# DEPARTMENT OF BIOCHEMISTRY P.U.CHANDIGARH

## M. Sc 1st Semester

<table>
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<th>Course No.</th>
<th>Title of the Paper</th>
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<tbody>
<tr>
<td>BC-501</td>
<td>Applications of Biochemistry to Biotechnology</td>
<td>100</td>
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<tr>
<td>BC-502</td>
<td>Clinical Biochemistry</td>
<td>100</td>
<td>4+0+0</td>
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<td>BC-503</td>
<td>Biochemical Toxicology</td>
<td>100</td>
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<tr>
<td>BC-504</td>
<td>Molecular Cell Biology</td>
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## M.Sc 2nd Semester

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<td>BC-505</td>
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<tr>
<td>BC-506</td>
<td>Medicinal Biochemistry</td>
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<td>BC-507</td>
<td>Industrial Biochemistry</td>
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<tr>
<td>BC-508</td>
<td>Molecular &amp; Cellular Immunology</td>
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<tr>
<td>BC-552</td>
<td>Practical</td>
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Objective: The course will focus on providing knowledge and understanding of the current technologies and process.

Unit-I
Micromethods in Protein Chemistry: Isolation of peptides for Sequence analysis. Peptide mapping, chemical and enzymatic hydrolysis of proteins. Extraction and fractionation of RNA and DNA, Isolation of plasmids, plasmid derived vectors, phages and yeast vectors, Enzymes involved in recombinant DNA technology, Genomic and cDNA library. Ti plasmid as tool for genetic engineering in plants, Bacterial transformation screening of transformants, use of Minicells and Maxicells to detect the expression of DNA, Hybrid released translation (HRT), Hybrid arrested translation (HART) for screening of protein.

Unit-II
N-labelling Random labeling of nucleic acid probes, Nick translation, Hybridization and blotting techniques. dot blot, Northern and Southern blot, South-Western blot analysis, In vitro translation, biotin-avidin system applications in detection of bio-molecules. Chromosomal walking & Chromosome jumping, DNA microarray chip technology, Auto-radiography and fluorography, Techniques to study DNA protein interactions, Generation of transgenic animals and plants, knockout animals.

Unit-III
Chemical Synthesis of oligonucleotides, Polymerase Chain Reaction (PCR), Basic principle, method, Variations of PCR, Amplification of specific DNA fragments: Applications in medicine and forensic sciences. Gene mapping, Polymorphism and Techniques to detect polymorphism: RAPD, RFLP, AFLP etc. DNA based diagnosis of genetic disorders, Recombinant DNA technology in medicine and industry. In situ Hybridization, gene therapy.

Unit-IV
Monoclonal Antibodies and Vaccines: Definition and nature of monoclonal antibodies (MCA); Antigen preparation for MCA production; Methodology producing MCA; Immunization and generation of immune response, Myeloma cells for hybridization; cell fusion and selection of hybrids using HAT medium. Cloning and isolation of hybrid cell lines. In vitro and in vivo culture of hybrid cell lines, Screening of specific MCA; Purificatin and labeling of MCA, uses and applications of MCA. T-cell hybridomas and their applications. Vaccines (subunit, live recombinant, attenuated and DNA Vaccines).

Books Suggested:
2. L.Davis et al, Basic Methods in Molecular Biology. Appleton & Lange
   Biochemical research Techniques McMillan Publishing Company, John Wiley & Sons
4. Winfried Hartmeier, Immobilized Biocatalysts, Spring-Verlager, Berlin,Germany
Objective: To provide understanding and applied knowledge to the theory and practice of clinical biochemistry.

Unit-I

Diagnostic Enzymes-enzyme assay in serum/plasma, urine and cells. Clinically important enzymes, use of isoenzymes in diagnosis.
Organ function tests: Assessment and clinical manifestation of hepatic, renal, gastrointestinal and pancreatic functions.

Unit-II

Disorders of Metabolism:
Carbohydrates- Diabetes mellitus, Glycogen Storage diseases, galactosemia, pentosuria.
Amino Acids- Disorders of glycine, sulfur containing amino acids, aromatic amino acids, histidine, branched chain amino acids and proline, disorders of propionate and methylmalonate metabolism.
Disorders in urea biosynthesis.

Unit-III

Lipids: Hyperlipoproteinemia, Abetalipoproteinemia, Hyperlipidemia, Tay-Sachs Disease (Gangliosidosisis), Neimann Pick Disease, Gaucher’s Disease, Krabb’s Disease, Metachromatic leukodystrophy and Fabry’s Disease, Wolman’s Disease.
Disorders of porphyrin and heme metabolism
Disorders in purine and pyrimidine metabolism

Unit-IV

Myocardial infarction and atherosclerosis
Electrolytes and acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, Disorders of electrolyte, water and acid-base balance.
Quality control in Clinical Biochemistry

Books Suggested:

5. Lieberman, M and Marks, A.D. MARK’S Medical Biochemistry, A Clinical Approach, 3rd Ed. Lippin Williman wilkins
Objective: A consolidated training on harmful effects of various chemical compounds, effect on biochemical processes, molecular mechanisms of action of toxicants, metabolism and experimental approaches in toxicology.

Unit-I
Definition, scope and relationship of Toxicology to other sciences. Nature of toxic effects. Acute and chronic exposure.

Dose: response relationship, Determination of LD-50, no observed effect level (NOEL), acceptable daily intake, bioavailability, volume of distribution, plasma half life, total body burden, total body clearance. Synergism and Antagonism

Unit-II

Unit-III
Toxicity Testing and Target organ toxicity, Ames test, Host mediated assay and dominant lethal test, Drosophillia sex linked recessive lethal test, micronucleus test. Toxicology of Medical devices, Haemotoxicology, Hepatotoxicity.

Unit-IV
Toxicity of Pesticides-Classes of pesticides: Organochlorine, Organophosphates and carbamates. DDT: Metabolism, toxicity, persistence and bioaccumulation. Organophosphate-Metabolism and mechanism of insecticidal action.

Metal Toxicity-Toxicity of Lead and its effect on heme synthesis. Toxicology of various forms of mercury, Arsenic Toxicity.

Drug Toxicity-Paracetamol, Metabolism and its Toxic effects.

Books Suggested:
1. Frenhe. LY, Lu’s Basic Toxicology 4th Ed. (2002),
2. A.Wallace Hayes, Principle & Methods of Toxicology 5th Ed. (2008)
3. E. Hodgson & R.C. Smart, Introduction to Biochemistry Toxicology 3rd Ed. 2001,
4. Curtis D. Klassen, Casarett & Doull’s Toxicology, the Basic science of Poisons 7th Ed.
5. Bryan Ballantyne – General and applied Toxicology
**Objective:** This course will provide in depth knowledge of cell cycle, cell proliferation and apoptosis, synthesis of function of diverse molecules in cell growth, mechanisms of nuclear control of cellular processes and cellular communications & system cells.

**Unit-I**

Cell Cycle: Cell cycle control system, cell cycle events in *S. pombe, S. cerevisiae*, and mammalian system, M phase kinase, protein phosphorylation and dephosphorylation, p34 as key regulator in yeast, CDC 28, Cdk-cyclin complexes, function of Cdc2-cyclin and Cdk-cyclin dimers. Cdk inhibitors, reorganization of the cell at mitosis.

**Unit-II**

Apoptosis and cell proliferation: Extrinsic and intrinsic pathways of apoptosis, techniques to analyze apoptosis, molecular basis of cancer, multistep carcinogenesis, signal transduction and cancer, tumor suppressor genes and protooncogenes and oncogenes, tumor causing viruses, DNA viral genes, Retroviral-associated oncogenes in growth regulation, strategies for cancer prevention and cure.

**Unit-III**

Signaling molecule and cell surface receptors: Intracellular signal transduction, second messengers, protein functioning as signal transducers, localization of receptors and signal transducers, G-protein coupled receptors and downstream signaling, TGF receptors and activation of SMADS, cytokine receptors and JAK-STAT signaling, receptor tyrosine kinases and activation of Ras, Raf, MAP kinase signaling, phosphoinositide as signal transducer, pathways that involve signal induced protein cleavage (NF-KB and NOTCH), Hedge hog and wnt signaling pathways (classical and nonclassical) down regulation of receptor signaling.

**Unit-IV**

Specialized tissues and stem cells: Renewal of epidermis, sensory epithelia, airways and the gut, blood vessels, multipotent stem cells, connective tissue cell family, stem cell engineering

**Books Suggested:**

Objective: The course aims to provide advanced education in enzymology so as to comprehend practical aspects of enzyme studies, measurement of rate constants, study of active site and enzyme turnover.

Unit-I

Concept of convergent and divergent evolution of enzymes; Purification of enzymes: strategy & criteria of enzyme purity, judging the success of purification procedure; Kinetics of multi substrate enzyme catalyzed reactions: classification, kinetics of multishubstrate reactions, Investigation of reaction mechanism by using initial velocity, inhibition and isotope exchange studies; Practical aspects of kinetic studies: Enzyme assays, coupled assays, Reaction conditions optimization (pH, temperature, substrate concentration), Design of inhibition experiments.

Unit-II

Methods of pre-steady state analysis: Rapid mixing and sampling techniques, Relaxation methods, Absolute concentration of enzymes, Sigmoidal Kinetics: Cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.

Unit-III

Identification of active site of enzymes: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with class-specific inhibitors and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, Structures & mechanisms of selected enzymes: Dehydrogenases, proteases, ribonuclease and lysozyme. Practical applications of protein inhibitors.

Unit-IV

Enzyme turnover: Kinetics of turnover, methods for measuring rates of enzymes turnover, Correlation between rates of turnover and the structure and functions of enzymes, Mechanism of enzyme degradation, significance of enzyme turnover.

Books Suggested:

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**BC-506: Medicinal Biochemistry**  
**Credits:** 4+0+0

**Objective:** Drug targets, drug discovery and development, antibiotic and herbal drugs

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**Unit-I**

Introduction: Biochemistry in Health & Disease.  
Molecular targets of drugs: Enzymes as targets: Medicinal uses of enzyme inhibitors, some examples of drug action at carrier and structural proteins.  
Receptors as targets: Families of Receptors, Agonists/Antagonists and their design.  
Nucleic acids and nucleic acid building blocks as targets.

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**Unit-II**

Drug Discovery and drug development: Identifying drug targets, finding and developing a lead compound, Metabolism of Drugs, Designing Drugs to resist metabolism, Designing pro-drugs, Quantitative Structure-Activity Relationships (QSAR), A Rational Approach to Drug Design.

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**Unit-III**

Antibacterial Agent: β-Lactam Antibiotics: Inhibitors of bacterial cell wall synthesis, Anti-bacterial Agents which interfere with protein synthesis, Anti-bacterial Agents which act on Nucleic Acid Transcription. Drug Resistance, Drugs acting at nervous system: Cholinergics, Anticholinergics and Anticholinesterases

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**Unit-IV**


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**Books Suggested:**

2. Lemke, T.L. Williams, D.A.; Roche, V.F. and Zito, S.W.Foyer’s, Principle of Medicinal Chemistry 6th Ed. Wallers Kluwer  
4. King, F.D., Medicinal Chemistry Principle and Practicals, Royal Society of Chemists
Objective: The course aims to provide an in-depth knowledge of key areas of industrial biochemistry including development of industrial fermentation, principles of fermentation process, enzyme biotechnology and biotreatment of effluents

Unit-I

Introduction: Definition and scope of Industrial Biochemistry, Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations, Biological reactors, Continuous and batch type reactors.

Unit-II

Biochemical principles of typical fermentation processes:
- Amino Acid: Glutamic Acid, Lysine, Tryptophan
- Vitamins: B_{12}, Riboflavin, β-Carotene, Tocopherol
- Industrial Products: Ethanol, Acetone, Glycerol
- Organic Acids: Citric Acid, Gluconic Acid
- Antibiotics: Beta lactam antibiotics, amino acid and peptide antibiotics, carbohydrate antibiotics, tetracyclines and anthracyclines, Nucleoside antibiotics, Aromatic antibiotics etc.

Unit-III

Enzyme biotechnology: Isolation, production and immobilization of enzyme and cells in biochemical reactions, support for immobilization, biofilms and biosensor development, Feature of enzymes in relation to biotechnology, Enzyme sources, release of enzymes from cells, Enzyme isolation and purification. Applications of biological catalysts, Immobilization techniques-enzymes adsorption, covalent coupling to a carrier surface, cross-linking and copolymerization, entrapment in matrix, Encapsulation, Conformational changes and stability, Steric restrictions and inactivation of enzymes molecules, Biotransformation by microbes, industrial and therapeutic uses of immobilized enzymes and their applications in agriculture, Food, Dairy, Textile, leather industry and in medicine.

Unit-IV

Biotreatment of Industrial effluents: Lipid technology: Natural resources of biologically important lipids, extraction, fractionation, esterification, and refining process, food emulsion and their storage, hydrogenation, Non-food uses of lipids.

Books Suggested:

1. Doble Mukesh and Kumar Anil, Biotreatment of industrial effluents
4. Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms
5. P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology
Objective: This intensive course will impart an insight of the immune response in relation to different disease etiologies, focusing on clinically applied and modern immunological concepts.

Unit-I
Receptors: variable lymphocyte receptors and generation of their diversity/ polymorphism, cytokine and chemokine receptors. Homing, migration and homeostasis of cells of the immune system with respect to specific tissues- mucosal, testis, immune privilege sites, materno- fetal interface, immune senescence.

Unit-II

Unit-III
Neuroimmunology: immune functions of cells, cytokines, chemokines, leukocyte trafficking (blood brain barrier, etc); tumors, viral/ bacterial/ parasitic infections. Glycosylation- in health and disease, cell adhesion, molecular trafficking glycomics-identification of potential markers, therapeutics, vaccine strategies for diverse pathogens, cancer, etc. Biomarkers: inflammatory and immunological monitoring.

Unit-IV

Books Suggested:
### M.Sc 3rd Semester

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<td>BC-601</td>
<td>Genomics and Bioinformatics</td>
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<tr>
<td>BC-602</td>
<td>Computational Techniques &amp; Biostatistics</td>
<td>100</td>
<td>4+0+0</td>
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<tr>
<td>BC-603</td>
<td>Comprehensive Examination</td>
<td>100</td>
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<td>BC-604</td>
<td>Journal Club</td>
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<td>BC-651</td>
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### M.Sc. 4th Semester

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3rd Semester

BC-601 Genomics and Bioinformatics

Objective: Introduction to genomics and bioinformatics

Unit-I


Unit-II

Nucleotide and Protein databases: Primary, secondary and composite database (genbank, EMBL, DDBJ, Uniprot, Swissprot, PIR, PDB, Genpepts). NCBI, EBI, DDBJ. nucleotide sequence flat files. Sequence formats: Genbank, FASTA,ASN. Introduction to metabolic pathway databases on the web-KEGG, EcoCyc, Metacyc. Enzyme databases- BREnda, LIGAND database. Molecule visualization softwares: RasMol, Pymol, Cn3D, VMD etc. Information retrieval from biological databases- NCBI resource, Entrez, Pubmed, Medline

Unit-III

Introduction to sequence alignment: Pairwise Sequence Alignment, Global alignment and Local alignment, general, gap and affine penalty. DotPlot, Scoring functions, Substitution Matrices- PAM and BLOSUM matrices. Heuristic algorithms, Word methods or k-tuple methods, Dynamic Programming- implementation of the Needleman and Wunsch algorithm and Smith Waterman Algorithm for pairwise alignment and testing alignment score

Unit-IV

Multiple Sequence Alignment- consensus sequence, motifs and profiles. SP (Sum of Pairs) measure, Position specific scoring matrices, Hidden Markov Model, Clustal W, Clustal X Blasta and Fasta, Blastp, Blastx, tBlastx, Blastn, PSI-BLAST Significance of alignment: Scores, E value, p value Comparative Genomics, Methods for predicting protein structure (secondary and tertiary)

Books Suggested:

BC-602 Computational Techniques & Biostatistics

Objective: To introduce the basic concept of the C programming language and Biostatistics.

Unit-I
Overview of C: Brief history of C, general structure of a C program, stages in the development of a C program, Basic building blocks of C Language.
Data Types, Operators & Expressions: Constants and variables, data types, declaring variables, storage classes, different types of expressions and their evaluation, conditional expression, assignment statement, enumerated data type, type casting.
Console Input/Output: Standard input/output devices, unformatted input/output functions (character I/O functions and string I/O functions), formatted input/output functions (scanf() function and printf() function).

Unit-II
Control Statements: Decision making using if, if - else, elseif and switch statements, Looping using for, while and do - while statements, transferring program control using break and continue statements, programming examples to illustrate the use of these control statements.
Functions: Defining a function, local variables, return statement, invoking a function, specifying and passing arguments to a function, function prototyping, pointer to a function, recursion.

Unit-III
Arrays & Strings: Introduction to arrays, declaring arrays, initializing arrays, processing of arrays, pointers & Arrays, introduction to strings, programming examples to illustrate the use of arrays and strings. Discussion on arrays is to be limited up to 2-D arrays only.
Structures & Unions: Introduction to structures, declaring structures, initializing structures, accessing elements of structures, pointers to structures, passing structures as arguments to a function, introduction to unions.
Data Files: Introduction to data files, different ways of file processing (standard I/O & system I/O), description of various library functions for file handling, updating files, programming examples to illustrate the processing of files.

Unit-IV
Biostatistics: Expression and critical evaluation, interpretation and presentation of data, Statistical methods for analysis of data- Probability, Mean, median, frequency, t-test (paired and unpaired), ANOVA and correlations, statistical software

Books Suggested:


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