**CENTRE FOR BIOTECHNOLOGY**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**Kukatpally, Hyderabad-500 085, Telangana State, India**

**Master of Science**

**in**

**BIOTECHNOLOGY**

**(FTPG)**

**COURSE STRUCTURE**

**&**

**DETAILED SYLLABUS**

**W.E.F.2015**



# EACH SEMESTER IS APPROXIMATELY 20-21 WEEKS DURATION INCLUDING EXAMINATIONS. EACH PERIOD IS ABOUT 50 MINITUES DURATION. THERE WILL BE NORMALLY FOUR SESSIONS PER DAY EACH OF ABOUT 100 MINITUES DURATION. TWO SESSIONS OF LABORATORY IS EQUIVALENT TO ONE SESSION OF THEORY

**Centre for Biotechnology (CBT)**

**M.SC BIOTECHNOLOGY**

**Course Structure**

**(W.e.f-2015 Batch)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject code** | **II semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | BT-201 | Core Course IV | Analytical Techniques in Biotechnology | 25 | 75 | 4 | - | 4 |
| 2. | BT-202 | Core Course V | Immunology | 25 | 75 | 4 | - | 4 |
| 3. | BT-203 | Core Course VI | Process Engineering Principles | 25 | 75 | 4 | - | 4 |
| 4. | BT-204 | Core Elective II | (i) Environmental Biotechnology(ii) Biopharmaceutical Technology  | 25 | 75 | 4 | - | 4 |
| 5. | BT-205 | Open Elective II | (i) Enzyme Technology(ii) Computer Programming and Data Structures | 25 | 75 | 4 | - | 4 |
| 6. | BT-206 | Laboratory III | Analytical techniques and Immunology Lab  | 25 | 75 | - | 8 | 4 |
| 7. | BT-207 | Laboratory IV | Process Engineering Principles and Environmental biotechnology/ Biopharmaceutical Technology Lab | 25 | 75 | - | 8 | 4 |
|  |  | **Total** | **175** | **525** | **20** | **16** | **28** |

 **I YEAR**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **I semester** | **Course Title** | **Int. Marks** | **Ext.****marks** | **L** | **P** | **C** |
| 1. 11.
 | BT-101 | Core Course I | Cell Biology | 25 | 75 | 4 | - | 4 |
|  | BT-102 | Core Course II | Biochemistry and Metabolic Regulation | 25 | 75 | 4 | - | 4 |
|  | BT-103 | Core Course III | Molecular Biology and Virology | 25 | 75 | 4 | - | 4 |
|  | BT-104 | Core Elective I | 1. Microbiology
2. Bioethics, Biosafety and IPR
 | 25 | 75 | 4 | - | 4 |
|  | BT-105 | Open Elective I | 1. Basic Mathematics and Biostatistics
2. Bio Business Management
 | 25 | 75 | 4 | - | 4 |
|  | BT-106 | Laboratory I | Cell Biology and Microbiology Lab | 25 | 75 | - | 8 | 4 |
|  | BT-107 | Laboratory II | Biochemistry and Molecular Biology Lab | 25 | 75 | - | 8 | 4 |
|  |  | **Total** | **175** | **525** | **20** | **16** | **28** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject code** | **III semester** | **Course Title** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | BT-301 | Core Course VII | Genetic Engineering | 25 | 75 | 4 | - | 4 |
| 2. | BT-302 | Core Course VII | Bioinformatics  | 25 | 75 | 4 | - | 4 |
| 3. | BT-303 | Core Course IX | Bioprocess Engineering | 25 | 75 | 4 | - | 4 |
| 4. | BT-304 | Core Elective III | (i) Plant Biotechnology(ii) Downstream Processing  | 25 | 75 | 4 | - | 4 |
| 5. | BT-305 | Open Elective III | (i) Nano-Biotechnology(ii) Animal Cell Science and Technology | 25 | 75 | 4 | - | 4 |
| 6. | BT-306 | Laboratory V | Genetic Engineering and Plant Biotechnology/ Downstream Processing Lab | 25 | 50 | - | 6 | 3 |
| 7. | BT-307 | Laboratory VI | Bioprocess Engineering and Bioinformatics Lab | 25 | 50 | - | 6 | 3 |
| 8. | BT-308 | Seminar  |  | 50 | - | - | 4 | 2 |
|  |  | **Total** | **225** | **475** | **20** | **16** | **28** |

**II YEAR**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **IV Semester** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
| 1. | BT-401 |  Project Work Review | 50 | - | - | 8 | 4 |
| 2. | BT-402 |  Project Evaluation (VivaVove) | - | 100 | - | 16 | 12 |
|  | **Total**  |  | 50 | 100 |  | 24 | 16 |

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CORE COURSE I

CELL BIOLOGY

**UNIT-I CELL STRUCTURE AND FUNCTION:** Diversity of cell size and shape; Cell theory; Structure of Prokaryotic and Eukaryotic cells; Plasma membrane structure and function, Cytoskeleton; Microtubules, Intermediate filaments, Microfilaments. Cellular organelles and their organization, Sub-cellular fractionation and criteria of functional integrity.

**UNIT-II INTRA CELLULAR TRANSPORT SYSTEMS:** Active and passive transport of ions, Na+/K+ pump, ATPase pumps, Co-transport, Symport, Antiport, Endo cytosis and Exo cytosis. Intracellular Protein traffic and Targeting.

**UNIT-III CELL CYCLE AND CHECK POINTS:** Cell cycle- Various phases of cell cycle, Interphase, Mitosis, Meiosis and Cytokinesis. Cell cycle Control & Checkpoints. Disruption in cell cycle; Biology of cancer- Types and causes, Classification of tumor.

**UNIT-IV CELL SIGNALING:** Overview, Cytosolic, Nuclear & membrane bound receptors, Concept of Secondary messengers, cAMP, cGMP, Protein kinases, G proteins. Signal transduction mechanisms.

**UNIT-V CELL DIFFERENTIATION:** General characteristics of cell differentiation, Cytoplasmic determinants, Nucleoplasmic interactions; Stem cell differentiation and its Biological importance.

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**TEXTBOOKS:**

1. Molecular Biology of cell, Alberts. B et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and inheritance, EB Wilson, MacMilan, New York.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall

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CORE COURSE II

 **BIOCHEMISTRY AND METABOLIC REGULATIONS**

**UNIT-I FUNDAMENTALS OF BIOCHEMISTRY:** Water, pH, pK, buffers, covalent bond, non-covalent interactions.

**Bioenergetics:** free energy, enthalpy, entropy, laws of thermodynamics, high energy compounds.

**UNIT-II BIOMOLECULES:** Classification, physical and chemical properties of carbohydrates, lipids, amino acids and proteins; protein structural hierarchy, ramachandran plot; nucleotides and nucleic acids; Pigments and storage materials.

**UNIT-III** **METABOLISM: Anabolism of biomolecules** – carbohydrates – synthesis of carbohydrates, HMP shunt, Biosynthesis of lipids, Biosynthesis of amino acids – Glutamate, Tyrosine, Proline.

Lipids – oxidation of fatty acids – saturated and unsaturated, fatty acids with odd no of carbon atoms.

**UNIT-IV:** **METABOLISM: Catabolism of biomolecules** – Carbohydrates- aerobic and anaerobic fate of carbohydrates, E.T.C, (GLYCOLYSIS,TCA cycle, Gluconeogenesis,Pentose phosphate pathway, glycogen metabolism).

Proteins – deamination, transamination of amino acids – eg; L-Aspargine, L-valine, L-phenyl alanine.

**UNIT-III Photosynthesis:** Bacterial & Plant photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll

as trapper of solar energy, photosynthetic reaction centres, Hill reaction, PS I & PS II,

Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO2 fixation

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**TEXT BOOKS:**

1. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
2. Biochemistry L. Stryer Third Edition

**REFERENCE BOOKS:**

1. Biochemistry White, Handler and R.B. Smith 7th Ed. 1983
2. Principles of Biochemistry A. Lehninger 1987.
3. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand and Company Ltd.

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CORE COURSE III

**MOLECULAR BIOLOGY AND VIROLOGY**

**UNIT-I DNA & RNA:**

**DNA:** Structure and types of DNA, Replication and repair mechanisms. Eukaryotic chromosome Structure. Repetitive DNA. CpG islands, Gene Families, Gene amplification. Gene Arrangement and regulatory elements.

**RNA:** Different classes of RNA and their functions.

**UNIT II GENE EXPRESSION: TRANSCRIPTION:**Transcription in prokaryotes and eukaryotes, other post transcriptional modifications, RNA editing, transport mechanisms (exportins & importins).

**UNIT-III GENE REGULATION:** Regulations of gene expression in prokaryotes (Lac. Ara and His operons). Transcriptional controls in Eukaryotes (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure/Transacting elements); Regulation at Post-transcriptional lelvel.

**UNIT-IV GENE EXPRESSION - TRANSLATION:** Genetic code, Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications, translational controls and inhibitors of polypeptide synthesis, protein targeting, Nucleic acid sequencing and recent developments.

**UNIT-V STRUCTURE & REPLICATION OF VIRUSES:** Structure and classification of viruses and Replication of bacteriophages , plant & animal viruses. A note on SV40 and HIV (Retro viruses) in transformation.

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**TEXT BOOKS:**

1. “Molecular Biology of the gene” by Waston et al 4th edition.
2. “Genes VI” by Benjamin Lewis
3. Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.

**REFERENCE BOOKS:**

1. “Genetics” by Ursula Goodenough
2. “Cytogenetics” by lGarl P. Swanson, Mertz & Young
3. “General Virology” by Luria & Darnell
4. “Biochemistry” by Stryer.

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CORE ELECTIVE I

**1. MICROBIOLOGY**

**UNIT-I INTRODUCTION TO MICROBIOLOGY**: Scope and history of Microbiology, Characterization, Classification and identification of microorganism, Microscopic examination (Staining and microscopic techniques), Pure culture techniques, Isolation and preservation. Control of micro organisms by physical and chemical agents.

**UNIT-II MICROBIAL MORPHOLOGY, NUTRITION AND GROWTH:** Principles of microbial nutrition, Design of culture media; Enrichment culture techniques, Morphology and fine structure of bacteria, Cell wall structure in details, Reproduction and growth, Growth kinetics.

**UNIT-III: OVERVIEW OF MICROBIAL METABOLISM AND CHARACTERIZATION:** Aerobic (Glycolysis, TCA, ET pathways) and Anaerobic (Lactic acid, Acetic acid fermentation) respirations, Products of Microbial Metabolism (Primary and secondary metabolites); Biochemical Characters and tests for identification of bacteria (Carbohydrate Utilization, Gelatin Liquefaction test, Amylase test, H2O2 test, Nitrate reduction test, Sulfate reduction test, IMViC,).

**UNIT-IV: OTHER MICROBES AND THEIR CLASSIFICATION:** Archea, Actinomycetes, Fungi, Algae and Protozoa, Mycoplasma, Ricketssia

**UNIT-V: MICROBIAL INFECTIONS:** Identification of Microbial Infections; Disease reservoirs (vectors); Epidemiology; Infectious disease and their transmission: Air (Tuberculosis), water (Typhoid,) and vector borne (Malaria), Food borne (Botulism), Zoo borne (Rabies,) STD diseases (AIDS) and treatment strategies.

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**TEXTBOOKS:**

1. Microbiology, Michael J Pelczar Jr, E.C.S.Chan and Noel R. Krieg, Tata McGraw-Hill Edition (5th Edition)
2. General Microbiology 5th Edition Stanier *et al*.
3. Text of Microbiology, D.K.Maheshwari and R.C.Dubey, S. Chand Publication Reprint 2009
4. Ananthanarayan and Paniker’s Text of Microbiology, Edited by C K J Paniker University Press (3rd Edition) 2008

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CORE ELECTIVE I

**2. BIO ETHICS , BIOSAFETY & INTELLECTUAL PROPERTY RIGHTS**

**UNIT I:** **BIOETHICS: PRINCIPLES OF BIOETHICS, ETHICS IN CLINICAL RESEARCH:** History structure regulation impact of Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF), shared responsibilities for decisions and the understanding of the risk.

**UNIT II: BIOSAFETY CONCEPTS & REGULATIONS:** Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol, Use of genetically modified organisms and their release in to the environment.Special procedures for r-DNA based products. International dimensions in Biosafety. Biotechnology and food safety. Case study – Bt Cotton, Bt Brinjal

**UNIT III: INTRODUCTION TO IPR & PATENTS:** Discovery, Creativity, Innovation, Invention, Need for IPR, Types of IPR, Genesis & development of IPR in India, Definition, Scope, Protection, Patentability Criteria, Types of Patents (Process, Product & Utility Models), Software Patenting. Types of searching, public & private searching Databases. Drafting & Filing of Patent applications, Patent Cooperation Treaty (PCT). Patent infringement.

**UNIT IV: OTHER TYPES OF IPR:** Copyrights – Definition, granting, infringement, searching & filing, distinction between copy rights and related rights; Trade Marks - role in commerce, importance, protection, registration, domain names; Trade Secrets, Unfair competition; Industrial Designs – Scope, protection, filing, infringement; Semiconductors, Integrated Circuits & Layout design; Geographical Indications & Appellations of Origin; Case Studies.

**UNIT V: IPRS AND BIOTECHNOLOGY:** Plant variety Protection, Farmers & Breeders Rights, Indian Biodiversity Act, Protection of Traditional Knowledge, Biopiracy & Bioprospecting, ITPGRFA, Budapest Treaty & IDA, Biotechnology Patenting issues, Gene Patenting, Case studies (Diamond vs Chakravarthy, Dimminaco AG vs. Controller of Patents, Basmati Rice, Turmeric, Neem, Harvard Oncomouse, Transgenic Plant Patents)

**TEXT BOOKS:**

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007.
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights,
4. Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

**REFERENCES:**

1. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
2. Anitha Rao R & Bhanoji Rao “Intellectual Property Rights – A Primer”, Eastern Book Company, 2008.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. M. M. S. Karki , Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009
5. Neeraj Pandey & Khushdeep Dharni, Intellectual Property Rights, Phi Learning Pvt. Ltd
6. Ajit Parulekar and Sarita D’ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
7. B. L. Wadehra. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
8. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

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OPEN ELECTIVE I

**1. BASIC MATHEMATICS & BIOSTATISTICS**

UNIT-I DIFFERENTIAL CALCULUS: Functions, limit continuity and differentiation. Differentiation of sum, product and quotient of function. Differentiation of implicit, trigonometrically universe trignomentrical functions; Differentiation of impllict, trigonometrical universe trigonometrical functions, Partial differentiation; Eulers theorem on homogenous function; Maxima and minima, Errors and approximation.

UNIT-II INTEGRAL CALCULUS: Basics, Methods of substitution integration by parts. Integration of national, irrational, trignometrical functions, Definite integrals; Areas (Cartesianas and parametric) Trapezoidal rule. Simpsons 1/3 rule; Ordinary differential equations of First order. Formation and method of variable separable, simple applications.

UNIT-III MATRICES: Basics, Determinants addition and subs traction of and multiplication of Matrices. Adjoint, Universe of a matrix, Rank of matrix; solution of linear system of equations, elementary operations, Gauss-Jordan method – Matrix inversion

UNIT-IV INTRODUCTION TO STATISTICS: population-sample –primary data and secondary data - graphical and diagrammatic representation of data- Measure of central tendency-Mean, median and mode-measure of dispersion-range-standard deviation -raw and central moments-skewness and kurtosis(definition only)-Concept of probability –classical and relative frequency definition of probability-addition and multiplication laws of probability ( without proofs) and examples.

UNIT-V CONCEPT OF RANDOM VARIABLES: Probability mass function-probability density function-probability distribution function (definitions only) - Binomial, Poisson and Normal distribution (definitions and statements of properties and examples).Principles of least square-fitting of straight line-parsons coefficient of correlation and concept of linear regression.

Tests of Significance: Concept of testing of hypothesis critical region-two type errors-level of significance of large sample tests for single mean and difference of means. single proposition and difference proportion- chi square test for goodness of fit and chi square test of means and f-test for equality of variances-arithmetic, Geometric and harmonic mean.

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**TEXTBOOKS:**

1. Statistical methods S.P.Gupta. S Chand Pubplications
2. Business Statistics by S.P Gupta & M.P.Gupta
3. Engineering Mathematics - N.P. Bali and others.
4. Engineering mathematics - B.V. Ramana

REFERENCES:

1. Differential Calculus - Shanthi Narayan

2. Integral Calculus - Shanthi Narayan

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OPEN ELECTIVE I

**2. BIOBUSINESS MANAGEMENT**

**UNIT I: INTRODUCTION TO BIOBUSINESS:** Principles of business management and concept of Biobusiness, SWOT analysis of Indian Biobusiness. **Project formulation** Project formulation and selection based on size, technological assessment, technical report, feasibility and commercial viability of project.

**UNIT II: PROJECT COST AND MARKET POTENTIAL:** Total product cost, capital investment and profitability, manufacturing costestimation, capital investment estimation, Risk capital and working capital,manufacturing cost estimation for an intracellular protein, using cost analysis for R& D decision making.

**UNIT III: LEGAL PROTECTION IN BIOTECHNOLOGY:** Regulatory and IPR issues in Biotechnology, Intellectual Property Protection (IPP), Trade secret protection, licensing of bio-product, procedure for obtaining US patent, characteristics of the disclosure for a biotechnology invention, marketing a biotechnology invention, trade regulations.

**UNIT IV: BIO-SAFETY:** General guidelines (GLP, GMP), containment facilities, types of containment, guidelines for recombinant DNA research, release of genetically modified

organisms (GMOs), ISO Series, GATT.

**UNIT V: INDUSTRIAL SICKNESS:** Symptoms, Control and rehabilitation and sick units. **Ethics in Biotechnology:** Statutory requirements of social responsibility and entrepreneurial discipline.

**BOOKS:**

1. Patent Law - P. Narayan
2. Economic reforms and Indian markets - S. L Rao
3. Manual of Industrial Microbiology and Biotechnology - A. L. Demain and N.A.

Solomon

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LABORATORY I

**CELL BIOLOGY & MICROBIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (CELL BIOLOGY)**

1. Microscopy: Compound Microscope
2. Motility of bacteria
3. Protoplast isolation
4. Cell cycle analysis
5. Isolation of Chloroplast
6. Feedback inhibition

### PART-B (MICROBIOLOGY)

1. Isolation, Purification & Quantification of bacteria
2. Factors affecting bacterial growth
3. Determination of thermal death point
4. Determination of antimicrobial activity (Disc diffusion, cup plate method)
5. Determination of minimum inhibitory concentrations
6. Transformations: Bacteria
7. Quantification of Viruses: Plaques

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LABORATORY II

**BIOCHEMISTRY & MOLECULAR BIOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (BIOCHEMISTRY)**

1. Titration of amino acids.
2. Determination of pK
3. Reactions ofamino acids, sugars and lipids- quantitative reactions
4. Analysis of oils-iodine number, saponification value, acid number.
5. UV, Visible, Absorption spectra.
6. Centrifugation, TLC & SDS-PAGE –Silver staining
7. Estimation of inorganic phosphorus by Fiske Subbarao Method
8. Isolation and estimation of protein using various colorimetric and spectrophotometric methods.

**PART-B (MOLECULAR BIOLOGY)**

1. Isolation of Nucleic Acids: Genomic DNA, Plasmid, RNA

2. Quality check for Isolated Nucleic Acids: Spectrophotometric (UV Method)

3. Visualization: Electrophoresis (Detection and separation of NA)

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CORE COURSE IV

**ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY**

UNIT I: MICROSCOPY

Bright field, Dark field, Fluorescent, Phase contrast, confocal microscopy, SEM & TEM Microscopy, Flow Cytometry.

UNIT II: SPECTROSCOPY

Beer – Lambert’s Law and apparent deviations, UV - VIS Spectrophotometer, Spectrofluorimeter, Principle and applications of Atomic absorption & Atomic emission spectroscopy.

UNIT III: SEPARATION TECHNIQUES

X-ray Diffraction, Optical Rotatory dispersion, Circular dichromism,Sedimentation, Centrifugation and Filtration, Electrophoresis of proteins and nucleic acids, 1D and 2D Gels, Types of Electrophoretic techniques (Capillary and Pulse field). Electrophoresis: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immuno precipitates (Immuno electrophoresis), Peptide mapping, IEF; Chromatography: Adsorption, affinity, Ion exchange, gel permeation, TLC, GLC, RPC, HPLC etc.

UNIT IV: RADIOACTIVITY AND FLOURESCENCE BASED METHODS:

Radioactivity, measurement of radioactivity, photographic emulsion, ionisation chamber, autoradiography, RIA, Fluorescent and Chemiluminiscent methods, Fluorescent Probes, FISH.

**UNIT-V SEQUENCING OF PROTEINS AND NUCLEIC ACIDS**: N-terminal sequencing for determination of protein sequence (Edman degradation); MALDI-TOF analysis. Nucleic acid sequencing automated methods (Sangers Dideoxy and Maxim Gilbert methods) and determination technologies

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TEXT BOOKS:

1. Biophysical Chemistry Principles & Techniques by Upadhya & Upadhya 4th edition, Himalaya Publishing House, 2012.

2. Instrumental methods of chemical analysis – Gurudeep R.Chatwal 7 Sham K Anand, Himalaya Publishing house, ISBN

REFERENCE BOOKS:

1. Hobert H Willard D. L. Merritt & J. R. J. A. Dean, Instrumental Methods of Analysis, CBS Publishers & Distributors, 1992
2. Vogal, Text Book of Quantitative Inorganic Analysis, 1990
3. Ewing, Instrumental Methods of Analysis, 1992
4. Pranb kumar Banerjee,Introduction to Biophysics, S.chand Publications,2008.
5. Instrumental methods of chemical analysis-Gurudeep R.ChatwAL 7 Sham K.Anand,Himalaya Publishing house,ISBN.
6. Principles & Techniques of Practical Biochemistry 5th edition. K. Wilson & J.Walker, Cambridge University Press, 2000.

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CORE COURSE V

**IMMUNOLOGY**

**UNIT-I INTRODUCTION** - Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response, Humoral and Cell mediated immunity, Nature and Biology of antigens haptens, immunogens and super antigens, applications of adjuvants.

**UNIT-II ORGANIZATION AND STRUCTURE OF LYMPHOID ORGANS:** Lymphoid follicle, Thymus Lymph node, Spleen, MALT, CALT, SALT. Skin associatetd Lymphoid Tissue.

Cells of the immune system: Hematopoiesis and differentiation, Inflammation (IL6), Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells (IL2).

**UNIT-III:** **HUMORAL IMMUNITY:** BCR and generation of Immunoglobulin diversity, Activation of B-Lymphocytes,Antibody structure and function, Hybridoma Technology and Monoclonal antibodies, Antigen- antibody interactions**.**

**UNIT-IV CELL MEDIATED IMMUNITY:** Major histocompatibility complex, MHC restriction, Antigen processing and presentation, TCR, generation of diversity, generation of cell mediated immune responses, Mechanism of T cell cytotoxicity, Antibody dependent cell mediated cytotoxicity.

**UNIT-V AUTOIMMUNE DISORDERS, INFECTIONS AND TRANSPLANTATIONS:** Rheumatoid arthritis, Insulin dependent Diabetes Melletus, Diphtheria (bacteria), Hepatitis, Transplantation, Vaccination for disease control.

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**TEXT BOOKS:**

1. Kuby Immunology (Kindt, Kuby Immunology) - Thomas J. Kindt, Barbara A. Osborne, Richard

 A. Goldsby, publisher: W. H. Freeman, 2006

2. Immunology- David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby, 2006

**REFERENCE BOOKS:**

1. Fundamental Immunology- William E Paul, publisher: Lippincott Williams & Wilkins, 2008

# 2. Immunology, Infection, and Immunity - Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler,

#  Publisher: ASM Press, 2004

3. Lecture Notes: Immunology, 5th Edition- Ian Todd, Gavin Spickett, publisher: Wiley-

 Blackwell, 2005

4. Immunology: A Short Course- Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell,

 2009

5. Cellular and Molecular Immunology- Abul K. Abbas MBBS, Andrew H. Lichtman MD PhD,

 Shiv Pillai MD, publisher: Saunders, 2007

6. Roitt's Essential Immunology (Essentials) - Peter Delves, Seamus Martin, Dennis Burton,

 Ivan Roitt, publisher: Wiley-Blackwell, 2006

7. Schaum's Outline of Immunology- George Pinchuk, publisher: McGraw-Hill, 2001.

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CORE COURSE VI

 **PROCESS ENGINEERING PRINCIPLES**

**UNIT-I PROCESS CALCULATIONS & THERMODYNAMICS:** Overview of Chemical Engineering, Concepts of Unit operations & Unit processes with examples, Units & Dimensions, Stoichiometric principles, Law of conservation of mass, Material balance with and without chemical reactions.

**Thermodynamics:** Scope of Thermodynamics, Force, Temperature, Volume, Pressure, Work, Energy, Heat, Heat capacities, Enthalpy, Law of thermodynamics.

**UNIT-II UNIT OPERATION & FLUID MECHANICS:** Introduction, Characterization of solid particles, Screen analysis, Size reduction – law of crushing, various types of size reduction equipment.

**FLUID MECHANICS:** Fluid Flow, Newton’s law of viscosity, Classification of Fluids, Hydrostatic Pressure, Manometers, Continuity equation, Bernoulli’s equation & Its applications, Metering & Transportation of fluids using orifice meter, venture meter & Rota meter.

**UNIT-III HEAT TRANSFER:** Modes of heat transfer with examples, Conduction – Fourier’s law, one dimensional conduction through plane wall, composite wall, cylinder and spherical system.

**CONVECTION:** Introduction, natural and forced convection, Concept of heat transfer coefficient, relationship between Individual and overall heat transfer coefficient.

**UNIT-IV RADIATION & HEAT TRANSFER EQUIPMENT:**

**Radiation:** Introduction, Black body, Laws of black body; Kirchoff’s law, Stefan-Boltzmann law, Wein’s displacement law.

**Heat Transfer Equipment:** Overview of heat exchangers-types and temperature area graphs, Concept of LMTD. Concepts of Biology & evaporation-types of boiling & its mechanism, evaporation and types of evaporators.

**UNIT-V MASS TRANSFER:** Introduction, Molecular diffusion, Fick’s law of diffusion, diffusivities of gases and liquids, Theories of mass transfer, Concept of mass transfer coefficients, Principles of Absorption, Adsorption, extraction, Distillation and Drying.

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**TEXT BOOKS:**

1) Unit operations of Chemical Engineering, (1993), by McCabe, Smith and Harriott, McGraw

 Hill publishers.

2) Introduction to Biochemical Engineering, Second edition, By D G Rao, Tata McGraw Hill

 Publications.

3) Bioprocess Engineering principles By Pauline M Doran, Academic Press.

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CORE ELECTIVE II

**1. ENVIRONMENTAL BIOTECHNOLOGY**

**UNIT-I INTRODUCTION:** Introduction to Environmental pollution, Air, water and soil pollution-common effects and control measures.

**Air Pollution Treatment:** Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste:

**UNIT-II WASTE WATER TREATMENT:**

**Water:** Water Pollution and treatment technologies (clean technology). Waste water types, major contaminants in waste water. Physical, chemical and biological methods of waste water treatment.

**Aerobic:** Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactor.

**Anaerobic:** Contact Digesters, Packed Column Reactors, UASB biological treatment process.

**UNIT-III MANAGEMENT OF WASTE:** Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting.

**UNIT-IV** **BIOREMEDIATION:**  Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

**UNIT-V** **BIOENERGY & BIOMINING:**

**Bio Energy:** Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass. **Biomining:** Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

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**REFERENCE BOOKS:**

1. Wastewater Engineering-Treatment, Disposal, and Resuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Industrial Pollution control Engineering- AVN Swamy., Galgotia Publication, (2006).
3. Environmental Biotechnology- Allan Stagg.

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CORE ELECTIVE II

**2. BIOPHARMACEUTICAL TECHNOLOGY**

**UNIT I: PROKARYOTIC AND EUKARYOTIC CELLS IN BIOTECH PRODUCTION**: Actinomycetes in BiotechProduction, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in BiotechProduction, Transgenic Plants as Functional Foods or Neutraceuticals Transgenic Plants andPlant Cell Culture as Bioreactors of Secondary Metabolites, Transgenic Plants as Bioreactors ofRecombinant Protein.

**UNIT II: DRUG MODIFICATIONS:** Pharmacodynamics of protein therapeutics; Chemical modificationof proteins/ therapeutics; Immuno suppressor in antibody therapy; PharmacoGenomics.**,**Molecular modification of lead compounds; Assay systems and models (e.g., KnockoutMice). Antisense technology as cell based therapeutics.

**UNIT III: PHARMACEUTICALS PRODUCTION IN PLANTS:** Drugs derived from plants, , Antitumor agent -Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic – Convallatoxin,Acetyldigoxin, Adoniside, Antiinflammatory – Aescin, Bromelain, Choleretic – Curcumin,Biopharmaceuticals Expressed in Plants Alternative Expression Systems, Three PromisingExamples: Tobacco (Rhizosecretion, Transfection) and Moss (Glycosylation).

**UNIT IV: DNA VACCINES AND ANTIBODY DRUG:** DNA Vaccine Construction and Immunology DNAVaccine Expression Plasmids Delivery of DNA Vaccines. Peptide vaccine, Gene Pharming,Cytokines as biopharmaceuticals, Rituximab, therapeutic enzymes.

**UNIT V: BIOGENERIC DRUGS RECOMBINANT THERAPEUTIC PROTEINS:** Erythropoietin (EPO), ColonystimulatingFactors (CSFs), Human Growth Hormone (hGH), Insulins, Hepatitis B Vaccine,Factor VIII (FVIII), Interferons (IFN) **.**Therapeutic hormone- insulin production throughrecombinant DNA technology.

**BOOKS:**

1. Pharmaceutical Biotechnology; Oliver Kayser, Rainer H. Müller, Wiley Publishers, 2005.
2. Drug Discovery and Clinical Applications; Heinrich Klefenz, 2002.
3. Industrial Pharmaceutical Biotechnology, WILEY-VCH Publication, Germany. Daan Crommelin, Robert D Sindelar, 2002.
4. Pharmaceutical Biotechnology; Tailor and Francis Publications, Newyork. Jay P Rho, Stan G Louie, 2003, Hand.

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OPEN ELECTIVE II

**1.ENZYME TECHNOLOGY**

**UNIT-I FUNDAMENTALS OF ENZYMES:** Chemical Nature of enzymes, enzyme nomenclature, sources of enzymes, Isolation of enzymes from different sources, Screening for novel enzymes, media for enzyme production, Enzyme assay methods, purification of enzymes, preparation of enzymes, industrially important enzymes, safety and regulatory aspects of enzyme use.

**UNIT-II ENZYME CATALYSIS**: active site, substrate, transition state, activation energy, binding energy, enzyme specificity, Thermodynamics of enzyme catalysis; mechanism of enzyme action- covalent catalysis, metal ion catalysis, general acid-base catalysis, Induced-fit, proximity and orientation, factors affecting enzyme activity.

**UNIT-III ENZYME KINETICS**: First, second, zero and pseudo-order kinetics; Pre-steady and steady-state kinetics; Derivation of Michaelis-menten equation, Km, V max, turnover number, catalyte efficiency, specificity constant, linear transformation to M.M equation, kinetics of bi-substrate reactions, Random and sequential order, Ping-pong mechanism, Differentiation of different mechanism of bi substrate reactions.

**UNIT-IV REGULATORY ENZYMES:** Allosteric enzymes**-** MWC model and KNF model, kinetic properties of allosteric enzymes; Isoenzymes, Multienzyme complexes and multifunctional enzymes Enzyme Inhibition**;** Reversible and irreversible inhibition and kinetic properties.

**UNIT-V MECHANISM OF ENZYME ACTIVITY AND APPLICATIONS:** Structure and activity of the enzymes, Mechanism of action of chymotrypsin, lysoenzyme. Various techniques used for the immobilization of enzymes; Applications of immobilized enzyme in Biotechnology. Enzyme activity in non- aqueous media and their industrial applications.

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**TEXT BOOKS:**

1. Biochemical Engineering fundamentals by J E Bailey and D F Ollis, 2nd ed, McGraw-Hill 1986.
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by T. Palmer Horwood Publications 2001.
3. Enzymology by Devasena, Oxford higher education 2010.
4. Enzyme technology, Pace maker of Biotechnology by Nooralabettu Krishna Prasad, Easter Economy Edition 2011.
5. General Enzymology by Kulkarni, Deshpande, Himalaya publishing house 2007.

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OPEN ELECTIVE II

**2. COMPUTER PROGRAMMING AND DATA STRUCTURES**

**UNIT - I**

Introduction to Computers – Computer Systems, Computing Environments, Computer Languages, Creating and running programmes, Software Development Method, Algorithms, Pseudo code, flow charts, applying the software development method.

**UNIT - II**

Introduction to C Language – Background, Simple C Programme, Identifiers, Basic data types, Variables, Constants, Input / Output, Operators. Expressions, Precedence and Associativity, Expression Evaluation, Type conversions, Bit wise operators, Statements, Simple C Programming examples.

Selection Statements – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, goto, Simple C Programming examples.

**UNIT - III**

Designing Structured Programmes, Functions, basics, user defined functions, inter function communication,

Standard functions, Scope, Storage classes-auto, register, static, extern, scope rules, type qualifiers, recursion- recursive functions, Preprocessor commands, example C programmes

Arrays – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays, C programme examples.

Strings – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion, C programme examples.

**UNIT - IV**

Input and Output – Concept of a file, streams, standard input / output functions, formatted input / output functions, text files and binary files, file input / output operations, file status functions (error handling), C programme examples.

**UNIT - V**

Data Structures – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack application-infix to postfix conversion, postfix expression evaluation, recursion implementation, Queues-operations, array and linked representations.

**TEXT BOOKS :**

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Pearson

 education.

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LABORATORY III

 **ANALYTICAL TECHNIQUES & IMMUNOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (ANALYTICAL TECHNIQUES)**

1. Microscopy
2. Electrophoresis of Proteins - native and under denaturing conditions –silver staining, coomassie staining.
3. Determination of Tm of nucleic acid.
4. Séparation techniques (HPLC, GPC, FPLC, Ion-Exchange).
5. IEF Demonstration

**PART-B (IMMUNOLOGY)**

1. Radial immuno diffusion,
2. Ouchterolony double immuno diffusion
3. Dot blot,
4. Immuno electrophoresis,
5. ELISA
6. Purification of antibodies,
7. Lateral flow diagnostics – HCG, malaria, Tuberculosis (Kits)
8. Blood grouping – Agglutination,

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 LABORATORY IV

**PROCESS ENGINEERING PRINCIPLES & ENVIRONMENTAL BIOTECHNOLOGY / ENZYME TECHNOLOGY LABORATORY**

**LIST OF EXPERIMENTS:**

 **PROCESS ENGINEERING PRINCIPLES**

**Fluid Mechanics**

1. Reynold’s apparatus (Demo)
2. Bernouli’s Theorem (Verification)
3. Determination of friction factor of Pipeline
4. Determination of Coefficient of Discharge by venturimeter, orifice meter and notch
5. Flow measurement with Rota meter

**Heat Transfer**

1. Thermal Conductivity of insulating material
	1. Searles apparatus
	2. Concentric sphere
	3. Lee’s disc apparatus
	4. Lagged pipe
2. Heat Transfer coefficient from a vertical tube and free convection

**PART- A ENVIRONMENTAL BIOTECHNOLOGY**

1. Biological Oxygen Demand
2. Chemical Oxygen Demand
3. MPN
4. Coli form bacteria
5. Reduction of BOD & COD after incubation with microbes

**PART- B BIOPHARMACETUICAL TECHNOLOGY LAB**

* + 1. Isolation of Pharmaceutically important phytochemicals from crude drugs.
		2. TLC characterization of medicinal plant extracts and isolation of phytochemicals.
		3. CC Characterization of medicinal plant extracts and isolation of phytochemicals.
		4. Secondary metabolite extraction from plant cell suspensions.
		5. Chemical tests for alkaloids, glycosides, steroids, flavonoids, tannins and resins.
		6. Estimation of plant phytoconstituents using HPLC.

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CORE COURSE VII

**GENETIC ENGINEERING**

**UNIT-I SCOPE OF GENETIC ENGINEERING:**  Milestones in Genetic Engineering, Biosafety issues – Genetic engineering guidelines; Patenting of life forms.

Molecular Tools in Genetic Engineering – Restriction enzymes and DNA Modifying enzymes (Polmerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc.).

DNA and RNA markers. Restriction mapping of DNA fragments and Map construction, Nucleic acid Amplification (PCR analysis) and its applications.

**UNIT-II BASIC PRINCIPLES OF GENE CLONING AND DNA ANALYSIS:**Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids), cloning vectors for yeast, plants and animals, (Artificial chromosomes, Agrobacterium tumifacience, Ti and Ri plasmics, p elements, insect virus based vectors), Gene cloning without vector, transformation and selection of recombinants.

**UNIT-III GENE EXPRESSION AND DETECTION:** Gene expression in bacteria and Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants, Phage display, Yeast Two- and three Hybrid system, micro array.

Detection of gene (Southern), m RNA(Northern), protein (Western); Dot and Slot blot; Genomic and cDNA library construction and application.

**UNIT-IV TRANSGENIC TECHNOLOGY:** Gene tagging (T-DNA tagging and Transposon tagging) in gene analysis (identification and isolation of gene), Transgenic and Gene Knockouts Technologies - Targeted gene replacement, Chromosome engineering, Gene Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing and silencing.

**UNIT-V APPLICATIONS OF GENETIC ENGINEERING** Genome sequencing projects, Site-directed Mutagenesis and Protein Engineering, RNAi, Antisense technology, Ribozymes.

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**TEXTBOOKS:**

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

**REFERENCES:**

1. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.
2. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
3. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
4. DNA Science. A First Course in Recombinant Technology, D,A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New YorK, 1990.
5. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
6. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
7. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.

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CORE COURSE VIII

**BIOINFORMATICS**

UNIT-I Introduction to Bioinformatics & Sequencing alignment CONCEPTS:

Need of Computers in Biotechnology Research; File Transfer Protocol (FTP), TELNET,HTTP; Bioinformatics- Introduction, Scope, Applications; Strings, Edit distance, Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment.

UNIT-II biological Databases and datamining:

Biological Information on the web- Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (RASMOL).

UNIT-III Phylogenetic analysis and prediction: Understanding Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods, Tools & Problems (Clustal W).

UNIT-IV genOME MAPPINg and prediction:

Genome sequencing; Genome Mapping; Comparative Sequence Analysis; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP).

**RNA Sequence and structure Analysis** - si-RNA design and development, micro RNA identification strategies, RNA secondary structure, RNA structure Prediction Methods.

**UNIT-V PROTEIN STRUCTURE PREDICTION METHODS:**

Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods)

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**TEXT BOOKS:**

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
2. Bioinformatics Basics, Applications in Biological Science and Medicine- Hooman
3. Bioinformatics: Genome and sequence analysis by David W Mount.
4. Bioinformatics: A practical guide to analysis of genes and proteins by Baxevanis, Andreas D Wiley – Interscience publishers.

**REFERENCE BOOKS:**

* 1. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, Jhon Wiley & Sons
	2. Essential Bioinformatics : by Jin Xiong, Cambridge University Press
	3. Bioinformatics Principles & Applicatrions by Zhumur Ghosh, Oxford University Press.

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CORE COURSE IX

**BIOPROCESS ENGINEERING**

**UNIT-I INTRODUCTION TO BIO PROCESS ENGINEERING:** Introduction to Biotechnology and Bioprocess Engineering, bioprocess techniques, biotechnology products. Raw material used for industrial fermentation and processing, chemical, physical and physiochemical treatment.

**Media for Industrial Fermentation:** Introduction, types of media, media formulation; water, carbon source, energy source, nitrogen source, minerals, buffers, precursors, etc,,

**UNIT-II MEDIA FOR INDUSTRIAL FERMENTATION:** Media optimization techniques with special emphasis on statical techniques, Placket-Burman design, response surface methodology, central composite design, etc.

**Sterilization:** Introduction, media sterilization, the design of batch sterilization process, the design of continuous sterilization process, sterilization of fermentor, sterilization of feed, sterilization of air and filter design.

**UNIT-III MICROBIAL KINETICS:** Kinetics of microbial growth and death, Monod equation, yield coefficient, conversion, selectivity.

**Overview of Ideal Bioreactors:** Batch reactor, Continuous Stirred Tank Reactor (CSTR), Fed batch and Plug Flow reactors, Cascade reactors, Recycle reactors, Air lift reactor, fluidized bed bioreactors, Immobilized bed bioreactors, etc,.

**Transport Phenomena in Bioprocess Systems:** Introduction, oxygen transfer process, oxygen transfer by aeration and agitation. Determination of oxygen transfer coefficient by various methods. Factors affecting oxygen transfer coefficient.

**UNIT-IV DOWNSTREAM PROCESSING:** Introduction, removal of microbial cells and solid matter, foam based separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment and disposal**.**

**UNIT-V APPLICATIONS OF BIOPROCESS-I:** Alcohol (Methanol, Butanol, Ethanol, etc), Acids (citric acid, Acetic acid, Gluconic acid etc), Solvents (glycerol, Acetone, Butanol etc).

**Applications of Bioprocess-II:** Antibiotics (penicillin, Streptomycin, tetracycline) Amino acids (Lysine, Glutamic acid), Single Cell Protein, Mineral beneficiation & Oil recovery.

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**TEXT BOOKS:**

1) Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986

2) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987

3) Introduction to Biochemical Engineering by Dr D G Rao.the Mc Graw Hill companies

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CORE ELECTIVE III

**1. PLANT BIOTECHNOLOGY**

**UNIT-I PLANT TISSUE CULTURE & TOTIPOTENCY:** Totipotency,Different areas and applications of plant tissue culture, Nutritional components of tissue culture media, Establishment of aseptic cultures, Initiation of callus and suspension cultures.

**UNIT-II TISSUE CULTURE TECHNIQUES-I:** Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis. Anther Pollen culture, Production of haploids and their application, Storage of plant genetic resources (Cryopreservation), Somoclonal variation.

**UNIT-III TISSUE CULTURE TECHNIQUES-II:** Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization, Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites, Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells. Biotransformations using plant cell cultures.

**UNIT-IV TRANSGENIC TECHNOLOGY-I:** Genetic Transformation methods for production of transgenic plants (Direct, Indirect), Direct Gene Transfer (DGT) methods, Agrobacterium mediated genetic transformation (Indirect), Chloroplast transformation and production of transplantomics.

**UNIT-V TRANSGENIC TECHNOLOGY-II:** Production of genetically modified plants/crops for agronomic traits, transgenic plants for biotic and abiotic stress tolerance, transgenic plants for quality traits, Industrial enzymes, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines).

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**TEXTBOOKS:**

1. Bhojwani SS and Rajdan MK Plant Tissue Culture: Theory and Practice, A revised Edition. 2002

2. Hammond, R McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000

3. Glick BR and Pasternak JJ. Molecular Biotechnology principles and applications of

 Recombinant DNA. 2006

**REFERENCES:**

1. H.S. Chawla: Biotechnology in Crop Improvement. International Book Distributing Company,

 1998.

2. Giri CC and Archana Giri: Plant Biotechnology Practical Manual. I K International 2007

3. R.J. Henry: Practical Application of Plant Molecular Biology. Chapman and Hall. 1997

4. P.K. Gupta., Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

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CORE ELECTIVE III

**2. DOWNSTREAM PROCESSING**

**UNIT-I: SCOPE OF DOWNSTREAM PROCESSING:** Importance of Down Stream Processing (DSP) inBiotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics. **Cell Disruption Methods:** Various cell disruption methods, need for cell disruption for intracellular products (Homogenizer, French press & Dynomill), cell disruption equipment. Applications in bio-processing. **Flocculation:** Principles of flocculation, various flocculating agents, applications in bio-processing. **Coagulation:** Principles of coagulations and its applications in bio-processing.

**UNIT-II SOLID- LIQUID SEPARATION:**

**Filtration:** Principles, filter aids, Types of filtrations, constant and continuous (TFF), depth filtration, constant volume filtration, constant pressure filtration, specific cake resistance, equivalent cake thickness, filtration equipments viz; plate and frame filter press, vacuum filters, leaf filters. **Sedimentation:** Principles of particle settling, batchsedimentation equipment viz., thickener. **Centrifugation:** Principles of centrifugation, centrifuge effect, g-number, sigma factor, various centrifuges viz., basket centrifuge, tabular centrifuge, disc-bowl centrifuge, scale –up of centrifuges.

**UNIT-III: ADSORPTION:** adsorption equilibria and isotherms, principles of adsorption, adsorption equipment, applications. **Precipitation:** Principles of precipitation, precipitation equipment, applications in bio-processing. **Foaming:** Principles of foaming, various foaming agents and their interaction with the products, applications in bioprocess.

**Liquid-liquid Extraction;** Extraction process and principles, phase equilibrium and distribution, batch and continuous extraction, co-current and counter current extraction processes, L-L-E equipment. Applications in bio-technology.

**UNIT-IV: SEPARATION AND PURIFICATION PROCESSES:** Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.

**Chromatographic and Electrophoresis Methods:** Principles of chromatographic separation methods, different types of chromatographic methods, viz., adsorption chromatography, ion – exchange chromatography, gel chromatography, affinity chromatography etc. with applications in bio-processing.

Principles of electrophoresis, SDS- PAGE, Hydrophobic chromatography, 2D gel electrophoresis, capillary electrophoresis.

**UNIT-V: SCALE-UP AND SCALE DOWN OF DOWNSTREAM UNIT OPERATIONS:**

**Crystallization**: Principles of crystallization, crystallization equipment. Applications in bio-processing. **Drying:** Various types of drying methods, principles of drying, EMC-RH data, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bio-processing. Overview.

**TEXT BOOKS:**

1. Genekopolis, Transport phenomena and Unit Process.
2. Bailey and Ollis, Biochemical Engineering Principles
3. Blanch, Biochemical Engineering
4. Mc Cabe and Smith, Unit Operations in chemical Engineering
5. Principles of Fermentation Technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications.

**REFERENCE BOOKS:**

1. Separation Process in Biotechnology edited by Juan A. Asenjo, Taylor & Francis Group
2. Comprehensive Biotechnology Vol.2 Edition, M. Moo –young (1985).
3. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth –Heinemann**.**

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OPEN ELECTIVE III

**1. NANO BIOTECHNOLOGY**

**UNIT-I INTRODUCTION TO NANO-BIOTECHNOLOGY:** Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

**UNIT-II: BASIC CHARACTERIZATION TECHNIQUES**; Electron microscopy; Atomic force: microscopy; Photon correlation Spectroscopy.

**UNIT-III NANO STRUCTURES:** Thin films; Colloidal nanostructures; Nanovesicles; Nanospheres; Nanocapsules.

**UNIT-IV NANOSTRUCTURES FOR DRUG DELIVERY:** Concepts, targeting, routes of delivery and advantages.

**UNIT-V APPLICATIONS OF NANO STRUCTURES:** Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nanodevices for sensor development.

**TEXT / REFERENCE BOOKS:**

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH

 Verlag GmbH & Co. KGaA ISBN: 3527304401

2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss

 ISBN: 047141719X

3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press

 ISBN: 0-8247-2579-4.

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OPEN ELECTIVE III

**2. ANIMAL CELL SCIENCE AND TECHNOLOGY**

**UNIT-I BASICS OF ANIMAL CELL & ITS CULTURE:** Structure and organization of an animal cell, Types of animal cell culture – Organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology.

**UNIT-II CELL CULTURE MEDIUM, COMPONENTS, TYPES & THEIR PHYSIOLOGICAL SIGNIFICANCE:** Introduction to the balanced salt solutions and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon-di-oxide and role of serum and its supplements in maintaining cells in culture medium, Serum and protein free defined media and their application.

**UNIT-III BASIC TECHNIQUES OF MAMMALIAN CELL CULTURE *IN VITRO*:** primary and established cell lines, Biology and characterization of the cultured cells, measuring parameters of growth. Maintenance of cell culture, Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity, Apoptosis – characteristic features and molecular mechanisms, Measurement of cell death.

**UNIT-IV** **ENGINEERING ANIMAL CELLS:** Somatic cell genetics, Cell culture based vaccines, Genetic engineering of mammalian cells in culture, Scaling up of animal cell culture, Stem cell cultures – embryonic and adult stem cells and their applications.

**UNIT-V: APPLICATIONS OF ANIMAL CELL CULTURE:** three dimensional culture and tissue engineering, Applications of animal cell culture technology (Heterologous, Primary culture/CEF culturing, Protein Expression).

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**TEXTBOOKS:**

1. Culture of Animal Cells, (3rd Edition), Fl. Ian Freshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
3. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd.Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

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LABORATORY V

**GENETIC ENGINEERING & PLANT BIOTECHNOLOGY / DOWN STREAM PROCESSING LABORATORY**

**LIST OF EXPERIMENTS:**

**GENETIC ENGINEERING**

1. Isolation of DNA
2. PCR-Amplification of DNA
3. Restriction digestion
4. Ligation
5. Screening for recombinants

**PART-A (PLANT BIOTECHNOLOGY LABORATORY)**

1. Preparation of medium.
2. Surface sterilization.
3. Organ culture.
4. Cell suspension cultures.
5. Growth and production kinetics for secondary metabolite production and quantification.
6. Genetic transformation studies using ***Agrobacterium***.

**PART-B (DOWN STREAM PROCESSING LABORATORY)**

1. Cell disruption techniques.
2. Centrifugation techniques.
3. Chromatographic techniques.
4. Electrophoresis.
5. Isolation, Extraction ,Product recovery of industrially important products.

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LABORATORY VI

**BIOPROCESS ENGINEERING & BIOINFORMATICS LABORATORY**

**LIST OF EXPERIMENTS:**

**PART-A (BIOPROCESS ENGINEERING)**

1. Study of enzyme kinetics of invertase.
2. Effect of pH on enzyme kinetics
3. Enzyme inhibition.
4. Enzyme immobilization experiments (Different methods)
5. PLACKETT BUKMAN DESIGN for Media
6. Response surface methodology for media design
7. Sodium sulphite oxidation method for determination of mass transfer coefficient, Dynamic gassing method for determination of mass transfer coefficient
8. Growth kinetics in batch culture.
9. Ethanol production from S. cerevesiae
10. Determination of Enzyme activity for cellulase
11. Pretreatment techniques for lignocellulosic Biomass for ethanol production

**PART-B (BIOINFORMATICS)**

1. Data Retrieval Tools (NCBI, EntreZ, Pub Med),
2. FASTA & BLAST

3. Pair wise Alignment (EMBOSS)

4. Multiple Sequence Alignments & Phylogenetic Analysis (ClustalW)

5. Proteomic Analysis

 (a) Primary structure analysis,

(b) Secondary structure prediction,

(c) Tertiary structure Prediction (SPDBV),

(d) Molecular Visualization tools (RASMOL, SPDBV).

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| **IV Semester** | **Int. Marks** | **Ext.****Marks** | **L** | **P** | **C** |
|  Project Work Review | 50 | - | - | 8 | 4 |
|  Project Evaluation (Viva-Vove) | - | 150 | - | 16 | 12 |
| **Total**  | 50 | 150 |  | 24 | 16 |