Ph.D. Course work

Pre-Ph.D. Examination Syllabus

DEPARTMENT OF BIO-TECHNOLOGY,
K L UNIVERSITY,
VADDESWARAM - 522502, ANDHRA PRADESH, INDIA.

List of Pre-Ph.D Courses

DEPARTMENT OF BIO-TECHNOLOGY
L-T-P-S: 3-0-0-0

S.No	Paper 1	Subject Code
1	RESEARCH METHODOLOGY	21RES104

S.NO	**PAPER – 2**	**Code**	**PAPER – 3**	**Code**
1	Bioanalytical Techniques	21BT201	Plant Biotechnology	21BT301
2			Genetic Engineering	21BT302
3			Microbial Technology	21BT303
4			Biochemistry	21BT304
5			Molecular Modeling and Drug Design	21BT305
6			Bioprocess Engineering	21BT306
7			Immunotechnology	21BT307
8			Microbial Technology	21BT308
9			Nanobiotechnology And Nanomedicine	21BT309

BIO-ANALYTICAL TECHNIQUES

Unit I: ***Spectroscopy Techniques***

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

Unit II: ***Chromatography Techniques***

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Unit-III: ***Electrophoretic techniques***

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit IV : ***Centrifugation***

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Unit V: ***Advanced Techniques***

Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis and sequencing.

Texts:

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H.
2. Freeman & Company, San Fransisco, 1982.
3. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.

References

1. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
2. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag 1994.

Code: 21 BT 301

Plant Biotechnology

Unit-1

An Overview of Plant Biotechnology: Totipotency, Media, types of media used, media composition, nutritional variations, cell nutrition, cytodifferentiation, invitro growth parameters, contamination and recalcitrance, invitro cultivation methods, molecular farming

Unit – 2

Organogenesis, Caulogenesis and Rhizogenesis: Descriptive understanding of invitro grown plantlets showing disease- resistant, herbicide tolerant and induction of environment sustainance. Direct and indirect methods of regeneration Suspension cultures, Somaclonal and gametoclonal variations and Genetic stability.

Unit - 3

Secondary Metabolite production & Germplasm conservation : Plant secondary metabolites, commercial production using appropriate media supplements viz., elicitors, growth factors, stress factors, defense proteins, precursors and anti-metabolites. Cryo preservation exsitu and insitu methods, freezing, thawing and drying and cryoprotectors.

Unit – 4

Genetic Transformation & Molecular breeding : Protoplast isolation, culture and fusion technique, protoplast induced transformation, Target cells for transformation, methods of gene transfer, selectable marker genes, reporter genes, screenable genes, Agrobacterium mediated transformation, histo chemical assay,transgenic plants, Plant DNA finger printing, RAPD, RFLP, PCR studies in plants with a focus on molecular assisted selection.

Unit – 5

Plant Bioinformatics: New approaches to scientific research with computers, Information and communication technologies (ICT model systems), genomics (functional and structural), proteomics, molecular bioinformatics, chemi-informatics and their applications in Plant improvement.

TEXT BOOKS:

1. Plant Cell, Tissue, and Organ culture" by J Reinert and Y P S Bajaj.
2. Plant Tissue Culture Theory and Applications Bhojwani SS and Razdan ,Elsevier Publication.
3. Introduction to Plant Biotechnology by H.S Chawla Second edition. Oxford & IBH Publishing Co.Pvt.Ltd.

REFERENCE BOOKS

1. Plant Biotechnology New Products and Applications. Hammond PM and Yusibov V . Springer International Edition.
2. Plant Tissue Culture" Thorpe, T.A. (Ed.).
3. Handbook of Plant Cell Culture" Eds. Sharp et al. Plant Biotechnology" Eds. Mantell & Smith.

Code: 21BT 302

Genetic Engineering

UNIT I:

Eukaryotic chromosome Structure, DNA Structure, Genes arrangement, Prokaryotic and Eukaryotic replication and repair. Repetitive DNA. CpG islands. Different classes of RNA and their functions. Prokaryotic and Eukaryotic Transcription and post transcriptional modifications.

UNIT II:

Protein synthesis and translational control. Control of gene expression in prokaryotes. Transcriptional control in Eukaryotes. Transposable elements and TY elements. Molecular mechanism of antisense molecules, Biochemistry of ribozyrne; Applications of antisense and ribozyme technologies.

UNIT III:

Nucleic Acid Purification, Yield Analysis. Nucleic Acid Amplification and Its Applications. Nucleic Acid Sequencing. Restriction enzymes, ligases, s1 nuclease, terminal deoxynucleotides, transferases, Poly A polymerases, Reverse Transcriptase, Alkaline phosphatase. DNA and RNA markers. Restriction Mapping of DNA Fragments and Map Construction.

UNIT IV:

Gene Cloning Vectors: Plasmids, phagemids, cosmids, Artificial chromosomes. cDNA Synthesis and cDNA library preparations. Cloning mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors, Library construction and screening. Genomic libraries (complete sequencing projects). Alternative Strategies of Gene Cloning, Cloning interacting genes- Two-and three hybrid systems, cloning differentially expressed genes. Site-directed Mutagenesis and Protein Engineering.

UNIT V:

DNA transfection, Southern and Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays. Nucleic acid microarrays. Vector engineering and codon optimization, host engineering. In-vitro transcription and translation, Expression Strategies for Heterologous Genes in Bacteria, Yeast and mammalian cells. Processing of Recombinant Proteins, Purification and refolding. Phage Display, Transgenic and Gene Knockout Technologies, Targeted gene replacement, Chromosome engineering. Gene Therapy Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

TEXT BOOKS:

1. "Molecular Biology of the gene" by Waston et al 4th ed.
2. "Genes VI" by Benjamin Lewis.
3. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

REFERENCES:

1. DNA Science. A First Course in Recombinant Technology, D,A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New YorK, 1990.
2. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994.

Code: 21 BT 303

Microbial Technology

Unit 1. Microbial Diversity
Tools and techniques of microbial diversity, culturables and non culturables, metagenomics.

Unit - III: Production of Primary Metabolites, Enzymes

A brief outline of processes for the production of some commercially important Organic acids (e.g., Citric acid, Lactic acid , Acetic acid, Gluconic acid); Amino acids (Glutamic Acid, Lysine, Aspartic Acid and Phenylalanine); and Alcohols (Ethanol, 2,3-butanediol) secondary metabolites: Antibiotics-beta-lactams (Penicillin's), aminoglycosides (Streptomycin), Macrolids (Erythromycin), Quinines and aromatics. Vitamin B12 and steroids, Enzymes.

Unit IV: Production of Recombinant Proteins, Special bioproducts

Production of Recombinant Proteins- Insulin and Special Bioproducts- Biopesticides; Biofertilizers Natural Biopreservatives (Nisin); Biopolymers (Xanthan Gum, EPS); process of bioleaching; bioremediation; Probiotic and food applications.

UNIT V: Fermentation

Fermentation Microbial Growth and Death Kinetics; Media for Industrial Fermentation; media optimization; Air and Media Sterilization; Types of fermentation processes - Analysis of batch, Fed-batch and continuous bioreactions, bioreactors, specialized bioreactors (pulsed, fluidized, photobioreactors etc. Concept of SSF, down stream processing, product recovery.

Unit - II: Screening and Strain improvement techniques

Primary and Secondary screening. Strain improvement by Physical, Chemical and Molecular techniques. Emerging techniques (genome shuffling etc), screening techniques, high throughput screening, food grade technologies, GMO (including labeling, release, identification), metabolic pathway engineering.

Suggested Readings

1. Molecular Biotechnology: Principles and Application of Recombinant DNA3rd edition, B.R. Glick & J.A. Pasternak, 2005.
2. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
3. General Microbiology, Stainer RY, Ingraham JL, Wheelis ML. & Painter PR. The Macmillan Press Ltd., (2000).
4. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
5. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
6. Biochemical Engineering Fundamentals (2nd ed), JE Baily & DF Ollis, McGraw Hill Book Co. New York. 1986.
7. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000.
8. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. 1995

Code: 21 BT 304

BIOCHEMISTRY

Unit I: Enzymes and Coenzymes:

Classification, factors affecting rate of enzyme action- pH, temperature, concentration, oxidation, Coenzymes. Kinetics of single substrste reactions, MM equation and its modifications, LB plots and their significance, significance of Km and V max. Bisubstrate reactions, random and ordered bisubstrate reactions. Enzyme inhibition- competitive, non competitive, uncompetitive and allosteric. Specificity and mechanism of enzyme action.

Unit I: Chemistry and Metabolism of Carbohydrates

Chemical basis of life; pH, Biological buffers, Composition of living matter; Sugars – Stereochemistry and reactivity of mono, di, homo and hetero polysaccharides; Suitability in the context of their different functions- Glycolysis, TCA cycle and HMP shunt pathway and their regulation.

Unit-II: Chemistry and Metabolism of Lipids

Structure and Physicochemical properties of important members of storage and membrane lipids; lipoproteins. Behavior of amphipathic lipids in water. Synthesis and degradation of fatty acids and Cholesterol

Unit III : **Chemistry and Metabolism of Amino acids**

Structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function, relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; general reactions of amino acid metabolism, ureogenesis.

Unit IV : **Nucleic acids**

Bases, nucleosides, nucleotides, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non – enzymatic transformation of nucleotides and nucleic acids, methylation, Sequencing, chemical synthesis of DNA. Three dimensional structure of DNA. Different forms of DNA – circular DNA and Supercoiling. Types of RNA. Strucure of t-RNA. Nucleotids as regulatory molecules, enzyme Cofactors and mediatros of chemical energy in cells.

Text Books

1. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company,

Reference Book

2. L.Stryer, Biochemistry, 5th Edition
3. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.

References

1. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
2. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag 1994.

Code: 21 BT 305

MOLECULAR MODELING AND DRUG DESIGN

UNIT – I: Introduction to Molecular Modeling

History of molecular modeling, physical and computer models, different representations of computer models, Generation of 3D coordinates–using x-ray crystallographic databases, compilation of fragment libraries with standard geometrics, drawing of 2D structures using sketch.

UNIT – II: Basic concepts of Protein Modeling

Concepts of Force Fields, Quantum and Molecular mechanical force fields, Generation of potential energy surfaces, Geometry Optimization, Energy-Minimizing Procedure, and Use of Charges. Salvation Effects, Methods, Ab initio Methods, Semi-empirical Molecular Orbital Methods, Conformational Analysis

UNIT– III: Protein Structure predictions

Basic principles of secondary structure prediction methods, Algorithms of Chou Fasman, GOR, PHD, PSI-PRED, Stereo-chemical method of Lim and Neural network method, concepts in measuring the accuracy of predictions.

UNIT – III: Protein structure elucidation

Steps involved in Homology Modeling. Fold Recognition and ab-initio methods, Derivation and significance of Ramachandran Plot, Root Mean Square Deviation (RMSD), Energy Plot based on Potential of mean force, Packaging Quality, Helical Wheel, Hydrophobicity profiles, Amphiphilicity detection, Transmembrane prediction methods. Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Structure-function relation, Function inference from structure.

UNIT – V: Molecular modeling applications in drug designing

Identifying Putative Drug Targets and Potential Drug Leads: Starting Points for Virtual Screening and Docking Receptor Flexibility for Large-Scale Insilico Ligand Screens: Chances and Challenges, Molecular Docking

Recommended textbooks:

1. Molecular modeling basic principles and applications-Hans-Dieter Holtje and Folkers, Wiley 2003.
2. Molecular modeling of Proteins-edited by Andreas Kukol, Humana Press, Apr 2008
3. Introduction to Protein Architecture, Arthur M. Lesk,, Oxford University Press, 2001

Reference books:

1. Molecular Modeling Principles and Applications- AR Leach, Longman, 1996.
2. Structural Bioinformatics, Edited by Philip E. Bourne and Helge Weissig, Wiley-Liss, 2003.

Code: 21 BT 306

Bioprocess Engineering

UNIT–I: Introduction to Bioprocess

An of overview of traditional and modern applications biotechnology industry, outline of an integrated bioprocess (upstream and downstream) with process flow sheet,steps in development of a complete bioprocess for commercial manufacture of recombinant-DNA derived product.

UNIT– II: Dimensions and system units

Basic Biochemical Calculations: atomic, molecular and equivalent weights. Molarity,Molality,Normality and partial pressures,laws of chemical combination, Definition ofstochiometry, Composition of mixtures and solutions, weight fractions, volumetriccomposition, Density and Specific gravity.

UNIT –III: Fermenation and Enzyme Processes

Aerobic and Anaerobic fermentation processes and their application in the biotechnology industry behavior of microbes in different reactors (air lift, batch,continuous ,fed batch condition). Production of enzymes in submerged and solidstate processes, extraction and purification of enzymes, methods of characterization,specific activity and activity definitions.

UNIT–IV: Metabolic Stoichiometry and Energetics

Stoichiometry of cell growh and product formation; Elemental balances; degree of reduction of substrate and biomass.available electron balance; yield coefficients of biomass and product formation, maintenance coefficients, Energetic analysis of microbial growth and product formation; thermodynamic efficiency of growth.

UNIT – V: Kinetics of microbial growth and Product formation

Phases of cell growth in batch cultures, Simple unstructured kinetic models formicrobial growth, Monod model, Growth of filamentous organisms. Growthassociated (primary) and non-growth associated (secondary) product formation Kinetics. Leudeking-Piret models.

Textbook:

1. D.G.Rao, Introduction to Biochemical Engineering, McGraw-Hill, 2005.
2. Pauline and Doran , Bio Process Engineering Principles , Elsevier.

Reference Book:

1. Bailey Ollis, Biochemical Engineering fundamentals, 2nd edition, McGraw-Hill, 1986.
2. M.L.Shuler and F. kargi Bioprocess engineering, Prentice Hall of India 1992.

Code: 21 BT 307

Immunotechnology

Unit – I: Basic immunology

Nature and Biology of antigens and super antigens. B & T cell antigens, Role of hapten and adjuvant in antibody and T cell response induction. BCR & TCR, antibody and its classes, Antibody diversity, MHC restriction, antigen processing and presentation,

Unit – II: Immune regulation and Effectors function

Cytokines and their role in immune regulation – T cell regulation. Cell - mediated cytotoxicity-Mechanism of T cell and NK cell mediated lysis. Antibody dependent cell mediated cytotoxicity (ADCC), macrophage mediated cytotoxicity. Immunomodulation – Induction, suppression.

Unit– III: Applied immunology

Hypersensitivity– inflammation, tissue necrosis, Autoimmunity, Transplantation. Immunological tolerance. Monoclonal antibodies, Antibody engineering, recombinant and chimeric antibodies. Abzymes and its applications. Principles and strategies for development of candidate vaccines.

Unit– IV: Tumor immunology

Basic feature of Normal and Cancer cell. Factors influencing the development of cancers - Chemical, Physical & Viral carcinogenesis. Types of tumors, metastasis – mechanism and control. Cell cycle regulation, Effect of cell receptors, Diet and cancer. Tumor suppressor gene products – p53, Rb. Cancer therapy -Chemotherapy, Radiotherapy, Immuno therapy.

Unit – V: Immunotechniques

Factors effecting the Ag-Ab reactions – Antigen-antibody interaction, EIA, FIA, RIA, Western blotting, FACS and tissue typing. Immunodiagnosis of infectious diseases. Recent advances in immunotechnology.

Recommended Books:

1. Kuby Immunology, 5th Edition, -R.A. Goldsby, Thomas J. Kindt, Barbara, A.Osbarne.(Freeman).
2. Immunology-A short Course, 4th Edition, - Eli Benjamini, Richard Coico, Geoffrey Sunshine.(Wiley-Liss)
3. Fundamentals of Immunology, William Paul.
4. Margaret A Knowles and Peter. J. Shelly, Introduction to Molecular and Cellular Biology of Cancer. 4th Edition. Elsevier publications
5. Abul K. Abbas K. Litchman, Jordan S. Pober. Cellular & Molecular immunology, 3rd edition Saunders text and review series.

Code: 21 BT 308

MICROBIAL TECHNOLOGY

Unit 1. Microbial Diversity

Tools and techniques of microbial diversity, culturables and non culturables, metagenomics

Unit - III: Production of Primary Metabolites, Enzymes

A brief outline of processes for the production of some commercially important Organic acids (e.g., Citric acid, Lactic acid , Acetic acid, Gluconic acid); Amino acids (Glutamic Acid, Lysine, Aspartic Acid and Phenylalanine); and Alcohols (Ethanol, 2,3-butanediol) secondary metabolites: Antibiotics-beta-lactams (Penicillin's), aminoglycosides (Streptomycin), Macrolids (Erythromycin), Quinines and aromatics. Vitamin B12 and steroids, Enzymes

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3. General Microbiology, Stainer RY, Ingraham JL, Wheelis ML. & Painter PR. The Macmillan Press Ltd., (2000).
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5. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
6. Biochemical Engineering Fundamentals (2nd ed), JE Baily & DF Ollis, McGraw Hill Book Co. New York. 1986.
7. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000.
8. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford. 1995

Code: 21 BT 309

NANOBIOTECHNOLOGY AND NANOMEDICINE

1. Nanobiotechnology: Nanomaterial in biotechnology -nanoparticles, quantum dots, nanotubes and nanowires etc. Development of nanobiotechnology – timelines and progress, overview.

2. Synthesis, characterization, and properties of smart nanomaterials, Nanocarriers (e.g. liposomes, polymer capsules, polymer nanoparticles, porous materials, nanogels, dendrimers, micro emulsions, inorganic nanoparticles, carbon nanotubes, lipoproteins, solid lipid nanoparticles) for drug delivery applications. Biological nanoparticles production - plants and microbial.

3. Properties and Characterizations: Optical (UV-Vis/Fluorescence) –X-ray diffraction – Imaging and size (Electron microscopy, light scattering, Zeta potential)- Surface and composition (ECSA (Electro chemical surface area), EDAX, AFM/STM etc) – Vibrational (FT-IR and RAMAN), SERS (Surface-Enhanced Raman Spectroscopy), Magnetic, Electrical and Electrochemical.

4. Biosensors: different classes-molecular recognition elements, transducing elements.

   Applications of molecular recognition elements in nano sensing of different analytes. Application of various transducing elements as part of nanobiosensors. Miniaturized devices in nano biotechnology - types and applications, Bio MEMS, lab on a chip concept.

5. Nano biotechnological applications in health and disease - infectious and chronic. Nano biotechnological applications in Environment and food - detection and mitigation.

6. Nanomedicine: Introduction to nanomedicine- Overview of nanotechnology from medical perceptive, different types of nano biomaterials and their biomedical applications, and cell nanostructure interactions.

7. Nanonephrology, Nanoneurology and molecular imaging, Drug delivery (modes and example applications), Nanomedicine and cancer (diagnostic and imaging), Regenerative medicine, including tissue engineering, cell and gene therapy, DNA-based nanostructures, Cellular nanomachines.

8. Nanomaterials and Toxicity Evaluation: Cyto-toxicity, Geno-toxicity In vivo tests/assays etc. Assessing nanotoxicity at the single cell level, encoding information into nanomedical systems. Other emerging ethical issues in Nanobiotechnology and Nanomedicine.