practical Experience of identification and preservation of microbial cultures.

SYLLABUS

List of Experiments:
1. To identify bacteria on the basis of Gram’s Staining.
2. To study the growth of E.coli / bacillus in broth media and plot the growth curve.
3. To determine the cell count of *S. cerevisiae* using Neubauer chamber.
4. To determine the concentration of glucose by DNSA reagent and plot the standard curve for glucose.
5. To study the utilization of glucose by *S. cerevisiae* / *Bacillus subtilis*.
6. To plot a standard curve of ethanol by using dichromate oxidation method.
7. To study the production of ethanol during the growth of *S. cerevisiae*.
8. To identify industrially important fungi from slides.
9. To perform cryopreservation of bacteria/yeast.
Course Code: BIO 415
Course Title: Immunology and Immunotechnology (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods:
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50

Course Prerequisites:
Student should have prior knowledge of structure and functions of vital organs of human body

Course Objectives:
1. To understand the basis of Immunology, cells and tissues of immune system
2. To understand the basic of antigen and antibodies and their generation
3. To understand about importance of antigen processing, presentation and Major Histocompatibility Complex
4. To understand the details of vaccines

Course Outcome:
1. Students learn the basis of Immunology, cells and organs of immune system
2. Student learn about antigen, antibodies and their generation
3. Student learn about importance of antigen processing, presentation and Major Histocompatibility Complex
4. Students learn about the Antigen-antibody reactions so to understand the details of vaccines.

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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- Introduction and historical perspectives of immune system. (2)

Cell and Tissues of immune system: Lymphoid cell, mononuclear cell, granulocytes, mast cells, dendritic cells, primary lymphoid organs, lymphatic system, secondary lymphoid organs (4)

Antigens and Haptens: Immunogenecity, chemical composition, susceptibility to antigen processing, immunogen dosage and route of administration, haptens, adjuvants. (4)

Antibody Structure, Function and Diversity: Basic structure, Immunoglobulin domains, classes. (6)
Major Histocompatibility Complex: MHC molecules, cellular distribution, general importance.

Antigen processing and Presentation to T cell: Antigen presenting cells and their role, pathway.

SECTION-B

B and T cell activation: Antigen recognition and activation of immune response.

Autoimmunity: Organ specific and systematic autoimmune diseases.

Hypersensitive Reactions: Types, mechanisms of hypersensitivity.

Complement System: Components, Complement activation, consequences.

Antigen-antibody reactions: interaction, cross reactions, precipitation and agglutination.

Vaccines: Active and Passive immunization, various types of vaccines

Applications of antibodies: Polyclonal and monoclonal antibodies, Immunoassays, radioimmunoassay, Enzyme linked immunosorbent assay, Western blotting. Immunochemistry, supershift assays

RECOMMENDED BOOKS

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<tr>
<th>S. No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
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</thead>
</table>
Course Code: BIO 465
Course Title: Immunology and Immunotechnology (Practical)
Type of Course: Core
L T P: 0 0 2
Credits: 1

Course Assessment Methods:
- End Semester Assessment (University Exam.): 00
- Continuous Assessment (Sessional): 50

Course Prerequisites:
Theory of Immunology and Immunotechnology

Course Objectives:
1. To understand basic techniques used for isolation and characterization of different cells of the immune system
2. To understand various antigen and antibodies reactions

Course Outcome:
1. Student learn about isolation, separation and quantification of various cells and biomolecules of immune system present in blood
2. Student learn about the various antigen and antibodies reactions

SYLLABUS

List of Experiments:
1. TLC and DLC for blood samples.
2. Determination of cell number (viable/non-viable).
3. Separation of lymphocytes cells from blood
4. Determination of blood group antigens by hemeagglutination assay
5. Radial immunodiffusion Assay.
7. Characterization of immunobiologicals by ELISA.
SYLLABUS
B.E. IN BIOTECHNOLOGY
FIFTH SEMESTER

Course Code
BIO 501

Course Title
Enzyme Engineering & Technology (Theory)

Type of Course
Core

L T P
4 0 0

Credits
4

Course Assessment Methods
End Semester Assessment (University Exam.)
Continuous Assessment (Sessional)

50
50

Course Prerequisites
Introductory biochemistry and general reaction kinetics.

Course Objectives
1. To introduce the basic concepts and different types of enzyme.
2. To understand the mechanisms of enzymatic reaction.
3. To understand about enzyme inhibitors and activators; effect of pH and temperature.
4. To understand about enzyme immobilization and its applications.
5. To understand about enzymatic reactors for batch/continuous and biochemical reaction in enzymatic reactors.

Course Outcome
1. Learn about basic concepts and kinetic reaction of enzyme.
2. Understand about various methods of Immobilization and micro-environmental effect.
3. Understand about reactors for batch/continuous enzymatic processing, choice of reactor type; idealized enzyme reactor systems.
4. Understand about steady state analysis of mass transfer and biochemical reaction in enzyme reactors bio-process design.

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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 & Scope; General distinctive features and industrial applications; enzyme kinetics; single, substrate steady state kinetics; King-Altman’s method; inhibitors and activators; effect of pH and temperature; multi-substrate systems allosteric enzymes.

SECTION-B

Immobilization of enzymes; advantages; carriers; adsorption; covalent coupling; cross linking and entrapment methods; micro-environmental effect; enzyme reactors; reactors for batch/continuous enzymatic processing, choice of reactor type; idealized enzyme reactor systems; mass transfer in enzyme reactors; steady state analysis of mass transfer and biochemical reaction in enzyme reactors bio-process design; physical parameters, reactor operational stability; operational strategies; a few case studies.

RECOMMENDED BOOKS

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<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
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<tbody>
<tr>
<td>3</td>
<td><em>Enzymes</em>: Biochemistry, Biotechnology, Clinical Chemistry</td>
<td><em>Trevor Palme</em></td>
<td>Horwood <em>Publishing Limited</em>.</td>
</tr>
</tbody>
</table>
Course Code: BIO 551
Course Title: Enzyme Engineering & Technology (Practical)
Type of Course: Core
L T P: 0 0 2
Credits: 1

Course Assessment Methods
End Semester Assessment (University Exam.): 00
Continuous Assessment (Sessional): 50

Course Prerequisites: Enzyme Engineering & Technology (Theory)

Course Objectives:
1. The course aims to provide the practical knowledge of enzymatic reactions.

Course Outcome:
1. Learn about enzyme kinetics.
2. Understand about immobilized enzyme application.

SYLLABUS

List of Experiments:
1. To find out enzyme activity.
2. To study the effect of substrate concentration on enzyme.
3. To find out $V_{max}$ and $K_m$ of enzyme.
4. To study the effect of temperature on enzyme.
5. To study the effect of pH on enzyme.
6. To find out half life of enzyme.
7. To study the Enzyme immobilization by sodium alginate method and find out immobilized enzyme activity.
Course Code: BIO 502
Course Title: Bioprocess Engineering
Type of Course: Core
L T P: 400
Credits: 4
Course Assessment Methods:
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50
Course Prerequisites: Chemical reaction engineering concepts and basics of microbiology.
Course Objectives:
1. To understand the characteristics of microbial growth in different processes.
2. To study concepts of sterilization of media and air.
3. To understand the importance of aeration and agitation in fermentations.
4. To learn scale up and scale-down concepts.
Course Outcome:
1. Understanding of various components of microbial fermentation in different modes.
2. Learning of design aspects of sterilizers.
3. Learning of oxygen requirement and power requirement calculation for any fermentation process.
4. Understanding of scale-up approaches and their implementation.

SYLLABUS
Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

Rheology of fermentation fluids and Scale-up concepts.

Introduction to modeling of growth kinetics: General structure for kinetic models, overview of structure and unstructured models.

SECTION-B
Sterilization of media: design of heat sterilization processes; kinetics; Sterilization in place and Cleaning in place concepts.
Sterilization of air: Filter sterilization and kinetics.  

Design of fermentation media and optimization.  

Aeration and agitation: various correlations and mass-transfer aspects, k_La determination.

RECOMMENDED BOOKS

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Course Code: BIO 552  
Course Title: Bio-Process Engineering (Practical)  
Type of Course: Core  
L T P: 002  
Credits: 1  
Course Assessment Methods:  
- End Semester Assessment (University Exam.): 00  
- Continuous Assessment (Sessional): 50  
Course Prerequisites: Bio-Process Engineering (Theory)  
Course Objectives:  
1. Impart the knowledge to students, how to study microorganisms in different environmental conditions.  
2. Physical and chemical transitions on microbial cultures and impact of these factors on final product formation.  
Course Outcome:  
1. Students will learn about the concepts of growth kinetics.  
2. Importance of nutritional requirements for getting desired properties of microbes.  
3. Understanding of metabolic changes in bacteria during oxic and anoxic environmental conditions.  
4. Bioreactor functioning in different physical conditions and final product formation.  
5. To estimate oxygen requirements by microbes by applying numerical methods.  
SYLLABUS  
List of Experiments:  
1. Study of different phases of microbial growth; Estimation of cell mass; Growth rate; mass and energy balance in a typical bioconversion process.  
2. Concept of limiting nutrient and effect of its concentration on cell growth.  
4. Comparison between aerobic and anaerobic bioconversion processes.  
5. Power consumption in a fermentation process and its correlation with rheology of the fermentation fluid; effect of speed on the mixing time in a bioreactor.  
6. Estimation of kLa in a fermentation process.
Course Code: BIO503
Course Title: Animal Cell Culture & Bio-Technology
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50

Course Prerequisites: Student should have knowledge of cell, cell structure, function and behavior

Course Objectives
1. To understand the biology of animal cell culture and its growth
2. To understand the large scale animal cell culturing in bioreactors
3. To understand the use of recombinant DNA Technology in cell culture
4. To understand about transgenic and their uses

Course Outcome
1. Learn about growth, growth kinetics and factors affecting growth of animal cell culture
2. Learn about scaling up process of animal cell culture
3. Learn how genetic engineering can be combined with animal cell culture
4. Learn about stem cell biology and its application

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

Animal Cell metabolism, regulation and nutritional requirement; (5)
Animal cell growth characteristics and kinetics; nutrients, substrate and product transport through mammalian cell; (3)
Primary & secondary culture; cell culture in continuous (6)
Perfusion and hollow-fiber reactor; mass transfer in mammalian cell culture; (4)
Scale-up of cell culture processes; case studies. (4)

SECTION-B

Gene transfer in animal cells and its applications; (8)
Contamination & cyno presentation; Transgenese and transgenic animals including live stock; (6)
Transgenics as bioreactors ; Biotechnology or aquaculture, silkmoth, past control; (4)
Biodiversity, characterization, conservation; In vitro fertilization, embryotransfer technology; (4)
RECOMMENDED BOOKS

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<th>S. No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
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</table>
Course Code: BIO 553  
Course Title: Animal Cell Culture & Bio-Technology (Practical)  
Type of Course: Core  
L T P: 0 0 2  
Credits: 1  
Course Assessment Methods:  
End Semester Assessment (University Exam.): 00  
Continuous Assessment (Sessional): 50  
Course Prerequisites: Animal Cell Culture & Bio-Technology (Theory)  
Course Objectives:  
1. To understand basic techniques used for isolating animal cell culture  
2. To understand basic techniques used for culturing and subculturing cells for establishing animal cell culture  
Course Outcome:  
1. Learn the basic techniques used for isolating animal cell culture  
2. Learn the basic techniques used for culturing and subculturing of cells for establishing animal cell culture  

SYLLABUS  
List of Experiments:  
1. Preparation of cell culture medium.  
2. Dissection of rat for recovery of organs  
3. Establishment of primary adherent cell culture using cold trypsinization  
4. Establishment of primary adherent cell culture using warm trypsinization  
5. Establishment of primary suspension cell culture  
6. Subculturing of adherent cell line  
7. Counting of animal cells using haemocytometer
Course Code: BIO 504  
Course Title: Transport Phenomena  
Type of Course: Core  
L T P: 4 0 0  
Credits: 4

Course Assessment Methods:  
End Semester Assessment (University Exam.) 50  
Continuous Assessment (Sessional) 50

Course Prerequisites:  
Mathematical ability to solve analytically simple first and second order differential equations, concepts of heat and mass transfer, fluid flow and Process Calculations.

Course Objectives:  
1. To provide engineering students the fundamentals to solve problems involving transport of momentum, energy and mass in biological and other systems using a unified approach.

Course Outcome:  
1. Set up shell balance for conservation of momentum, energy and mass, employ these equations to obtain desired profiles for velocity, temperature and concentration.
2. Build the fundamentals for developing mathematical models for a given process.
3. Appreciate relevance of transport principles in diverse applications of chemical, biological and material science and engineering.

SYLLABUS

Note: The semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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


Transport properties-Viscosity, Thermal Conductivity and mass diffusivity.

Development of mathematical models of transfer processes through shell momentum balance for solving specific problems of transport of momentum in laminar flow or in
solids in one dimension.

Development of **general differential equations of fluid flow** and their applications in solving one-dimensional steady state and unsteady state problems of momentum transfer. (10)

Emphasis on the **analogy** between momentum heat and mass transfer with respect to transport mechanism and governing equations. (3)

**SECTION-B**

Development of mathematical models of transfer processes through shell energy balance and shell mass balance for solving specific problems of transport of heat and mass in one dimension. (10)

Development of general differential equations for heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of heat and mass transfer.

Dimensional Analysis. (4)

**RECOMMENDED BOOKS**

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<th>S No.</th>
<th>NAME</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Transport Phenomena</td>
<td>R.B.Bird, W.E.Stewart</td>
<td>John Wiley and Sons</td>
</tr>
<tr>
<td>2</td>
<td>Fundamentals of momentum heat and mass Transfer</td>
<td>J.R.Weity, R.E. Wilson and C.E.Wicks</td>
<td>John Wiley and Sons</td>
</tr>
<tr>
<td>3</td>
<td>Momentum Heat and Mass Transfer</td>
<td>C.O.Bennett and J.E.Myers</td>
<td>McGraw Hill</td>
</tr>
</tbody>
</table>
**Course Code**  
BIO 554

**Course Title**  
Transport Phenomena Practical

**Type of Course**  
Core

**L T P**  
0 0 2

**Credits**  
1

**Course Assessment Methods**
- End Semester Assessment (University Exam.)  00
- Continuous Assessment (Sessional)  50

**Course Prerequisites**  
Transport Phenomena (Theory)

**Course Objectives**
1. To demonstrate and validate the theoretical concepts.

**Course Outcome**
1. Application of the theoretical concepts.

**SYLLABUS**

**List of Experiments:**

1. Determination of density of liquids using pycnometer.
2. Measurement of viscosity of liquids
3. Thermal Conductivity of solids
5. Heat transfer in forced convection.
6. Determination of mass transfer coefficient for vaporization of naphthalene in air.
7. Determination of mass transfer coefficient as a function of gas mass velocity in a wetted wall column.
Course Code          BIO505
Course Title         Bio-Process Technology
Type of Course       Core
L T P                4 0 0
Credits              4
Course Assessment Methods
   End Semester Assessment (University Exam.)  50
   Continuous Assessment (Sessional)          50
Course Prerequisites
Knowledge of the various eukaryotic and prokaryotic living systems and the diversity of their metabolic end products
Course Objectives
1. Comparison of bioprocess technology over chemical technology
2. Knowledge of various substrates to be used in different bio-productions
3. To study the production, importance and application aspects of different industrially important bio-products
4. To understand the nature, treatment and disposal of waste generated from a bioprocess industry
Course Outcome
1. The course would impart to students knowledge about various components of bioprocess technology and its benefit over chemical technology
2. Knowledge and identification of substrates and their judicious use for designing media for carrying out different bioprocesses and improving their overall efficiency
3. Knowledge of the production of different bio-products of scientific and commercial interest and ability to design different bioprocesses and improve their overall efficiency.
4. Students learn the importance and methods of efficient disposal of biowaste

SYLLABUS
Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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**

Characteristics and comparison of bioprocess technology with chemical technology 1

Substrates for bioconversion processes and design of media. Industrial application of cells and enzymes 3

Process technology for the production of cell Biomass, Ethanol, acetone butanol, Citric acid, Dextran, aminoacids 2,2,2,2,3

Microbial production of some industrially important enzymes, Glucose isomerase, cellulase 2,3

**SECTION-B**

Process technology for the production of penicillin, tetracycline, steroid 4,2,2

Process technology for the production of vaccines, Bioenergy production; Bio-polymer design and synthesis 4,2,2

Fermentation technology for waste stabilization and bio-product synthesis 6,2

**RECOMMENDED BOOKS**

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<tbody>
<tr>
<td>1</td>
<td>Bioprocess Technology- fundamentals and applications</td>
<td>Enfors, S.O. and Hagstrom, L.H</td>
<td>Cambridge University Press. (1992)</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Microbiology</td>
<td>Casida, L.E.</td>
<td>Wiley eastern Ltd. (1989) IInd ed.</td>
</tr>
</tbody>
</table>
Course Code: BIO506
Course Title: Bioinstrumentation
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50

Course Prerequisites
Knowledge of human physiology, Basics of signal and systems, Basics of electrical and electronic instrumentation and measurement

Course Objectives
1. The course aims at introducing the students to the basic principle, design and application of biomedical instruments.
2. To make them aware of the concept of biomedical instruments.
3. To representation them to tools of data recording, processing and analysis.
4. To make them aware of the different signal and systems and how to analyses them.

Course Outcome
1. The students understand the working of the biomedical devices involved in measurement of the biological phenomenon
2. The students will be able to analyze the various tools of data recording, processing and analysis.
3. The students are able to differentiate and analyses the frequency response of different signals.

SYLLABUS
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SECTION-A

Introduction: Problems unique to bioinstrumentation; Lab View: A graphical programming language for virtual instrumentation

Basic Principles: Review of system concepts input/output characteristics, the black box signals linear, time-invariant systems static characteristics dynamic characteristics time versus frequency domain analysis
Fourier Analysis; Fourier transforms of common and important signals windowing Discrete
Fourier Transforms The Fast Fourier Transform Spectrum Analyzers windows Frequency
Analysis transfer functions, frequency response magnitude and phase functions signals through
systems 'ideal' and 'best' systems time vs frequency domain filters how to measure frequency
response in the laboratory

Sample systems in the time and frequency domains; 0th, 1st, and 2nd order systems; Non-ideal
systems noise and signal-to-noise ratio; non linearities and distortion products

Wave-analyzer synchronous [lock-in] detection modulator, demodulator digital techniques
analog to digital conversion signal averaging V. Transducers and associated electronics
placement transducers resistive strain gages bridge circuits capacitive displacement
transducers piezoelectric transducers optical transducers temperature transducers

Blood pressure, pressure transducers (manometers) extra-vascular techniques blood sounds
stethoscopes intra-vascular techniques catheter-manometers

Blood Volume and Flow indicator-dilution methods , electromagnetic flowmeters, ultrasonic
methods

SECTION-B

Bioelectric Potentials-Electrophysiology

Origins of biopotentials dipoles remote versus local potentials muscle and nerve cells,
intracellular potentials resting potential action potential stimulators discriminators histograms
remote potentials evoked potentials; example: evoked potential audiometry

Electrodes electrode interfaces fluid-fluid salt-fluid metal-fluid surface (skin) electrodes metal
micro-electrodes glass micro-electrodes microelectrode preamplifiers

Recording and Stimulating Systems, Putting it all together interference minimization and
rejection stimulus isolation shielding grounding ground-loops; Sample recording system:
electrocardiogram; ECG instrumentation

Other cardiac devices ; Pacemakers power and pulse sources electrodes; Defibrillators

Introduction to medical imaging

RECOMMENDED BOOKS

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<tbody>
<tr>
<td>1</td>
<td>Handbook of Biomedical Instrumentation, 2nd Edition.</td>
</tr>
<tr>
<td>2</td>
<td>Medical Instrumentation application &amp; Designs, 4th edition</td>
</tr>
<tr>
<td>3</td>
<td>Principles of applied Biomedical Instrumentation, 3rd edition.</td>
</tr>
<tr>
<td>4</td>
<td>Electrical and Electronic Measurements and Instrumentation</td>
</tr>
<tr>
<td>5</td>
<td>Transducers and Instrumentation</td>
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<tr>
<td>Khandpur, R.S.</td>
<td>Tata McGraw Hill</td>
</tr>
<tr>
<td>Webster, G. J.</td>
<td>John Wiley &amp; Sons, Inc.</td>
</tr>
<tr>
<td>Geddes, L.A. and Baker, L.E.</td>
<td>A Wiley Interscience publication</td>
</tr>
<tr>
<td>Sawhney A K</td>
<td>DhanpatRai and Sons</td>
</tr>
<tr>
<td>Murthy D V S</td>
<td>Prentice Hall of India, New Delhi,</td>
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</tbody>
</table>
BIO507 Training of 4-6 weeks after 4th semester exams: 50 Marks  Credits: 1
Course Code: BIO 601  
Course Title: Recombinant DNA Technology  
Type of Course: Core  
L T P: 4 0 0  
Credits: 4  

Course Assessment Methods:  
End Semester Assessment (University Exam.): 50  
Continuous Assessment (Sessional): 50  

Course Prerequisites:  
Student should have prior knowledge of structure, functions and application of DNA, RNA and proteins  

Course Objectives:  
1. To understand the basic concept of gene cloning with basis of isolation and purification of different types of DNA molecules  
2. To understand about different vector molecules and enzymes used in gene cloning experiments  
3. To understand about gene expression, regulation and protein-protein interaction  
4. To study the applications of recombinant DNA technology in the fields of Medicine, Agriculture, Forensic and Environment  

Course Outcome:  
1. Learn the basis of isolation and purification of different types of DNA molecules  
2. Learn about different vector molecules and enzymes used in gene cloning experiments  
3. Learn about gene expression, regulation and protein-protein interaction  
4. Learn the applications of recombinant DNA technology in the fields of Medicine, Agriculture, Forensic and Environment  

SYLLABUS  
Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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  
Gene cloning and need to clone a gene; Isolation and purification of plasmid, (10) chromosomal and genomic DNA from bacterial, plant and animal cells. Different cloning vectors like plasmids, cosmids, phagemids, shuttle vectors, and other (10)
vectors for plant and animals; enzymes used in recombinant DNA technology like restriction endonucleases, ligases, polymerases, kinases and phosphatases.

SECTION-B

Cloning of a specific gene; studying gene location and structure; studying gene expression; expression of foreign genes in research and biotechnology; maximization of recombinant proteins; brief introduction to sequencing and site directed mutagenesis, different types of PCR and applications; safety measures and regulations for recombinant DNA work

A brief introduction to the followings: phage display system, Yeast two hybrid system, and RNAi technology.

Applications of recombinant DNA technology in the fields of Medicine, Agriculture, Forensic and Environment

RECOMMENDED BOOKS

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<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
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</table>
Course Code: BIO 651  
Course Title: Recombinant DNA Technology (Practical)  
Type of Course: Core  
L T P: 0 0 2  
Credits: 1  

Course Assessment Methods:  
End Semester Assessment (University Exam.): 00  
Continuous Assessment (Sessional): 50  

Course Prerequisites:  
Student should have knowledge about various biomolecules and basic techniques used in recombinant DNA technology  

Course Objectives:  
1. To understand practical aspect of DNA isolation techniques used in recombinant DNA technology  
2. To understand digestion and ligation of various DNA molecules for generating recombinant molecules  

Course Outcome:  
1. Learn the practical aspect of DNA isolation and quantification techniques used in recombinant DNA technology  
2. Learn the use of various enzymes used for DNA manipulation for generating recombinant molecules  

SYLLABUS  
List of Experiments:  
1. In-situ Oligonucleotide synthesis.  
2. Extraction of genomic DNA from yeast cells  
3. Amplification of DNA using PCR  
4. Isolation of plasmid DNA from E.coli  
5. Digestion of plasmid DNA by restriction endonuclease  
6. Ligation and Transformation assay  
7. Induction and expression of a gene cloned in an expression vector in E.coli
**Course Code**  BIO602  
**Course Title**  Operations Research  
**Type of Course**  Core  
**L T P**  4 0 0  
**Credits**  4  

**Course Assessment Methods**  
End Semester Assessment (University Exam.)  50  
Continuous Assessment (Sessional)  50  

**Course Prerequisites**  
Student should have the knowledge of real world problems so that he can formulate it and solve it  

**Course Objectives**  
1. To give the student experience in modeling, solving and analyzing problems using linear programming. Emphasis is stressed on theory, applications, and computer usage.  
2. Optimization, i.e., "to do things best under the given circumstances."  
3. To improve a quantitative decision making procedure.  
4. To help the decision-maker to select the key decision variables that will influence the overall quality of decisions.  

**Course Outcome**  
1. Identify and develop operational research models from the verbal description of the real system.  
2. Understand the mathematical tools that are needed to solve optimisation problems.  
3. Use mathematical software to solve the proposed models.  
4. Learn about the strategy that a salesman should follow so that he can travel in all the destinations in minimum amount of time. Learn about the Alternate method to look at linear programming problem  

**SYLLABUS**  

*Note:* The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

Optimization Problems. Linear Programming:
Graphical Method  Solution of simultaneous linear equations: An overview
Basic solutions, lines and hyperplanes, convex sets, extreme points, convex sets and
hyperplanes
Reduction of any feasible solution to a system of equations to a basic feasible solu
tion. Simplex Method: The simplex algorithm

Tableau format for simplex computations, Charne’s M-method, Two phase method
The revised simplex method

Duality theory:
Formulation of the dual problem, Theorems on duality: Weak Duality Theorem,
Strong Duality Theorem, Complementary Slackness Theorem, Dual Simplex Algorithm
Integer Linear Programming:
Branch and Bound Algorithm, Cutting Plane Algorithm

SECTION-B

Transportation Problem:Initial solution by North-West corner rule, Row minima
method, Column minima method, Matrix minima method, Vogel’s method. Tableau of
transportation problem, u-v algorithm for solving transportation problem. Degeneracy
in transportation problem
The Assignment Problem:Hungarian Method Traveling Salesman Problem

Dynamic Programming:Shortest route problem, Knapsack Model, Workforce size
model, Equipment replacement model, Investment model, Game of chance
CPM and PERT:Network representation, Critical path computations, Construction of
time schedule
Linear programming formulation of CPM, PERT networks
Basic Queuing Systems:Elements of a queuing model, Pure birth and pure death model,
Generalized Poisson queuing model

RECOMMENDED BOOKS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Linear Programming</td>
<td>G. Hadley</td>
<td>NarosaPublishing House, NewDelhi</td>
<td>2002</td>
</tr>
<tr>
<td>2</td>
<td>OperationsResearch, An Introduction</td>
<td>Hamdy A. Taha</td>
<td>Pearson Education, Delhi</td>
<td>Seventh</td>
</tr>
</tbody>
</table>
Course Code: BIO652
Course Title: Operation Research (Practical)
Type of Course: Core
L T P: 0 0 2
Credits: 1
Course Assessment Methods:
End Semester Assessment (University Exam.): 00
Continuous Assessment (Sessional): 50
Course Prerequisites:
Operation Research (Theory)
Course Objectives:
1. To give the student experience in modeling, solving and analyzing problems using linear programming. Emphasis is stressed on theory, applications, and computer usage.
2. Optimization, i.e., "to do things best under the given circumstances."
3. To improve a quantitative decision making procedure.
4. To help the decision-maker to select the key decision variables that will influence the overall quality of decisions
Course Outcome:
1. Identify and develop operational research models from the verbal description of the real system.
2. Understand the mathematical tools that are needed to solve optimisation problems.
3. Use mathematical software to solve the proposed models.
4. Learn about the strategy that a salesman should follow so that he can travel in all the destinations in minimum amount of time Learn about the Alternate method to look at linear programming problem

SYLLABUS

List of Experiments:
Based on the theory
<table>
<thead>
<tr>
<th><strong>Course Code</strong></th>
<th>BIO 603</th>
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<tbody>
<tr>
<td><strong>Course Title</strong></td>
<td>Introduction to bioinformatics (Theory)</td>
</tr>
<tr>
<td><strong>Type of Course</strong></td>
<td>Core</td>
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<tr>
<td><strong>L T P</strong></td>
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<td><strong>Credits</strong></td>
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<td><strong>Course Assessment Methods</strong></td>
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<td>End Semester Assessment (University Exam.)</td>
<td>50</td>
</tr>
<tr>
<td>Continuous Assessment (Sessional)</td>
<td>50</td>
</tr>
<tr>
<td><strong>Course Prerequisites</strong></td>
<td>Knowledge of biomolecules like DNA, RNA, proteins and some fundamentals of computer.</td>
</tr>
</tbody>
</table>

**Course Objectives**

1. To introduce the students about objectives and areas of bioinformatics; genome sequencing projects, basic concepts of database, types of databases
2. To develop understanding for using databases in protein sequence analysis and nucleic acid sequence analysis
3. To introduce about gene prediction in prokaryotic and eukaryotes genomes, prediction of protein secondary structure, three-dimensional structure
4. To understand concepts of molecular modeling and use of molecular graphics packages, computer aided drug design

**Course Outcome**

1. Students would be able to understand objectives and areas of bioinformatics
2. The course would also enable them to understand about genome sequencing projects, some concepts and types of databases
3. Students would be able to use databases for protein and nucleic acid sequence analysis, sequence homology, gene prediction, protein structure prediction by various tools
4. The course would also enable them to understand concepts of drug design
**Note:** The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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 Bioinformatics:** History of Bioinformatics; Objectives and areas of Bioinformatics; Genome sequencing projects; Human Genome Project - history, techniques and insights.

**Introduction to databases:** Basic concept of database, Type of databases; Literature Databases-PUBMED, MEDLINE; Nucleic acid and protein databases- GenBank, EMBL, DDBJ, SWISS PROT, UNIPROT; Human, animal and plant databases- Ensembl, Genome project TIGR database, Maize GDB etc. Structural databases- PDB, PDBsum, NDB etc; Motifs and Pattern Databases- PROSITE, Pfam, BLOCKS, PRINTS etc; Database Retrieval and deposition systems- SRS, Entrez, Bankit, Seqin, Webin, AutoDep.

**Basic Sequence Analysis:** Protein Sequence Analysis- composition, hydropathy, flexibility, pattern, motif etc; Nucleic acid Sequence Analysis- Composition, motif, restriction site, primer design etc.

**Sequence Homology:** Scoring matrices, Local and global alignment concepts, Dot matrix sequence comparison, Dynamic programming; Statistics of alignment score; Database searches for homologous sequences- FASTA, BLAST, PSI-BLAST and PHI-BLAST; Multiple sequence alignment: CLUSTALW, PILEUP; Evolutionary analysis- Concept of phylogeny and trees, Relationship of phylogenetic analysis to sequence alignment.

**Gene prediction:** Gene prediction in prokaryotic and eukaryotes genomes; evaluation of gene prediction methods.

### SECTION-B

**Protein structure prediction:** Prediction of protein secondary structure from the amino acid sequence- Chou-Fasman/GOR method, JPRED, PSIPRED, PHD; Prediction of three-dimensional protein structure-Homology-based structure prediction, Fold recognition and ab initio methods for structure prediction; Evaluating the success of structure predictions-CASP and CAFASP.

**Introduction to the concepts of molecular modeling:** Molecular structure and internal energy; Molecular Mechanics; Energy Minimization and related methods for exploring the energy surface; Molecular Dynamics, Conformational analysis; Use of molecular graphics packages- Rasmol, MOLMOL, Chimera, Pymol, spdbviewer.

**Computer Aided drug design:** Drug discovery process; Role of molecular recognition in drug design; Concepts in Quantitative structure activity relationships (QSAR);
Docking problem, Concepts of docking; Structure based Drug design.

**Applications of Bioinformatics**: Comparative Genomics; Proteomics; Gene expression informatics; Metabolomics; Computer aided vaccine design.

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<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Introduction to Bioinformatics</td>
<td>T.K. Atwood and D.J. Parry Smith</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Computational Molecular Biology</td>
<td>P. Clate &amp; R. Backofen</td>
<td>Willy Publication</td>
</tr>
</tbody>
</table>
Course Code: BIO653
Course Title: Introduction to Bioinformatics (Practical)
Type of Course: Core
L T P: 0 0 2
Credits: 1
Course Assessment Methods:
   End Semester Assessment (University Exam.): 00
   Continuous Assessment (Sessional): 50
Course Prerequisites: Introduction to Bioinformatics (Theory)

Course Objectives:
1. To develop skills in using various computational tools available online for retrieving DNA and Protein sequences, similarity searches among them, phylogenetic analysis, gene prediction, 2D and 3D protein structure analysis

Course Outcome:
1. Students would be able to study and analyse biological databases at NCBI, EBI, Expasy, NBRF-PIR
2. Students would learn to retrieve DNA and Protein sequences from databases
3. Students would be able to develop skills in using various computational tools available online for similarity searches, phylogenetic analysis, gene prediction, 2D and 3D protein structure analysis for DNA and protein sequences

SYLLABUS

List of Experiments:

a) To Study & analyse various biological databases at NCBI, EBI, Expasy, NBRF-PIR
   Nucleic acid sequence databases like Gene Bank, EMBL etc.
   Protein sequence databases SWISSPROT, UNIPROT etc.
   Structural databases- PDB, NBD

b) To retrieve sequences from NCBI/EBI/ExPasy using ENTRZ, SRS

c) Similarity searches using various tools like
   BLAST/ FASTA, BLAST N, BLAST P, BLAST X

d) CLUSTALW / Phylogenetic analysis tools

e) To predict gene/ORF for genomic DNA sequences of prokaryotic and eukaryotic origin.
f) To analyze protein sequence using Secondary Structure prediction Methods:
   Chou-Fasman/GOR method, JPRED, PSIPRED, PHD etc.

  g) Energy minimization using SPDBV.
  h) To download structures of proteins in software like RASMOL, SPDBV and analysis of
     structures in these software
  i) Fold recognition
  j) Homology modeling using SPDBV.
<table>
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<th>Course Code</th>
<th>BIO 604</th>
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<td>Course Title</td>
<td>Bioreactor Design &amp; Operation</td>
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<tr>
<td>Type of Course</td>
<td>Core</td>
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<tr>
<td>L T P</td>
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<tr>
<td>Continuous Assessment (Sessional)</td>
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<th>Course Prerequisites</th>
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<tr>
<td>Basics of bioprocess engineering concepts.</td>
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<tr>
<th>Course Objectives</th>
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<tbody>
<tr>
<td>1. To understand the characteristics of biological systems.</td>
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<tr>
<td>2. To study about different types of reactors and their non-ideal behavior.</td>
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<tr>
<td>3. To gain understanding of control and instrumentation of various process parameters.</td>
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<tr>
<td>4. To understand modeling and stability of a reactor process.</td>
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<table>
<thead>
<tr>
<th>Course Outcome</th>
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</thead>
<tbody>
<tr>
<td>1. Knowledge of different types of microorganisms and their effect on the reactor design.</td>
</tr>
<tr>
<td>2. Understanding of performances of different types of reactors and their non-ideality calculation.</td>
</tr>
<tr>
<td>3. Knowledge of principles of measurement of various process parameters and their control.</td>
</tr>
<tr>
<td>4. Learning about the fermentation dynamics and their stability in terms of operation.</td>
</tr>
</tbody>
</table>

**SYLLABUS**

*Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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 reactor design and Kinetics of Bioreactions (review).

Biological systems: Organism selection; bacterial, yeast and fungal cultures; Effect of microorganism type and culture characteristics on bioreactor design and operation.

Ideal Reactors: Batch reactor (Closed and fed-batch), continuous reactors; PFTR, CSTR design equations. Reactors for biomass growth; reactors in series; recycle reactors; overview of pneumatically agitated bioreactors; Membrane bioreactors and Photo bioreactors.

RTD in reactors: Models for non-ideal reactors; Tanks in series and dispersion models.

SECTION-B
Instrumentation and control of various parameters in bioreactors for Dissolved oxygen, foam, pH, temperature, flow, pressure, microbial biomass, CO₂ etc; Methods of measuring process variables and control systems: Proportional, Proportional integral and Proportional integral derivative.

Operation and scale-up of bioreactors.

Bioreactor modeling and stability: Fermentation dynamics, Biomass production and dilution factor, Thermal stability concepts.

Mechanical design Concepts: Application to continuous sterilizers, RTD concepts, Application of design principles.

RECOMMENDED BOOKS

<table>
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<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Basic Bioreactor Design</td>
<td>Van’t R et KK. &amp; Tramper J.</td>
<td>Marcel Decker, 1991 C R C Pr.</td>
</tr>
</tbody>
</table>
4 Bioprocess Engineering Principles Pauline M. D. Academic Press
An imprint of Elsevier.
Course Code: BIO605
Course Title: Downstream Processing
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Knowledge of various bioprocesses of industrial importance and their components

Course Objectives
1. To make students understand the difference between upstream and downstream processing and different phases of downstream processing of different bio products
2. To impart knowledge about the various unit operations involved in the isolation and extraction of bio-products from the fermentation broth
3. To learn different methods of concentration, purification and final polishing of the bio-product before commercial use

Course Outcome
1. Understanding of different stages of downstream processing
2. Knowledge of principles and working of different unit operations for the isolation and extraction of bio-products
3. Knowledge of different methods and industrial equipments used for the concentration, purification and final polishing of bio-products at the industrial level

SYLLABUS

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SECTION-A

Introduction; An overview of Bioseparation, Separation of cells and other insolubles from fermented broth; 2
Filtration and microfiltration; Centrifugation (batch, continuous). Designing of centrifuges for desired product of desired capacity; 7
Cell disruption: Physical methods – osmotic shock, grinding with abrasives solid shear, liquid 2
shear, Chemical methods- alkali reagents, enzymatic methods;
Product isolation: Extraction and adsorption method, solid-liquid separation, liquid-liquid separation, distillation, precipitation method using ammonium sulfate, organic solvents, high molecular weight polymers, reverse osmosis;

**Section-B**

Electrophoresis and chromatography principles for product purification. Different electrophoresis techniques viz. isoelectric focusing, chromatographic techniques viz. paper, gel filtration, column, ion exchange, affinity, GLC, HPLC. Dialysis, ultrafiltration;
Product polishing: crystallization and drying.

**RECOMMENDED BOOKS**

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<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
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</table>
**Course Code**  
BIO655  

**Course Title**  
Down Stream Processing (Practical)  

**Type of Course**  
Core  

**L T P**  
0 0 2  

**Credits**  
1  

**Course Assessment Methods**  
- End Semester Assessment (University Exam.) 00  
- Continuous Assessment (Sessional) 50  

**Course Prerequisites**  
Down Stream Processing (Theory)  

**Course Objectives**  
1. To impart to students working knowledge of different methods and techniques used during different stages of downstream processing of different bio-molecules  

**Course Outcome**  
1. The students learn to isolate, concentrate and purify bio-molecules using different techniques pertaining to downstream processing  

**List of Experiments**  
1. Cell lysis and release of cell contents  
2. Use of centrifugation, ultra centrifugation, ultra filtration  
3. Lypohilization  
4. Crystallization  
5. HPLC for bio-separation
**Course Code**  
BIO606  
**Course Title**  
Biomaterials  
**Type of Course**  
Core  
**L T P**  
4 0 0  
**Credits**  
4  
**Course Assessment Methods**  
End Semester Assessment (University Exam.)  
Continuous Assessment (Sessional)  
50  
50  
**Course Prerequisites**  
Knowledge of human anatomy and physiology and basics of immunology  
**Course Objectives**  
1. The course aims at introducing the students to properties of biomaterials  
2. To make them aware of different types of tissue grafts and immunological response to the grafts  
3. To make them understand the utilization of different classes of synthetic polymers and biopolymers as implant material in various organ systems  
**Course Outcome**  
1. To students learn about the mechanical, thermal and surface properties of biomaterials  
2. Learn about the application of synthetic and biopolymer as implant material for soft and hard tissues  
3. The students learn about the interaction of implant material with the body tissues and approaches to prevent rejection of the implant  

**SYLLABUS**  
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**SECTION-A**  
**Introduction to biomaterials:** Characterization of materials, mechanical properties, thermal properties, surface properties and adhesion, Various classes and forms of biomaterials  

**Metals:** Stainless steel, Cobalt- Chromium Alloys, Titanium based alloys, other metals, metallic corrosion and biological tolerance.  

**Ceramics:** Carbons, Alumina, Resorbable ceramics, Composites, Ceramic surface analysis.  

**Synthetic polymers:** Polymers in biomedical use, Polyethylene, Polypropylene,  


**Biopolymers**: Collagen, Elastin, Mucopolysaccharides, Proteoglycans, Cellulose and derivatives and other.

**Tissue grafts**: Blood, Tissue grafts and rejection processes, Skin and grafts.

**Soft tissue application**: Spacefillers, Maxillofacial and fluid transfer implants, Biomaterials in urological practice.

**SECTION-B**


**Biomaterials in ophthalmology**: Anatomy of eye, Viscoelastic Solution, Contact Lens and Optical implants, Scleral buckling material for retinal detachment, Vitreous implants, Artificial tears.

**Orthopedic implants**: Bone composition and materials, Fixation devices, Fracture healing by electrical and electromagnetic stimulation, Hip joint replacement, Knee joint repair, Bone regeneration with resorbable materials.

**Dental Materials**: Tooth composition and mechanical properties, Impression materials, Filling and restorative materials, Metal in dentistry, Oral implants, Use of collagen in dentistry.

**RECOMMENDED BOOKS**

<table>
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<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biomaterials</td>
<td>Sujata V. Bhat</td>
<td>Alpha Science International</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2005) 2nd edition</td>
</tr>
<tr>
<td>3</td>
<td>Biomaterials: An Introduction</td>
<td>Joon Park, R.S. Lakes</td>
<td>Springer Science+ Business Media</td>
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# SYLLABUS

## SEVENTH SEMESTER

<table>
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<tr>
<th>Course Code</th>
<th>BIO 701</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Environmental Biotechnology (Theory)</td>
</tr>
<tr>
<td>Type of Course</td>
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<tr>
<td>L T P</td>
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<td>Credits</td>
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### Course Assessment Methods

- End Semester Assessment (University Exam.) 50
- Continuous Assessment (Sessional) 50

### Course Prerequisites

Basic concepts of environmental Pollution and general reaction kinetics.

### Course Objectives

1. To introduce the concepts and types of Environmental Pollution.
2. To understand the methods of waste water treatment.
3. To understand the mechanisms of Solid Waste management.
4. To understand the Microbial Leaching and Mining.
5. To introduce the concepts of Environmental Genetics.

### Course Outcome

1. Learn about Environmental Pollution, Biodegradation and Bioremediation-definitions and examples.
2. Understand about Waste Water Treatment, kinetics and methods.
3. Learn about Uses and Management of Solid Waste.
4. Understand about Degradative plasmids, release of genetically engineered microbes in environment.
SYLLABUS

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SECTION-A

Introduction: Environmental Pollution: Sources and effects. Biodegradation and Bioremediation—definitions and examples.


SECTION-B


Microbial Leaching and Mining: Recovery of metals from solutions, microbes in petroleum extraction, microbial desulphurization of coal.

Environmental Genetics: Degradative plasmids, release of genetically engineered microbes in environment.

RECOMMENDED BOOKS

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<th>PUBLISHER</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>Environmental Biotechnology</td>
<td>T. Srinivas</td>
<td>New Age International (P) Ltd.</td>
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Course Code: BIO 751

Course Title: Environmental Biotechnology (Practical)

Type of Course: Core

L T P: 0 0 2

Credits: 1

Course Assessment Methods:
- End Semester Assessment (University Exam.): 00
- Continuous Assessment (Sessional): 50

Course Prerequisites: Environmental Biotechnology (Theory)

Course Objectives:
1. The course aims to provide the practical training of estimation of Environmental Pollutant such as aromatic compounds.
2. To perform the measurement in waste water treatment such as DO and COD.

Course Outcome:
1. Learn about measurement in waste water treatment.
2. Learn about Environmental Pollutant such as aromatic compounds.
3. To understand about biochemical calculation in waste water treatment.

SYLLABUS

List of Experiments:

1. To estimate dissolved oxygen content of a given water sample.
2. Estimation of phenolic compounds in the drinking water and effluent sample.
3. Quantification of total detergents /surfactants content in drinking water.
5. Estimation of chemical oxygen demand of a given water sample.
6. To measure biochemical oxygen demand of a sample by titrimetric method.
7. Isolation of poly aromatic hydrocarbons(PAHs) degrading microorganisms from soil.
Course Code: BIO 702
Course Title: Food Biotechnology (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Knowledge of microbiology concepts

Course Objectives

1. To introduce students about history of microorganisms in food, primary sources of microorganisms in foods
2. To familiarize students with synopsis of common food borne bacteria, fungi and yeasts
3. To understand about Extrinsic & Intrinsic parameters of foods
4. To develop understanding in relating above parameters with food spoilage, food borne diseases, food preservation,
5. To introduce about methods for diagnosis of microbial contents of food, food biosensors

Course outcomes

1. Student would learn about history of microorganisms in food, primary sources of microorganisms in foods.
2. Students would understand about factors affecting food.
3. Students would learn role of microorganisms as food spoilage, food borne diseases and fermented food
4. Student would understand methods to detect microbial content in food.

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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

History of Microorganisms in food, Primary sources of Microorganisms in foods, (11)
Synopsis of common food borne bacteria, fungi and yeasts.

Incidence & Behavior of Microorganisms in foods, Extrinsic & Intrinsic parameters of foods, Role and Significance of Microorganisms as Single cell proteins, Food value of Mushrooms, Yeasts, Production of Fermented foods.

SECTION B
Food types and their physical & chemical properties, Food Spoilage, Food Borne diseases.

Food Preservation, Diagnosis of microbial contents of food: Classical & Molecular approach, Food biosensors.

RECOMMENDED BOOKS

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<td>Course Title</td>
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**Course Assessment Methods**
- End Semester Assessment (University Exam.) 00
- Continuous Assessment (Sessional) 50

**Course Prerequisites**
- Food Biotechnology Theory

**Course Objectives**
1. To develop skills in observing contaminated foods through different tests and microscope

**Course outcomes**
1. Students would be able to develop skills in observing contaminated foods through different tests and microscope

**SYLLABUS**

**List of Experiments:**
Microbiological Examination of food/s. Enumeration and detection of food borne organisms. Estimation of quality of milk-by dye reduction, direct microscopic count, Determination of diacetyl, titrable acidity in the milk sample.
Course Code: BIO 703
Course Title: Plant Tissue Culture (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50

Course Prerequisites
Concepts and techniques in biotechnology

Course Objectives
1. The course aims at familiarizing the students with fundamental aspects of plant tissue culture, concept of totipotency and utilization of tissue culture systems for plant improvement and optimized production of metabolites.

Course outcomes
1. The students understand the basic concepts, recent advances and implementation of plant tissue culture techniques for research and commercial application
2. Learn different methods and techniques in plant tissue culture

SYLLABUS

Note: The Semester question paper of a subject be of 50 Marks having 7 questions of equal marks. First question, covering the whole syllabus and having questions of conceptual nature, 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, requirements and techniques, (4)

Tissue culture media and cell culturing (5)

Cellular Totipotency, Somatic Embryogenesis, synthetic seeds (6)

Haploid Production: Zygotic Embryo Culture: Morphogenesis in the culture of seeds with partially differentiated embryos.
SECTION B


Genetic engineering and production of pathogen free plants: Gene expression, genetic stability, and field performance

Introduction, Strategies used to optimize product yield, commercial aspects, Germplasm storage: Introduction, long term Storage, Short or Medium term storage.

RECOMMENDED BOOKS

<table>
<thead>
<tr>
<th>S.No</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
<th>PUBLISHER</th>
</tr>
</thead>
</table>
Course Code: BIO 704
Course Title: Bioanalytical Techniques (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods:
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Understanding of various analytical techniques in terms of their fundamental principles and applications.

Course Objectives:
1. To gain understanding of various aspects of UV-Visible and fluorescence spectroscopy.
2. Understanding of infrared, Raman and NMR techniques and their instrumentation.
3. To understand working principles of electron microscopy and radio isotopy.
   To gain overview of atomic absorption and mass spectroscopic techniques.

Course outcomes:
1. Well understanding of principle, instrumentation of UV-Visible and fluorescence spectroscopy.
2. Learn to elucidate structure of a chemical compound using IR and NMR techniques.
3. Knowledge of various aspects of electron microscopy and radio isotopy in terms of sample preparation and final application.
   Learn to implement atomic absorption and mass spectroscopic techniques as per the nature of the sample under investigation.

SYLLABUS

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SECTION A

Spectrophotometry (UV and Visible): Principle, single beam and double beam spectrophotometer, factors influencing the absorption spectra, overview of empirical rules, solvent perturbation method and difference spectroscopy; various applications of absorption spectroscopy with respect to biotechnology.

Spectrofluorimetry: Principle, significance and various details related to instrumentation
Cellular Totipotency, Somatic Embryogenesis, synthetic seeds

Atomic absorption Spectrophotometry: Principle, instrumentation details, various interferences in atomic absorption spectroscopy and applications.

Infrared and Raman Spectroscopy: Principle, factors deciding the spectra, instrumentation, overview of different class of compounds and their IR spectra.
Introduction to Raman scattering

Nuclear Magnetic resonance: Phenomena of resonance, instrumentation, diamagnetic shielding, anisotropy, chemical shift, free induction decay (FID), population distribution of nuclei, and prediction of NMR spectra on the basis of (n+ 1) rule for basic class of compounds. Overview of electron spin resonance spectroscopy (ESR) and magnetic resonance imaging (MRI).

SECTION B

Electron Microscopy: Transmission and scanning electron microscopy, significance of vacuum, basic instrumentation for TEM and SEM, sample preparation for electron microscopy. Overview of Atomic force microscopy and tunneling microscopy with respect to their working principle and comparison with other scanning techniques.

Crystallography and X-ray diffraction: Introduction to x-ray and general theory and instrumentation, Bragg’s law, various techniques to determine crystal structure.

Radioisotope techniques: Radiotracers, units of radioactivity measurement, proportional and scintillation counters, introduction to autoradiography and nuclear medicine.

Mass Spectroscopic Techniques: Introduction to mass-spectroscopy, significance, instrumentation details of a mass-spectrometer, ionization techniques, single and double focusing, alternate mass separation techniques- time of flight and quadruple. Interface of mass-spectra with liquid and gas chromatography (LC-MS and GC-MS).
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<th>S.No</th>
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</table>
Course Code          BIO 754
Course Title          Bioanalytical Techniques (Practical)
Type of Course        Core
L T P                0 0 2
Credits              1
Course Assessment Methods
End Semester Assessment (University Exam.) 00
Continuous Assessment (Sessional) 50

Course Prerequisites       Bioanalytical Techniques Theory

Course Objectives
1. Learning of spectroscopic techniques for different types of applications.
2. To investigate the sample given for its identification.

Course Outcome
1. Learn to design assay for various types of samples.
2. Learn to elucidate structure by using different spectroscopic techniques.

SYLLABUS

List of Experiments:

1. To determine maximum wavelength ($\lambda_{\text{max}}$) for a given colored solution.
2. To confirm the Beer’s Lambert law for the given colored solution.
3. To elucidate a structure of a given chemical compound using NMR.
4. To investigate different samples for the elemental composition using X-ray fluorescence.
5. To confirm the presence of different functional groups using FT-IR spectroscopy.
6. Rapid protocol for enzyme detection.
7. Using HPLC for analyzing different components.
<table>
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<tr>
<th>Course Code</th>
<th>BIO 705</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Minor Project Practical</td>
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<th>Course Code</th>
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<td>Course Title</td>
<td>Training of 6 weeks after 6th semester</td>
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<tr>
<td>Credits</td>
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<td>End Semester Assessment (University Exam.)</td>
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<td>Course Code</td>
<td>BIO 801</td>
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<tr>
<td>Course Title</td>
<td>Major project (Practical)</td>
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<td>Type of Course</td>
<td>Core</td>
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<td>L T P</td>
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<td>Credits</td>
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**Course Assessment Methods**
- End Semester Assessment (University Exam.) 00
- Continuous Assessment (Sessional) 50

**Course Prerequisites**
Core courses in Biotechnology
Course Code: BIO 802
Course Title: Enzyme Catalyzed Organic Synthesis (Theory)
Type of Course: Core
L T P: 4 0 0
Credits: 4
Course Assessment Methods:
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Introductory Enzyme Technology

Course Objectives:
1. To introduce the basic concepts and different types of enzyme.
2. To understand the mechanisms of enzymatic reaction.
3. To understand about enzyme inhibitors and activators; effect of pH and temperature.
4. To understand about enzyme immobilization and its applications.
5. To understand about enzymatic reactors for batch/continuous and biochemical reaction in enzymatic reactors.

Course Outcome:
1. Learn about basic concepts and kinetic reaction of enzyme.
2. Understand about various methods of Immobilization and micro-environmental effect.
3. Understand about reactors for batch/continuous enzymatic processing, choice of reactor type; idealized enzyme reactor systems.
4. Understand about steady state analysis of mass transfer and biochemical reaction in enzyme reactors bio-process design.

SYLLABUS

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candidate is required to attempt at least two questions from each section.

SECTION-A

Biocatalysis: Definition of Biocatalysis, advantages and disadvantages of Biocatalysis over chemical catalysis.
Different types of Biocatalysis; microbial, enzymatic and immobilized system of Biocatalysis; current industrial Biocatalysis with different enzymes.
Immobile enzymes for Biocatalysts.

SECTION-B

Stereo selective biocatalysts for the synthesis of chiral pharmaceutical intermediate such as synthesis of ACE inhibitors, definition, mode of action of inhibitors.
Recent developments synthesis of anticholesterol drug by biocatalysis routs, Calcium channel blocking drugs, potassium channel openers, antiviral.

RECOMMENDED BOOKS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>NAME</th>
<th>AUTHOR(S)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biocatalysis: Fundamentals &amp; Applications</td>
<td>J Andreas S. Bommarius, Bettina R. Riebel.</td>
<td>WILEY-VCH.</td>
</tr>
<tr>
<td>3</td>
<td>Enzymes: Biochemistry, Biotechnology, Clinical Chemistry</td>
<td>Trevor Palme</td>
<td>Horwood Publishing Limited.</td>
</tr>
</tbody>
</table>
Course Code: BIO 852
Course Title: Enzyme Catalyzed Organic Synthesis (Practical)
Type of Course: Core
L T P: 0 0 3
Credits: 2
Course Assessment Methods:
  End Semester Assessment (University Exam.): 00
  Continuous Assessment (Sessional): 50
Course Prerequisites:
  Enzyme Catalyzed Organic Synthesis (Theory)
Course Objectives:
1. The course aims to provide the practical knowledge of Optimization of enzymatic reactions.
Course Outcome:
1. Learn about enzymatic catalysis reaction conditions.
2. Learn about enzymatic catalysis reaction with activators and inhibitors.
3. Understand about immobilized enzyme application.

SYLLABUS

List of Experiments:
1. To find out specific enzyme activity.
2. To study the Optimization of enzymatic catalysis reaction conditions.
3. To study the effect of organic solvent on enzyme activity.
4. To study the enzymatic catalysis reaction with activators.
5. To study the enzymatic catalysis reaction with inhibitors.
6. To study the Product identification using different analytical technique.
7. To study the cell immobilization and enzyme immobilization of various method.
Course Code: BIO803
Course Title: Project Management and Entrepreneurship

Type of Course: Core
L T P: 4 0 0
Credits: 4

Course Assessment Methods:
End Semester Assessment (University Exam.): 50
Continuous Assessment (Sessional): 50

Course Prerequisites:
Student should have prior knowledge of Project Management, basics about corporate sector and basic corporate laws

Course Objectives:
1. To appraise the students about entrepreneurship
2. Encourage students to take up self employment/Entrepreneurship
3. Promote innovation amongst students
4. Make students aware of Project Management and related topics

Course Outcome:
1. With limited jobs, this course gives an option to innovative individuals to set up their own venture
2. Turn students into job creators rather than be job seekers.
3. Guide the students in project planning and management
4. Incubate viable projects that may come from students

SYLLABUS

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SECTION-A

Project Formulations and Planning, Private commercial criteria for project choice, project cycle, feasibility, marketing feasibility (6)

Financing for Projects and financial feasibility (6)
Project Implementation. Brief outline of social cost benefit analysis: rationale.

UNIDO and little Mirrlees approaches, UNIDO-IDCAS manual, shadow prices and conversion factors, applications in India. Planning and scheduling networks

Critical path, PERT model, CPM model, PERT/cost, resource leveling and allocation.

SECTION-B

Entrepreneur- Concept on percent - Functions and clarifications of entrepreneurs - Characteristics of entrepreneur - Nature and importance of entrepreneur

Entrepreneur vs. professional manager - Women entrepreneurs. Concept of Entrepreneurship - Entrepreneurship and environment-Policies governing entrepreneurs, entrepreneurial development programmes

Institutions for - entrepreneurship development, entrepreneurship.

Entrepreneurship -Entrepreneurship development in other countries.

Institutions for Entrepreneurial Development - Role of constancy organizations - Role of financial institutions - Bank finance to entrepreneurs Entrepreneurship development: Role of development financial institutions.

RECOMMENDED BOOKS

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<tr>
<td>2.</td>
<td>Entrepreneurship</td>
<td>Hisrich, Peters and Shepherd</td>
<td>Tata McGraw Hill</td>
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<tr>
<td>3.</td>
<td>UNIDO: Guidelines for Project Evaluation, United Nations</td>
<td>UNIDO</td>
<td>UNIDO</td>
</tr>
<tr>
<td>5.</td>
<td>Project Appraisal and Planning in Developing Countries</td>
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<td>IMD little and J.A. Mirrlees:</td>
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</table>
**Course Code**  
BIO 804

**Course Title**  
Modeling and Simulation of Bioprocesses (Theory)

**Type of Course**  
Core

**L T P**  
4 0 0

**Credits**  
4

**Course Assessment Methods**

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<th>End Semester Assessment (University Exam.)</th>
<th>Continuous Assessment (Sessional)</th>
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**Course Prerequisites**  
Introductory Bioprocess Engineering and Mathematical Calculation.

**Course Objectives**

1. To introduce the Basic concepts about kinetic models.
2. To understand the Mathematical representation of bioprocess.
3. To understand the Development of compartment and metabolic pathway models.
4. To introduce the Dynamic simulation of batch, fed-batch, CSTR and transient culture metabolism.
5. To introduce the Numerical optimization.

**Course Outcome**

1. Learn about basic concepts of Kinetic Models.
2. Learn about bioprocess design in a various systems solve model equation.
3. To learn the dynamic simulation of metabolic pathway models.
4. To study the mathematical modeling of batch, Continuous & Fed-Batch Reactors.
5. To learn about the Numerical integration techniques for model validation.

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**SYLLABUS**

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**SECTION-A**

Types of kinetic models. Data smoothing and analysis.
Mathematical representation of bioprocess; parameter estimation; numerical integration techniques; parameter sensitivity analysis; statistical validity.

Discrimination between two models. Physiological state markers and its use in the formulation of a structured model.

SECTION-B

Development of compartment and metabolic pathway models for intracellular state estimation.

Dynamic simulation of batch, fed-batch steady and transient culture metabolism; Numerical optimization of Bioprocesses using Mathematical models.

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<tbody>
<tr>
<td>1</td>
<td>Chemical Engineering Dynamics: Modeling with PC Simulation</td>
<td>John Ingham, Irving J. Dunn, Elmar Heinzle &amp; J.E. Prenosil</td>
<td>Wiley-VCH</td>
</tr>
<tr>
<td>2</td>
<td>Biological Reaction Engineering: Dynamic Modeling Fundamentals with Simulation Examples</td>
<td>Dr. Irving J. Dunn</td>
<td>Wiley-VCH</td>
</tr>
<tr>
<td>4</td>
<td>Bioprocess Engineering Principles”</td>
<td>Pauline Doran</td>
<td>Academic Press</td>
</tr>
</tbody>
</table>
Course Code: BIO 854  
Course Title: Modeling and Simulation of Bioprocesses  
Type of Course: Practical  
Credits: 2  
L T P: 0 0 3  

Course Assessment Methods:  
End Semester Assessment (University Exam.): 00  
Continuous Assessment (Sessional): 50  

Course Prerequisites: Modeling and Simulation of Bioprocesses (Theory)  

Course Objectives: To demonstrate and validate the theoretical concepts.  

Course Outcome: The students shall be able to use computers for solving the differential models developed for the defined systems.  

SYLLABUS  
List of Experiments:  

Exercises are conducted in the computational lab using C/C++ language illustrating the simulation of lumped parameter system models.
Course Code          BIO 805
Course Title         Nanobiotechnology
Type of Course       Elective
L T P                4 0 0
Credits              4
Course Assessment Methods
End Semester Assessment (University Exam.)  50
Continuous Assessment (Sessional)          50
Course Prerequisites  Basic concept in biotechnology, physics, basic electrical engineering.
Course Objectives    1. The course aims at providing the understanding of basic concepts of nanobiotechnology, interface between biology and nanotechnology and its applications.
Course Outcome       1. Students learn about the recent advances in the field of nanobiotechnology.
                      2. The students gain insight in the integration of scientific disciplines for approaching the nanoscale dimensions and its application in healthcare and medicine

SYLLABUS

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SECTION-A

Cell nanostructure interactions: Surface patterning to control the adhesion of cells using nanoscale topography and chemical modifications.


Tissue engineering: Significance, Methodology, Tissue engineering scaffolds-composition, properties, fabrication, cell seeding and proliferation.

Nanomembranes: Freely suspended nanomembranes.
SECTION-B


Molecular motors: Surface patterning and the control of motility of the actin/myosin motor system.

Engineered nanopores: Classes of nanopores, engineering techniques, potential applications of nanopores.

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<tbody>
<tr>
<td>1</td>
<td>Nanobiotechnology: Concepts, Applications and Perspectives,</td>
<td>Christof M. Niemeyer, Chad A. Mirkin(Eds)</td>
<td>Wiley-VCH</td>
</tr>
<tr>
<td>2</td>
<td>Bionanotechnology: Lessons from Nature</td>
<td>David S. Goodsell</td>
<td>Wiley Liss</td>
</tr>
<tr>
<td>3</td>
<td>Nanobiotechnology II: More Concepts and Applications</td>
<td>Chad A. Mirkin, Christof M. Niemeyer(Eds)</td>
<td>Wiley-VCH</td>
</tr>
<tr>
<td>4</td>
<td>Handbook of Nanotechnology</td>
<td>Bharat Bhushan(Ed)</td>
<td>Springer Verlag</td>
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</table>
Course Code: BIO 805

Course Title: Microbial Biodiversity

Type of Course: Elective

L T P: 4 0 0

Credits: 4

Course Assessment Methods:
- End Semester Assessment (University Exam.): 50
- Continuous Assessment (Sessional): 50

Course Prerequisites: Basic concept in bioinformatics and microbiology.

Course Objectives:
1. The course aims at introducing students to the diverse microbial communities and their interactions with the environment.

Course Outcome:
1. Students learn about the diversity of various microbial populations
2. Students learn different techniques for analyzing microbial diversities and understanding their impact on the environment.

SYLLABUS

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SECTION-A

Microbial biodiversity: definition and introduction, evolution and diversity of microorganisms. (7)
Physiological and metabolic diversity of microorganisms. (7)
Microbial diversity of major ecosystems. (8)

SECTION-B

Biodiversity & role of microorganisms in plants and animal symbiosis. (8)
Microbial diversity in extreme environments. (9)
Microbial biodiversity, biotechnology and future biodiversity. (6)
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<tbody>
<tr>
<td>1</td>
<td>Biology Brought to Life (Student Version)</td>
<td>Jo Handelsman</td>
<td>McGraw-Hill, 2002</td>
</tr>
<tr>
<td>3</td>
<td>Microbial Diversity and Bioprospecting</td>
<td>Alan T. Bull</td>
<td>American Society Microbiology, 2003</td>
</tr>
</tbody>
</table>