B. E. SYLLABUS

BIOTECHNOLOGY

VII& VIII SEMESTER

With

Scheme of Teaching

& Examination

DEPARTMENT: BIOTECHNOLOGY ENGINEERING

1	Dr. C. VamanRao	M.Sc., Ph.D.	Prof. & Head
2	Dr. Ujwal P.	M.Sc., Ph.D.	Professor
3	Dr. Vidya S.M.	M.Sc., Ph.D.	Professor
4	Dr. Shyama Prasad S.	M.Sc., Ph.D.	Assoc. Prof.
5	Dr. D.M. Chetan	M.Sc., Ph.D.	Assoc. Prof.
6	Dr. Anil Kumar H.S.	M.Sc., Ph.D.	Assoc. Prof.
7	Dr. Bharath B.R.	M.Sc., Ph.D.	Asst. Prof. Gd III
8	Mr. VenkateshKamath H.	M.Tech., (Ph.D.)	Asst. Prof. Gd II
9	Mr. Vinayaka B. Shet	M.Tech., (Ph.D.)	Asst. Prof. Gd II
10	Mr. Sandesh K.	M.Tech., (Ph.D.)	Asst. Prof. Gd II
11	Ms. SnehaNayak	M.Tech., (Ph.D.)	Asst. Prof. Gd I
12	Ms. Louella C. Goveas	M.Tech., (Ph.D.)	Asst. Prof. Gd I
13	Ms. Harshitha M. Jathanna	M.Tech., (Ph.D.)	Asst. Prof. Gd I

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING

Vision :

To accomplish excellence in Biotechnology research and creating manpower for the benefit of society and human kind with an emphasis on present and future global needs.

Mission :

To empower the students of Department of Biotechnology Engineering in to

1. Competent professionals to undertake projects by providing academic training and technical achievements,
2. A successful professionals in research, academia and industry,
3. An engineer for effective utilization of natural resources in biotechnology related industries.

Program Educational Objectives (PEOs):

The program educational objectives are set in line with Institutional and Departmental mission statements. The program educational objectives of B.E. Biotechnology are to produce professionals who later take the role of engineering professionals and researchers with following qualities:

PEO1. Apply fundamental knowledge of mathematics, principles of physics and chemistry, and biological sciences for the engineering applications.

PEO2. Demonstrate the application of biotechnological processes and engineering principles through designing of industrial biochemical processes that are of societal and industrial importance.

PEO3. Exhibit skills of handling microbial processes, biochemical analysis by making use of state of the art instruments.

PEO4. Exhibit strong, independent learning, analytical and problem solving skills with special emphasis on design, communication, and an ability to work in teams.

PEO5. To have successful career as engineering professional or a researcher through lifelong learning in the field of biotechnology.

Graduate Attributes (GA):

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

GA-1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

GA-2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

GA-3. Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

GA-4. Conduct investigations of complex problems: Use researchbased knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

GA-5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

GA-6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

GA-7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

GA-8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

GA-9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

GA-10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

GA-11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

GA-12. Lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Outcomes (POs):

In addition to PEOs, the B.E. Biotechnology program established a set of Program Outcomes (POs), expected to be met by every graduating student from the program at the time of graduation. Program outcomes listed below embrace the required outcomes as listed in Graduate Attributes (GAs) of National Board of Accreditation (NBA), India.

The graduates of B.E. Biotechnology will have ability to:

PO a. Apply knowledge of mathematics, physics, chemistry and biological science and engineering to analyze bioprocesses and related systems.

PO b. Identify and formulate and solve bioprocess engineering problems.

PO c. Design bioprocess systems involving unit operations, reacting systems, reactors and product purification systems.

PO d. Design and conduct experiments, as well as to analyze and interpret data.

PO e. An ability to function on multidisciplinary teams.

PO f. Understand professional and ethical responsibility.

PO g. Communicate effectively, work independently, and practice leadership and teamwork.
PO h. Use the techniques, skills, and modern engineering tools necessary for engineering practice.
PO i. Design system, components or processes to meet realistic needs of society, environment, health and safety, and sustainability.
PO j. Recognize the need for, and an ability to engage in lifelong learning.
PO k. Acquire knowledge of contemporary issues.

Program Specific Outcomes (PSOs):

Program Specific Outcomes for B.E. programme in Biotechnology set by Faculty in Biotechnology Engineering are as follows:
PSO 1. Demonstrate proficiency in basic science and foundation engineering courses.
PSO 2. Demonstrate a working knowledge of advanced biological sciences.
PSO 3. Demonstrate competence in application of engineering principles to biological systems.

The following tables provide mapping of statements and outcomes.

Table 1: Mapping of Mission statements with Program Educational Objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
Institution*: To develop NMAM Institute of Technology, Nitte as a Center of Excellence by imparting Quality Education to generate Competent, Skilled, and Humane Manpower to face emerging Scientific, Technological, Managerial and Social Challenges with Credibility, Integrity, Ethics and Social Concern.*	**M**	**H**	**M**	**H**	**H**
Department*: To empower the students of Department of Biotechnology Engineering in to* *1. Competent professionals to undertake projects by providing academic training and technical achievements.*	**M**	**H**	**H**	**H**	**M**
2. A successful professionals in research, academia and industry	**H**	**H**	**M**	**H**	**M**
3. An engineer for effective utilization of natural resources in biotechnology related industries.	**M**	**H**	**H**	**M**	**M**

* L = Low, M= Moderate, H= High

Table 2: Mapping of Program Outcomes with Program Educational Objectives (PO/PSO vs PEO)

PO/PSO / PEO	POa	POb	POc	POd	POe	POf	POg	POh	POi	POj	POk	PSO1	PSO2	PSO3
PEO1	**H**	**M**	**L**	**L**					**L**			**L**	**M**	**M**
PEO2		**M**	**H**	**H**	**L**		**M**	**L**	**H**			**H**	**H**	**H**
PEO3	**M**	**M**		**H**		**M**	**L**	**H**		**M**	**L**	**M**	**M**	**L**
PEO4		**H**	**H**	**H**	**M**	**L**	**M**		**H**		**L**	**H**	**L**	**M**
PEO5	**L**	**L**		**M**		**M**	**L**	**M**		**H**	**H**	**M**	**H**	**M**

Table 3: Mapping of program outcomes with Graduate Attributes (PO/PSO vs PO)

PO/PSO / GA	POa	POb	POc	POd	POe	POf	POg	POh	POi	POj	POk	PSO1	PSO2	PSO3
GA1	**H**											**H**	**H**	**H**
GA2		**H**									**M**	**H**	**H**	**H**
GA3			**H**									**M**		**H**
GA4				**H**	**M**							**H**	**M**	**M**
GA5					**M**			**M**				**M**	**H**	
GA6									**H**				**M**	**M**
GA7								**H**	**H**		**M**		**M**	**M**
GA8						**H**						**H**	**H**	**H**
GA9					**H**		**H**					**L**	**M**	**M**
GA10							**H**		**M**			**M**	**M**	
GA11												**H**		
GA12										**H**	**M**	**L**	**H**	**L**

CURRICULAR COMPONENTS

Degree Requirements for B. E. in Biotechnology

Category of courses	Category code	Credits offered	Min. credits to earn
Basic Science Core	BSC	28	28
Engineering Science Core	ESC	27	27
Humanities & Social Sciences Core	HSC	5	5
Professional Core Courses	PCC	106	106
Professional Elective Courses	PEC	21	21
Open Elective Courses	OEC	3	3
Programme Major Project	PMP	12	12
Add on courses/Audit Courses	AOC	0	0 (Optional for student)
Mandatory Learning Courses	MLC	0	Student should secure PP grade to graduate
Total		200	200

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VII Semester **30Hrs/Week**

Sl. No.	Code	Course Title	Theory/Tuto./ Prac./ Self study	Total Hrs. / Week	CIE	SEE	Credits
1	13BT701	Immunology	4+0+0+S	4	50	50	4
2	13BT702	Bioethics, Biosafety & IPR	4+0+0+S	4	50	50	4
4	13BT703	Plant Design & Economics	4+0+0+0	4	50	50	4
5	13BT71X	Elective - IV	3+0+0+0	3	50	50	3
6	13BT72Y	Elective - V	3+0+0+0	3	50	50	3
7	13BT704	Seminar	0+0+3+0	3	50	50	2
8	13BT705	Analytical Techniques & Molecular Biology Lab	0+0+3+0	3	50	50	2
9	13BT706	Immunology Lab	0+0+3+0	3	50	50	2
10	13BT707	Project – Phase I	0+0+3+0	3	50		2
TOTAL			**30**	**30**	**500**	**450**	**26**

Elective - IV 13BT71X		**Elective - V 13BT72Y**	
13BT711	Forensic Science & Technology	13BT721	Environmental Biotechnology
13BT712	Transport Phenomena in Biological Systems	13BT723	Phytochemistry
13BT713	Research Methodology	13BT724	Waste Water Treatment
13BT715	Biofuels Engineering	13BT725	Solid & Hazardous Waste Management

DEPARTMENT OF BIOTECHNOLOGY ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VIII Semester **28 Hrs/Week**

Sl. No.	Code	Course Title	Theory/Tuto./ Prac./ Self study	Total Hrs. / Week	CIE	SEE	Credits
1	13BT801	Industrial Management & Entrepreneurship	4+0+0+S	4	50	50	4
2	13BT81X	Elective - VI	3+0+0+0	3	50	50	3
3	13BT82Y	Elective - VII	3+0+0+0	3	50	50	3
4	13BT8X	Open Elective	3+0+0+0	3	50	50	3
5	13BT802	Project Phase - II	0+0+15+0	15	100	100	10
TOTAL			**28**	**28**	**300**	**300**	**23**

Elective - VI 13BT81X		**Elective -VII 13BT82X**	
13BT811	Biology of Stem cells	13BT821	Biopharmaceuticals
13BT812	Protein Engineering	13BT822	Modeling and Simulation in Biosystems
13BT813	Cancer Biology	13BT823	Pharmaceutical Chemistry
13BT814	Nanobiotechnolgy	13BT824	Genetically Modified Organisms

IMMUNOLOGY

Sub Code : 13BT701 **Credits : 04**
Hrs/Week : 4+0+0+S * **Total Hours : 52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Nil

***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn various aspects of human immune system, its types, functioning and its response to foreign materials.
2. To understand principles behind inmmunodiagnostic techniques.
3. To study immune system related topics such transplantation and immunological disorders.

UNIT - I

IMMUNODIAGNOSTIC TECHNIQUES

Antigen antibody interactions: Nature of interaction, antibody affinity, forces that govern the interaction of particulate and soluble antigens. Precipitin reactionsDoubleimmunodiffusion, radial immunodiffusion, counter current immunoelectrophoresis, immunoelectrophoresis, rocket immunoelectrophoresis, Agglutination reactions (Active and Passive agglutinations) Radioimmunoassay (RIA) and ELISAPrinciples and applications, Nonisotopic methods of immunodetections: Immunofluorescence and immunocytochemistry, immunoelectron microscopy (ferritin technique), chemilumenescence (immunoenzymatic)chemiluminescentimmunoassay, enzyme multiplied immunoassay, fluorescence polarization immunoassay. **7 Hours**

UNIT -II

THE IMMUNE SYSTEM

Introduction, Innate and Adaptive immune response, Cells of the Immune system: Monocytes, Lymphocytes, NK cells, Neutrophils, Eosinophils and Basophils, Antigen presenting cells: Macrophage, Langerhan's cells, Dendritic cells, B lymphocytes, Organs of the immune system (Structure and function): Thymus, spleen, MALT, Peyers patch, Bursa fabricius, lymph nodes, tonsils and appendix. Artificial immunity: Vaccines: Conventional, whole organisms, recombinant vaccines, subunit vaccines, DNA vaccines, Antigens: Characteristics of antigens and haptens, adjuvants, Major histocompatibility complex and HLA antigens: Structure of class I and II MHC molecule, Peptide interaction with class I and class II MHC molecules and their role in immune response. Complements and their biological functions: Classical, alternate and lectin pathways, Biological consequences of complement activation . **15 Hours**

UNIT - III

IMMUNE RESPONSE

Humoral Immunity: Types of immunoglobulins and their physiological role, Fine structure of antibody, isotypes, allotypes and idiotypes, B lymphocytes, Bcell receptors, Bcellcoreceptors, B Cell maturation, B cell activation and differentiation, Genetic control of antibody production and organization of antibody genes, Mechanism of rearrangements in antibody

genes, Allelic exclusion and generation of antibody diversity, Class switching mechanism and expression of immunoglobulin genes.

*CellMediated Immunity***:** Antigen processing and presentation: Endocytic and cytosolic pathways, Tcells: characteristics, ontogeny,α, β and $\gamma\delta$ T cells, Tcell receptor (TCR), Tcell maturation, Tcell activation, costimulatory signals, clonal expansion and clonal anergy, Cytotoxic Tcells, activation and destruction of target cells, Clonal selection theory.

15 Hours

*Self Study Component***:** Cytokines and their role in immune response: Classification, chemical nature and functions of IL2, IL4, IL5, IL6, IFN–α, β and γ, TNFα, TGFβ.

UNIT – IV

DISEASES AND DISORDERS OF IMMUNE SYSTEM

Hyper sensitivity: Type I, II, III, IV and V, Allergic reaction, Macrophage activation and granuloma formation (ex. Tuberculosis, pathogens and nematodes); Autoimmune disorders: Autoantibodies in humans, pathogenic mechanisms (HLA and autoimmune diseases), experimental models of autoimmune diseases, Treatment of autoimmune diseases, AIDSSecondary autoimmune disease: immunological disorders associated with AIDS

8 Hours

UNIT – V

TRANSPLANTATION AND TUMOR IMMUNOLOGY

Types of grafts, immunological basis of graft rejection, Role of CMI in graft rejection. Transplantation antigenMHC class I, Prevention of graft rejection: Immunosuppressive drugs and immunosuppression, Immune tolerance, Stem cells and their applications in transplantation, Mechanism of immunity to tumors: Brief account on tumor antigens and their classification, Immune surveillance and immunological response to tumors, Mechanism of immune evasion by tumors, Immune therapy of cancer. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Judge and apply various immunological diagnostic techniques.
2. Classify the immune system and its components, immune response to external stimulus and types of defense mechanisms.
3. Differentiate between cell mediated immune response and humoral or proteins involved in defense.
4. Integrate cellular and humoral immunity, and highlight the importance of T cellmediated immune response for long term immune memory.
5. Explain immunological disorders, tumour immunology, immune therapy for cancer and immune response to transplantation.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M			L						L			M	
CO2	M												M	
CO3	M												M	
CO4	M												M	
CO5	M									M			M	

PO = Programme Outcome; CO = Course Outcome; PSO = Programme Specific Outcome
Mapping codes: L = Low, M= Mid, H= High

TEXT BOOK

1. Gangal, S. and Sontakke, S. Text book of basic and clinical immunology, University Press, 2013.

REFERENCE BOOKS

1. Roitt, I. M. *Essentials of Immunology*, 10th Ed., Blackwell Scientific Publications, 2001.
2. Kuby, J. *Immunology*, 4th Ed., W. H. Freeman, 2000.
3. Stanley, J. *Essentials of immunology and serology*, Thomson Publication, 2002.
4. Tizzard, I. R. *Immunology –An introduction*, Thomson Publication, 1994.

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BIOETHICS, BIOSAFETY & IPR

Sub Code : 13BT702 **Credits : 04**
Hrs/Week : 4+0+0+S* **Total Hours:52**

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

***Prerequisites*:** Nil

***Corequisites*:** Nil

Course Learning Objectives :

The objective of this course is

1. To understand ethical concerns about patenting of living organisms and genetic material.
2. To learn the effects of international trade, future economic systems and the ethical and social impact of Biotechnology.

UNIT – I

BIOTECHNOLOGY, SOCIETY AND LEGAL ISSUES

Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, Biotechnology and Biological knowledge in developing countries, Biotechnology and hunger: The legal and socioeconomic impacts of biotechnology, public awareness in genetic engineering – with case studies.

8 Hours

UNIT – II

ETHICAL ISSUES IN BIOTECHNOLOGY

Perception of ethical biotechnology, Bioethics, Autonomy, Rights, Beneficence; Interface of bioethics and law, Bioethics committee, Ethical issues in Livestock cloning, altering the human germline, ethical conflicts in biotechnology interference with nature, ethical issues of regenerative medicine, Ethics and Environmental Impact.

10Hours

UNIT – III

BIOSAFETY CONCEPTS AND ISSUES

Relationship between risk, hazard, exposure and safeguards, Risk AnalysisRisk Assessment; Risk management and communication.Assessment of biological hazards, levels of biosafety and risk groups, biosafety practices in the laboratory/institution/industry. Good manufacturing practice and Good laboratory practices (GMP and GLP). The Cartagena protocol on biosafety. Safety assessment of foods and food ingredients produced by genetically modified microorganisms. Social and ethical implications of biological weapons.

12 Hours

UNIT - IV

IPR AND REGULATIONS

Intellectual property rights (IPR) Copyright, Trade mark, Trade secret, Industrial design, Geographical indications. Traditional knowledge and IPR; Plant breeder's rights; GATT & TRIPS Agreement. Biosafety regulations national and international guidelines with regard to rDNA technology etc. **11 Hours**

UNIT - V

PATENT

Introduction to Patents Types of patent applications: Ordinary, PCT, Conventional.

Patent filing procedures National& PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/nondisclosure; Patent databases, Licensing. Case studies of biotechnological products.**11 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Relate the science, technology and society.
2. Define bioethics in the context of modern biotechnology.
3. Relate and practice the safety procedures in laboratory and assess the risk.
4. Explain the legal constraints related to IPR protection and transfer.
5. Illustrate the procedures related to patents.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L													
CO2	L					H				M			M	
CO3	L					M				L			M	M
CO4	L					L					L			M

CO5	L									L				M

REFERENCE BOOKS:

1. Krishna V. S. *Bioethics and Biosafety in Biotechnology*, New Age International Publishers, 2007.
2. Sateesh, M. K., *Bioethics and Biosafety*, I. K. International Publishers, 2010.
3. Thomas, J.A., Fuch, R.L. *Biotechnology and Safety Assessment* 3rd Ed., Academic Press, 1998.
4. Fleming, D.A. Hunt, D.L., *Biological safety Principles and practices*, 3rd Ed., ASM Press, Washington, 2000.
5. Sassoon A. *Biotechnologies and development*, UNESCO Publications, 1988.
6. Singh K. *Intellectual Property Rights on Biotechnology*, BCIL, New Delhi, 1998.
7. Rao, M. B. *WTO and International Trade*, Vikas Publishing House Pvt. Ltd., 2010.
8. Erbisch. F. H. and Maredia K. M. *Intellectual Property Rights in Agricultural Biotechnology*, Orient Longman Ltd., 1994.
9. Cartagena Protocol on Biosafety, January 2000.
10. Thompson, P. B. *Food Biotechnology in the Ethical prospective*, 2nd Ed., Springer, 2007.

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PLANT DESIGN & ECONOMICS

Sub Code : 13BT703 **Credits : 04**
Hrs/Week : 4+0+0+0 **Total Hours:52**

***Prerequisites*:** Nil

***Corequisites*:** Nil

Course Learning Objectives :

The objective of this course is

1. To learn the process design and development, general design consideration for a plant operation.
2. To understand the economic aspects in setting up production plant.

UNIT – I

GENERAL DESIGN CONSIDERATIONS

Introduction, Plant location, Plant layout, Plant operation and control, Patent considerations, Health and Safety hazards, loss prevention, Environmental Protection, Case study on general design consideration. **11 Hours**

UNIT – II

PROCESS DESIGN DEVELOPMENT

Development of design database, Process creation, Process design, Process flow diagrams, Piping and instrumentation diagrams, Vessel and piping layout isometrics, Equipment design and specification. **9 Hours**

UNIT – III

ANALYSIS OF COST ESTIMATION

Cash flow for industrial operations, Factors affecting investment and production cost, Capital investment, Estimation of capital investment, Cost components in capital investment, Methods for estimating capital investment, Estimation of revenue, Estimation of total product cost, Numericals. **12 Hours**

UNIT – IV

DEPRECIATION TAXES AND INSURANCE

Meaning of value, purpose of depreciation as a cost, types of depreciation, service life, salvage value, present value, Methods for determining depreciation (Straight line method, declining balance method, sum of the years digits, sinking fund method). Types of taxes.Insurance (types of insurance), Self insurance.Numericals.**10 Hours**

UNIT - V

PROFITABILITY AND DESIGN REPORT

Methods for the evaluation of profitability, Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Replacement and alternative Investments.Numericals. Design reports: written reports and oral reports.

10 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the concept of process design development and understand the design considerations for setting up of a bioprocess plant.
2. Summarize the importance of process design and specification and compare the process designs.
3. Estimate required capital investment utilizing the methods of cost estimation.
4. Utilize the concepts of depreciation and taxes.
5. Assess the methods to calculate profitability and build project reports.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M						L							M
CO2			L											M
CO3	L				L					L		L		L
CO4	L				L					L		L		L
CO5	L				L		L			L				M

TEXT BOOKS:

1. Peters, M. S. and Timmerhaus, K. D. "*Plant Design And Economics For Chemical Engineers"* 4th Ed., McGraw Hill International Edition, 1989.
2. Peters, M. S., Timmerhaus, K. D. and West, R. E. "*Plant Design and Economics for Chemical Engineers"*, 5th Ed., McGraw Hill Education (India) Private Limited, New Delhi, 2011.

REFERENCE BOOK:

1. Vogel, H. C. and Todaro, C. L. "*Fermentation and biochemical Engineering Handbook – principles, process design and equipment*", 2nd Ed., Standard publishers distributors, 2005.

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FORENSIC SCIENCE & TECHNOLOGY

Sub Code : 13BT711 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**
***Prerequisites*:** Nil

***Corequisites*:** Nil

Course Learning Objectives :

The objective of this course is

1. To learn the science of forensic analysis, techniques.
2. To understand the theories of biotechnology those are helpful in the analysis procedure.

UNIT - I

INTRODUCTION

Definition and Scope, History and Development of Forensic science, Legal procedures and use of court. Services of the crime laboratory: Basic services and Optional services provided by full service crime laboratories, Functions and duties of forensic scientist **6 Hours**

UNIT - II

FORENSIC ANALYSIS & BIOLOGY

Analysis of Physical evidence: Common types of physical evidences, Collection and preservation, Analysis of common evidences. Forensic Pathology: Rigor mortis, Livor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Forensic Engineering, DNA Analysis, Dactyloscopy or Fingerprints: Classification and patterns. **8 Hours**

UNIT - III

COMPUTER AND DIGITAL FORENSIC

Introduction, Processing the electronic crime scene: Forensic image acquisition, Analysis of electronic data, Evidentiary data. Digital cameras and forensic imaging, Uses of digital imaging, Maintaining chain of control with digital images, digital videos, scanned images, presenting pictures in courtroom, Detecting compression and forgeries and Maintaining Records. **9 Hours**

UNIT - IV

APPLIED FORENSIC STATISTICS

Weight of evidence and the Bayesian likelihood ratio, Transfer evidence: Basic concepts in transfer of evidence interpretation, Match Frequencies, Correspondence Frequencies, The Bayesian method for simple and complex cases. Application of statistics to particular areas of forensic science: Evidence from blood, DNA fingerprinting, Probability of paternity.

8 Hours

UNIT - V

ETHICS IN FORENSIC SCIENCE

The importance of professional ethics to science practitioners, Development of a code of conduct and code of ethics for forensic science, Application of codes and ethics, How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution.Ethical issues involving professional practice, Ethical issues involving technical competence. **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Describe the basic procedures in crime investigation.
2. Outline the significance of forensic biotechnology and apply concepts for forensic analysis.
3. Make Use of computer and digital tools for the maintenance and assessment of forensic data.
4. Apply statistical analysis and its significance in the investigation of the forensic data.
5. Justify the importance of ethical code and conducts in forensic analysis.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L				M								L	
CO2	M				M						L	L	M	
CO3	L							M					M	
CO4	M				M							L	M	
CO5	L					M				L			L	

TEXT BOOKS:

1. Sapherstein, R. *Criminalistics: An Introduction to Forensic Science*, 9th Ed., Prentice Hall, 2007.
2. Eckert, W. *Introduction to forensic Sciences*, 2nd Ed., CRC Press, 1992.

REFERENCE BOOKS:

1. DeForest, P. R., Gaensslen, R. E. and Lee, H. C. *Forensic Sciences: An Introduction to Criminalistics*, McGraw Hill Inc., 1983.
2. Aitkin, G. G. G. and Stoney, D. A. *The use of Statistics in Forensic Science*, Taylor & Francis e Library, 1991.
3. The Evaluation of forensic DNA Evidence. Committee on DNA Forensic Science: An update, National Research Council. The National Academies, USA, 1996.
4. Byrd, J. H. and Castner, J. L. (Ed.), *Forensic Entomology: The utility of Arthropods in Legal Investigations*. CRC Press, 2001.
5. Barnett, P. D. *Ethics in forensic Science: Professional Standards for the Practice of Criminalistics*, CRC Press, 2001.
6. Pickering, R. B. and Bachman, D. C. *The Use of Forensic Anthropology*, CRC Press, 1997.
7. Kipper, G. *Wireless Crime and Forensic Investigation*, Auerbach Publications, 2007.

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TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS

Sub Code : 13BT712 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

***Prerequisites*:** Momentum Transfer, Heat & Mass Transfer
***Corequisites*:** Nil

Course Learning Objectives :

The objective of this course is
1. To study balance equations of mass, energy and momentum.
2. To learn use of balance equations through simple examples.
3. To learn how mass, momentum, and heat transport equations can be used for biological systems.

UNIT - I

INTRODUCTION

Transport processes: Transport Processes; Levels of analysis: Molecular, micro and macroscopic, continuum and shell balance; Dimensions of analysis – 1D Cartesian, cylindrical and spherical coordinates.

Molecular transport equations: Molecular momentum transport (Newton's law of viscosity), molecular energy transport (Fourier's law of heat conduction) and molecular mass transport (Fick's I Law).

Transport properties: Momentum, heat and mass diffusivities, theories of molecular diffusivities.

Equations of change in continuum (Cartesian coordinates, No derivation): Equation of continuity, equation of motion (in terms of τ and velocity), equation of energy, Newtonian and nonNewtonian fluids, their constitutive equations. **8 Hours**

UNIT - II

MOMENTUM TRANSPORT

Shell momentum balance and velocity distribution in laminar flow: flow through circular tube. Equation of change for isothermal system: Equation of motion Euler equation, Bernoulli equation. Viscometers.

Frictional flow: Friction factors, flow in packed column. **7 Hours**

UNIT - III

ENERGY TRANSPORT

Steady state heat conduction: Slab (single and multi layer), cylinder (with and with out heat generation), extended surfaces; Transient heat transfer, Biot number.

Convective heat transfer: Heat transfer coefficient, dimensionless numbers in heat transfer. Heat transfer in bioreactors. **7 Hours**

UNIT -IV

MASS TRANSPORT

Mass and molar fluxes; Modes of mass transfer: Molecular, capillary, convective, diffusive and advective mass transfer; Shell mass balance: flux equation for steady state convection; boundary conditions.

Steady state mass diffusion in a slab; composite slab and over all mass transfer coefficient; diffusion in slab with reaction; mass transport in bioreactors. **8 Hours**

UNIT - V

BIOLOGICAL APPLICATIONS

Application of transport phenomena to the following cases from biological science: Physical and flow properties of blood (Marginal zone theory); Bioheat transfer: Furs and Fins, thermoregulation; Food sterilization; Freezing of biomaterials; Dialysis; Oxygen metabolism (uptake) of spherical bacterial aggregate; drug transport and pharmacokinetics.

9 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Explain the different modes of fluid flow, energy and mass transfer and relate them.
2. Develop the different transport equations and equations of change for fluid flow and apply it to simple systems.
3. Apply the concepts of energy transport to develop temperature profiles and analyze them.
4. Build the transport equations for the processes involving mass transport.
5. Use transport equations and evaluate them for the biological processes.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		M												M
CO2		H	L											M
CO3		H	L											M
CO4		H	L											M
CO5		M												M

TEXT BOOKS:

1. Bird, R. B., Stewart, W. E. and Lightfoot, E. W. *Transport Phenomena*, JohnWileys, 1960.
2. Datta, A. K. *Biological and Bioenvironmental Heat and Mass Transfer*, Marcel Dekker, 2002.
3. Johnson, A. T. *Biological Process Engineering, An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems*, 1st Ed., WileyInterscience, 1998.

REFERENCE BOOKS:

1. Fournier, R. *Basic Transport Phenomena in Biomedical Engineering*, 2nd Ed., Taylor and Francis, 2011.
2. Kandlikar, S. G., Garimella, Li, S. D. Colin, S and King, M. R. *Heat Transfer and Fluid Flow in Minichannels and Microchannels*, Elsevier 2006.
3. Brodkey, R. S. and Hershey, H. C. *Transport Phenomena A unified approach*, MGH, 1988.
4. Geankoplis, C. J. *Transport Processes and Separation Process Principles (Includes Unit Operations)*, 4th Ed., PHI, 2004.
5. McCabe, W. L., Smith, J. C. and Harriott, P. *Unit Operations of Chemical Engineering*, 7th Ed., MGH, 2010.

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RESEARCH METHODOLOGY

Sub Code : 13BT713 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours:39**
***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives :

The objective of this course is
1. To equip students with a basic understanding of the underlying principles of research.
2. To introduce students to the key data generation methods.
3. To enable students to chose the most appropriate research method to address a particular research question.
4. To enable students to gain a basic overview of a range of quantitative and qualitative approaches to analysis.
5. To provide students with the knowledge and skill to undertake the design of a research proposal.

UNIT –I

INTRODUCTION: Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, and Research Methods versus Methodology. Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Research Ethics Plagiarism, self plagiarism.
DEFINING THE RESEARCH PROBLEM: Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.
RESEARCH DESIGN: Meaning of Research Design, Need for Research Design, Features for Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Design. **7 Hours**

UNIT – II

MEASUREMENT AND SCALING TECHNIQUES: Measurement in Research, Measurement Scales, Sources of Error in Measurement.
METHODS OF DATA COLLECTION: Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some other Methods for Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection.
PROCESSING AND ANALYSIS OF DATA: Processing Operations, Some problems in Processing, Elements/Types of Analysis, Statistics in Research, Measures of Central

Tendency, Measures of Dispersion, Simple Regression Analysis, Multiple Correlation and Regression. **7 Hours**

UNIT – III

TESTING OF HYPOTHESES (PARAMETRIC OR STANDARD TESTS OF HYPOTHESES

Basic Concepts Concerning Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses, Hypothesis Testing of Means, Hypothesis Testing for Difference between Means, Limitations of the Tests of Hypotheses.

CHISQUARE TESTS: Chisquare as a Test for Comparing Variance, Conditions for the Application of X^2 Test, Steps Involved in Applying Chisquare test, Caution in Using X^2 Test.

ANALYSIS OF VARIANCE AND COVARIANCE: The Basic Principle of ANOVA, ANOVA technique, Setting up Analysis of Variance Table. **9 Hours**

UNIT - IV

DESIGN OF EXPERIMENTS

Classical One variable method. Two factorial design, Placket Burman design, Taguchi design, Response surface methodology: Experiment design, Mathematical analysis (Model building, Coefficients, ANOVA, regression coefficient, Std. error), analysis of results, analysis of plots. **8**

HoursUNIT – V

INTERPRETATION AND REPORT WRITING

Meaning of Interpretation, necessity of interpretation and its requirements, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. Selection of journal paper, Journal paper writing, impact factor of journal and reference styles.

THE COMPUTER IT'S ROLE IN RESEARCH: Softwares used for research –Analysis (MS Excel, Open office, Statistical softwares – freeware, Optimization softwares, Plotting softwares), Presentation (LaTeX, MS Power point, Open office, Other free wares for diagrams and flow charts). **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Define a research problem and design methods of carrying out research work.
2. Demonstrate the use of computer and softwares in data analysis
3. Measure and collect the experimental data.
4. Perform statistical design of experiments, process and analyze the outcomes of experiment using appropriate mathematical tools.
5. Formulate and develop skills of scientific writing.

Mapping of POs & COs:

PO	a	b	c	d	e	f	g	h	i	j	k	PSO

CO												1	2	3
CO1	L	M								L	M	M		
CO2	L							H		L		L		
CO3	L									L		L		
CO4	H			L						L		H	L	
CO5	L									L	M	M		

TEXT BOOKS:

1. Kothari C.K., *Research Methodology Methods and Techniques*, 2nd Ed., New Age International, New Delhi, 2004.

REFERENCE BOOKS

1. Montgomery, D. C. *Design and Analysis of Experiments*, 5th Ed., Wiley India, 2007.
2. Montgomery, D. C. and George C. R. *Applied Statistics & Probability for Engineers*, 3rd Ed., Wiley India, 2007.
3. Krishnaswamy, K.N., Sivakumar, A. I. and Mathiranjan, M. *Management Resarach Methodology; Integration of Principles, Methods and Techniques*, Pearson Education, New Delhi, 2006.
4. VTU Web portal – LaTex tutorial (http//www.research.vtu.ac.in)

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BIOFUELS ENGINEERING

Sub Code : 13BT715 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**
***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn the fundamental concepts of biofuels, types of biofuels, their production technologies.
2. To learn the concepts of feedstock utilization and energy conversion technologies.

UNIT -I

INTRODUCTION

Description of Biofuels; Energy Use & Efficiency; Biofuel Production – I and II generation biofuels; Alternative Energies; Biochemical Pathways Review for Organoheterotrophic, Lithotrophic& Phototrophic Metabolism; Importance of COD; Biofuel Feedstocks: Biomass, Starch, Sugar, Lignocellulosic, Agro & Industrial by-products. Biomass production for fuel – algal cultures, yeasts (Lipid and carbohydrate). Fuel production through biomass incineration.

7 Hours

UNIT -II

PRODUCTION OF BIODIESEL

Chemical, Thermodynamic & Reaction Kinetic Aspects of Biodiesel Production: Esterification and Transesterification. Free fatty acids; saponification; Single step and two step biodiesel production.Catalysts for biodiesel production – homogeneous (alkali/acidic) and heterogeneous.Sources of Oils – edible and non edible; General procedure of biodiesel production and purification. Production technologies: Conventional method, microwave, ultrasonic, supercritical fluid, Lipase mediated process. Quality Control Aspects: GC analysis of biodiesel, fuel property measurements, ASTM (D-6751) and Indian standards (IS15607). Usage: B100 and B20 and advantages. Algal Biodiesel production. **8 Hours**

UNIT -III

PRODUCTION OF BIOETHANOL

Process Technology for Bioethanol production using Sugar; Starch and LignocellulosicFeedstocks; Byproducts of biodiesel industry as feedstock; Selection of micro-organisms and feedstock – ethanol tolerance; Associated Unit Operations; Determination of Bioethanol yield; Recovery of Bioethanol; Process Integration. Advances in bioethanol production.

8 Hours

UNIT- IV

PRODUCTION OF BIOHYDROGEN

Enzymes involved in H_2 Production; Photobiological H_2 Production: Biophotolysis and Photofermentation; H_2 Production by Fermentation: Biochemical Pathway, Batch Fermentation, Factors affecting H_2 production, Carbon sources, Process and Culture Parameters; Detection and Quantification of H_2. Reactors for biohydrogen production.Advances in biohydrogen production technology. **8 Hours**

UNIT- V

MICROBIAL FUEL CELLS

Biochemical Basis; Fuel Cell Design: Anode & Cathode Compartment, Microbial Cultures, Redox Mediators, Exchange Membrane, Power Density; MFC Performance Methods: Substrate & Biomass Measurements, Basic Power Calculations, MFC Performance: Power Density, Single vs Two-Chamber Designs, Wastewater Treatment Effectiveness; Advances in MFC. **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Mark the significance of biofuels and raw materials and Identify suitable feedstock for production of biofuels.
2. Illustrate the production of biodiesel from various feed stocks.
3. Explain the production of bioethanol from various feed stocks.
4. Demonstrate production of biohydrogen.
5. Extend the concepts of microbial fuel cells towards development of specific application.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	I	j	k	PSO		
												1	2	3
CO1		M							L				L	

CO2		M							L				L	
CO3		M							L				L	
CO4		M							L				L	
CO5		M							L				L	

REFERENCE BOOKS:

1. Drapcho, C. M., Nhuan, N. P. and Walker, T. H. *Biofuels Engineering Process Technology*, McGraw Hill Publishers, New York, 2008.
2. Jonathan R.M, *Biofuels – Methods and Protocols (Methods in Molecular Biology Series)*, Humana Press, New York, 2009.
3. Olsson L. (Ed.), *Biofuels (Advances in Biochemical Engineering/Biotechnology Series*, Springer-Verlag Publishers, Berlin, 2007.
4. Glazer, A. and Nikaido, H. *Microbial Biotechnology – Fundamentals of Applied Microbiology*, 2 Ed., Cambridge University Press, 2007.

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ENVIRONMENTAL BIOTECHNOLOGY

Sub Code : 13BT721 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39

***Prerequisites*:** Environmental Studies, Microbiology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn biotechnological intervention in environmental perturbation, bioaccumulation of xenobiotics and its biomonitoring.
2. To learn processes in waste water and solid waste management.
3. To understand important biotechnological principles and processes in environmental management and production of valuable products.

UNIT – I

BIOACCUMULATION AND BIOMONITORING

Biotechnological methods of pollution detection. Bioaccumulation of toxicants: Process of toxicants uptake, uptake process for biodegradable organic substances and inorganic toxicants, Factors affecting bioaccumulation, Measurement of bioaccumulation. Genetically engineered microbes in biotreatment of wastes and environmental safety.

7 Hours

UNIT-II

WASTE WATER TREATMENT

Waste water characteristics, biological waste water treatment – preliminary treatment: screeners, grit chambers; skimming tank; primary treatment: sedimentation, types of settling, types of sedimentation tank, chemical aided sedimentation; secondary biological treatment: activated sludge process and trickling filters tertiary treatment: solids removal biological

nitrogen removal, biological phosphorous removal, disinfection. Membrane based industrial waste water treatment processes: reverse osmosis, nanofiltration, ultafilration and microfiltration. **8 Hours**

UNIT-III

BIOTECHNOLOGY OF SOLID WASTE MANAGEMENT

The general composition of urban solid waste, waste disposal by sanitary land filling, Aerobic treatment of solid wastes: composting, vermiculture, Anaerobic treatment of solid wastes and biogas generation, Hazardous wastes and Biomedical wastes management.

7 Hours

UNIT-IV

BIODEGRADATION

Aerobic and anaerobic degradation, Bio-oxidation of phenolic compounds, microbial basis of biodgradation; Biodegradation of herbicides and Pesticides, Biodegradation of some specific wastes: Polycyclic aromatic hydrocarbons, Polychlorinated biphenyls, Synthetic detergents, Biosurfactants, Organonitrocompounds, Vegetable Tannins; Testing for biodegradability.

9 Hours

UNIT-V

BIOTECHNOLOGICAL APPLICATIONS IN ENVIRONMENT MANAGEMENT

Bioremediation, Phytoremediation, Bioleaching and Biomining: metal recovery, Biopesticides: Bacteria, fungi and viruses as biopesticides, Biofertilizers: Bacteria, algae, fungi as biofertilizers, Biofilmsand its applications, Bioenergy and Biofuels: Biomass resources for fuel generation, Energy recovery systems from biomass-technology evaluation, Production of Biofuel-Biodiesel, Bioethanol, Biotechnology in biodiversity conservation.

8 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Illustrate environmental issues emphasizing accumulation of toxicants, environmental monitoring.
2. Summarize waste water management strategies.
3. Elaborate solid waste management methods.
4. Outline methods of biodegradation of various pollutants.
5. Apply knowledge of integrated science to resolve environmental problems.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		L							H				M	
CO2		L			L				M				M	
CO3		L			L				M	L			M	
CO4		L							M	L			M	
CO5		L							H	L	L		M	

TEXT BOOKS:

1. Young, M. M. *Comprehensive Biotechnology*, Vol 1-4, (Eds) Pergamon Press, 2004.
2. Thakur, I. S. *Environmental Biotechnology-Basic concepts and applications*, I K International 2006.
3. Chatterji, A. K. *Introduction to environmental Biotechnology*, 2nd ed., Prentice-Hall of India Private Ltd., New Delhi, 2007.
4. Mohapatra, P. K. *Text book of Environmental Biotechnology*, I K International, 2006.

REFERENCE BOOKS:

1. Foster, C.F. and Ware, J. D. A., *Environmental Biotechnology*, Ellis Horwood Limited, 1987.
2. Anderson, L. and Tillman, D. A. *Fuels from waste*, Academic Press, 1997.
3. Enfors, S. O. and Hagstrom, L. *Bioprocess Technology – Fundamentals and Applications*, RIT, Stockholm, 1992.
4. DeSilva, E. J., Ratledge, C. andSasson, A. *Biotechnology, Economic and Social Aspect*, Cambridge University, Press, Cambridge. 1992.
5. Scragg, A. *Environmental Biotechnology*, 2nd Ed. Oxford University Press, 2005.

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PHYTOCHEMISTRY

Sub Code : 13BT723Credits :03
Hrs/Week : 3+0+0+0 Total Hours: 39

***Prerequisites*:** Chemistry, Microbiology and Unit Operations
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

- To provide an understanding of the range of metabolites synthesized by plants and the varied applications of these metabolites.
- To gain an understanding of theoretical principles related to the metabolic pathways leading to the synthesis of these metabolites *in vivo* and various modern techniques for the purification and identification.
- To introduce the latest techniques and theory related to the range of industrially important compounds including pharmaceuticals, cosmetics, food-flavours, biofuels and oils to substitute unsustainable products.

UNIT – I

OVERVIEW OF PLANT SECONDARY METABOLITES

Drugs from plants - Insecticides and rodenticides- Industrially important plant products essential oils, fatty oils & waxes, fibers & fiber plants, forest products: wood and cork, forest resources, gums & resins, rubber and other latex products, tanning, dye & processing materials. **8 Hours**

UNIT – II

METABOLITES DERIVED FROM THE SHIKMATE CHORISMATE PATHWAY

Plant acids, fatty acids and lipids, alkanes and related hydrocarbons, polyacetylenes, sulphur compounds. nitrogen compounds-amino acids, amines, alkaloids, cyanogenic glycosides, inoles, purines, pyrimidines and cytokinins, chlorophylls.

8 Hours

UNIT – III

METABOLITES DERIVED FROM THE MALONIC AND MEVALONIC ACID PATHWAYS

Phenols and phenolic acids, phenylpropanoids, flavonoid pigments, anthocyanins, flavaonols and flavones, tanins, quinones.essential oils, diterpenoids and gibberellins, triterpenoids, steroids and catotenoids. **8 Hours**

UNIT - IV

CONVENTIONAL METHODS IN PLANT ANALYSES

Introduction, selection of plants and plant parts, methods of extraction and isolation, methods of separation, methods of identification, analysis of results and application. **8 Hours**

UNIT – V

ADVANCES IN PLANT ANALYTICAL TECHNIQUES

GC, HPLC, HPTLC, OPLC, NMR, MS, RT PCR, RNA SEQ –fluorescence and confocal microscopy, CHNS analysis, X ray crystallography.

7 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Explain the structural complexity and diversity of pharmaceutically relevant plant metabolites.
2. Impart knowledge in principles underlying plant secondary metabolism.
3. Present an overview of different classes of metabolites present in plants.
4. Illustrate the technologies underlying the isolation, purification, quantitation and identification of plant metabolites.
5. Appraise the diversity of plant metabolites and their utility.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L	L											L	
CO2	L	L			L								L	
CO3	L	L			L								L	
CO4		M											L	
CO5	L				L								L	

TEXT BOOK

1. Harborne, J. B. *Phytochemical Method: A guide to modern techniques of plant analysis*, 3rd Ed., Chapman and Hall (Springer India Pvt. Ltd.), 2008.

REFERENCE BOOKS

1. Sarker, S. D., Latif, Z and Gray A. I. (Ed.), *Methods in Biotechnology: Natural Product Isolation*, 2nd Ed., Humana Press, 2005.
2. Raman, N. *Phytochemical Techniques*, 1st Ed., New India Publishing Agency, 2006.

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WASTE WATER TREATMENT

Sub Code : 13BT724Credits :03
Hrs/Week : 3+0+0+0 **Total Hours: 39**

***Prerequisites*:** Chemistry, Microbiology and Unit Operations
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn water quality and its standards.
2. To learn various methods of waste water treatment like primary, secondary and advanced treatment.
3. To learn the need and usefulness of wastewater reclamation and reuse and performance analysis of treatment plant.

UNIT- I

WATER & WASTEWATER ENGINEERING: AN OVERVIEW

Water quality, Physical chemical and biological parameters of water, Water quality standards, Water quality indices.

Wastewater: Terminology, sources of waste water, Impact of regulation on waste water engineering, health and environmental concern in waste water management, Current status and future trends, Waste water reclamation and reuse, Biosolids and residual management.

Constituents of waste water, Physical chemical and biological parameters of waste water, sampling methods, Waste water effluent standards, Sewage disposal: Methods of disposal.

7 Hours

UNIT – II

PRIMARY AND SECONDARY TREATMENT OF WASTE WATER

Screens, Oil traps grease chambers, detritus tank, Grit chambers, Sedimentation and Coagulation (with simple problems), Clariflocculation, Oxidation ponds and lagoons, Attached growth biological treatment: Activated sludge process and its modifications, Trickling filter , Biological nitrification and denitrification, Anaerobic process, Sludge treatment and disposal. Disinfection: chlorine dioxide, Chloramines, Ozonation, UV

radiation.

8 Hours

UNIT – III

ADVANCED WASTE WATER TREATMENT

Removal of Dissolved organic constituents, Inorganic constituents, Biological constituents, Adsorption with principle and isotherms, Gas stripping, Ion exchange, advanced oxidation process.

Membrane filtration: RO, UF, MF, NF, Electrodialysis. **8 Hours**

UNIT – IV

WASTE WATER RECLAMATION AND REUSE

Waste water reuse application, Need for water reuse, public health and environmental issues in water reuse, Introduction to risk assessment for water reuse, Different reuse options: Agriculture and landscape irrigation, Industrial reuse, ground water Recharge, Nonportable uses with case studies. **8 Hours**

UNIT – V

ISSUES RELATED TO TREATMENT PLANT PERFORMANCE

Need for upgrading treatment plant performance, odour management, introduction to automatic process control, energy efficiency, upgrading waste water treatment plant performance by process optimization, important design consideration for new waste water treatment plants : liquid stream, solid processing, odour control. **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the effect of characteristics on the quality of water and wastewater
2. Explain the fundamental concepts of various water and wastewater treatment methods
3. Justify the needs of advanced technologies for waste water treatment.
4. Appraise the need for wastewater reclamation and reuse.
5. Choose the knowledge of different techniques for the optimization of treatment plant performance.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L	L							L				L	L
CO2	L	M				L			L				L	L
CO3	L	M				L			L					L
CO4	L	L				L			L					L
CO5	M	M							L					L

TEXTBOOKS

1. Shammas, N. K. Wang, L. K. Fair, Geyer, and Okun's*Water and Wastewater Engineering: Water Supply and Wastewater Removal*, 3rd Ed.John Wiley & sons, 2011.
2. Shastry, C. A. *Water treatment plants*, Narosa Publishing House, Bombay 1996.
3. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G. *Environmental Engineering*, McGraw Hills, New York 1985.
4. Rao, C. S. *Environmental Pollution Control Engineering*, 2nd Ed., New Age International, 2015.

REFERENCE BOOKS

1. Weber, W.J., *Physicochemical process for water quality control*, John Wiley and sons, New York, 1983.
2. Tchobanoglous, G.,Stensel, H. D., Tsuchihashi, R., Burton, F., Metcalf and Eddy, *Waste Water Engineering, Treatment and reuse*, 5th Ed. Tata McGraw. Hill Publication, New Delhi 2003.

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SOLID & HAZARDOUS WASTE MANAGEMENT

Sub Code : 13BT725 Credits :03
Hrs/Week : 3+0+0+0 Total Hours: 39
***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn types of solid wastes, collection, treatment and disposal methods.
2. To understand various processing techniques and regulations of treatment and disposal.

UNIT – I

INTRODUCTION TO SOLID AND HAZARDOUS WASTES

Solid waste – Definition, Sources of waste, Classification of Solid waste, Characteristics of Solid Waste (Physical, Chemical, Biological), Hazardous Waste Definition - Properties and classification of hazardous waste. Solid and Hazardous waste problems – impact on environment and health. Concept of waste reduction, recycling and reuse. **6 Hours**

UNIT -II

WASTE COLLECTION, SEGREGATION & TRANSPORTATION

Waste collection and segregation: Solid waste generation, Onsite handling and segregation of wastes at source, Collection and storage of municipal solid wastes, Equipments used and manpower required in collection, Collection systems and routes, Handling, collection, storage of hazardous wastes.

Transportation: Transfer stations: types, location, maintenance, Methods and means of transportation, Transport of hazardous waste (Bulk and Non Bulk Transport), Labelling and handling of hazardous wastes, Manpower requirements. **9 Hours**

UNIT – III

PROCESSING TECHNIQUES AND RECOVERY OF RESOURCES

Processing Techniques:Unit operations for separations and processing, mechanical and thermal volume reduction, Incineration of solid wastes – process and types of incinerators (liquid injection, rotary kiln and fluid bed), Biological processing – composting, vermicomposting, biomethanation, fermentation, Hazardous waste processing: Physical, chemical and thermal treatment of hazardous wastes – solidification, chemical fixation, encapsulation, pyrolysis and incineration. Drying and dewatering of wastes.

Recovery of Resources: Heat recovery in incineration process, energy recovery and conversion of products from biological processes.**10 Hours**

UNIT – IV

DISPOSAL OF WASTES

Dumping of solid wastes, Landfills – Types, site selection, preliminary design, operation, case study, Advantages and disadvantages of landfills, Leachate and landfill gases: Collection and treatment, Landfill disposal for hazardous wastes. **8 Hours**

UNIT-V

SOLID WASTE MANAGEMENT RULES AND PLANNING ISSUES

Legislative trends and impacts: Major legislations, Government agencies. Municipal Solid Waste Management Act (1999), Hazardous Wastes (Handling and Management) Rules, Biomedical Waste (Handling and Management) Rule (1998)

Planning and developing a site for solid waste management, Site Remediation: Assessment and Inspection, Remedial techniques, Siting guidelines. **6Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Identify the sources, classification and characteristics of solid and hazardous wastes
2. Develop insight into the collection, transfer, and transport of solid waste.
3. Apply waste processing techniques and recovery of resources from the waste.
4. Select the alternatives of solid waste disposals and its impacts.
5. Acquire knowledge about solid and hazardous waste management legislative rules.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L				L									L
CO2	L	L			L				L					L
CO3		M			L								L	L
CO4		M			L				L					L

CO5	L				L						L			L

REFERENCE BOOKS:

1. Tchobanaglous, G., Theisen, H. and Vigil, S. A. *Integrated Solid Waste Management,* McGraw – Hill. 1993.
2. Tchobanoglous, G., Thiesen, H., Ellasen, *Solid Waste Engineering Principles and Management*, McGraw – Hill, 1997.
3. Landrefh, R. E. And Rebers, P. A. Lewis, *Municipal Solid Wastes-Problems & Solutions*, 1997.
4. Bhide, A. D. and Sundaresan, B. B. *Solid Waste Management in Developing Countries,* Indian National Scientific Documentation Centre. New Delhi, 2000.
5. Wentz C.A., *Hazardous Waste Management*, McGraw Hill, 1989.
6. LaGrega M.D., Mercer, *Hazardous Waste Management,* 2nd Ed., McGraw Hill, 2001.

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SEMINAR

Sub Code : 13BT704 Credits : 02
Hrs/Week : 0+0+3+0 Total Hours: NA

***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To inculcate skills of public speaking.
2. To acquire knowledge of contemporary issues in biotechnology.
3. To develop skills in report writing, reading and understanding the research articles.

An Individual seminar given by student on either
- i. Project topic (literature, methodology)
- ii. Topic of his/her choice

Only internal evaluation (CIE = 50 marks) shall be conducted. The CIE marks breakup shall include weightage for seminar report, open room presentation, viva and attendance (for all presentations).

Course Outcomes:

At the end of this course, the student will be able to
1. Identify current topics in biotechnology, procure research articles, understand and interpret the same.
2. Prepare technical reports and communicate effectively with peers.
3. Recognize the need for ability to engage in life-long learning.

Mapping of Course Outcomes:

PO CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		M					L				H	L		
CO2							H	L			L	L		
CO3										H		L		

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ANALYTICAL TECHNIQUES & MOLECULAR BIOLOGY LAB

Sub Code : 13BT705 Credits : 02
Hrs/Week : 0+0+3+0 **Total Hours: 39**
***Prerequisites*:** Analytical Techniques, Molecular Biology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn and understand the various tools and techniques those are used in separation technology and analysis of biomolecules.

EXPERIMENTS
1. Absorption spectra of proteins and amino acids by using UV-visible spectrophotometer
2. Isolation and separation of pigments from leaves or flowers by adsorption column chromatography
3. Separation of amino acids by ion exchange column chromatography using cation exchanger
4. Isolation of proteinby ammonium sulfate precipitation and dialysis for desalting the precipitate
5. Separation of isolated protein by SDS-polyacrylamide gel electrophoresis
6. Extraction of DNA from Plant tissue and Quantification by UV visible spectrophotometry and colorimetry (Diphenylamine method)
7. Extraction of RNA from Plant tissues andQuantification by UV visible spectrophotometry and colorimetry (Orcinol method)
8. Isolation of Plasmid from Bacteria
9. Separation of genomic DNA by Agarose gel electrophoresis
10. Performing RAPD technique
11. Restriction Digestion and Restriction Mapping Technique
12. Bacterial transformation

Course Outcomes:

At the end of this course, the student will be able to

1. Identify the need for various analytical techniques.
2. Develop extraction methods for various biological materials and analyze them using suitable analytical tool
3. Perform experiments using molecular biological tools.

Mapping of Course Outcomes:

PO / CO	a	b	c	d	e	f	G	h	i	j	k	PSO		
												1	2	3
CO1		M		M			L			L			M	L
CO2		L	M	H			L			M			M	L
CO3		M		M			L			M			M	

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IMMUNOLOGY LAB

Sub Code : 13BT706 **Credits : 02**
Hrs/Week : 0+0+3+0 **Total Hours: 39**

***Prerequisites*:** Nil

***Corequisites*:** Immunology

Course Learning Objectives:

The objective of this course is

1. To develop experimental skills in immuno-technical methods.
2. To apply immunotechniques for clinical diagnosis.

EXPERIMENTS

1. Ouchterlony Double Diffusion (ODD)
2. Radial Immunodiffusion (RID)
3. Quantitative precipitin assay (QPA)
4. ELISA- Dot blot assay and with ELISA Reader.
5. Countercurrent immunoelectrophoresis (CCIEP)
6. Immunoelectrophoresis (IEP)
7. Rocket immunoelectrophoresis (RIEP)
8. Western blotting technique
9. Agglutination technique: Blood group active agglutination test and passive latex agglutination test (RA test or pregnancy test) or Bacterial agglutination Technique-Widal test (Tube agglutination)
10. Differential staining of WBC's and Lymphocyte isolation by Hi-sep method
11. Total count of WBC
12. Total count of RBC
13. Serial Dilution: Agglutination and immunoprecipitation techniques

Course Outcomes:

At the end of this course, the student will be able to

1. Gain experimental skills and knowledge in immuno-techniques.
2. Perform experiments for clinical diagnosis.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		M		L			L			L			M	
CO2		H		L			L			M	L		M	

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PROJECT – PHASE I

Sub Code : 13BT707 Credits : 02
Hrs/Week : 0+0+3+0 Total Hours: NA
***Prerequisites*:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To perform effective literature survey, identification of research problem / project idea.
2. To develop skills of planning to execute the project.
3. To assess the needs and necessity of a project.
4. To learn time management and documentation.

Course Description: A group of students (not more than 4) is assigned to a guide/project supervisor. The students must do a thorough literature review and come out with a project plan. They are expected submit a project proposal (not more than 10 pages) including project idea, protocols, designs (if any), expected outcome, major requirements, and approximate budget. They shall present the same in a proposal seminar in front of the panel of internal examiners (involving guide) and shall get their proposal approved. The presentation must involve projected time line of the project execution.

Evaluation Pattern:

CIE: Shall involve project proposal, proposal seminar, continuous evaluation of the project progress by Guide and HOD.

SEE: No semester examination.

Course Outcomes:

At the end of this course, the student will be able to

1. Use various methods or sources for finding literature and analyze data for relevance and appropriateness to the research project undertaken.
2. Identify and propose suitable methods of analysis and/or design or develop appropriate experiments to address the specific research objectives.
3. Apply suitable standardized method/s for experimental design.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		L			M	M	H	L			H	L	M	M
CO2		L	M	L	L		L	M	L		L	L	M	M
CO3		L	M	M	L		L	L	L	L	L	L	M	M

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INDUSTRIAL MANAGEMENT & ENTREPRENEURSHIP

Sub Code : 13BT801Credits : 04
Hrs/Week : 4+0+0+S* Total Hours: 52

*** Self Study to be exercised under the supervision of course instructor and to be restricted to not more than 10% of the total teaching hours.**

Prerequisites **:** Nil
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To introduce the technology and engineering interaction with management.
2. To learn as how to evaluate and finance projects.
3. To understand why mere technology is not enough, management and planning are also necessary.
4. To appreciate marketing strategy and entrepreneurial opportunities in the field of bioprocess industry.

UNIT-I
DEVELOPMENT OF MANAGEMENT THOUGHTS

Concept & definition of Management, Social Responsibilities of Management, Management and functions: Definition and functions of administration, Planning Organizing, Staffing, Directing and Controlling, Concept of Authority and Responsibility. **11 Hours**

UNIT – II

QUANTITATIVE TECHNIQUES IN MANAGERIAL DECISIONS

Concept of productivity, Measuring productivity, Network analysis, PERT, CPM analysis, Break even analysis. **11 Hours**

UNIT – III

PERSONNEL AND PRODUCTION MANAGEMENT

Recruitment and Selection, Training of personnels, Employer-Employee relationship, Settlement of Disputes.Influence of ILO on the Indian Industry.
Types of production, Types of planning, Manufacturing planning, Factory planning, Production planning, Scheduling, Work study, Method study, Motion study.

12 Hours

UNIT – IV

MATERIAL AND MARKETING MANAGEMENT

Functions of purchasing and material management, Quality standard & Inspection, Sources of supply, Pricing, Principles & practices, Inventory management, ABC analysis, EOQ model, Value analysis & engineering. Functions of marketing, Market research, Pricing and Promotion of sales. **10 Hours**

UNIT – V

ENTREPRENEURSHIP

Meaning of entrepreneur, evaluation of the concept, function of an entrepreneur, development of entrepreneurship and its role and barriers in economic development. Case studies on different aspects of Industrial application: Managerial decision, making of an entrepreneur-success and barriers, production concepts, marketing concepts. **8 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Relate the importance of industrial management to bioprocess industry.
2. Use quantitative techniques in managerial applications.
3. Appraise the management systems with regard to personnel and production units.
4. Summarize the significance of marketing and material management in industry.
5. Appraise and develop the entrepreneurial skill and its applications.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1					M		L							M
CO2					M		L	L						M
CO3					M		M							L
CO4					M		M							L

CO5					M		H				L			M

REFERENCE BOOKS:

1. Telsang, M. T. *Industrial and Business Management*, S. Chand & Co. 2001.
2. Khanna, O. P., *Industrial Engineering and Management*, DhanpatRai& Sons, 1996.
3. Nagendra S. and Manjunath, V. S. *Entrepreneurship & Management*, Sanguine technical publishers, 2008.

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BIOLOGY OF STEM CELLS

Sub Code : 13BT811 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39
***Prerequisites*:** Cell biology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To provide broad outline of different types of stem cells and their origin.
2. To appreciate the concepts of differentiation of stem cells into different types of tissues, the process of trans-differentiation.
3. To learn the application of stem cells in curing certain diseases.

UNIT – I

INTRODUCTION

Definition of stem cells, unique properties of stem cells, Embryonic stem cells (ES cells), Growing of ES cells in laboratory, markers of ES cells, differentiation of ES cells. Adult stem cells (AS cells), Characteristics and locations of AS cells, Potential use of AS cells, As cell plasticity, Similarities and differences between embryonic and adult stem cells, Definition of progenitor and stem cells, Multipotent adult progenitor cells (MAPC), Amniotic fluid derived pluripotent cells, Isolation, characterization and differentiation potential of amniotic fluid derived cells, Stem cells and progenitor cells from cord blood, characteristics and cryopreservation of stem and progenitor cells from cord blood, cardiac stem cells (CSC), distribution of CSC in the heart.

TRANSDIFFERENTIATION

Definition and process of transdifferentiation, Transdifferentiation of: liver to pancreas, pancreas to liver, bone marrow to other cell types, prerequisites for transdifferentiation, transdifferentiation of non-islet cells to islet cells-pancreatic acinar cells, bone marrow cells to islet cells, engineering other non β cells to produce insulin. **7 Hours**

UNIT-II

ORGAN SPECIFIC STEM CELLS

Human epidermal stem cells (ESCs): anatomy of epidermis, skin stem cells, stem cell compartments, epidermal stem cell culture, clinical applications, markers of ESCs, epithelial skin stem cells, Mammary epithelial stem cells, Intestinal epithelial cells. Neural crest cells and stem cells, stem cells in adult brain, glial characterization of neural stem cells, adult neurogenesis in vivo.

Mesenchymal stem cells (MSCs): skeletal muscle stem cells-phenotype, in bone marrow vasculature, adipose tissue derived stem cells-cell population, composition and characterization, multipotentiality, adipogenesis, osteogenesis and chondrogenesis. Stem cells in the adult kidney- stem cell therapy for renal failure, Liver stem cells, pancreatic stem cells-progenitor cells during early embryogenesis of pancreas and in adult pancreas. Adult progenitor cells as potential treatment for diabetes-defining β cells, stem cells and progenitor cells. **9 Hours**

UNIT–III

HAEMATOPOIETIC STEM CELLS (HSCs)

Sources of HSCs, isolation HSCs based on function and biological response, isolation of HSCs based on cell surface antigen expression, separation of human HSCs, Ex-vivo expansion of haematopoietic progenitor cells (HPCs), clinical trials with HPCs, Ex-vivo expansion of HSCs, circulating HSCs transplantation, nomenclature of haematopoietic colonies and lineages, colony forming units. Haematopoietic stem cells transplantation (HCT) for solid tumors-HCT as allogenic immunotherapy, allogenic immunotherapy for solid tumors; non-myeloblastic HCT for renal cell carcinoma (RCC), for other solid tumors and for melanoma, Immunoreconstitution of HCT: autologous and allogenic, HCTs for treating autoimmune diseases. **8 Hours**

UNIT–IV

APPLICATION OF STEM CELLS I

Neurological diseases: sources of stem cells for brain cell repair, isolation and manipulation of stem cells for cell replacement in CNS, inductive signals in the adult CNS environment, strategies to promote the intrinsic neurogenic potential of the adult CNS. Restoration of vision: retinal neurogenesis, neurogenesis in the central visual targets, regeneration of optic tectum. Repair of myocardial damage by: non resident primitive cells and resident primitive cells, myocardial regeneration in humans. Regeneration of epidermis from adult keratinocyte stem cells: characteristics of keratinocyte stem cells, keratinocyte cultivation, transplantation of keratinocyte stem cells, regeneration of epidermis. **8 Hours**

UNIT–V

APPLICATION OF STEM CELLS II

Orthopedic application of stem cells: bone, cartilage, meniscus, ligaments and tendons, spine.

Stem cells in tissue engineering and gene therapy: Current approaches to tissue engineering, tissue engineering by mesenchymal stem cells (MSCs), ex-vivo delivery of stem cells, reconstruction of-skeleton, bone, cartilage, teeth, skeletal and cardiac muscle.

Ex-vivo reconstruction: cells and scaffolds, Recruitment and mobilization of distant cells. Stem cell gene therapy: gene addition, gene editing. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Explain various types of stem cells in the human body and explain their trans-differentiation and application.
2. Make use of stem cells for tissue repair, regeneration and restoration.
3. Appraise the use of stem cells in tissue engineering and gene therapy.
4. Elaborate on different conditions required for maintenance of different types of stem cells.
5. Summarize the use of engineered tissues in orthopedic and other medical applications.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L				L				L				L	
CO2	L				L				L				L	
CO3					L				L	L			L	
CO4					M				L	L			L	
CO5					M				L	L			L	

REFERENCE BOOKS :

1. Lanza, R. Ed. *Handbook of Stem Cells*-Vol. 2, *Adult and fetal stem cells*, Elsevier Acad. Press, 2004.
2. *Stem cell information*, The National Institute of Health, Bethesda, MD USA- Resource for stem cell research, 2008.
3. Alberts, B. et al., *Molecular Biology of the Cell*, 5th Ed., Garland Sci., 2007.
4. Lodish, H., Baltimore, D. & Darnell, J. *Molecular Cell Biology*, 4th Ed., WH Freeman, 2000.
5. Glick, B. R. and Pasternak, J. J. *Molecular Biotechnology-Principles and Applications of Recombinant DNA*, 4th Ed., ASM Press, Washington DC, 2010.
6. Gilbert, S. *Developmental Biology*, 10th Ed., Sinauer Associates Inc., 2013.

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PROTEIN ENGINEERING

Sub Code : 13BT812 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39

Prerequisites: Nil
Corequisites: Nil

Course Learning Objectives:

The objective of this course is

1. To learn engineering aspects of protein designing along with docking method.
2. To learn modeling criteria for *in silico* drug design.
3. To learn methods in *Insilico* drug designing and use of computers for drug designing.

UNIT-I

STRUCTURE OF PROTEINS & PREDICTION

Overview of protein structure, PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions. Primary structure and its determination, secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, protein folding pathways, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, post translational modification.

PROTEIN ENGINEERING AND DESIGN

Methods of protein isolation, purification and quantitation; large scale synthesis of proteins, design and synthesis of peptides, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

8 Hours

UNIT-II

MOLECULAR MODELING

Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking, Calculation of Molecular Properties, Energy Calculations (no derivation), Examples of Small Molecular Modeling Work, Nicotinic Ligands, Sigma Ligands, Antimalarial Agents.

7 Hours

UNIT-III

INSILICO DRUG DESIGN & COMPUTER ASSISTED NEW LEAD DESIGN

Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural Similarities and Superimposition Techniques, Rational Drug Design and Chemical Intuition, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives. Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Conformation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure.

8 Hours

UNIT-IV

DOCKING METHODS

Program GREEN Grid: Three - Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods

with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Scope and Limitations, Points for Consideration in Structure, Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives, Types of programs available for molecular modeling- scope and limitations-interpretation of results.

8Hours

UNIT-V

COMPUTER - ASSISTED DRUG DISCOVERY

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD), Current Practice of CADD in the pharmaceutical Industry, Management Structures of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

8 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Choose the necessary the steps required to produce an expression system for a new protein.
2. Extend the capability to use protein molecular modeling techniques.
3. Use *insilico* approaches for drug design through use of modern computational tools.
4. Construct protein docking methods and demonstrate the use of software for protein visualization, sequence alignment and modelling.
5. Illustrate the use of computational tools for drug design methods.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		M			L								L	
CO2		M			L								L	
CO3	L	L			L			M		L		L	L	
CO4		M			L			M					L	
CO5	L	L			L			L				L	L	

REFERENCE BOOKS:

1. Moody, P. C. E. and Wilkinson, A. J. *Protein Engineering*, IRL Press, Oxford, 1990.
2. Creighton, T.E. *Proteins*, 2nd Ed., WH Freeman, 1993.
3. Branden, C. and Tooze, R. *Introduction of protein structure*, Garland, 1993.
4. Cohen, C. N. *The molecular modeling perspective in drug design*, Academic Press, 1996.
5. Rastogi, S. C. Mendiratta, N. and Rastogi, P. *Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery*, PHI, 2006.

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CANCER BIOLOGY

Sub Code : 13BT813Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39
***Prerequisites*:** Immunology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn concepts in biological phenomenon of cancer and molecular mechanism of carcinogenesis.
2. To understand methods of cancer treatment and techniques involved.

UNIT-I

FUNDAMENTALS OF CANCER

Cancer cell characteristics, terminologies used in cancer cell biology, different forms of cancer, differences between benign and malignant tumor, different stages in development of cancer, Diet and cancer, tumor markers, detection using biochemical assays, molecular tools for the Hallmarks of cancer, terminologies used in cancer cell biology, different forms of cancer, differences between benign and malignant tumor, different stages in development of cancer. Influential factors in human carcinogenesis, carcinogenic contaminants, smoking, dietary deficiencies, obesity, reproductive life, chronic alcohol consumption, hormones and cancer, role of Vitamin-D in prevention of cancer.

6 Hours

UNIT-II

PROCESS OF CARCINOGENESIS

Environmental causes for carcinogenesis, chemical carcinogenesis, carcinogen metabolism, radiation and carcinogenesis, DNA and RNA tumor viruses, Cancer cell origin from single abnormal cell (clonal origin) and different cell types (polyclonal origin), change in cells DNA Environmental causes for carcinogenesis, chemical carcinogenesis, carcinogen metabolism, radiation and carcinogenesis, DNA and RNA tumor viruses, Cancer cell origin from single abnormal cell (clonal origin) and different cell types (polyclonal origin), stem cell origin, change in cells DNA sequence and origin of cancer, Mutations that accelerate the development of cancer, Contribution of non-mutagenic agents, toxic and mitogenic agents and inflammation to tumorigenesis, Genetic instability and Chromosomal anomalies in cancer cells, tumor progression involving mutation. Darwinian evolution and natural selection, Deranged control of cell differentiation during carcinogenesis, Enhanced mutability and drug resistance in cancer cells, defects in DNA repair mechanism leading to tumorigenesis.

8 Hours

UNIT–III

MOLECULAR ASPECT OF CANCER

Proto-oncogenes and Oncogenes, Oncogenes that encode: growth factors or their receptors, cytoplasmic protein kinases, nuclear transcription factors, product that affect apoptosis, promote tumor formation through secondary effect on other genes. Association of different Oncogenes, Properties of Proto-oncogenes and Oncogenes, Oncogenes that encode: growth

factors or their receptors, cytoplasmic protein kinases, nuclear transcription factors, Wnt- β-catenin pathway contributes to cell proliferation, an altered growth factor receptor can function as oncoprotein, A growth factor gene can become an oncogene (sis), G-protein coupled receptors involvement in tumorigenesis, Anti-apoptosis promote tumor formation through secondary effect on other genes. Association of different oncogenes with immortalization and transformation.Multi-step tumorigenesis-histopathological evidence, genetic alterations, collaboration of two or more oncogenes. Angiogenesis is the key for cancer progression, involvement of blood vessels in metastasis, antiangiogenic approach to combat cancer. Metastasis-Colonization, E-cadherins, epithelial-mesenchymal transition (EMT), Extracellular proteases, metastatic tropism, metastasis suppressor genes.Telomeres and Telomerases in cancer.

9 Hours

UNIT-IV

TUMOR SUPPRESSOR GENES

Tumor suppressor genes and their functions, genetic status of tumor suppressor genes and oncogenes-Cell fusion experiments to prove the status of tumor suppressor genes and oncogenes.Hereditary predisposition to cancer due to mutant tumor suppressor gene, loss of heterozygosity.Loss of heterozygosity of retinoblastoma gene and its expression. The role of retinoblastoma gene in regulating cell cycle clock-cyclin dependent kinases (CDKs), CDK inhibitors, retinoblastoma proteins (pRb) and its role in cell cycle regulation, viral oncoproteins and blocking of pRb, perturbation in pRb function and tumorigenesis, the role of TGFβ in cell cycle, the role of p53 in normal cell, mutant p53 interference with normal p53 function, Mdm2 and ARF role in p53 function, inactivation of p53 and inherited mutant allele of p53 in predisposition to cancer, inactivation of apoptotic machinery by cancer cells. Other tumor suppressor genes-Neurofibromatosis (NF1), Adenomatous Polyposis Coli (APC) and von-HippelLindau syndrome (VHL).

9 Hours

UNIT-V

THERAPIES FOR CANCER

Chemotherapy of cancer, Therapy from plant derived materials, Radiation therapy. Immune therapy of cancer: nonspecific immune stimulation, vaccination against cancer, adoptive immune therapy, passive therapy with anti-tumor antibodies, cytokine therapy, nanomedicine in treatment of tumors. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Demonstrate knowledge of concepts of cancer as a genetic disease.
2. Explain cancer-related terminology, cancer causes and trends.
3. Summarize the knowledge of carcinogenesis and molecular basis of cancer.
4. List and Explain the types of gene mutations possible and how these mutations can contribute to cancer formation.
5. Adapt the therapies for the treatment of cancer.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M				L								M	

CO2	L				L								M	
CO3	M				L								M	
CO4	L				L								M	
CO5	L				L					L	L		M	

REFERENCE BOOKS:

1. Weinberg, R. A. *The Biology of Cancer*, Garland Science, New York, 2007.
2. Pecorino, L. *Molecular Biology of Cancer-Mechanism, Target, Therapeutics*, 3rd Ed., Oxford University press, 2012.
3. Karp, G. *Cell and Molecular Biology*, John Wiley and Sons Inc. New York, 1996.
4. Lewin, B. *Genes VIII*, Pearson Prentice Hall, 2004.
5. Alberts, B. et al., *Molecular Biology of the Cell*, 3rd Ed. Garland Publishing, 1994.
6. Patrick, G. L. *An introduction to Medical Chemistry*, Oxford University Press, New York, 1995.
7. Lodish, H., Baltimore, D. & Darnell, J. *Molecular Cell Biology*, 4th Ed., WH Freeman, 2000.
8. Hansh, D., Sammes, P. G., Toylor, J. B. *Comprehensive Medicinal Chemistry*, Pergamon Press, Oxford, 1990.
9. Wilson and Gisvold's*Text book of organic medicinal and pharmaceutical chemistry*, 10th Ed., Lippincott-Raven Pub., 1998.

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NANOBIOTECHNOLOGY

Sub Code : 13BT814 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39

***Prerequisites*:** Fundamentals of Physics and Chemistry
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To gain insight to fundamentals of nanoscience and nanotechnology.
2. To learn the methods and techniques involved in nanotechnology.
3. To apply nanotechnology to life sciences applications.

UNIT- I

INTRODUCTION

Introduction to nanoscience, A Brief History of the Super Small, Definition of nanotechnology, Nanobiotechnology, scope of nanobiotechnology, nanobiology Bottom-Up versus Top-Down; Discussions on microfabrication and nanofabrication, Nanolithography (Dip pen, photo, X-ray, Electron beam), nanosphere lithography, Structure-property relationships in materials, biomolecule-surface interactions.

7 Hours

UNIT – II

NANOMATERIAL AND NANO TOOLS

Zero dimensional : Nano particle, 1-D: Nano wires, nano rods, 2-D: Thin films, Special nanomaterials: Buckyballs (Fullerenes), Nanotubes, Dendrimers, Nanoshells, Magnetic nanoparticle, Quantum Dot (Nanocrystals), self assembled monolayers, Scanning probe microscopy (Scanning tunneling microscopy, Atomic force microscopy). Characterization of nanomaterials: Physical, chemical and structural. Applications of nanomaterial.

UNIT – III

NANOTECHNOLOGY FOR DRUG DISCOVERY & DRUG DELIVERY

Fundamentals of Nanotechnology in Drug Delivery, Biopharmaceutical, Physiological, and Clinical Considerations for Nanotechnology in Drug Delivery, Nanotechnology for the Delivery of Small Molecules, Proteins and Nucleic Acids, Liopsomes for anticancer drug delivery, Nanotechnology in Drug Development and Life Cycle Management, Nanopharmaceuticals: Challenges and Regulatory Perspective.

8 Hours

UNIT – IV

MICROFLUIDICS

Microflows (Laminar flow), Micro drops, Hagen-Poiseuille equation, micromixing, microvalves&micropumps, Fabrication of Soft Materials, application of Microfluidics: Lab on a chip (cellomics, immunoassay), microparticle based assays, magnetic particle in biotechnology**.** Micro manipulations and separations using electric fields**.**On chip single cell cultivation system, micro fluidiccell culture device, micro machined bioreactor. Micro chips for genomic and proteomic analysis. **9 Hours**

UNIT –V

MEMS and APPLICATIONS

Introduction to MEMS, biomems, Design of bioMEMS, Mems process steps, Biosignal Transduction Mechanisms: Electromagnetic Transducers, Mechanical Transducers, Chemical Transducers, Optical Transducers – Applications of optical and chemical transducers. Recent Developments in BioMEMS and Nanochips.DNA based BioMEMS, application of BioMems in diagnostics. Bioconjugated Nanoparticles for Biotechnology and Bioanalysis, Surgical application of MEMS. Drug delivery systems. **7 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Relate the terminologies of nanotechnology and structure property relation of materials.
2. Explain the synthesis of nanomaterials, structure and their methods of characterization.
3. Apply nanotechnology concepts in the field of drug discovery, drug delivery.
4. Relate the use of nanotechnology to microfluidics application.
5. Select MEMS and BioMEMs for targeted applications

Mapping of POs & COs:

PO CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M				L							L	L	
CO2	M				L							L		
CO3		M			L								M	
CO4	L	M			L								M	
CO5	M	L			L								M	

REFERENCE BOOKS:

1. VO-Dinh, T. *Nanotechnology in Biology & Medicine*, Taylor Francis, 2007.
2. Booker, R. and Boysen, E. (Eds), *Nanotechnology*, Wiley Dreamtech, 2005.
3. Murthy, D. V. S. *Transducers and instrumentation*, Prentice Hall of India, 2010.
4. Schmid, G. *Nanotechnology Assessment and perspectives*, Springer, 2006.
5. Ratner, M. and Ratner, D. *Nanotechnology – A gentle Introduction to the Next Big Idea*, Pearson Education, 2005.
6. Berthier, J. and Silberzan, P. *Microfluidics for Biotechnology*, ARTECH house, 2010.
7. Cao, G. *Nanostructure and nanomaterial*, World scientific, 2011.
8. Kutz, M. *Biomedical engineering and design book*, McGraw Hill, 2009.
9. Banerjee, R. (Ed.), *Nanotechnology: Diagnosis and treatment of cancers*, Narosa publications, 2012.
10. de Villiers, M. M. *Nanotechnology in drug delivery*, AAPS Press, 2008.

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BIOPHARMACEUTICALS

Sub Code : 13BT821 Credits : 03
Hrs/Week : 3+0+0+0 Total Hours: 39

***Prerequisites*:** Biochemistry, Microbiology, Genetic Engineering & Applications, Immunology
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To learn principles of development of biopharmaceutical products.
2. To understand working principle of polypeptide based therapeutic agents, nucleic acid based drugs, neutraceuticals, antibiotics, drug delivery systems.
3. To know actual commercial products approval process and manufacturing technology.

UNIT- I

INTRODUCTION

Biopharmaceuticals: Pharmaceuticals products of DNA technology, Traditional pharmaceuticals of biological origin: Pharmaceutcals of animal origin, plant origin, microbial orgin. Production sources of biopharmaceuticals, Influences altering biological properties of biopharmaceuticals, Delivery of biopharmaceuticals, Targetting of therapeutic proteins-Monoclonal antibodies and colloidal carrier particles viz., liposomes, micelles, dendrimers. Biosimilars.

7 Hours

UNIT- II

METABOLOMICS, GENOMICS AND PROTEOMICS FOR DRUG DISCOVERY

Introduction, Importance of metabolites in global biochemical networks, metabolome measurement techniques, applications of metabolomics, clinical applications of metabolomics in oncology. Pharmacogenomics: single nucleotide polymorphism.

6 Hours

UNIT - III

ANTIMICROBIAL DRUGS

Characteristics, Microbial sources of antibiotics, Antibiotic spectrum of activity, Modes of antimicrobial action, Antibacterial antibiotics, Antifungal drugs, Antiviral drugs, Antiprotozoan drugs, Antihelminthic drugs, Assay of antibiotics, Acquisition of antibiotic resistance, Spread Characteristics, Microbial sources of antibiotics, Antibiotic spectrum of activity, Modes of antimicrobial action, Antibacterial antibiotics, Antifungal drugs, Antiviral drugs, Antiprotozoan drugs, Antihelminthic drugs, Assay of antibiotics, Acquisition of antibiotic resistance, Spread of antibiotic resistance, Improvement of existing antibiotics.

9 Hours

UNIT- IV

NUTRACEUTICALS

Introduction to Nutraceuticals - Phytotherapy, nutritional therapy; Water soluble and fat soluble vitamins: Nutritional importance, deficiency diseases. Vitamin like compounds-Biotin, L-carnitine, Choline, Vitamin F, Inositol, Taurine, Minerals and trace elements acting as neutraceuticals, Probiotics and prebiotics as neutraceuticals, Assay of vitamins-Animal assays and microbiological assays. **8 Hours**

UNIT – V

PHARMACEUTICAL PRODUCTS OF DNA TECHNOLOGY

First generation and Second generation therapeutic proteins-Eg., Insulin, tissue plasminogen activator, monoclonal antibodies, Viral vaccines, Interferon and Interleukins and its applications, Enzyme therapy, Gene therapy, Stem cell therapy, antisense technology in therapy.

9 Hours

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the basic requirements of biopharmaceutical industry.
2. Appraise the use of metabolomics, genomics and proteomics for drug discovery.
3. Elaborate on production and characterization of antimicrobial drugs.
4. Explain the therapeutic importance of nutraceuticals.
5. Apply concepts of rDNA technology for biopharmaceutical development.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1				L	L								M	L
CO2		L			L			L			L		M	
CO3		M		L	L			L			M		M	L

CO4		L		L	L			L				M	L
CO5		M			L			L			L	M	L

TEXT BOOK

1. Walsh, G. *Biopharmaceuticals*, 2nd Ed., Wiley-Blackwell, 2003.

REFERENCE BOOKS:

1. Ratledge, C. *Basic Biotechnology*, 3rd Ed., Cambridge University Press, 2006
2. Tortora, Funk and Case, *Microbiology an Introduction*, 11th Ed., Benjamin Cummings, 2012.
3. Casida, L. E. *Industrial Microbiology*, Wiley Publisher, 1968.
4. Augustin, J. and Venugopal, P. B. *Methods of Vitamin Assay*, 4th Ed, Wiley-Blackwell, 1985.
5. Crommelin, D. J. and Sinddar, R. D. *Pharmaceutical Biotechnology*, 4th Ed., Springer, 2013.
6. Jogdand, S. N. *Medical Biotechnology*, Himalaya Publishing House, 1899.
7. Patel, A. H. *Industrial Microbiology*, Macmillan India Limited, 2nd Ed, 2011.
8. Price, N. C and Stevens, L. *Fundamentals of enzymology*, Oxford University Press, 3rd Ed., 2007.
9. Ramakrishnan, S., Prasannan, K. G. andRajan, *R. Text book of Medical Biochemistry*, 2nd Ed. Sangam Books Ltd., 1990.

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MODELING AND SIMULATION IN BIOSYSTEMS

Sub Code : 13BT822 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Prerequisites: Calculus, Unit Operations, Heat & Mass Transfer, Reaction Engineering
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn the concepts and need for process modeling and simulation.
2. To apply the concepts of modeling to linear and nonlinear bioprocesses.
3. To apply the modeling principles to systems generating ordinary and partial differential model equations.
4. To understand principle of stochastic modeling.
5. To use and apply software tools for simulation of model equations.

UNIT– I

FUNDAMENTALS & LINEAR ALGEBRAIC EQUATIONS

Concept of modeling and simulation, general aspects of modeling, dependent and independent variables, classification of models. Material and Energy balance equations, constitutive equations, general strategy of modeling, solution strategies and simulation. Measurements, errors (absolute & relative) and accuracy. Developing linear algebraic model

equations: Stoichiometry of product formation (elemental balances, degrees of reduction & RQ), extraction (multi component), and multi component spectroscopic analysis using Beer – Lambert's law (*solution using Gauss elimination method & Gauss-Siedel method*).

8 Hours

UNIT– II

NON LINEAR ALGEBRAIC EQUATIONS

Models of enzyme kinetics (Michaelis-Menten), growth kinetics (Monod) and product formation kinetics (Leudeking – Piret model), steady state Monod chemostat.Receptor-ligand dynamics, qPCR modeling, model of left ventricular pressure (LVP curve), Colebrookeeqation (*Solution using Newton – Raphson method*).

7 Hours

UNIT – III

ORDINARY DIFFERENTIAL EQUATIONS

Models of predator-prey, commensalism and mutualism, structured kinetic models, pharmacokinetic (drug absorption and elimination) models, Windkessel circulatory model, 2 compartment glucose regulatory system (negative feedback).Bioreactors modeling (dynamics of chemostat with linear and nonlinear kinetics), Models of heat and mass transfer in bioreactor.(*Solution using RungeKutta 4th order method*).

8 Hours

UNIT – IV

PARTIAL DIFFERENTIAL EQUATIONS & STOCHASTIC MODELING

Kinetics of immobilized system with internal mass transfer, diffusion across biological membranes, fluid flow in physiological vessel (convective – diffusive & only diffusive blood flow), developing solution scheme for PDEs using finite difference technique.Principles of stochastic modeling, age distribution of microbial cells, budding of yeast cells.

8 Hours

UNIT- V

MODEL SIMULATION

Introduction to simulation languages, open source and commercial packages (with examples).
MATLAB: Basic commands, plotting tools and annotation, matrices and operation, flow control, ODE & PDE toolboxes. MATLAB (m file) program for solving problems with Gauss elimination method, Gauss Siedel method, Newton – Raphson method and RungeKutta method.
SIMULINK & MATLAB: components, sources, sink, simple model, model of Predator – Prey kinetics.
Artificial neural networks and genetic algorithm.

8 Hours

Course Outcomes:

At the end of this course, student will be able to:

1. Relate the concepts and need for process modeling and simulation.
2. Apply the concepts of modeling to linear and nonlinear bioprocesses.
3. Apply the modeling principles to systems generating ordinary and partial differential model equations.

4. Explain the principle of stochastic modeling.
5. Justify and apply software tools for simulation of model equations.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1		M												L
CO2	L	M	L									L		L
CO3	L	M	L									L		L
CO4		M												L
CO5	L				L			L				L		L

REFERENCE BOOKS:

1. Dunn, J. I., Heinzle, E., Ingham, J. and Prenosil, J. E. *Biological Reaction Engineering*, 2nd Ed, Wiley-VCH, 2003.
2. Dunn, S. M., Constantinides, A. and Moghe, P. V. *Numerical Methods in Biomedical Engineering*, Academic Press, 2006.
3. Ramirez, W. F. *Computational Methods in Process Simulation*, 2nd Ed, Elsevier, 1998.
4. Datta, A. K. *Biological and Bioenvironmental Heat and Mass Transfer*, Marcel Deccer Inc., 2002.
5. Nielsen, J., Villadsen, J. and Liden, G. *Bioreaction Engineering Principles*, 2nd Ed., Plenum Publishers, 1994.
6. Doran, P. M. *Bioprocess Engineering Principles*, Elsevier, 1995.

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PHARMACEUTICAL CHEMISTRY

Sub Code : 13BT823 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours:39**
***Prerequisites*:** Chemistry
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is

1. To learn the basic chemical components, reactions, importance and applications that forms the back bone of pharmaceutical industry.
2. To learn a general group of chemicals with few important examples.

UNIT – I

INTRODUCTION AND SUBSTITUTION REACTIONS

Introduction to pharmaceutical chemistry, classification and nomenclature of organic pharmaceutical compounds, hyperconjugation, steric effects, inductive effects and mesomeric effect.Nucleophilic and electrophilic substitution reaction in aromatic system. Theory of resonance, Orientation in electrophilic substitutions reactions on benzene ring, Carbonium ion rearrangements (Pinacol-pinacolone, Wagner-Merwein, wolf, Hofmann and Beckmann rearrangements), Carbanions: condensation reactions (aldol condensation, Favorskii rearrangement; Witting reaction; Free radicals: Introduction, structure and stability.

6 Hours

UNIT – II

TRACE ELEMENTS AND INORGANIC DRUGS

Essential and trace elements: their role in biological systems and their toxicity. Inorganic drugs: Occurrence, preparation, physical characteristics, chemical properties, purity test, incompatibilities, assay and pharmaceutical uses of inorganic drugs such as: Aluminum hydroxide, ammonium chloride, sodium carbonate, sodium chloride, sodium thiosulfate, sodium tetraborate (borax), Magnesium carbonate, potassium chloride, Lithium carbonate, sodium nitrite, calcium gluconate, calcium carbonate, calcium chloride, calcium lactate, ferrous fumarate, ferrous sulfate, ferrous gluconate, Iron polysaccharide, silver nitrate, antimony gluconate, boric acid zinc oxide, iodine hydrogen peroxide. **8 Hours**

UNIT – III

PHYSICAL CHEMISTRY

Physical properties and molecular constitution: surface and interfacial tension, dielectric constant, dipole moment, refractive index, optical rotation, density, specific gravity, viscosity, molar refraction, parachor.

Colloids and colloidal systems: characteristic features of colloids, type of colloidal system, properties of colloids and colloidal systems. Preparation and purification of colloidal solutions, stability of colloids, pharmaceutical applications.

Solutions: Definition, types and properties, concentration, solubility and solubilization, factors affecting solubility, solvents used in pharmacy, solutions of electrolytes and non-electrolytes, isotonic solutions, dissolution and dissolution rates, distribution phenomenon, molecular weight determination. **8 Hours**

UNIT – IV

DRUG PREPARATIONS, PHYSICOCHEMICAL PROPERTIES AND BIOLOGICAL ACTION OF DRUGS

Introduction to medical chemistry, drug designing, discovery of lead structure (different approaches), classification of drugs on the basis of sources, structure, site of action and mode of action, drug receptor interaction, structure activity relationship, physico chemical

properties of drugs, structural features of drugs, preparation and properties of medicinally important heterocyclic compounds such as pyrrol, furan, thiophene, pyridine, pyrimidine and pyrazine. Preparation and properties of heterocyclic compounds in which benzo-ring fused with five and six membered ring containing one heteroatom: indole, quinoline and isoquinoline. General properties, chemistry, biological action, structure activity relationship and therapeutic applications of: alicyclic compounds-cyclopropane, terpenes, menthol, carotenes. General properties, chemistry, biological action, structure activity relationship and therapeutic applications of alkaloids: atropine, morphine and related compounds (codeine, thebaine), ergotamines, reserpine, ephedrine. **8 Hours**

UNIT – V

DRUG CHEMISTRY AND MECHANISM OF ACTION

Chemistry, structure, mechanism of action, structure activity relationship and therapeutic applications of the following:

Analgesics and antipyretics:paracetamool, salicylic acid analogues, quinolines derivatives, pyrazolones and pyrazolodines.

Local anesthetics: benzoic acids derivatives, lidocaine derivatives (anilides), amino benzoic acid, miscellaneous compounds such as: lignocaine, cocaine and benzocaine.

CNS depressants: general anesthetics, inhalation anesthetics, ultrashort acting barbiturates, dissociative anesthetics such as halothane, nitrous oxide, chloroform, thiopental sodium, ketamine.

Anxiolytics: sedatives, hypnotics such as benzodiazepines, barbiturates, chloral hydrate and alcohols.

CNS stimulants: analeptic picrotoxin, monoamine oxidase inhibitors, tricyclic compounds.

Diuretics: carbonic anhydrase inhibitors, thiazide, potassium sparing diuretics.

Antineoplastic agents: alkylating agents, antimetabolites, antibiotics, plant products, hormones.

Cardiovascular agents:antianginal agents and vasodilators, antiarrhythmic drugs, antihypertensive drugs, angiotensin converting enzyme inhibitors, antihyperlipidemic drugs, anticoagulants.

Antihistamines: H1-antagonists, H2-antagonists, propylamine derivatives, phenothiazine derivatives, piperazine derivatives. **9 Hours**

Course Outcomes:

At the end of this course, the student will be able to

1. Identify the reaction mechanisms and theory of resonance.
2. Relate the concepts of inorganic drugs and significance of trace elements.
3. Appraise the physical chemistry of colloids and solutions.
4. Describe drug preparation methods, its physicochemical analysis.
5. Elaborate on mechanism of action of various therapeutic drugs.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M				L							M		

CO2	M				L				L			L	L	
CO3	M				L				L			L	L	
CO4	M				L				L			L	L	
CO5	M				L				H				L	

REFERENCE BOOKS:

1. Streitwieser, A. Jr., Heathcock, C. H. *Introduction to organic chemistry*, 2nd Ed., Macmillan Publishing Co., Inc., New York, 1981.
2. Solomons, G. T. W. *Organic chemistry*, 5th Ed. John Wiley & Sons, Inc., 1992.
3. Sykes, P. *A guide book to mechanisms in organic chemistry*. 4th Ed. Longman Group Ltd., 1978.
4. Ghosh, J. S. *A Text book of pharmaceutical chemistry*, Chand and Co. New Delhi, 1997.
5. *Mellor's Modern Inorganic Chemistry*, Longman Green and Co. Ltd. London, 1997.
6. Rogers *Inorganic Pharmaceutical Chemistry of Lea and Febiger*, Philadelphia, USA, 1992.
7. Patrick, G. L. *An introduction to Medical Chemistry*, Oxford University Press, New York, 1995.
8. Hansh, D., Sammes, P. G., Toylor, J. B. *Comprehensive Medicinal Chemistry*, Pergamon press, Oxford, 1990.
9. Wilson and Gisvold's*Text book of organic medicinal and pharmaceutical chemistry*, 10th Ed. Lippincott-Raven Pub., 1998.
10. Wolff (Ed.), Burger's *Medicinal Chemistry and Drug Discovery*, 6th Ed., Wiley Interscience, New York, 2003.

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GENETICALLY MODIFIED ORGANISMS

Sub Code : 13BT824 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

***Prerequisites*:** Molecular Biology, Genetic Engineering, Bioethics & Biosafety
***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To study the recent developments in the field of genetically modified organisms.

UNIT – I

INTRODUCTION TO GMO
Introduction to GM microbes, plants and animals.Introduction to GM foods – Advantages& applications.Genetically engineered bacteria – hormones (insulin).Genetically modified *Sachharomyces*strains – applications in Beer, wine, sake and bread, Chymosin, Bovine Somatotrophin, Light Beer, L-tryptophan.

6 Hours

UNIT – II

GENETICALLY MODIFIED PLANTS
Herbicide tolerant crops – Frost resistance – Drought and salinity resistance – Insect resistance – Virus resistance – Nutritional fortification Methods of establishing.
Transgenic plants - Commercially available GM crops – *Bacillus thuringiensis*corn (StarLink corn) – Golden Rice – Fungal resistant Bintje potatoes – Lectin potato - Methionine enriched oil – Calgene FLAVR SAVR tomato – Indian Bt eggplant (Brinjal).

8 Hours

UNIT – III

TRANSGENIC ANIMALS
Creation of Transgenic animals – Gene transfer in poultry – Gene transfer in fish – Transgenes –gene constructs - Improved growth rate, carcass composition and feed efficiency – Transgenic mammalian farm animals - Transgenic fish -Atlantic Salmon - Bovine Somatotropin in Milk – *alpha* lactalbumin and lactoferrin in milk - Growth harmone genes in pigs. **8 Hours**

UNIT – IV

PHARMACEUTICALS FROM GM PLANTS & ANIMALS
Beta-carotene in rice, Transgenic "heart-healthy" Canola oil, Edible vaccines – Hepatitis B vaccine in maize, Cholera vaccine in potatoes. Transgenic animals for the production of human blood clotting factor VIII, IX and antithromin III, erythropoietin, tissue plasminogen activator (tPA), alph-antitrypsin, MAbs from animal cell culture.

7 Hours

UNIT – V

FOOD SAFETY AND ETHICAL ISSUES

Risk associated with GM foods – Allergens, toxins, antibiotic resistance, soil contamination - Creation of superbugs and superweeds - Increased risk of immune-suppression and cancer risks – Labeling GM foods – Ethics related to cloning – Biosafety and risk assessment. Potential risks associate with use of herbicide resistant crops- building weed resistance, environmental risks, health risks. **8 Hours**

Case Studies: Current affairs

Course Outcomes:

At the end of this course, the student will be able to

1. Outline the methods producing genetically modified organisms.
2. Summarize various cases of genetically modified plants
3. List and explain transgenic animals and GMOs
4. Explain the significance and production of plant and animal origin pharmaceutical components
5. Inspect safety issues and ethical issues related to GM Foods.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	M									L			L	L
CO2	M												L	L
CO3	M									L			L	L
CO4	M				L					L			L	M
CO5	M					L				L	L		L	L

REFERENCE BOOKS

1. Heller, K. J. *Genetically engineered food – Method and detection,* Wiley – VCH, 2nd Ed., 2006.
2. Carter, C. A., Moschini, G. and Sheldon. I. M. *Genetically modified food and Global welfare*, Frontiers of Economics and Globalization, Emerald Group Publishing Limited, 1st Ed., 2011.
3. Nottingham, S. *Eat your genes: How genetically modified food is entering your diet,* Zed Books Ltd, 2nd Ed., 2003.
4. Shain-Dow, K. *Biotechnology and Food Quality,* Butterworth, 1989.
5. Freedman, J. *Genetically modiefied food – How Biotechnology is changing what we eat,* The Rosen Publishing Group, Inc., 1st Ed., 2009.
6. Thomas, J. A. Biotechnology and safety assessment, Taylor and Francis, 2nd Ed. 1999.

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PROJECT PHASE - II

Sub Code : 13BT802 **Credits : 10**
Hrs/Week : 0+0+15+0 **Total Hours: NA**
***Prerequisites*:** Nil

***Corequisites*:** Nil

Course Learning Objectives:

The objective of this course is
1. To expose the students to research aspects like literature review, executing experiments and analysis of results.
2. To gain experience in documentation and report writing.

Course Description: A group of students (not more than 4) is assigned to a research coordinator/guide. The students must do a thorough literature review and come out with a project plan. They are expected submit a project proposal (not more than 10 pages) including project idea, protocols, designs (if any), expected outcome, major requirements, and approximate budget. They shall present the same in a proposal seminar in front of the panel of internal examiners (involving guide) and shall get their proposal approved. The presentation must involve projected time line of the project execution.

Evaluation Pattern:

CIE: Shall involve project proposal, proposal seminar, continuous evaluation of the project progress by Guide and HOD.

SEE: SEE marks shall have weightage for final report, viva voce, and presentation at EXPRO (Final year project competition organized by NMAMIT, Nitte).

Distribution of Marks:

Continuous Internal Evaluation (CIE):	50 Marks
Semester End Viva voce (SEE):	40 Marks
Presentation in EXPRO 2017:	10 Marks
Project Report:	100 Marks
Total	200 Marks

Course Outcomes:

At the end of this course, the student will be able to
1. Use various methods or sources for finding literature and analyze data for relevance and appropriateness to the research project undertaken.
2. Identify and propose suitable methods of analysis and/or design or develop appropriate experiments to address the specific research objectives.
3. Apply suitable standardized method/s for experimental design.
4. Analyze and interpret the research findings and compare with reported results in order to arrive at suitable conclusions.
5. Adopt appropriate documentation protocol to organize research findings, learn good laboratory practices and work in a team.

Mapping of POs & COs:

PO / CO	a	b	c	d	e	f	g	h	i	j	k	PSO		
												1	2	3
CO1	L	L			M	M	L	M	M	L	H	L	L	M
CO2	L	H	L	H	L	L	M		M			L	H	M
CO3	L	L	M	H	L	L	M	M	M			L	H	M
CO4	L	M				M	M	M	M		M	L	H	M
CO5	L					M	M	L	M	L		L	L	L

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