Dr. B.R.AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY JALANDHAR
DEPARTMENT OF BIOTECHNOLOGY
SYLLABUS FOR Ph.D Course Work

Ph D courses:

Semester-I

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-503	Bioenergetics and Metabolism	3	0	0	3
BT-505	Bioreactor and Bioprocess Design	3	0	0	3
BT-507	Bioseparation Engineering	3	0	0	3

Semester-II

Course Code	Course	Hours/week			Credits
		L	T	P	
BT-504	Enzyme Biotechnology	3	0	0	3
BT-506	Modern Methods of Analysis	3	0	0	3

BT 503 : BIOENERGETICS AND METABOLISM [3 0 0 3]

Unit – I

Introduction: First and second law of thermodynamics, standard free energy, reasons for high standard free energy of hydrolysis of ATP, Electron transport, oxidative phosphorylation,chemiosmotic model, prenention of oxidative phosphorylation by uncoupling agents and ionophores. Metabolism – anabolism/ catabolism, differences between catabolic & anabolic pathways.

Anaerbolic Carbohydrate Metabolism: Individual reactions of glycolysis, entry of galactose & fructose in glycolysis, utilization of sucrose and lactose, alcoholic fermentation , reduction of pyruvate to lactate, glycogenlysis, biosynthesis of starch & sucrose, gluconeogenesis, regulation of glycolysis.

Cittric acid cycle: Oxidation of Pyruvate to Acetyl CoA,individual reaction of TCA cycle, energetics of the cycle, anaplerotic reactions, regulation of TCA.

Unit – II

Lipid Metabolism: Individual reaction of beta oxidation pathway, omega oxidation, oxidation of unsaturated fatty acid and odd chain fatty acids, formation of ketone bodies, biosynthesis of fatty acids, role of serum lipoproteins (LDL & HDL) in the developlemt of coronary heart diseases.

Nitrogen Metabolism: Transamination , deamination reactions, transport of ammonia from peripheral tissues to liver by glutamine, excretion of nitrogen (Ammonotelic, Uricotelic), Urea cycle (preliminary account), Metabolism of purines & pyrimidines (preliminary account), biosynthesis of non essential amino acids, as precursors of biological amines like dopamine, non epinephrine, epinephrine, GABA, & Histamine.

Unit – III

Transport across cell membrane: Passive transport (transport of chloride and bicarbonate across erythrocyte membrane, glucose transport), Active transport (Primary & secondary), Na* and K* pump, glucose transport in intestinal epithelial cells, symport, antiport, and uniport (examples), ion channels (voltage gated and ligand gated) brief idea.

Books Recommended:

1. Albert Lehninger, Principles of Biochemistry
2. Lehninger, Nelson, Cox, Principles of Biochemistry
3. Cohn and Stumpf, Outlines of Biochemistry
4. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko, Biochemistry
5. M. Treven, Immobilized Enzymes
6. R.K. Murray, D.K. Granner at al., Harper's Biochemistry
7. Voet & Voet, Biochemistry

BT 505: BIOREACTOR AND BIOPROCESS DESIGN [3 0 0 3]

Unit – I

Design consideration for designing bioreactors: oxygen transfer, heat transfer, rheology, mixing.
Analysis of ideal bioreactors: fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with recycle and Wall growth, Ideal Plug- Flow Tubular Reactor.
Reactors with non-ideal mixing: Mixing time in agitated tanks, Residence time distributions, Models for non-ideal reactors.
Scale up and scale down concepts,

Unit – II

Mechanical Fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and clearing of production plants.
Calculation for designing a bioreactor.

Unit – III

Instrumentation and control of bioprocesses: Physical and chemical sensors for the medium and gases, online sensors for cell properties, off-line analytical methods; Biosensors.

Books Recommended:

1. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon Press.
2. Lydersen, D' Elia, Nelson, Bioprocess engneering: Systems and equipment.
3. Bailey and Ollis, Biochemical Engineering Fundamentals.

BT 507: BIOSEPARATION ENGINEERING [3 0 0 3]

Unit – I
Separation of insoluble products: sedimentation, filtration, centrifugation, coagulation and flocculation. Cell Disruption: Mechanical methods, Non-mechanical methods.

Unit – II
Separation of soluble products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption. Dialysis, electro-dialysis, ultra-filtration and micro-filtration, cross-flow ultra-filtration and micro-filtration.

Unit – III
Chromatography: Adsorption chromatography, Ion- exchange chromatography, gel-filtration chromatography, affinity chromatography, high pressure liquid chromatography, hydrophobic chromatography. Chromatography scale-up. Crystallization and drying.

Books Recommended:
1. M.R. Ladisch, Bioseparation Engineering
2. Kennedy and Cabral, Recovery processes for biological materials.
3. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.

BT 504: ENZYME BIOTECHNOLOGY [3 0 0 3]

Unit –I
Discovery, classifications and nomenclature of enzymes. Enzyme isolation. Enzyme assay, Intracellular localization of enzymes. Isozymes, Multienzyme complex, and multifunctional enzymes.
Enzyme kinetics and kinetics of enzyme inhibition. Competitive, non-competitive and un-competitive inhibition of enzymes. Double reciprocal plots. Effect of PH, temperature, substrate and enzyme and inhibitors concentration on enzyme kinetics. Phenomena of allosterism and allosteric kinetics.

Unit – II
Molecular structure and function of enzymes. Physico-chemical characterization of enzymes. Folding and active site formation in enzymes. Stability of enzymes: Enzyme stabilization by genetic engineering, protein engineering, reaction environment rebuilding.
Techniques used in the purification of the enzymes. Criteria of enzyme homogeneity, Techniques used for determinations of native and sub-unit molecular weight of enzymes.

Unit – III
Bio-separations in enzymology: solid-liquid separation (filtration, centrifugation, membrane, flocculation), extraction, concentration (reverse osmosis, ultrafiltration), drying, instrumentation (GC/HPLC).

Enzyme immobilization, production and application of free and immobihzed enzymes in food and feed, detergent, textiles, pulp and paper, pharmaceuticals, diagnostics.

Books Recommended:

1. Godfrey and West, Industrial enzymology
2. Dordick, Biocatalyst for industry.
3. Bommatius, A.S. et al., Biocatalysis: Fundamentals and Application- Wiley Publication
4. Hans Bisswanger, Enzyme Kinetics- Wiley Publication
5. Methods in Enzymology- A series.

BT 506: MODERN METHODS OF ANALYSIS [3 0 0 3]

Unit -I

Chromatographic Techniques – I: (a) Introduction to chromatography; General principles, column chromatography - columns, stationary phases. Packing of columns, application of simple, column development, fraction collection and analysis). Partition and adsorption chromatography. (b) Affinity Chromatography; Principle, materials – matrix, selection of attachment of attachment of ligands, practical procedures, specific and non-specific elution, applications. (c) Ion Exchange Chromatography: Principal, types of Exchangers , materials, choice of exchangers and buffers and applications. (d) Gel Filtration: Principle, idea of distribution coefficient, exclusion limit, fractionation range, bed volume, void volume, elution volume, chemical properties of gel and applications.

Chromatographic Techniques – II: (a) Gas Chromatographic: Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection system and applications. (b) HPLC: Principle, components of HPLC system, column, column packing, chromatographic solvents, pumping systems, detectors system, and its applications.

Unit – II

Electrophoresis: (a) General Principle, factors affecting electrophrosis – voltage, current, resistance, buffer – composition, concentration, pH. (b) Gel electrophoresis;

Types of gel (strarch,agarose, polyacrylamide), Idea of electrophoresis unit, preparation of gel , sample application, running the samples, SDS-PAGE – Principle, apparatus and methods, gradient gels , Two dimensional gels, Isoelectric focusing.

Spectroscopy – I: (a) Spectroscopic Techniques; Introduction, Energy levels and transition of electrons, Types of spectra, Beers Lamberts law, molar and and extinction coefficient, limitations of Beers Lamberts law. (b) Visible and UV Spectrophotomerty; Principles, Instrumentation and application. (c) Spectroflourimetry; Principle, stoke's shift, quantum efficiency, Instrumentation and application.

Unit - III

Spectroscopy – II (a) Atomic and Flame Spectrophotomerty; Principles, Instrumentation and application for flame emission/atomic absorption spectrophotomerty and their comparative study. (b) Mass spectrometry; Principles, Instrumentation and application

Thermal Analysis Differential scanning calorimetry and differential analysis – Instrumentation, Thermogravimetry, Methodology of Thermogravimetry, differential scanning calorimetry and differential thermal analysis.

Books Recommended:

1. K. Wilson & K.H. Goulding, A biologist's guide to Princles and Tehniques of Practical Biochemistry.
2. Wilard and Merit, Instrumentation Methods Analysis.
3. Ewing GW Instrumental Methods of Chemical analysis.