Cell and Molecular Biology

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	Core	BT104101BT

[Pre Requisite-Basic Biosciences]

Course Objectives

1. Understand the membrane and transport system
2. Understand the cell signalling and communication
3. Acquainted with post transcriptional and translational modifications.
4. Know the metabolism of DNA, RNA and proteins.
5. Understand the regulation of gene expression.

Course Content

Unit 1 – Cell membrane and Transport

Electrical properties of membranes, transport processes across the plasma membrane, membrane channels & pumps, mechanism of sorting and regulation of intracellular transport, membrane transporters.

Unit 2 – Cell Communication and Signaling

Cell surface & intracellular receptors, signaling through G-protein coupled receptors & protein kinase, signal transduction pathways viz MAPK/cAMP, second messengers, molecular transmission, regulation of signaling pathways.

Unit 3 – Post-transcriptional and Post-translational Modification

Processing of hnRNA, tRNA, rRNA, 5'-Cap formation, 3'-end processing, polyadenylation, splicing, RNA editing, nuclear export of mRNA, various types of PTMs.

Unit 4–Metabolism of Biomolecules and Regulation of Gene Expression

DNA methylation, damage & repair, DNA recombination, RNA stability & transport, catalytic RNA, micro RNA, aptamers, protein folding, protein trafficking & degradation, Control of gene expression at transcription/translation level, regulation of gene expression in prokaryotr& eukaryote, role of chromatin in regulating gene expression, gene silencing.

Course Materials

Required Text: Text books

1. Essential Cell Biology by Alberts.
2. Molecular Cell Biology by Harvey Lodish, David Baltimore.

Optional Materials: Reference Books

1. The Cell: A molecular Approach by Cooper.
2. Genes IX by Lewin.

Enzyme Technology

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	Core	BT104102BT

[Pre Requisite-Biochemistry, Microbiology]

Course Objectives

1. Understand the concepts and mechanisms of enzymes.
2. Understand the isolation purification and immobilization techniques.
3. Determine the kinetic parameters of enzymatic reactions

Industrial and clinical applications of enzymes

Course Content

Unit 1: Introduction, history and catalysis of Enzymes:

Why enzymes, Brief history, Enzyme nomenclature & classification, Enzyme units, the mechanism of enzyme action, Proximity and orientation effects etc. Coenzyme and Cofactors, Zymogen, Holo enzyme, Ribozyme &Abzymes, Allosteric enzymes. Lock and key, Induced fit and Transition state Hypotheses. Mechanism of Serine proteases-Chymotrypsin, Lysozyme.

Unit 2: Enzyme kinetics: Factors affecting the enzyme activity-

Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition (Reversible Inhibition-Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition).

Unit 3: Enzyme immobilization: Methods of immobilization of enzymes-

Physical & chemical techniques, Kinetics of immobilized enzyme, Effect of external mass transfer & intra-particle diffusion, limitation & applications of immobilized enzymes, Bioreactors using immobilized enzyme. Introduction to Cross linking enzyme activity (CLEA) and Magnetic CLEA. Carrier free immobilization, enzyme reaction in organic solution.

Unit 4: Enzyme engineering and downstream processing:

Strategies of isolation and purification of new enzymes from different sources, Large-scale industrial enzyme production, downstream processing, Modification of enzymes, Enzyme Structure activity Relationship (SAR) and Drug Discovery, Properties of Enzymes. Enzyme Engineering methods, Site directed evolution, catalysis in non-aqueous environment.

Course Materials

Required Text: Text books

1. Enzyme by Palmer (2001); Horwood publishing series.
2. Fundamental of Enzymology by Price and Stevens (2002): Oxford University Press.

Optional Materials: Reference Books

1. Enzyme technology by Helmut uhling (1998): John Wiley
2. A. L. Lehringer, d.L. Nelson, M.M Cox- “Principle of Biochemistry “ byWerth publishers.
3. L. Stryer, J.M. Berge, J.L. Tymoezko-“Biochemistry” W.H. freeman & Co. 2002
4. Introduction to protein structure by B randen and Tooze(1998): Garland publishing group.

Genetics

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	Core	BT104103BT

[Pre Requisite- Basic Biosciences, Microbiology]

Course Objectives

1. Acquainted with Mendelian genetics and sex determination.
2. Understand the Microbial, evolutionary and molecular genetics.
3. Understand the genetics of human.
4. Know the developmental and population genetics.

Course Content

Unit 1 – Mendelian Genetics and Sex Determination

Allele, Mendel's experiments, Mendel's Laws, Back & test cross, Linkage & crossing over, Deviations of Mendel's ratios due of gene interaction, Hugo de Vries mutation theory, Genetic mapping in eukaryotes and prokaryotes. Chromosomal basis of sex determination, Sex linked inheritance, Sex influence & sex limited traits, Genetic balance theory, Cytoplasmic, Polygenic &criss-cross inheritance.

Unit 2 – Microbial, Evolutionary and Molecular Genetics

Methods of genetic transfers – transformation, conjugation, transduction, & sex-duction, Genetic mapping in microbes, Concepts of neutral selection & evolution, molecular divergence & molecular clocks, Molecular tools in phylogeny, Origin of new genes & proteins, Gene duplication & divergence.

Unit 3 – Human Genetics

Inborn error in metabolism, Sex linked disorders, Genetic disorders, Molecular basis of genetic diseases, Blood group & Rh factor inheritance, Erythroblastosisfetalis, Twins, Amniocentesis, Genetic counselling.

Unit 4 – Developmental and Population Genetics

Genes in early development, Maternal effect genes; Pattern formation genes, Homeotic genes, Gene flow, Genetic drift, Hardy-Weinberg's law, Selection, Pedigree analysis, Genetic advances in agriculture & medicine.

Course Materials

Required Text: Text books

1. Principles of Genetics by Gardner.
2. Concepts of Genetics by Klug and Cummings.

Optional Materials: Reference Books

1. Genetics by Russel Benjamin Cumming Comp. Inc
2. Principles of Genetics by Robert Tamarin

Animal Cell and Plant Tissue Culture

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	Core	BT104104BT

[Pre Requisite- Basic Biosciences, Microbiology]

Course Objectives

1. Understand the introductory of animal and plant tissue culture
2. Know the basis techniques involved in animal and plant tissue culture
3. Understand the application of animal cell culture
4. Acquainted with application of plant tissue culture

Course Content

Unit 1 - Introduction of Animal & Plant Tissue Culture

Scope of animal & plant tissue culture, Types of cultures, Laboratory Design and Layout, Essential Equipments, General Safety Measures, Aseptic Techniques & Sterile Handling, Risk Assessment & management, Types of animal culture media, chemical composition and common animal medial used in lab, Plant tissue culture media types and composition.

Unit 2 - Basic Techniques in Animal Cell Culture

Animal cell culture basic techniques, Isolation of animal Cells, Steps involved in Primary Cell Culture, Culture environment & maintenance, Subculture & propagation, Cell Proliferation & Viability assay, Culture contamination & their identification techniques, Cell lines

Unit 3 – Basic Techniques in Plant Tissue Culture

Callus culture, Micropropagation, Haploid production, Somaclonal variations, Embryo culture and Reuse, Morphogenesis, Molecular marker assisted selection, Molecular marker aided Plant breeding, and Quantitative trait loci.

Unit 4- Application of Plant Tissue culture and Animal Cell Culture

Application of biotic stress resistant variety, insect/virus resistance, fungal/bacterial diseases resistance, Resistance to abiotic stress, Herbicide resistance, hairy root culture and secondary metabolite production, germplasm preservation, Transgenic Animal Production, Applications of transgenic animals. Embryonic Stem Cell Technology, In-vitro Fertilization, Embryo Transfer Technology and its significance.

Course Materials

Required Text: Text books

1. Culture of Animal Cell by Freshney
2. Introduction to plant tissue culture by M.K. Razdan

Optional Materials: Reference Books

1. Introduction to cell & tissue culture by Jennie P. Mather and Penelope E. Roberts Plenum Press, New York and London.
2. Plant Cell and Tissue Culture by Jeffrey W Pollard and John M Walker

Thermodynamics & Reaction Engineering

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	Core	BT104105BT

[Pre Requisite- Chemistry, Bioprocess Calculation]

Course Objectives

1. Understand the laws of thermodynamics
2. Apply power and refrigeration cycles for bioprocesses
3. Calculate thermodynamic parameters involved in biochemical reactions
4. Differentiate between ideal and non-ideal solutions

Course Content

Unit 1 - Introduction to Thermodynamics

First and second Law of Thermodynamics and Other Basic Concepts, Calculation of Work, energy and property changes in reversible processes, Thermodynamics of Flow Process and fluids, Volumetric Properties of Real Gases, Maxwell's relationships and their applications Residual Properties Estimation of Thermodynamic Properties using Equation of State, Power cycles and refrigeration cycles.

Unit 2 - Solution Thermodynamics:

Partial Properties, Concepts of Chemical Potential and Fugacity, Ideal andNon Ideal Solutions, Gibbs free energy , enthalpy and entropy. Thermodynamics Theories: Phase and Chemical Reaction Equilibria: Criteria for phase equilibrium ,Vapour Liquid equilibrium calculations for binary mixtures, Liquid –Liquid Equilibria and Solid Liquid Equilibria.

Unit 3- Biochemical Thermodynamics: Metabolic Pathways and energetics ;

Energy Coupling (ATP & NADH) Stoichiometry and energetic analysis of Cell Growth and Product Formation elemental Balances, Degree of reduction concepts; available electron balances; yield coefficients.

Unit 4- Thermodynamics of microbial growth:

Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth, Energy balance equation for free cell culture ; React ion thermodynamics. pH dependence of a Biochemical Reaction, Unfolding of a protein as a function of Temperature.

Course Materials

Required Text: Text books

1. J.M. Smith, H.C. van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 2005
2. Stanley I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, 4Th Edition, Wiley, 2006.

Optional Materials: Reference Books

1. J.A Roels, Kinetics and Energetics in Biotechnology, Elsevier, 2003
2. Robert A. Alberty, Biochemical Thermodynamics: Applications of Mathematica 1stEdition, Wiley Interscience, 2007.

Mathematics-IV (Numerical Methods)

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Mathematics	4-0-0, (4)	EPR	BT104001MA

[Pre-requisites: Mathematics-I, Mathematics-II]

Course Objective

1. To enable the students to apply the knowledge of Mathematics in various fields:
1. To solve the algebraic, transcendental and simultaneous linear equations and its application.
2. To solve the problems related to data appear equal or unequal intervals and to obtain a functional relationship between the observed values.
3. To calculate the derivative of the function and evaluate the definite Integral from set of numerical values.
4. To solve the ordinary differential equations using different numerical techniques.

Course Content

UNIT-1:NUMERICAL SOLUTIONS OF ALGEBRAIC, TRANSCENDENTAL AND SIMULTANEOUS LINEAR EQUATIONS

Errors in numerical computation, Error type, Bisection Method, Regula–Falsi Method, Secant Method, Newton-Raphson Method, Direct Methods: Gauss Elimination, Gauss-Jordan &Crout'sTriangularisation Method, Iterative Methods: Jacobi, Gauss- Seidel & Relaxation Methods.

UNIT-2:INTERPOLATION AND CURVE FITTING

Finite differences, Forward, Backward & Central Difference Interpolation, Lagrange's method and Newton's Divided Difference method, Principle of Least Squares, Fitting a Straight Line, Fitting a Parabola, Exponential function, Method of Group Averages.

UNIT-3:NUMERICAL DIFFERENTIATION AND INTEGRATION

Derivatives using Forward, Backward and Central Difference methods, Derivatives using unequally spaced values, Newton-Cote's Quadrature method, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Weddle's rule.

UNIT-4:NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

Numerical Solution of ODE using Picard's Method, Taylor's Series Method, Euler's Modified Method, Runge-Kutta Method of Fourth Order, Milne's Method, Adams–Bashforth Method..

Course Materials

Required Text: Text books

1. M. K. Jain, S. R. K. Iyengar& R. K. Jain Numerical Methods for Scientific and Engineering Computation, New Age International (P) Limited, Publisher.
2. B. S. Grewal, Numerical Method in Engineering and Science, Khanna Publisher.
3. J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, Inc. Publisher.

Optional Materials: Reference Books

1. P. Kandasamy, K. Thilagavathy, & K. Gunavathi, Numerical Methods, S. Chand Publisher.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Inc. Publisher.
3. S. S. Sastry, Introductory methods of numerical analysis, PHI, Publisher.

Cell and Molecular Biology Lab

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	0-0-2, (2)	Core	BT104401BT

[Pre Requisite- Basic Biosciences Lab, Biochemistry and Microbiology Lab]

Course Objectives

1. Experimentally verify the theoretical concepts and knowledge.

Course Content

1. Isolation of genomic DNA from plant cell by CTAB method.
2. Isolation of genomic DNA from microbial/blood cell.
3. Isolation of RNA from yeast cell.
4. Isolation of plasmid
5. Agarose gel Electrophoresis of isolated DNA/RNA/plasmid
6. DNA Elution from Agarose Gel
7. PCR to perform amplification of DNA
8. Restriction Digestion of genomic and plasmid DNA.
9. DNA Ligation
10. Southern blotting

Course Materials

Required Text: Text books

Cell and Molecular Biology - A Lab Manual by K. V. Chaitanya.

Optional Materials: Reference Books

Molecular cloning: A laboratory manual" by Sambrook, J., & Russell, D. W.

Enzyme Technology Lab

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	0-0-2, (2)	Core	BT104402BT

[Pre Requisite- Basic Biosciences Lab, Biochemistry and Microbiology Lab]

Course Objectives

1. Will be able to isolate an enzyme
2. Will be able to study parameters effect on enzyme production
3. Estimate the kinetic parameters of enzymatic reactions
4. Study various techniques for enzyme purification

Course Content

1. Isolation of Alpha/Beta Amylase.
2. Alpha/Beta Amylase Enzyme purification: Ammonium sulphate precipitation, Gel filtration and ion exchange chromatography
3. Effect of temperature/pH/concentration on amylase activity.
4. Determination of Specific and total activity calculation
5. Purity analysis: SDS gel electrophoresis, HPLC
6. Enzyme kinetics (Effect of substrate concentration on Enzyme kinetics and determination of Km and Vmax, Kcat, catalytic affect)
7. Various Techniques of enzyme immobilization, use of sodium alginate for immobilization of amylase enzyme.
8. Enzyme inhibition kinetics
9. Enzyme production at reactor scale
10. Recycling of co-enzymes

Course Materials

Required Text: Text books

Julio Polaina and Andrew P. MacCabe: Industrial Enzymes Structure, Function and Applications, Springer, Dordrecht, The Netherlands, 2007.

Optional Materials: Reference Books

Bioprocess Engineering Principles. By Paulin M. Doran. Elsevier Science & Technology Books.2008.
