M.Sc BIOTECHNOLOGY 2022

SYLLABUS

For CBCS Based M.Sc. (Regular/Full Time) Programmes
(Effective for the students admitted into I year from the
Academic Year 2022-23 and onwards)

Centre for Biotechnology (CBT)
University College of Engineering Science and Technology
JNTUH, Hyderabad

M.SC BIOTECHNOLOGY 2022

Centre for Biotechnology (CBT)
M.Sc BIOTECHNOLOGY
Course Structure (CBCS)
W.E.F. 2022

SEMESTER I

Subject Code	Course Title	Int. Marks	Ext. marks	L	P	C
1BTPC101	**Program Core – I** Cell and Developmental biology	**40**	**60**	**3**	**-**	**3**
1BTPC102	**Program Core – II** Biochemistry and Metabolic pathways	**40**	**60**	**3**	**-**	**3**
1BTPC103	**Program Core – III** Genetics & Molecular Biology	**40**	**60**	**3**	**-**	**3**
1BTPE104	**Program Elective- I** 1. General Microbiology 2. Virology	**40**	**60**	**3**	**-**	**3**
1BTOE105	**Open elective -I** 1. Basic Mathematics and Biostatistics 2. Bio entrepreneurship	**40**	**60**	**3**	**-**	**3**
1BTL106	**Lab I** - Cell Biology and Microbiology Lab	**40**	**60**	**-**	**6**	**3**
1BTL107	**Lab II** - Biochemistry and Molecular Biology Lab	**40**	**60**	**-**	**6**	**3**
1BTS108	**Seminar**	**-**	**50**	**3**	**-**	**2**
Total		**280**	**470**	**18**	**12**	**23**

SEMESTER II

Subject Code	Course Title	Int. Marks	Ext. Marks	L	P	C
2BTPC209	**Program Core – IV** Enzyme Technology	**40**	**60**	**3**	**-**	**3**
2BTPC210	**Program Core – V** Process Engineering Principles	**40**	**60**	**3**	**-**	**3**
2BTPC211	**Program Core – VI** Genetic engineering	**40**	**60**	**3**	**-**	**3**
2BTPE212	**Program Elective- II** 1.Animal cell science and Technology 2.Research Methodology & Communication skills	**40**	**60**	**3**	**-**	**3**
2BTOE213	**Open elective -II** 1. Analytical Techniques in Biotechnology 2. Biologics & Vaccine technology	**40**	**60**	**3**	**-**	**3**
2BTL214	**Lab III** - Enzyme Technology and Genetic engineering Lab	**40**	**60**	**-**	**6**	**3**
2BTL215	**Lab IV** - Process Engineering Principles and Cell culture Lab	**40**	**60**	**-**	**6**	**3**
2BTS216	**Seminar**	**-**	**50**	**3**	**-**	**2**
Total		**280**	**470**	**18**	**12**	**23**

M.SC BIOTECHNOLOGY 2022

SEMESTER III

Subject Code	Course Title	Int. Marks	Ext. Marks	L	P	C
3BTPC317	**Program Core – VII** Immunotechnology	**40**	**60**	**3**	**-**	**3**
3BTPC318	**Program Core – VIII** Bioprocess Engineering	**40**	**60**	**3**	**-**	**3**
3BTPC319	**Program Core – IX** Plant Biotechnology	**40**	**60**	**3**	**-**	**3**
3BTPE320	**Program Elective- III** 1. Bioinformatics 2. Pharmaceutical Biotechnology	**40**	**60**	**3**	**-**	**3**
3BTPE321	**Open elective -III** 1. Cancer biology 2. Ecology and Environmental Biotechnology	**40**	**60**	**3**	**-**	**3**
3BTL322	**Lab V** -Immunotechnology and Bioprocess Engineering Lab	**40**	**60**	**-**	**6**	**3**
3BTL323	**Lab VI** - Plant Biotechnology and Bioinformatics/ Pharmaceutical Biotechnology Lab	**40**	**60**	**-**	**6**	**3**
3BTS324	**Seminar**	**-**	**50**	**3**	**-**	**2**
Total		**280**	**470**	**18**	**12**	**23**

SEMESTER IV

Subject Code	IV Semester	Int. Marks	Ext. Marks	L	P	C
	Dissertation Work Review- I	**00**	**00**	**0**	**0**	**0**
4BT425	Dissertation Work Review- II	**50**	**-**	**-**	**4**	**2**
4BT426	Dissertation Evaluation (Viva-Voce)	**-**	**100**	**-**	**18**	**09**
Total		**50**	**100**		**22**	**11**

Marks: 750+750+750+150=**2400**

Credits: 23+23+23+11=**80**

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M.SC BIOTECHNOLOGY 2022

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2022

Program core – I

CELL AND DEVELOPMENTAL BIOLOGY

Course Objective: The cell and developmental biology course provides a basic understanding of the structure and function of cellular organelles and components, the functional interaction of the cell with its microenvironment and developmental process in plants and animals.

UNIT-I: CELL STRUCTURE AND FUNCTION: Structure of Prokaryotic and Eukaryotic cells; Cellular organelles and their organization, Extracellular matrix, Structure and function of cell wall in microbes. Sub-cellular fractionation and criteria of functional integrity. Plasma membrane structure and function, Active and passive transport of ions, Na+/K+ pump, ATPase pumps, Co-transport, Symport, Antiport, Endo cytosis and Exocytosis.

UNIT-II: CELL INTERACTIONS AND CYTOSKELETON: Cell adhesion molecules: cadherins, Immunoglobulin like molecules, integrins and selectins. Cell junctions: tight junction, desmosome, hemidesmosome and gap junctions. Microtubules, intermediate filaments, microfilaments and their dynamics. Centrosome, cilia, flagella. Mitotic apparatus and movement of chromosomes.

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, Apoptosis, Wnt and JAK-STAT signaling.

UNIT – V: DEVELOPMENTAL BIOLOGY : Basic concepts of development ; Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Morphogenesis and organogenesis in plants and animals; Caenorhabditiselegans, Drosophila, Frog and Arabidopsis.

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Understand the basic information about classification of organisms, basic differences between prokaryotic and eukaryotic cells, structural and functional integrity of a cell.
CO2. Evaluate the cell interactions and the role of cytoskeleton in the development.
CO3. Analyse the molecular mechanism behind cell cycle, causes of deregulation of cell cycle and effects
CO4. Evaluate the underlying molecular mechanism of cell signaling, different types of receptors, different signal transduction pathways with examples.
CO5. Understand cellular differentiation, basic concepts of development and stem cells, morphogenesis and organogenesis of plants and animals.

TEXT BOOKS:

1. Molecular Biology of cell, Alberts. B et al.
2. Molecular Cell Biology, Lodish et al.
3. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
4. Cell in Development and inheritance, EB Wilson, MacMilan, New York.
5. Developmental Biology- Scott F Gilbert.
6. Essential Developmental Biology - Jonathan Slack
7. Developmental Biology,-Werner A Muller

REFERENCE BOOKS:

1. Reproduction in Eukaryotic cells, DM Prescott, Academic press.
2. Principles of Development - Lewis Wolpert
3. Fertilization, FT Longo, Chapman and Hall
4. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.

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M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Program core – II

BIOCHEMISTRY & METABOLIC PATHWAYS

Course Objective: The main objective of the course is to study the various biomolecules, structures, properties and their metabolic pathways.

UNIT-I: FUNDAMENTALS OF BIOCHEMISTRY: Water, pH, pK, buffers, covalent and non covalent interaction, oxido-reduction reactions and colligative properties
Bioenergetics: free energy, enthalpy, entropy, laws of thermodynamics, high energy compounds
UNIT-II: CARBOHYDRATES AND LIPIDS: Classification, physical chemical & biological properties of carbohydrates and Lipids.
UNIT –III: PROTEINS AND NUCLEIC ACIDS: Classification, physical, chemical & biological properties of Amino acids, Proteins & Nucleic acids, Ramachandran Plot.
UNIT –IV: METABOLISM OF CARBOHYDRATES AND LIPIDS:
Catabolism: Glycolysis, TCA Cycle, E.T.C, Pentose Phosphate Pathway, Glycogenolysis. Lipids: β-Oxidation of fatty acids (C16)
Anabolism: Gluconeogenesis, Glycogenesis, Synthesis of fattyacids (C16) and Cholesterol.
UNIT V: METABOLISM OF PROTEINS AND NUCLEIC ACIDS:
Catabolism: Amino acids: Glutamate, Tryptophan, Cysteine and Proline Nucleic acids: Structure of purines, pyrimidines nucleoside and nucleotide. Purine and Pyramidine, nucleotides degradation.
Anabolism: Amino acids: Glutamate, Tryptophan, Cysteine and Proline. Synthesis of Purine and Pyramidine Nucleotides (Denovo and Salvage pathway).

COURSE OUTCOMES:

At the end of the course students will be able to

CO1. Understand the basics of biochemistry and Bioenergetics.
CO2. Evaluate the knowledge of characteristics and reactions of Carbohydrates and Lipids.
CO3. Analyse the knowledge of Characteristics and reactions of Proteins and Nucleic acids.
CO4. Evaluating the Various metabolic pathways relating to Carbohydrates and Lipids.
CO5. Analyse the Various metabolic pathways related to Proteins and Nucleic acids.

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.

M.SC BIOTECHNOLOGY 2022

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Program core – III

GENETICS AND MOLECULAR BIOLOGY

Course Objective: The objective of this course is to explain the basics in inheritance biology, structure of nucleic acids, gene regulation and Demonstrate knowledge and understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.

UNIT-I: INHERITANCE BIOLOGY:
Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Co dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Inheritance of Mitochondrial and chloroplast genes, maternal inheritance

UNIT-II MUTATION and DNA REPAIR
Types of mutagens, Molecular basis of mutations. Physical and chemical mutagenic agents: UV, Ethidium Bromide and Nitrous oxide. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test etc). DNA damage and repair mechanisms. Recombination: Homologous and non-homologous recombination.

UNIT-III: GENETIC MATERIAL & MOBILE GENETIC ELEMENTS:
Discovery of DNA and RNA as genetic material**,** Structure and types of DNA, Replication. Eukaryotic chromosome Structure, regulatory elements. RNA**:** Different classes of RNA and their functions. Mobile Genetic elements**:** Classification of mobile genetic elements, Horizontal gene transfer.

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

UNIT-V: GENE EXPRESSION - TRANSLATION: Genetic code, Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications, translational controls and inhibitors of polypeptide synthesis, protein targeting.

COURSE OUTCOMES:
At the end of the course students will be able to

CO1. Understand the basic concepts in Inheritance biology.
CO2. Analyze the DNA repair & Mutation.
CO3. Differentiate DNA, RNA structures and understand the mobile genetic elements.
CO4. Analyze the gene regulation in prokaryotes and eukaryotes and understand the post translation modifications
CO5. Understand the process of translation, their inhibitors, post translation modifications and protein targeting.

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. "Biochemistry" by Stryer.

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M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Program Elective – I

1. GENERAL MICROBIOLOGY

Course Objective: This course intends to provide insights into the historical developments in microbiology, classification, growth, culture methods, control, metabolic activities and different types of diseases caused by microorganisms.

UNIT - I

Introduction to Microbiology: Scope and history of Microbiology, 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 test, Gelatin Liquefaction test, Amylase test, H_2O_2 test, Nitrate reduction test, Sulfate reduction test, IMViC,).

UNIT - IV

Other Microbes and Microbial Genetics: Structure and Classification of Viruses, Archea, Actinomycetes, Fungi, Algae and Protozoa, Mycoplasma, Ricketssia, Microbial Genetics**:** Methods of Genetic Transfers – Transformation, Conjugation, Transduction and Sex-duction.

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), Swine Flu, Dengue, Ebola and treatment strategies.

COURSE OUTCOMES:

At the end of this course student will be able to

CO1. Acquire knowledge of the history of microbiology, classification, culturing & preservation techniques and control of microorganism.

CO2. Analyse the morphology, nutrition and growth kinetics of bacteria.

CO3. Evaluate microbial metabolism and characterization.

CO4. Understand diverse group of prokaryotic organisms, the structure and classification of viruses and analyze the knowledge of Microbial Genetics.

CO5. Differentiate types of infectious diseases, their mode of transmission, disease reservoirs, epidemiology and control.

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Brock Biology of Microorganisms by Michael T. Madigan (Author), John M. Martinko (Author), David A. Stahl (Author).
2. Prescott, L.M., Harley, J.P. and Klein, D.A. (2005). Microbiology. McGraw Hill Science, US.

M.SC BIOTECHNOLOGY 2022

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Program Elective – I

2. VIROLOGY

Course Objective: This course intends to provide insights into the historical developments in Virology, Structures, Classification, virological diagnostics methods and viral replications etc.

UNIT-I: Microorganisms lacking cell structures: Introduction tovirology, nature of viruses,nomenclature and classification of viruses, General characteristics of viruses: Physical, Biological, Biochemical properties, Methods of cultivation, Purification and assay of viruses Biology of sub-viral agents

UNIT-II: Virological Methods:

Diagnostic Methods: Immunodiagnostic, Haemagglutination and Haemagglutination-inhibition tests, complement fixation, neutralization, RIA, flow cytometry and immunohistochemistry

Nucleic Acid Based Diagnosis: Hybridization, Blotting techniques, polymerase chain reaction, Microarray and nucleotide sequencing

UNIT-III: Virus Cell Interaction:

Cellular Receptors and Virus Entry: Polio, Herpes, VSV, HIV Mechanism of Entry into cells,

Mechanisms of Host Cell Damage: Host cell 'Shut off', Apoptosis, Necrosis, Stress response, Alteration of signaling pathways, Cellular basis of transformation, Types of cytopathic effects

UNIT-IV: Virus Replication:

RNA Viruses: Replication of Plus stranded RNA virus (Polio), Negative Strand RNA viruses (VSV and influenza) Replication of double Stranded RNA viruses (rota), and retro viruses (HIV and HTLV)

DNA Viruses: Replication of doubles Stranded DNA Viruses (SV 40 and Pox), ss DNA Viruses (AAV), DNA tumor virus (Hepatitis B Virus).

UNIT-V: Application of viruses in biomedicine

Viral vectors: Development of viral vectors, gene transfer, gene therapy, vaccine development Protein expression, Viral subunits (Virus like particles VLP), Oncolytic Virus (Virotherapy for cancer)

COURSE OUTCOMES:

At the end of the course students will be able to

CO1. Understand the knowledge of the viruses, structures and their properties.
CO2. Evaluate the knowledge of the viral diagnostic methods and their analysis.
CO3. Analyzing the virus cell interactions and host cell damage mechanisms.
CO4. Evaluate the viral replication of DNA and RNA viruses.
CO5. Understand the knowledge of applications of the viruses in biomedicine.

TEXT BOOKS:

1. Intoduction to Modern Virology - Dimmock NJ, Primrose SB, Blackwell Scientific Publications, Oxford.
2. Text Book on Principles of Bacteriology, Virology and Immunology – Topley and Wilson's, Edward Arnold, London.

REFERENCE BOOKS:

1. Medical Virology – Morag C and Timbury M.C, Churchill Livingstone, London.
2. Virology – III – Conrat HF, Kimball PC and Levy JA, Prentice Hall, Englewood Cliff, New Jersey.
3. Diagnostic procedures for Viral and Rickettsial diseases – Lennetter EH, American Public Health Association, NY.
4. The Genetics of Bacteria and their Viruses – William Hayes, Blackwell Scientific Publishers, London.

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Open Elective – I

1. BASIC MATHEMATICS & BIOSTATISTICS

UNIT-I: DIFFERENTIAL CALCULUS:
Functions, limits, continuity and differentiation (only basics). Differentiation of sum, product and quotient of function. Differentiation of implicit, explicit, trigonometric, inverse trigonometric functions; Partial differentiation (Basics).

UNIT-II: INTEGRAL CALCULUS:
Basics, Methods of substitution integration by parts. Integration of rational, irrational, trigonometric functions (Basics), Definite integrals (Basics); Trapezoidal rule, Simpsons 1/3 rule, Simpsons 3/8 rule.

UNIT-III: MATRICES:
Basics, addition, subtraction, multiplication and Determinants of Matrices (Basic concept). Co-factors of matrix, Adjoint, inverse of a matrix, Real matrices: Symmetric, Skew symmetric and Orthogonal Matrices, Rank of matrix (Basics)-Det Method

UNIT-IV: INTRODUCTION- DEFINITION AND SCOPE OF BIOSTATISTICS:
Concept of Probability-definition of Probability- addition and multiplication laws of probability (without proofs) and examples. 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 ,Mathematical Expectation, Skewness,Curtosis.

UNIT-V: STATISTICAL OPTIMIZATION TECHNIQUES:
Estimation, types of estimation, estimation of parameters. Testing of Hypothesis: Z-test ; Correlation & Regression; Coefficient of correlation – Regression coefficient – The lines of regression (Basics).

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COURSE OUTCOMES:

At the end of the course students will be able to

CO1.Attain knowledge of the Functions, limits, continuity and differentiation CO2.Analyse integral calculus
CO3.Solve real matrices
CO4.Understand the various concepts of biostatistics
CO5.Evaluate various concepts of statistical optimization techniques.

TEXTBOOKS:

Statistical methods S.P.Gupta. S Chand Pubplications
Business Statistics by S.P Gupta & M.P.Gupta
Engineering Mathematics- N.P. Bali and others.
Engineering mathematics - B.V. Ramana
Fundamentals of Statistics, Gupta.M.K. Goon A.M, The world press, 2012.
Introduction to the theory of statistics, 3rd edition, Mood.A.M. Graybill, F.A & Boes. D.C (2007)
Probability and statistics by Rukmangada chari . E, Pearsln publications.

REFERENCE TEXT BOOKS:

Differential Calculus -Shanthi Narayan
Integral Calculus -Shanthi Narayan

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

Open Elective – II

2. BIOENTREPRENEURSHIP

Course Objective: The objective of this course is to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Unit I:BASICS OF BIOENTREPRENEURSHIP: Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; opportunities for bioentrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); patent landscape, IP protection & commercialization strategies.

Unit II:ACCOUNTING AND FINANCE BUSINESS PLAN PREPARATION; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; business plan proposal for „virtual startup company"; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet, profit and loss statement, double entry 36 bookkeeping; collaborations & partnerships; information technology for business administration and expansion.

Unit III:BUSINESS STRATEGY ENTRY AND EXIT STRATEGY; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions.

Unit IV:MARKETING MARKET CONDITIONS, SEGMENTS, PREDICTION OF MARKET CHANGES; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for „virtual startup company".

Unit V:KNOWLEDGE CENTRE AND R&D KNOWLEDGE CENTRES e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)

COURSE OUTCOMES:

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

CO1. Understand the advantages and identify the scope ofentrepreneurship in biosciences.
CO2. Analyse the ways and means of raising funds
CO3. Evaluate thevarious issues related to entry, exit, pricing strategies and managerial skills
CO4. Understand the marketing strategies involved in entrepreneurship
CO5. Evaluate the ways and means of developing research for business growth and expansion

TEXT BOOKS:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.

2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

REFERENCE BOOKS:

1. Onetti, A., &Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
2. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press. 5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

LAB I

CELL BIOLOGY & GENERAL MICROBIOLOGY LAB

PART-A (CELL BIOLOGY)

Course Objective: To provide hands on training in cell biology techniques

LIST OF EXPERIMENTS:

1. Microscopy: Compound Microscope
2. Motility of bacteria
3. Gram staining
4. Osmosis - Egg
5. Cellular Fractionation
6. Analysis of subcellular fractions
7. Mitosis and cytokinesis

Course outcome: At the end of the course students will have a thorough knowledge of the techniques involved in studying the motility of bacteria, isolation of cell organelles

PART-B (GENERAL MICROBIOLOGY)

Course Objective: To provide hands on training in microbiological techniques.

LIST OF EXPERIMENTS:

1. Isolation, Purification & Quantification of bacteria.
2. Morphological and Biochemical characterization of bacteria (Various staining, Amylase, Catalase, Gelatinase, Protease, Nitrate reductase, Urease, Indole, Methyl red, Vogesproskauer, Citrate utilization test).
3. Factors affecting bacterial growth (pH, Temperature and Osmolarity)
4. Determination of thermal death point.
5. Determination of antimicrobial activity (Disc diffusion/Well plate method).
6. Determination of minimum inhibitory concentrations.
7. Transformations: Bacteria.

Course outcome: At the end of the course, students will have a thorough knowledge of distinguish between various types of microbial media, culturing methods, Inspect and isolate the microbes from the day to day sources.

M.Sc. BIOTECHNOLOGY - FIRST SEMESTER– W.E.F.2021

LAB II

BIOCHEMISTRY & MOLECULAR BIOLOGY LAB

PART-A (BIOCHEMISTRY)

Course objective: The main objective of the course is to study the different methods used to estimate the various biomolecules.

LIST OF EXPERIMENTS:

1. Titration of amino acids.
2. Determination of pK
3. Estimations of amino acids, Proteins, sugars and lipids.
4. Analysis of oils-iodine number, saponification value, acid number.
5. UV, Visible, Absorption spectra.
6. Centrifugation
7. Paper & TLC

Course outcomes: At the end of the course students will have through knowledge of biomolecules estimations and analysis etc.

PART-B (MOLECULAR BIOLOGY)

Course objective: The main objective of the course is to provide practical knowledge of the isolation and quantification of DNA

LIST OF EXPERIMENTS:

1. Isolation of Nucleic Acids: Genomic DNA, Plasmid, RNA
2. Quality check for Isolated Nucleic Acids: Spectrophotometric (UV Method)
3. Visualization: Agarose Gel Electrophoresis (Detection and separation of NA)
4. Absorption maxima of Nucleic acids

Course outcomes: At the end of the course students will have through knowledge of the techniques involved in isolation and quantification of DNA

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M.Sc. BIOTECHNOLOGY – SECOND SEMESTER– W.E.F.2021

Program core – IV

ENZYME TECHNOLOGY

Course Objective: The subject provides knowledge about the principles and practice of the utilization of enzymes in biotechnology.

UNIT-I: FUNDAMENTALS OF ENZYMES: Chemical Nature of enzymes, enzyme nomenclature, sources of enzymes, Isolation of enzymes from different sources, Screening for novel enzymes, In-vivo and In-Vitro methods for selection of enzyme activity, media for enzyme production, optimization methods for enzyme production, Enzyme assay methods, purification of enzymes.

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

UNIT-III: ENZYME KINETICS: First, second, zero and pseudo-order kinetics; Pre-steady and steady-state kinetics; Derivation of Michaelis-menten equation, $K_{m,}$ $V_{max,}$ turnover number, catalyte efficiency, specificity constant, linear transformations to M.M equation-Lineweaver-BurK,Eadie-Hofstee, Hanes, Dixon plots; kinetics of bi-substrate reactions, Random and sequential order, Ping-pong mechanism, Differentiation of different mechanism of bi substrate reactions. Enzyme Inhibition**;** Reversible and irreversible inhibition and kinetic properties, , substrate inhibition, product inhibition, measurement of reversible inhibitor potency-percent inhibition and degree of inhibition,IC50 parametres for various reversible inhibitors

UNIT-IV: Regulatory enzymes: Allosteric enzymes-properties, Measurement of ligand binding, Hill equation, Scatchard equation, Monod-Wyman-Changeux model and Koshland-Nemethy-Filmer model, V type allosteric systems; Hysteresis, Enzyme amplification cascade, covalent modification, Substrate channeling, Isoenzymes, Multienzyme complexes and multifunctional enzymes

UNIT-V: Industrial applications of enzymes: Industrial applications of enzymes-food,pharma,agriculture; preparation of enzymes, industrially important enzymes, safety and regulatory aspects of enzyme use, Enzyme activity in non- aqueous media and their industrial applications, Various techniques used for the immobilization of enzymes and their industrial applications; Enzyme based sensors; Ribozymes, Xeno nucleic acids.

COURSE OUTCOMES:

At the end of the course student will be able to

- CO1. Understand the Fundamental aspects of enzymes
- CO2. Acquire the knowledge about How the enzymes work
- CO3. Understand the Kinetic aspects of enzymes
- CO4. Understand How the regulatory enzymes work
- CO5. Understand the Various applications of enzymes

TEXT BOOKS:

1.Principles of Biochemistry-Lehninger
2.Voet&Voet
3.Enzymes-Trevor Plamer,2004 ed.
4.Enzyme technology -Christopher Bucke, Martin F. Chaplin, Cambridge University Press, 1990

REFERENCES:

1.EnzymeKinetics: Catalysis & control by Daniel Purich, academic press 1st ed.
2.contemporary enzyme kinetics and mechanisms, Daniel Purich, academic press, 3rd ed.

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Program core –V

PROCESS ENGINEERING PRINCIPLES

Course Objective: This course enables students to understand the concept of fluids, flow properties, heat, heat flow mechanism, mass, mass flow mechanism and their equipment design.

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.
Thermodynamics: Scope of Thermodynamics, Force, Temperature, Volume, Pressure, Work, Energy, Heat, Heat capacities, Enthalpy, Law of thermodynamics.
UNIT-II MATERIAL & ENERGY BALANCE:
Material Balance Calculations: Law of conservation of mass, General material balance equation, Material balance calculations without chemical reactions, Material balance calculations with chemical reactions, Recycling, Bypass, Purge, Analysis of degrees of freedom.
Energy Balance Calculations: General energy balance equation, Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids, Latent heats, Heats of formation, combustion, reaction and dissolution, Enthalpy-concentration chart, Fuel heating value, Theoretical flame temperature, Energy balance calculations in unit operations and systems with and without chemical reactions,
UNIT-III: UNIT OPERATION & FLUID MECHANICS:
Unit Operation: 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-IV: 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. **Radiation:** Introduction, Black body, Laws of black body radiation; Kirchoff's law, Stefan-Boltzmann law, Wein's displacement law.
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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COURSE OUTCOMES:

At the formal end of the course student will be able to

CO1- Understand the basic process engineering concepts of unit operations, unit processes and concept of thermodynamic principles.
CO2- Apply and analyze theories in unit operations and fluid flow machineries.
CO3- Evaluate the heat transfer rate in different modes of heat transfer systems.
CO4- Apply various laws of radiation in heat transfer equipment.
CO5- Apply various theories of mass transfer in mass transfer equipment.

TEXT BOOKS:

1. Unit operations of Chemical Engineering, by W.L. McCabe, J.C. Simth and Harriott, McGraw Hill publishers.

REFERENCE BOOKS:

1. Bioprocess Engineering principles By Pauline M Doran, Academic Press.
2. Unit Operations-1, K. A. Gavhane, NiraliPrakashan Publication.
3. Introduction to Biochemical Engineering, Second edition, By D.G. Rao, Tata McGraw Hill Publications.

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Program core –VI

GENETIC ENGINEERING

Course Objective: To familiarize the student with emerging field of biotechnology i.e recombinant DNA technology as well as create understanding and expertise in wet lab techniques in 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, 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 plasmids, insect virus based vectors), 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, ChIP assay and 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, Gene Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene correction.

UNIT-V: APPLICATIONS OF GENETIC ENGINEERING: Next generation sequencing methods:, illumina sequencing, pyrosequencing and ion torrent sequencing. Site-directed Mutagenesis and Protein Engineering, RNAi, Antisense technology, Micro RNA Ribozymes, Gene editing Techniques: TALEN, Zinc fingers and CRISPER Cas 9 .

COURSE OUTCOMES:

At the end of this unit student will be able to

CO1. Understand the scientists contribution and the enzymes involved in recombinant DNA technology and also know the PCR and its application

CO2. Evaluation of different types of vectors, cloning, transformation and selection.

CO3. Understand the different expression systems, protein protein interaction studies, hybridization techniques and also Genomic and C-DNA library constriction and its application

CO4. Analysis on different transgenic techniques and advance techniques like TALEN, Zing finger nucleases and CRISPR Cas 9.

CO5. Applications of genetic engineering principles.

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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Program Elective – II

1. ANIMAL CELL SCIENCE AND TECHNOLOGY

Course Objective: This course aims to impart in students an understanding of the primary cell culture and methods that convert them to long term established cultures. They will be exposed to all the factors which could impact cell culture and equipment requirements for propagation. Awareness is generated about recent advances in the area of stem cell technology, organ culture, tissue engineering etc.,

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

UNIT-II: CELL CULTURE MEDIA AND FEED: 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 MAMMALIAN CELL CULTURE MAINTENANCE: Cell Banks, Commercial cell lines, Insect cell lines, Primary culture, established/continuous cell lines, Maintenance of cell culture : Cryopreservation, Revival of cells, Subculturing or passaging, Characterization of cells, growth kinetics., Apoptosis – characteristic features and molecular mechanisms

UNIT-IV: TECHNIQUES IN MAMMALIAN CELL CULTURE: Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity- MTT Assay, LDH assay and other methods, Measurement of cell death (FACS).

UNIT-V: APPLICATIONS OF ANIMAL CELL CULTURE: Cell culture based vaccines, Engineering animal cells for recombinant protein expression. Stable cell line generation, expression analysis. Scaffolds- types, preparation. Three dimensional culture and tissue engineering.

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Understand I basics of animal cell and its culturing
CO2. Evaluate the preparation of animal cell culture medium and its components and their significance
CO3. Apply and evaluate the basic techniques of mammalian cell culture
CO4. Engineer animal cells for the production of recombinant proteins
CO5. Apply the concepts of animal cell culture in research

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.

REFERENCE BOOKS:

1. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
2. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

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Program Elective – II

2.RESEARCH METHODOLOGY & SCIENTIFIC COMMUNICATION SKILLS

Course Objective: To use the framework of these methodologies for understanding effective lab practices and scientific communication - To use the framework of these methodologies to understand and appreciate scientific ethics.

UNIT-I: History of Science and Science Methodologies Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist vs holistic biology.
UNIT- II: Preparation for Research Choosing a mentor, lab and research question; maintaining a lab notebook with date-wise entry.
UNIT- III: Process of Communication Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding repetitions & breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non-verbal communication Interpreting non-verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences
UNIT- IV: Presentation skills - Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point slides with clearly legible fonts without crowding the content; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions Computing Skills for Scientific Research Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness.
UNIT- V: Scientific Communication Technical Writing Skills - Types of reports; Layout of a formal report; Scientific writing skills - Importance of communicating science; Problems while writing a scientific document; Plagiarism; Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts; Publishing scientific papers - the peer review process and problems, recent developments such as open access and non-blind review; Plagiarism; Characteristics of effective technical communication; Scientific presentations; Ethical issues; Scientific misconduct.

COURSE OUTCOMES:

At the end of the course student will be able to

- CO1. Develop an awareness of methodologies used to do research
- CO2. Understanding of methodology for proper initiation and execution of research
- CO3. Acquire knowledge of effective communication methods
- CO4. Acquire knowledge of proper presentation skills
- CO5. Analyse scientific communication and technical writing.

TEXTBOOKS:

1. Valiela, I. (2001). Doing science: Design, analysis, and communication of scientific research.Oxford: Oxford University Press.
2. On being a scientist: A guide to responsible conduct in research. (2009). Washington, D.C.:National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.

REFERENCE BOOKS:

1. Mohan, K., & Singh, N. P. (2010). Speaking English effectively. Delhi: Macmillan India.
2. Movie: Naturally Obsessed, The Making of a Scientist.

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Open Elective – II

1.ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

Course Objective: The objective of the course is to create general understanding of Microscopy, Spectroscopy, Electrophoresis, CD&ORD Spectroscopy, X ray crystallography Sequencing methods and different chromatographic methods**.**

UNIT I: MICROSCOPY Bright field, Dark field, Fluorescent, Phase contrast, confocal microscopy, SEM & TEM Microscopy, Different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM.

UNIT II: SPECTROSCOPY Principle, Instrument flow chat and applications; UV - VIS Spectrophotometer, Atomic absorption& Atomic emission spectroscopy, X-ray crystallography, Optical Rotatory dispersion, Circular dichromism, NMR.

UNIT III: SEPARATION TECHNIQUES Sedimentation, Centrifugation and Filtration, Electrophoresis of proteins and nucleic acids, 1D and 2D Gels, Types of Electrophoretic techniques: Capillary electrophoresis, Pulse field electrophoresis and Immuno electrophoresis, IEF; Chromatography: Adsorption, affinity, Ion exchange, gel permeation**,** TLC, GC, RPC, HPLC and FPLC.

UNIT IV: RADIOACTIVITY AND FLOURESCENCE BASED METHODS: Radioactivity, measurement of radioactivity, photographic emulsion, ionisation chamber, autoradiography, RIA, Fluorescent and Chemiluminiscent methods, Fluorescent Probes, FISH and Flow Cytometry.

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).

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Understand microscopictechniques and FACS analysis.
CO2. Analyse spectroscopy and principles of Beer- Lamberts Law and also get knowledge on X ray diffraction optical rotator dispersion, Circular dichromism.
CO3. Understand different biomolecules separation techniques like chromatography, electrophoresis sedimentation and centrifugation.
CO4. Evaluate radioactivity, measurement of radioactivity and different radiolabelled and flouresence labelled based techniques involved in Biotechnology.
CO5. Evaluate different techniques involved in sequencing of proteins and nucleic acids.

TEXT BOOKS:

1. Biophysical Chemistry Principles & Techniques by Upadhya&Upadhya 4th edition, Himalaya Publishing House, 2012.
2. Instrumental methods of chemical analysis – GurudeepR.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. PranbkumarBanerjee,Introduction to Biophysics, S.chand Publications,2008.
5. Instrumental methods of chemical analysis-GurudeepR.ChatwAL 7 Sham K.Anand,Himalaya Publishing house,ISBN.

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Open Elective – II

2.BIOLOGICS AND VACCINE TECHNOLOGY

COURSE OBJECTIVE: Objective of this course is to make students understand the processes/ methods involved in the development and characterization of biologics/ biosimilars/ novel biologics drugs and vaccines as well as their therapeutic uses.

UNIT-I: INTRODUCTION TO BIOLOGICS DRUGS

Concept of biologic drugs and their types; Therapeutic indications; Innovator molecules and biosimilars; Antibody structure and function; Therapeutic monoclonal antibodies (mAb) and their nomenclature; fusion proteins; Introduction and mechanism of action of key biologics including Granulocyte-colony stimulating factor (GCSF), Parathyroid hormone (PTH), insulin and key monoclonal antibodies like Adalimumab, Rituximab, Bevacizumab, Ranibizumab, Trastuzumab and Etanercept; novel biologics, bispecific antibodies, drug conjugates.

UNIT-II: UPSTREAM PROCESS DEVELOPMENT

Introduction to cell culture; Expression vectors, codon optimization, gene cloning; Host cells, E. coli, Chinese Hamster Ovary (CHO) cells, Human embryonic kidney (HEK) 293 cells; Cell line development, transient and stable transfection, clone selection, single cell cloning, clone evaluation and expansion of selected clones, cell banking; Process development, design of experiments (DOE), bioreactor operating parameters, feed and media design; Process characterization, scale up and transfer to commercial manufacturing.

UNIT-III: DOWNSTREAM PROCESS DEVELOPMENT AND FORMULATION

Cell culture broth harvesting, centrifugation, depth filtration; Affinity chromatography; Viral inactivation; Polishing steps, anion exchange chromatography, cation exchange chromatography; Viral filtration; Ultra-filtration/ diafiltration (UFDF) and Formulation; Drug substance and drug product; lyophilization.

UNIT IV: BIOLOGICS DRUG CHARACTERIZATION AND ANALYSIS

Characterization: physicochemical and structural properties, purity, impurities and biologic activity. mAb primary, secondary and tertiary structure analysis; N-terminal amino acid sequencing; Peptide mapping; Sulfhydryl groups and disulphide bridges; Post translational modifications; Glycan profiles; Heterogeneity, purity and variants; Appearance (includes colour, clarity / opalescence), pH, particulates, turbidity, osmolality, sterility and bacterial endotoxins; ELISA; Bioassays.

UNIT-V: VACCINE TECHNOLOGY

History of vaccines; Live-attenuated vaccines; Inactivated vaccines; Pathogen polysaccharide vaccines; Recombinant subunit vaccines; Toxoid vaccines; Conjugate vaccines; virus-like particles (VLPs); DNA vaccines; Structure-Based Vaccine Antigen Design.

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COURSE OUTCOMES:

At the end of this unit students will be able to

- CO1. Evaluate the concepts of biologics drugs and vaccines.
- CO2. Understand the process and methods involved in the Upstream development of biologics and vaccines.
- CO3. Understand the process and methods involved in the downstream development of biologics and vaccines.
- CO4. Analysis and characterization of biologics drugs.
- CO5. Understand the Vaccine and technology

TEXT BOOKS:

1. Cheng Liu and John Morrow Jr. Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical, and Clinical Development. Wiley.
2. Rodney Ho and Milo Gibaldi. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs. Second Edition.

REFERENCE BOOKS:

1. Steven M. Chamow, Thomas Ryll, Henry B. Lowman and Deborah Farson (editors). Therapeutic Fc-Fusion Proteins. Wiley Blackwell.
2. Barney S. Graham, Morgan S.A. Gilman and Jason S. McLellan. Structure-Based Vaccine Antigen Design. Annual Review of Medicine, 2019. 70:91–104.

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LAB III -(ENZYME TECHNOLOGY AND GENETIC ENGINEERING)
PART-B (ENZYME TECHNOLOGY)

Course Objective: This course intends to provide the practical knowledge required to study different aspects of microbial enzymes

LIST OF EXPERIMENTS:

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.(b) Compute specific growth rate (m), growth yield ($Y_{x/s,}$) from the above
4. Comparative studies of Ethanol production using different substrates.
5. Production of Citric acid using *Aspergillus Niger.*
6. Production and estimation of Alkaline Protease.
7. Use of alginate for cell immobilization.
8. Enzyme catalysis experiment

Course Outcome:
By the end of this course student will acquire skill for production and estimation of microbial enzymes.

PART-B (GENETIC ENGINEERING)

Objective: This course aim is to understand the different recombinant DNA techniques

LIST OF EXPERIMENTS:

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

Course Out comes:

After completion of the course student able to learn hands on training on different r–DNA Techniques.

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LAB IV

PROCESS ENGINEERING PRINCIPLES &CELL CULTURE LAB

PART-A (PROCESS ENGINEERING PRINCIPLES)

Course Objective: This course intends to provide the practical knowledge of equipment used in fluid mechanics and heat transfer.

LIST OF EXPERIMENTS:

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
2. Searles apparatus
3. Concentric sphere
4. Lee's disc apparatus
5. Lagged pipe
6. Heat Transfer coefficient from a vertical tube and free convection

Course Outcome:
By the end of this course student will acquires kill to perform experiments related to process engineering principles.

PART-B (CELL CULTURE)

COURSE OBJECTIVE: This course aims to provide students with basic concepts of cell culture and techniques.

LIST OF EXPERIMENTS:

1. Requirements of animal cell culture lab
2. Culture media preparation and sterilization
3. Cell culture from established cell lines: thawing and passaging
4. Cell counting using hemocytometer
5. Cell viability assays- MTT assay
6. Cryopreservation

Course outcomes: At the end of the course student will be able to understand basic needs of cell culture laboratory and familiarize with handling mammalian cells

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Program core VII

IMMUNOTECHNOLOGY

Course Objective: This course intends to provide the knowledge of cells, organs of immune system, innate & acquired immunity, humoral immunity & cell mediated immunity, the role of immunity in infectious diseases and type of vaccine & technology.

UNIT – I Immune system: Phylogeny of immune system; innate and acquired immunity **organs** and cells of the immune system; Lymphoid organs: Lymphoid follicle, Thymus, Lymph node, Spleen, MALT, GALT, SALT. Hematopoiesis and differentiation, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells. Clonal nature of immune response, antigens, immunogens, super antigens. MHC.

UNIT – II Humoral immunity: B cell types, B cell receptors and activation, Immunoglobulin diversity, Antibody structure and function, Antigen- antibody interactions (including ADCC), CDC antibodies in diagnosis, Hybridoma technology, B cell memory.

UNIT – III Cell mediated immunity: MHC restriction, Antigen presentation, T cell subsets and functions of each, T cell activation and regulation, Cell mediated immune functions- cytotoxicity, interferon; T cell memory - Central and peripheral.

UNIT – IV Immuno diseases: Immune response to infectious diseases (humoral, cell-mediated, examples), autoimmune disorders: Rheumatoid arthritis, Insulin dependent Diabetes Mellitus, Cells and organs transplantation, Graft rejection and psoriasis.

UNIT – V Immunotherapy, Vaccines and Adjuvants: Vaccines–Types, Technologies, Adjuvants–Function, mechanism of action, new generation adjuvants, Immunotherapy – antibodies (Polyclonal, Monoclonal), Cytokines, Cell therapy, diseases (HIV, HCV).

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Differentiate innate immunity and nature and biology of antigens
CO2. Understand different organs and cells of immune system
CO3. Evaluate antigen – antibody interactions, humoral immunity and hybridoma technology
CO4. Evaluate cell mediated immunity, MHC and mechanism of cytotoxicity
CO5. Evaluate autoimmune disorders and the role of immune system in infectious diseases and transplantation

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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Program core VIII

BIOPROCESS ENGINEERING

Course Objective: This course aims to provide students with an in depth understanding of bioprocess engineering process. It exposes the students to provide product by using microorganisms

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: BIOREACTORS: Introduction and types of reactors: Batch reactor, Continuous Stirred Tank Reactor (CSTR), Fed batch and Plug Flow reactors. Novel Bioreactors: Air lift reactor, trickle bed, loop reactor. Solid state fermentation and solid state bioreactors.

UNIT-IV: DOWN STREAM PROCESS: Introduction, removal of microbial cells and solid matter, cell disruptions Various cell disruption methods, need for cell disruption for intracellular products (Homogenizer, French press, & Dynomill. Physical Methods of Separation: filtration: filtration equipments viz; plate and frame filter press, vacuum filters, leaf filters, centrifugation: various centrifuges viz., basket centrifuge, tabular centrifuge, disc-bowl centrifuge, precipitation.

UNIT-V: ISOLATION & PURIFICATION OF PRODUCT & FINAL PRODUCT FINISHING OPERATIONS: Liquid-liquid extraction, Extraction process and principles, phase equilibrium and distribution, batch and continuous extraction, chromatography: Principles of chromatographic separation methods, different types of chromatographic methods, viz., adsorption chromatography, ion – exchange chromatography, gel chromatography, affinity chromatography, membrane separation, drying and crystallization.

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Understand basics of bioprocess engineering and media preparation for industrial fermentation.
CO2. Understand media optimization techniques and sterilization process.
CO3. Understand microbial kinetics and knowledge on various bioreactors.
CO4. Understand of product separation in bioprocess.
CO5. understand isolation & purification of product and final product finishing operations.

TEXT BOOKS:

1. Introduction to Biochemical Engineering by Dr D G Rao.the Mc Graw Hill companies
2. Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986
3. Bio separations: Principles and Techniques by sivashankar – 1 January 2005
4. Downstream Process Technology: A New Horizon in Biotechnology y Krishna Kant Prasad and Nooralabettu Krishna Prasad 2010

REFERENCE BOOKS:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987
2. Bioprocess Engineering Principles 2nd Edition by Pauline M. Doran, 2012

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M.Sc. BIOTECHNOLOGY - THIRD SEMESTER – W.E.F.2021

Program core IX

PLANT BIOTECHNOLOGY

Course Objective: The objective of this course is to familiarize students with the concepts of plant tissue culture its various areas and their applications. It also gives them an exposure to genetic transformation methods and application of transgenic crops for yield enhancement and as bioreactors.

UNIT-I: PLANT TISSUE CULTURE & TOTIPOTENCY: Totipotency, **A**pplications 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, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis, Organogenesis. 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. Hairy root 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, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines, Lysosomal enzymes).

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Understand the concept of totipotency in plants and its applications in science, agriculture and industry.

CO2. Acquire sufficient knowledge of role of cell cultures in development of pure breeding lines, germplasm conservation and production of variants.

CO3. Understand somatic hybridization for production of hybrid plants and advantages of plant cell cultures for production of pharmaceutically important secondary metabolites.

CO4. Acquire advanced level knowledge of Transformation techniques for transgenic plant production with their advantages and limitations .

CO5. Understand the role of plants as expression systems for production of therapeutic proteins viz. edible vaccines, plantibodies and lysosomal enzymes.

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 ArchanaGiri: 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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Program Elective III

1.BIOINFORMATICS

Course Objective: This course is formulated to provide students an in depth knowledge of biological data analysis using compilation methods. It is also useful for investigating molecular biology Problems from computational perspective. To enhance knowledge about protein structural predictions, moleculardocking and evolutionary relationships between organisms.

UNIT-I:INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS:
Need of Computers in Biotechnology Research; File Transfer Protocol; Bioinformatics- Introduction, Scope, Applications; 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 (PYMOL).

UNIT-III: PHYLOGENETIC ANALYSIS AND PREDICTION: Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods& Tools (Clustal W).

UNIT-IV: GENOME MAPPING AND PREDICTION:
Genome sequencing; 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), Molecular docking methods.

COURSE OUTCOMES:

At the formal end of the course student will be able to

- CO1. Understand the fundamentals and application of computational and bioscience useful for bioinformatics programming.
- CO2. Classify and apply Databases, data retrieval process, data mining, knowledge about the BLAST, FAST and Visualization tools for Proteomics.
- CO3. Evaluate evolutionary relationships between species, sequence alignment process and alignment tools.
- CO4. Understand sequencing and mapping of genomes which are useful in their molecular biology studies and RNA design and development
- CO5. Analyse Protein structures and protein modeling methods and tools.

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 & Applications by Zhumur Ghosh, Oxford University Press.

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Program Elective III

2. PHARMACEUTICAL BIOTECHNOLOGY

Course Objective: To introduce the students about biogenerics and biosimilars and their characterization using analytical methods and presumptions of therapeutic equivalence along with case studies. And main objective students acquire knowledge about aspects of traditional and modern biotechnology viz. Fermentation technology and Recombinant DNA technology. To enhance knowledge in Pharmacokinetic and to correlate theoretical principles with Industrial applications.

UNIT I: PROKARYOTIC AND EUKARYOTIC CELLS IN BIOSIMILARS PRODUCTION: in biosimilars production from bacteria, actinomycetes, *Saccharomyces cerevisiae* and other fungi. Plants in biosimilars production, transgenic plants as functional foods or neutraceuticals transgenic plants and plant cell culture as bioreactors of secondary metabolites.

UNIT II: BIOTHERAPEUTICS: Pharmacodynamics of protein therapeutics; chemical modification of proteins/ therapeutics; immuno suppressor in antibody therapy; pharmacogenomics**,** molecular modification of lead compounds; assay systems and models (e.g., knockoutmice). Antisense technology, small peptides, therapeutic enzymes and bacteriophage therapy.

UNIT III: PHARMACEUTICALS PRODUCTION IN PLANTS: Drugs derived from plants, antitumor agent -etoposide, colchicine, taxol, vinblastine, vincristine. Cardiotonic – convallatoxin, acetyldigoxin, adoniside, anti-inflammatory – aescin, bromelain, choleretic – curcumin, biopharmaceuticals expressed in plants alternative expression systems, three promising examples: tobacco (rhizosecretion, transfection) and moss (glycosylation).

UNIT IV: PROTEIN AND DNA VACCINES: DNA vaccine construction and immunology DNA vaccine expression plasmids delivery of DNA vaccines. Peptide vaccine, gene pharming, cytokines as biopharmaceuticals, therapeutic enzymes, t-cell therapy.

UNIT V: BIOGENERIC DRUGS RECOMBINANT THERAPEUTIC PROTEINS: Erythropoietin (EPO), colony stimulating factors (CSFs), human growth hormone (hGH), insulins, factor viii (Fviii), interferons (IFN)**.** Therapeutic hormone- insulin production through recombinant DNA technology, therapeutic monoclonal antibodies.

COURSE OUTCOMES:

At the end of the course student will be able to

- CO1. Understand the basic concepts of Neutraceuticals, microbes and Biotech production strategies at industrial level.
- CO2. Evaluate physiochemical properties and pharamacodynamics of biopharmaceuticals
- CO3. Estimate the production of plant drugs like antitumor, anti inflammatory etc.
- CO4. Analyse Protein & DNA vaccines.
- CO5. Understand biogenerics, and biopharmaceuticals

TEXT 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. DaanCrommelin, Robert D Sindelar, 2002.
4. Pharmaceutical Biotechnology; Tailor and Francis Publications, Newyork. Jay P Rho, Stan G Louie, 2003, Hand.

REFERENCE BOOKS:

1. Pharmaceutical Biotechnology Paperback – 2011 by Kokate
2. Pharmaceutical Biotechnology by AshutoshKar

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Open Elective III

1. CANCER BIOLOGY

Course objectives: The course is formulated to understand the fundamentals of cancer biology, regulation of cell cycle, the importance of physical and chemical carcinogens, cellular, viral oncogenes, tumor suppressor genes. To enhance the knowledge in different cell signalling pathways and the theories of cancer metastasis, cancer stem cells. To give a detailed inputs about diagnosis of cancer and treatment strategies.

UNIT I: Introduction: Cancer Definition, History of Cancer Research, Overview of the hallmarks of cancer, Warburg effect, Types of growth: Hyperplasia, Dysplasis, Anaplasia and Neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. Tumor microenvironment --- from monolog to dialog, Stem cells and epigenetics, Cell cycle control, regulation of the cell cycle by cyclins, cyclin-dependent kinases, Cdk inhibitors

UNIT II: Carcinogenesis: Radiation and chemical carcinogenesis, Stages in chemical carcinogenesis-Initiation, promotion and progression. Freeradicals, Antioxidants in cancer. Telomerases, Tumor suppressor genes, Molecular tools for identifying cancer genes

UNIT III: Oncogenes and cell signaling: Tumor markers, cellular proto oncogenes, Mechanisms of oncogene activation, growth factors and receptors as oncogenes, Retroviruses and Oncogenes, G-protein coupled receptors in development of cancer, Apoptosis, RAS signaling in cancer.

UNIT IV: Angiogenesis, Metastasis & Cancer stem cells: Metastasis, Principles of cancer metastasis, Classic theory of tumor Metastasis, Metastatic cascade, Epithelial-Mesenchymal Transition and Dissemination from the Primary Tumor, Cancer in Transit: Dynamics and Behaviors of Circulating Tumor Cells (CTCs), Cancer stem cells, Case study: Breast cancer & Colon cancer

UNIT V: Cancer Diagnosis & Treatment Strategies: Familial cancer syndromes, Genomic Screening, Biomarkers technology and nanotechnology in screening**,** traditional chemotherapy, Mode of action and metabolism of chemotherapeutic drugs, Immunotherapy, targeted therapy, Chemoprevention.

COURSE OUTCOMES:

At the end of the course student will be able to

- CO1. Understand the basic concepts of cancer, types of tumors and concept of cell cycle regulation.
- CO2. Evaluate the impact of tumor suppressor genes, physical, chemical carcinogens and freeradicals impact on carcinogenesis
- CO3. Estimate the role of oncogenes and their mechanisms
- CO4. Analyse principles of metastasis and cancer stem cells
- CO5. Understand various cancer syndromes, screening approaches and treatment strategies for cancer.

Text Books: -

1. The Biological Basis of Cancer: R. G. McKinnell,etal 2nd Ed, Cambridge University Press, 2006.
2. The Biology of Cancer: R.A.Weinberg. GarlandScience. 2006.
3. The Molecular Biology of Cancer: S.Pelengaris,M.Khan. Blackwell Publication.
4. Introduction to modern Virology, Dunmock N.J and Primrose.S.B.,Blackwel Scientific Publications.Oxford,1988.

Reference Books:

1. An Introduction to Cellular & Molecular Biology of Cancer,Oxford Medical publications,1991
2. Gene expression systems.JosephM.Fernandez & JamesP.Hoeffler. AcademicPress,1999.
3. Cancer Biology IV Ed Volume2 Raymond WRuddon M.D.(2007)
4. Cancer Biology(3rd_Edition)Roger J.B. etal(2006)
5. Advances in Cancer Stem Cell Biology, Roberto Scatena, Alvaro Mordente & BrunoGiardina(Ed)–Springer(2012)

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Open Elective III

2. ECOLOGY&ENVIRONMENTAL BIOTECHNOLOGY

Course Objective: The main objective of this course is to impart students an understanding of ecology and ecosystems, functions of all various components in the ecosystem. It also familiarizes them with various Technologies used in treatment of air, water, soil and other persistent chemicals in the environment.

UNIT I: **ECOLOGY AND ECOSYSTEMS:** Fundamentals of Ecology and Ecosystems, Components of Ecosystems, Food chain, Food Web, Trophic levels, Energy flow, Role of Producers, Consumers and Decomposers.

Ecosystems: Types, characteristic features, structure and functions of the following ecosystems: Pond ecosystem- Marine ecosystem - Grassland ecosystem - Forest ecosystem- Desert ecosystem – Cropland Ecosystem.

UNIT-II: ENVIRONMENTAL POLLUTION AND CONTROL: Introduction to Environmental pollution, Air, water and soil pollution- Types, common effects and control measures

Air Pollution Treatment Technologies: Biofilters and Bioscrubbers for treatment of industrial waste

UNIT-III: WASTE WATER TREATMENT:

Water: Waste water, Types of waste water, 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: Anaerobic digestion, anaerobic digesters, Contact Digesters, Packed Column Reactors, UASB for biological treatment process

UNIT-IV: BIOREMEDIATION AND PHYTOREMEDIATION: Definition, constraints and priorities of Bioremediation, Types of bioremediation: *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation, Applications of bioremediation.

Phytoremediation: Definition, Types and their role in degradation of pollutants, Natural attenuation and Vermicomposting. Microbial degradation of pesticides and other recalcitrant chemicals, microbial degradation of petroleum and hydrocarbons; biodeterioration and control

UNIT-V:BIOENERGY & BIOMINING: Bio Energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen production. **Biomining:** Bioleaching, Types, Applications. Biofilms formations and its use, microbially enhanced oil recovery, microbial fuel cells and their applications

COURSE OUTCOMES:

At the end of the course students will be able to

- CO1. Understand the basic information of Ecology and Ecosystems.
- CO2. Evaluate the Knowledge of Air, Water and soil Pollution and their control Technologies.
- CO3. Analyzing the various Waste water treatment technologies.
- CO4. Evaluate the Knowledge of Bioremediation and Phytoremediation Technologies.
- CO5. Understand the Bioleaching and Bio-mining technologies their Applications.

TEXT BOOKS:

1. Fundamentals of Ecology by Eugene P. Odum (Author), Gary W. Barrett
2. Introduction to Environmental Science Hardcover – 2004 by Y Anjaneyulu

REFERENCE BOOKS:

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

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LAB V

(IMMUNOTECHNOLOGY AND BIOPROCESS ENGINEERING)

PART-A (IMMUNOTECHNOLOGY)

Course Objective: This course intends to provide the practical knowledge of different immunological techniques.

LIST OF EXPERIMENTS:

1. Blood grouping – Agglutination
2. Agglutination reactions – Widal, VDRL, HA
3. Radial immuno diffusion,
4. Ouchterolony double immuno diffusion
5. Immuno-electrophoresis,
6. ELISA
7. Purification of antibodies
8. Latex agglutination test (Indirect agglutination-Pregnancy hCG Ag).

Course Outcome:

By the end of this course student will acquire skill to perform different immune diffusion techniques, ELISA, immune-electrophoresis and purify antibodies.

PART-A (BIOPROCESS ENGINEERING)

COURSE OBJECTIVES: This course aims to provide students with an in depth understanding bioprocess engineering. It exposes the students to produce product by using microorganisms.

LIST OF EXPERIMENTS:

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

Course outcomes: After completion of the course student able to understand how environment conditions influence cell growth and means to achieve optimal cell growth in large scale and also separation of product by using different separation techniques.

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LAB VI

PLANT BIOTECHNOLOGY AND BIOINFORMATICS/PHARMACEUTICAL BIOTECHNOLOGY LAB

PART-A(PLANT BIOTECHNOLOGY)

Objective: This course aim is to understand the different plant tissue culture techniques

LIST OF EXPERIMENTS:

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***.
7. Induction of hair root culture.

Course Out comes:

After completion of the course student learn different plant tissue culture techniques.

PART-B (BIOINFORMATICS)

Course Objective: This course provides the practical knowledge on Bioinformatics.

LIST OF EXPERIMENTS:

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

Course Outcome:

By the end of this course student will acquire skills on different bioinformatics tools and techniques.

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PART B (PHARMACEUTICAL BIOTECHNOLOGY)

Course Objective: This course intends to provide the practical knowledge of Biopharmaceutical technology

LIST OF EXPERIMENTS:

1. Isolation of Pharmaceutically important phytochemicals from crude drugs.
2. TLC characterization of medicinal plant extracts and isolation of phytochemicals.
3. GC 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. L Asperginase production by Streptomyces sp or other bacteria

Course Outcome:

By the end of this course student will acquire skill for isolation, separation and estimation of pharmaceutically important phytochemicals.

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THESIS TEMPLATE

TITLE NAME

(Capital letters only, Centre & Bold, Bookman Old style -14)

A THESIS

(Centre & Bold, Bookman Old style - 12)

Submitted

(Italic, Centre & Bold, Bookman Old style - 12)

in the partial fulfillment of the requirements for
the award of degree
(Italic, Centre & Bookman Old style -12)

MASTER OF SCIENCE

IN

MICROBIOLOGY

(Centre & Bold, Bookman Old style -14, Space line 1.5)

By

Mr. or **Miss. SAI MANISHA MALLELA**

[Roll No.: 19031D03**]

(Centre & Bold, Bookman Old style -14 & 12, Space line 1.5)

Under the supervision of

(Italic, Centre & Bookman Old style - 12)

Dr. K. VENKATESHWAR REDDY

Assistant Professor (C)

(Centre & Bold, Bookman Old style -14 & 12, Space line 1.5)

CENTRE FOR BIOTECHNOLOGY

UNIVERSITY COLLEGE OF ENGINEERING SCIENCE AND TECHNOLOGY,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD,

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DECEMBER – 2021 (Submitted Month & Year)

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M.SC BIOTECHNOLOGY 2022

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ACCREDITED BY NAAC
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CENTRE FOR BIOTECHNOLOGY
UNIVERSITY COLLEGE OF ENGINEERING SCIENCE AND TECHNOLOGY
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
(Established by Govt. Act No. 30 of 2008)
Kukatpally, Hyderabad – 500 085, Telangana State (India)

Dr. L. SAIDA, Ph.D.
Associate Professor & Head

Hyderabad
Date:

CERTIFICATE

This is to certify that the dissertation entitled "**TITLE**" is being submitted by Mr./Miss. **Name** bearing Roll No.: ------ to the Centre of Biotechnology, University College of Engineering Science and Technology, Jawaharlal Nehru Technology University Hyderabad in partial fulfillment for the award of **Master of Science** in **Biotechnology/ Microbiology** is a record of bonafide work carried out under the supervision of **Dr. K.VENKATESWAR REDDY**, Assistant Professor (C), CBT, UCEST, JNTUH, Hyderabad.

Dr. L. Saida Naik
(Head of the Department)

If possible **Saida sir** students only write as:
is a record of bonafide work carried out by **him/her** at our organization/ institution. And remaining faculty members write as above format.

M.SC BIOTECHNOLOGY 2022

SUPERVISOR LETTER HEAD

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ACCREDITED BY NAAC
A-GRADE

CENTRE FOR BIOTECHNOLOGY
UNIVERSITY COLLEGE OF ENGINEERING SCIENCE AND TECHNOLOGY
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
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Kukatpally, Hyderabad – 500 085, Telangana State (India)

Dr. K.VENKATESWAR REDDY, M.Sc., M. Tech., & Ph.D.
Assistant Professor (C)

Hyderabad
Date:

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The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Dr. K. Venkateswar Reddy
(Research Supervisor)

Outside Project work students done by Different Institutions Organization Certificates

With Letter Head/Letter Pad

(Soft/Hard copy, Taken/Collect in the department Office or Colour print)

DECLARATION

I hereby declare that the project work embodied in the dissertation entitled "**TITLE**" is being submitted to CBT, IST, JNTUH was carried out by me at Centre for Biotechnology (CBT), University College of Engineering Science and Technology (UCEST), under the supervision of **Dr. K. Venkateswar Reddy**, Assistant Professor (C), Centre for Biotechnology, University College of Engineering Science and Technology, JNTUH. This report is submitted in partial fulfillment for the award of Master of Technology in Biotechnology at CBT, UCEST, Jawaharlal Nehru Technological University Hyderabad, Kukatpally – 500 085, Hyderabad, Telangana State, India.

This work is original and no part of this has been submitted to any other university or institute for the award of any degree or diploma.

Place: Hyderabad

Date:

Signature

(**Name**)

Reg. No.:------

ACKNOWLEDGEMENTS

(Acknowledge assistance from **advisors, sponsors, funding agencies, colleagues, technicians**, and so on.)

My sincere thanks to **Dr. L. SAIDA**, Associate Professor and Head of the Department for permitting me to carry out the project work at Centre for Biotechnology, UCEST, JNTUH.

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My heartfelt thanks to **Dr. A. UMA,** Associate Professor, Centre for Biotechnology, UCEST JNTUH for guiding and supporting me throughout my project work at Centre for Biotechnology Laboratory.

My thanks are owed to **Teaching Staffs**, **Non-teaching staff's** members and Colleagues in the Biotechnology department of UCEST, JNTUH.

I would like to express my sincere thanks to all the **Colleagues** and **Ph.D scholars** of Centre for Biotechnology, UCEST, JNTUH for their valuable suggestions and support.

(**Name**)
Reg. No.: -----

ABSTRACT

- The abstract may not exceed **500 words** for a master's. In style, the abstract should be a miniature version of the thesis. It should be a briefly state the (1) Research problem, (2) Methodology, (3) Key summary of the results, (4) Conclusions or main arguments presented in the thesis.
- Abstract should be in minimum 3 to 5 paragraphs and **justify** with **1.5 space** lines**.**
- **Key words:** Minimum 5 key words**.**

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

Abbreviation	Signification
DNA	Deoxyribonucleic acid
RNA	Ribonucleic acid

UNITS OF MEASUREMENTS & SYMBOLS	
cm	: Centimetre
^{o}C	: Degree Celsius
gm	: Gram
h	: Hour
kg	: Kilogram
µg	: Microgram
mg	: Milligram
mM	: Millimolar
mm	: Millimeter
µm	: Micrometer
µl	: Microlitre
ml	: Millilitre
min	: Minutes
M	: Molar concentration

M.SC BIOTECHNOLOGY 2022

FULL THESIS FORMAT GUIDELINES IN DETAILS
(CBT, UCEST, JNTUH)
Thesis Templates

Some of our students have contributed thesis templates which you may find helpful as you begin your thesis writing. If you have developed a template that you would like to share, please let us know and we will add it to our department of CBT.

- **Thesis hard copy** should be in **A4 Size** format with **300 gsm Gray sheet** soft binding.
- The thesis document is to be **printed on single side of the executive bond-paper**.

Fonts Size & Spacing:

- All the text words should be in **Times new roman** and font size is **12**.
- All text words should be **Justified** with **1.5 space line**
- Only footnotes, long quotations, bibliography entries should be double spaced, table captions, and similar special material may be single spaced.
- Paragraph to paragraph **1.0 cm** distance.
- All **headings** should be same font and **bold**, size is **12**.

Margins:

- We recommend a **left margin of "1.5**" and a **top, bottom,** and **right margin of "1.0"**.
- **Page numbers** do not need to meet the "1.0" margin requirement.
- If you do not follow the appropriate margin guidelines that are included here, you might lose content if your thesis is bound. Some students may wish to extend their work beyond the margin requirement for aesthetic reasons, this is acceptable.
- Labels for the Tables, Figures and Structures should be **centred**.

Table of contents:

- List the key **subject headings** and **subheadings** of your thesis with their page numbers.

List of figures:

- Include the figure numbers, figure titles, and page numbers.

List of tables:

- Include the table numbers, table titles, and page numbers and all text words should be **justified** with **1.0 space line anywhere in complete thesis.**

Hyperlinks:

- **Hyperlinks are not to be used** as a substitute for complete bibliographic citations.

Page numbering:

- Page numbers should be placed in the upper/ lower right corner of the page. Only the number should appear, not "page 9" or the abbreviation "p. 9."
- On the first page of each chapter, the number may be placed at the centred bottom, one double space below the last line of type (the conventional placement), or at the top right corner.

Body:

In the thesis body, you provide the introduction, narrative, and analysis of your work. The body includes these elements/chapters:

- **1. Introduction:** State (1) the purpose of the investigation, (2) the problem being investigated, (3) the background (context and importance) of the problem and **Objectives**.
- **2. Review of Literature:** It should be written based on update previous literature/available related to your work.
- **3. Materials, apparatus, and procedures:** List and describe key materials and apparatus. Then describe the procedure in detail that others can duplicate it. For design studies, this section includes component design, fabrication, assembly, and testing procedures. Use illustrations.
- **4. Results:** Present the results, usually with accompanying tables and graphs. Characterize the patterns and quality of the results and estimate their accuracy and precision. Detailed data may be presented as an appendix. Use analytical graphics.
- **4. Discussion:** Discuss the results, stating clearly what their significance is over the earlier reports. Compare the results with theoretical expectations and account for anything unexpected.
- **5. Conclusions:** Review the results in relation to the original problem statement. Assess the success of the study in light of the criteria of success you gave in the introduction.
- **6. Bibliography:** List alphabetically any works referred to in your study. Follow the bibliographical and footnote formats of your department.
- **Recommendations:** If applicable, recommend directions for future work.
- **Appendixes:** Provide detailed calculations, procedures, and data in separate appendixes. Give each appendix a title, a letter (Appendix A, B, C), and an introductory paragraph.

Standard References order should be following format:

1) All **Authors Names** included followed by **Year** of publication.
2) **Title of the publication**.
3) **Journals Names/ Title of the book; Subtitle & Publisher Names** (this should be written in ***italics***).
4) **Volume, Issue** and **Page Number**.
5) **Digital object identifiers** (DOIs) are commonly featured in reference entries for journal articles, as well as in entries for other types of electronic resources, **if available**.

Examples:

One Author:

1. Binnall, **J.** M (2019). Jury diversity in the age of mass incarceration: An exploratory mock jury experiment examining felon-jurors' potential impacts on deliberations. *Psychology, Crime & Law*, 25(4): 345–363. **DOI:** 10.1080/1068316X.2018.1528359.

Two Authors:

1) Machado, M. M., & Swank, **J.** M (2019). Therapeutic gardening: A counselling approach for bereavement from suicide. *Death Studies*, 43(10): 629–633. **DOI:** 10.1080/07481187.2018.1509908.

Three to More Authors:

1) Prinzie, P., Stams, G. **J. J.** M., Deković, M., Reijntjes, A. H. A., & Belsky, **J** (2009). The relations between parents' Big Five personality factors and parenting: A meta-analytic review. *Journal of Personality and Social Psychology*, 97(2): 351–362. **DOI:** 10.1037/a0015823.

If Book Chapters/ Text Books like:

1) Bale, T., Webb, P., & Poletti, M (2020). Foot soldiers: Political party membership in the 21st century. Oxford University Press. Routledge.

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