**M.Sc. (Biochemistry/Environmental Biotechnology/Biotechnology/Microbiology/Pharmaceutical Microbiology) CBCS Common Structure (2019-20) under Horizontal Mobility**

**M.Sc. Part-I**

| | Sr. No. | Course code | Teaching Scheme | | | Examination Scheme | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theory and Practical | | | University Assessment (UA) | | | Internal Assessment (IA) | | |
| | | | Lectures (per week) | Hours (per week) | Credit | Maximum Marks | Minimum Marks | Exam. Hours | Maximum Marks | Minimum Marks | Exam. Hours |
| **SEMESTER-I (Duration- Six month)** | | | | | | | | | | | |
| **CGPA** | 1 | **CC 101A:** Cell Biochemistry and Nucleic Acids **OR** **CC-101B**: Cell Biology, Microbiology and Virology | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 2 | **CC-102**: Proteins: Structure and Functions | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 3 | **CC-103**: Biomolecules | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 4 | **CC-104A:** Basics of Physiology and Endocrinology **OR** **CC-104B**: Biostatistics and Computer Applications | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 5 | **CCPR-105:** Laboratory Course | 16 | 16 | 08 | 200* | 80 | - | - | - | # |
| **Total (A)** | | | **-** | **-** | **24** | **520** | **-** | **-** | **80** | **-** | **-** |
| **Non-CGPA** | 1 | **AEC-106** | 2 | 2 | 2 | - | - | - | 50 | 20 | 2 |
| **SEMESTER-II (Duration- Six month)** | | | | | | | | | | | |
| **CGPA** | 1 | **CC-201:** Enzymology | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 2 | **CC-202**: Molecular Biology | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 3 | **CC-203:** Bioenergetics | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 4 | **CC-204:** Tools and Techniques in Biosciences | 4 | 4 | 4 | 80$ | 32 | 3 | 20 | 8 | 1 |
| | 5 | **CCPR-205**: Laboratory Course | 16 | 16 | 08 | 200* | 80 | - | - | - | # |

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| **Total (B)** | | | **-** | **-** | **24** | **520** | **-** | **-** | **80** | **-** | **-** |
| **Non-CGPA** | 1 | **SEC-206** | 2 | 2 | 2 | - | - | - | 50 | 20 | 2 |
| **Total (A + B)** | | | **-** | **-** | **48** | **1040** | **-** | **-** | **160** | **-** | **-** |

1. ***Practical Examination will be internal/external as per department choice**
2. **$ Question no. 1 of each question paper will be subjective (Long answer question instead of objective questions)**
3. **# Duration of Practical Examination will be 4 days (1 inspection day and 3 Practical days)**

**SYLLABUS OF M. Sc. DEGREE COURSES OFFERED UNDER HORIZONTAL MOBILITY PROGRAM**

**(Biochemistry/Environmental Biotechnology/Biotechnology/Microbiology/**

**Pharmaceutical Microbiology)**

## Nodal Department: Department of Biochemistry

## Shivaji University, Kolhapur

The two years M. Sc. program under Horizontal Mobility concept is formulated for developing competent biochemists/biotechnologists/microbiologists for which significant job opportunities exist in this country and abroad. The course is based on interdisciplinary nature of Chemistry, Quantitative Biology, Genetics, Microbiology and Biophysics. The program obliges students to read original publications and envisages significant inputs in laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. This program gives common basic knowledge (Biochemistry, Biomolecules, Enzymology, Molecular Biology, Tools and techniques, Basics of Physiology & Endocrinology) at first year level to become good biochemists/biotechnologists/microbiologists. The specializations introduced in the course at second year level are in the disciplines of Immunochemistry, Neurochemistry and Carcinogenesis, Genetic Engineering, Fermentation Technology, Bioinformatics, Clinical Biochemistry, Environmental Biochemistry and Toxicology, General Biotehnology, Plant Biotechnology, Microbiology and Microbial Technology.

### SEMESTER I — 600 Marks

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|---|---|
| **CC-101A** | **Cell Biochemistry and Nucleic Acids (CBCS)** |
| | **OR** |
| **CC -101B** | **Cell Biology, Microbiology and Virology (CBCS) (Offered by Department of Microbiology)** |
| **CC- 102** | **Proteins: Structure and Functions** |
| **CC -103** | **Biomolecules** |

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|---|---|
| **CC-104A** | **Basics of Physiology and Endocrinology (CBCS)** |
| | **OR** |
| **CC -104B** | **Biostatistics and Computer Applications (CBCS)** |
| | **(Offered by Department of Microbiology)** |
| **CCPR -105** | **Laboratory Course** |
| **AEC-106** | **Mandatory Non-CGPA compulsory Ability Enhancement Course** |

**SEMESTER II** **600 Marks**

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| **CC -201** | **Enzymology** |
| **CC- 202** | **Molecular Biology** |
| **CC- 203** | **Bioenergetics** |
| **CC -204** | **Tools and Techniques in Bioscience** |
| **CCPR -205** | **Laboratory Course** |
| **SEC- 206** | **Mandatory Non-CGPA compulsory Skill Enhancement Course** |

| SEMESTER I | | |
|---|---|---|
| **CC -101A: Cell Biochemistry and Nucleic Acids (CBCS)** | | **60 Hrs** |
| **Unit I** | **Water**<br>Structure of water, interactions viz. ionic, polar-non polar, colligative properties of aqueous solutions.<br>**Concept of pH**<br>Henderson Hasselbalch equation, Concept of pKa, Buffers, titration curves, blood buffers and their regulation<br>**Chemical Foundation**<br>Concept of covalent bond, ionic bond, and coordinate bond, hydrogen bond, Van der Waals interactions, hydrophobic interactions, electrostatic interactions and London forces bond length and bond energy,<br>**Thermodynamics**<br>Laws of thermodynamics and their application to living systems. Concept of free energy, enthalpy, entropy and their relation to chemical equilibrium. Energy rich compounds ATP, Creatine phosphate.<br>**Basics of evolution**<br>Evolution of biomolecules, Miller's experiment, RNA as primitive catalysts, Evolution of prokaryotes and eukaryotes,<br>**Introduction to Cell Biology**<br>Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structural and functional properties of cell organelles –mitochondria, chloroplast, lysosomes, golgi bodies, plasma membrane , cell wall, and nucleus. | **15 Hrs** |
| **Unit II** | **Cell cycle and cell division**<br>Mitosis and meiosis, Chromosome structure, gene. Polytene and Lampbrush chromosome. Packing of DNA and supercoiled DNA, nucleosome, inverted repeats, satellite DNA, gene number, gene clusters and pseudogene. | **15 Hrs** |
| **Unit III** | **Nucleic Acids**<br>Bases, sugars, nucleosides, nucleotides, oligonucleotides, polynucleotides.<br>RNA: Ribosomal RNA (rRNA), messenger RNA (mRNA), small nuclear RNA (snRNA), transfer RNA (tRNA) and HnRNA<br>DNA: Structure, base pairing, double helix, coding of genetic information, sense and antisense strands<br>Molecular models of DNA: B-DNA, A-conformation, Z-confirmation | **15 Hrs** |

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| **Unit IV** | **Nucleic Acid Metabolism**<br>Biosynthesis and degradation of nucleotides: *de novo* pathways and the salvage pathway.<br>Degradation of nucleotides: difference in purine and pyrimidine degradation, generation of inosine monophosphate (IMP), allantoin, allantoinic acid, glyoxylate, release of uric acid and thyamine as intermediates, β-alanin, γ-aminoisobutyrate. | **15 Hrs** |

**Suggested Readings**


1. Cells by David Prescott
2. Cell Structure and Function by Loewy and Gallant
3. Molecular Biology of the Cell by Albert Bruce et al, Garland Publication New York 1997
4. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
5. Biochemistry by Lubert Stryer, 4th Edition
6. Biochemistry by David Rawn

**OR**

| **CC -101B: Cell Biology, Microbiology and Virology (CBCS) (Offered by Department of Microbiology)** | | **60 Hrs** |
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| **Unit I** | **CELL BIOLOGY:**<br>Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells.<br>Structural and functional capitalization of cell –mitochondria, chloroplast, lysosomes,<br>golgi bodies, plasma membrane and cytoskeleton, cell wall, nucleus. | **15 Hrs** |
| **Unit II** | Cell cycle, cell division - mitosis and meiosis. Chromosome structure, gene, gene number, gene clusters and Pseudo gene. Polytene and lamp brush chromosomes. Packing of DNA, supercoiled DNA, nucleosome, Inverted repeats, repetitive DNA sequence, satellite DNA. Cell trafficking. | **15 Hrs** |
| **Unit III** | **MICROBIOLOGY:**<br>Structure, classification and general characteristics of Bacteria (including ribotyping), Micoplasma, Protozoa, archea and yeast, fungi. Association of bacteria.<br>Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing.<br>Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture. | **15 Hrs** |
| **Unit IV** | **VIROLOGY:**<br>Classification and General properties of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny. Structure of viruses, assembly of viral membrane.<br>Life cycle and replication of viruses:<br>RNA-negetive strand (VSV), positive strand (Polio), segmented [Influenza] Retrovirus- RSV and HIV DNA- adenovirus and SV-40<br>Cultivation in cell culture, chick embryo and animal inoculation.<br>Persistent chronic and acute viral infections. Mechanism of interferon and antiviral therapy. Host virus interactions; plant and animal. | **15 Hrs** |

**Suggested Readings**


- Clark M S & Wall W. J. (1996) Chromosomes, Chapman & Hall, London.
- Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. Saunders Publication, 9th Edition , 1996
- Physiology Illustrated by Lipfold and Cogdell
- Cells by David Prescott
- Cell Structure and Function by Loewy and Gallant
- Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997
- Introduction to Modern Virology by Dimmock and Primrose
- Molecular Virology by Alan Cann
- Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed.
- Prentice Hall Int. (U.K.) Ltd, London.
- General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong.

| CC -102: Proteins : Structure and Functions | | 60 Hrs |
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| **Unit I** | **Amino Acids**<br>Chemical structure and general properties, pI of amino acids, acid base concepts. Henderson and Hasselbaclh equation. General metabolism scheme of amino acids and Urea cycle.<br>**Proteins**<br>Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory). Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. | **15 Hrs** |
| **Unit II** | Types of protein structures; Primary, Secondary structures - alpha helix and beta pleated structure, triple helix (collagen), Tertiary and Quaternary structures, forces stabilizing tertiary and quaternary structures, prediction of secondary and tertiary structures. Unfolding / refolding experiment. Dynamics of protein folding, role of molecular chaperones in protein folding, lysosomal and membrane proteins, potassium ion channel. Structure function relationship - myoglobin and hemoglobin. | **15 Hrs** |
| **Unit III** | Techniques for studying primary sequence of proteins, end group analysis, finger printing and sequenators.<br>Chemical synthesis of peptides/ solid phase automated synthesis, prediction of conformation from amino acid sequence, zymogens and their conversion into active proteins<br>Protein evolution - convergent and divergent trees,<br>Protein turnover: Ubiquitination, proteasome and protein degradation | **15 Hrs** |
| **Unit IV** | Concept of prosthetic group, apoenzyme, holoenzyme, enzyme.<br>Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins, structure and biochemical role.<br>Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function. | **15 Hrs** |

**Suggested Readings**

- Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
- Biochemistry by Lubert Stryer, 4th Edition
- Biochemistry by David Rawn
- Principles of protein structure by Shulz and Schirmer
- Fundamentals of Enzymology by Royer
- Fundamentals of enzymology by Price and Steavens

| CC- 103: Biomolecules | | 60 Hrs |
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| **Unit I** | Introduction and classification of carbohydrates, Stereoisomersm in monosaccharides, Reactions of glucose and fructose, Reducing sugar, Mutarotation, Osazone formation, Cyclic structure of glucose and fructose , Glycosidic bonds , Disaccharides, Polysaccharides: Glycogen , Starch Cellulose. Carbohydrates as informational Molecules- The Sugar Code. Digestion and absorption of carbohydrates.Complex carbohydrates: Chitin,Pectin Xylan Agarose Dextran Peptidoglycan Blood group antigens, Lectins carbohydrate binding proteins. Selectins. Glycosaminoglycans, Glycoconjugates: Proteoglycans, Glycoproteins, Enzymes responsible for oligosaccharide assembly, Glycoproteins Oligosaccharide linkages in glycoproteins, Protein glycosylation , Glycolipids, Lipopolysaccharides, Methods of carbohydrate analysis. | **15 Hrs** |
| **Unit II** | Principles of bioenergetics ,Glycolysis, Feeder pathways for glycolysis ,Fates of pyruvate under anaerobic conditions: Fermentation, , Gluconeogenesis, Citric acid cycle, Glyoxylate cycle, Pentose phosphate pathway of glucose oxidation, Entner–Doudoroff pathway, Glucuronate pathway, Cori cycle. Principles of metabolic regulation, Illustrated with the metabolism of glucose and glycogen, The Metabolism of glycogen in animals, Coordinated regulation of glycolysis and gluconeogenesis, Coordinated regulation of glycogen synthesis and breakdown, Analysis of metabolic control. | **15 Hrs** |
| **Unit III** | **Lipids**<br>Lipids- Introduction, Defination, Functions, Classification. Storage lipids, Fatty acids, Triacylglycerols, Waxes, Steroids, Structural lipids in membranes Lipids as signals, Prostaglandins, Clinical significance of lipids, Characterization of lipids. | **15 Hrs** |
| **Unit IV** | Digestion, mobilization, and transport of fats, Beta oxidation of fatty acids pathway and regulation, Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid - fatty acid synthetase complex, pathway and regulation. synthesis of triacyl glycerides. Ketone bodies. Lipid metabolism disorders. | **15 Hrs** |

**Suggested Readings**


- Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
- Biochemistry by Lubert Stryer, 4th Edition
- Biochemistry by Zubay
- Biochemistry By Garrett and Grisham
- Complex Carbohydrate by Nathan Sharon

| CC- 104A: Basics of Physiology & Endocrinology (CBCS) | | 60 Hrs |
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| **Unit I** | **Gastro intestinal system**- General structure of alimentary canal and functions, Gastric secretion, Pancreatic secretion, Gastrointestinal hormones Digestion of carbohydrates, lipids and proteins<br>**Liver**<br>Structure and functions of liver in carbohydrate and lipid metabolism, synthesis of serum proteins, detoxification reactions<br>Liver function tests – albumin/globulin, AST-ALT, alkaline phosphatase, Bilirubin – direct and indirect<br>**Kidney**<br>Structure and function of kidney. Structure of nephrons, Glomerular filtration, reabsorption and secretion mechanism.<br>Kidney function tests - inulin clearance, urea, albumin/creatine ratio, GFR | **15 Hrs** |
| **Unit II** | **Nervous system**<br>Structure and function of the brain. Central Nervous System, Peripheral and Autonomic Nervous system. Cells of Nervous System – Neurons, Astrocytes, Glial cells, Oligodendrocytes and Schwan cells.<br>Utilization and uptake of glucose and amino acids, Blood – Brain barrier<br>**Vision**<br>Rod and cone cells, visual cycle, regulation of vision and color vision<br>**Biochemistry of muscle contraction**<br>Thick and thin filaments, interaction of actin and myosin in skeletal muscle contraction, regulation of muscle contraction by calcium<br>Smooth muscle contraction and its regulation | **15 Hrs** |
| **Unit III** | General classification of hormones – Peptide hormones, steroid hormones and derivatives of amino acids. Secondary messenger signaling – cAMP, $Ca^{++}$, IP3, DAG cGMP<br>**Pituitary Hormones**<br>Hormones of anterior and posterior pituitary, Growth hormone – Gigantism, dwarfism and acromegaly, ACTH, TSH, prolactin, Vasopressin (ADH), Oxytocin and gonadotrophic hormones<br>**Sex hormones**<br>Estrogen, progesterone, testosterone functions. Menstrual cycle, and pregnancy | **15 Hrs** |

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| **Unit IV** | **Thyroid hormones**<br>Thyroxin (T3 & T4) its synthesis and regulation. Hyper and hypothyroidism, Graves disease, Myxoedema, Goitre and cretinism<br>**Adrenal hormones**<br>Adrenal cortical hormones – Glucocorticoids and mineralocorticoids, Cushings syndrome and Addisons disease, Adrenal medullary hormones – Epinephrine and nor-epinephrine – functions | **15 Hrs** |

**Suggested Readings**


1. A Text Book of Medical Physiology by Guyton (Recent Edition).
2. Human Physiology by Davidson.
3. Illustrated Physiology by B. R. Mackenna and Robbin Callander
4. Hormones by Norman Litwack.
5. Basic and Clinical Endocrinology by Greenspan and Baster.
6. Biochemistry of Tissues by Banks.

**OR**

| **CC- 104B: Biostatistics and Computer Applications (CBCS) (Offered by Department of Microbiology)** | | **60 Hrs** |
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| **Unit I** | **BASIC TERMS, MEASURES OF CENTRAL TENDENCY AND DISPERSION*:***<br>Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, pie diagram, histograms, cumulative frequency curves. Mean, median, mode, quartiles, measures of dispersion: range, quartile deviation, mean deviation, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis, examples.<br>**BIVARIATE DATA:**<br>Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination, examples. | **15 Hrs** |
| **Unit II** | **METHODS OF SAMPLING:**<br>Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.<br><br>**HYPOTHESIS TESTING:**<br>Hypothesis, error probabilities, level of significance, critical region, and P-value of the statistic. Tests for means, equality of means of normal populations when variances are unknown, test for proportions, test for equality of proportions. Chi-square test for independence, Confidence limits, Introduction to one way and two-way analysis of variance. | **15 Hrs** |
| **Unit III** | History of development of computers, generations of computers; (I, II, III, IV and V), classifications of computers; analog computers, digital computers, mainframe computers, miniframe computers, microcomputers, Hardware; CPU, input, output, storage devices.<br>Software; operating systems, Programming languages (Machine, Assembly and Higher level).<br><br>**Memory**<br>Primary memory or main memory; magnetic core memory, RAM, ROM, PROM, EPROM, EEPROM. Secondary memory or auxillary memory. | **15 Hrs** |

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| **Unit IV** | **COMPUTER APPLICATIONS:**<br>Modern computers; Workstations, parallel processing computers, super-computers and servers for analysis of biological data.<br><br>**APPLICATION SOFTWARE**<br>Introduction to MS-EXCEL, MS-WORD. Introduction to Internet and use of the same for communication, internet related programmes, searching of database, PubMed, NCBI, ENTREZ, Data mining, Data management and interpretation. | **15 Hrs** |

**Suggested Readings**


- Biostatistics: A foundation for Analysis in the Health Sciences 7/E Wayne W. Daniel, Wiley Series in Probability and Statistics.
- Introductory Statistics. Fifth Edition. (2004) Prem S. Mann. John Wiley and Sons (ASIA) Pte Ltd.
- Basic Statistics-Aprimer for Biomedical Sciences- (Olive Jean Dunn).
- Biostatistics-An introductory text - (Auram Gold Stein).
- Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
- Computer Fundamentals, 6th Edition, P. K. Sinha and Priti Sinha, BPB Publications, 2007.
- Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication.

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| **CCPR- 105: Laboratory Course** | **(120 Hrs)** |
| | **A** **100 Marks** |
| • | Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc. |
| • | Determination of total amino acid concentration by ninhydrin method. |
| • | Estimation of protein concentration by<br>• Biuret method<br>• Lowry method<br>• Spectrophotometric method<br>• Dye binding method |
| • | Estimation of reducing sugar concentration by DNSA method |
| • | Estimation total sugar concentration by<br>• Phenol-$H_2SO_4$ method<br>• Anthrone method |
| • | Estimation of glucose concentration by Glucose oxidase method |
| • | Determination of fructose concentration by resorcinol method. |
| • | Estimation of cholesterol |
| | **B** **100 Marks** |
| • | Estimation of vitamin C concentration by DCPIP method. |
| • | Isolation of Characterization of casein from milk. |
| • | Isolation and characterization of starch from potato. |
| • | Isolation of cholesterol and lecithin from egg yolk. |
| • | Formal titration |
| • | Detection of Carbohydrates |
| • | Detection of Amino acids |
| • | Studies on lipids: Acid value, saponification value and iodine number |

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| **AEC 106** | **Mandatory Non-CGPA compulsory Ability Enhancement Course** | **30 Hrs** |

| SEMESTER II | | |
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| **CC -201: Enzymology** | | **60 Hrs** |
| **Unit I** | **Enzymes**<br>Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory.<br>**Enzyme Catalysis**<br>Factors affecting catalytic efficiency - proximity and orientation effects , distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes. | **15 Hrs** |
| **Unit II** | **Enzyme Kinetics**<br>Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting.<br>Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination.<br>Enzyme activity, international units, specific activity, turnover number, end point kinetic assay | **15 Hrs** |
| **Unit III** | **Structure Function Relations**<br>Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase. | **15 Hrs** |
| **Unit IV** | **Allosteric Interactions**<br>Protein ligand binding including measurements, analysis of binding isotherms, co-operativity**,** Hill and Scatchard plots and kinetics of allosteric enzymes.<br>**Enzyme Regulation**<br>Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.<br>**Immobilized Enzymes**<br>Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Various | **15 Hrs** |

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| | methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) , microencapsulation and gel entrapment. Immobilized multienzyme systems Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors | |

**Suggested Readings**

- Fundamentals of Enzymology Price and Stevens
- Enzymes Dixon and Webb
- Isoenzymes By D. W. Moss
- Immobilized Biocatalysts W. Hartneir
- Selected papers Allosteric Regulation M. Tokushige

| CC -202: Molecular Biology | | 60 Hrs |
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| **Unit I** | **Genome organization**<br>Organization of bacterial genome, Structure of eukaryotic chromosomes; role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, transposable elements, molecular components, DNA re-association kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting.<br>**Mutation**<br>Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, transitions, transversions, physical, chemical and biological mutagens. | **15 Hrs** |
| **Unit II** | **DNA Replication, Repair & Recombination**<br>Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, replication of single stranded circular DNA. Gene stability and DNA repair DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. Recombination: homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases. | **15 Hrs** |
| **Unit III** | **Prokaryotic & Eukaryotic Transcription**<br>Prokaryotic Transcription & Regulation: Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho-dependent and independent termination, Anti-termination, Transcriptional regulation, positive and negative regulation, operon concept, Regulation of transcription of lac, trp, ara, his, and gal operons, transcriptional control in lambda phage, Transcript processing, Processing of tRNA and rRNA Eucaryotic transcription and regulation: RNA polymerase structure and assembly, RNA polymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors, transcription initiation, elongation and termination, activation and repression, Transcriptional and post-transcriptional gene silencing, expression and processing of heterogeneous nuclear RNA, tRNA, rRNA, 5'-Cap formation,3'-end processing and polyadenylation, Splicing, RNA editing, Nuclear export of mRNA, mRNA stability, catalytic RNA. | **15 Hrs** |

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| **Unit IV** | **Translation & Transport**<br>The translation machinery, ribosomes, composition and assembly, Universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis. Mechanism of initiation, elongation and termination, Co- and post-translational modifications, genetic code in mitochondria. Protein synthesis, Transport of proteins and molecular chaperones, protein stability, protein turnover and degradation | **15 Hrs** |

**Suggested reading**


- Stryer L (1995) Biochemistry, 4 th / 5 th edition, W. H. Freeman & company, New York.
- Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M. (1988) Molecular biology of the gene, 4 th edition, The Benjamin/Cummings publishing companies, inc, California.
- Benjamin Lewin (1999) Genes VII, oxford University Press, Oxford.
- Weaver R. F. (1999) Molecular biology, WCB McGraw-Hill companies, Inc, New York.
- Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IR press, Oxford.
- Genes and Genomes Maxine Singer and Paul Berg

| CC- 203: Bioenergetics | | 60 Hrs |
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| **Unit I** | Principles of bioenergetics, Oxidative phosporylation Biochemical anatomy of a mitochondrion, Membrane-Bound electron carriers, Mitochondrial Electron-Transfer Chain, effects of inhibitors of electron transfer Agents that interfere with oxidative phosphorylation. ATP Synthesis Chemiosmotic model, Mitochondrial ATP synthase complex, Binding-Change mechanism for ATP Synthesis, , Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, Regulation of oxidative phosphorylation, Heat generation by uncoupled mitochondria, Mitochondria evolved from endosymbiotic Bacteria, Mitochondrial genes: Their origin and the effects of mutations, Mutations in mitochondrial genes, The role of mitochondria in apoptosis and Oxidative stress. | **15 Hrs** |
| **Unit II** | Photosynthesis: Harvesting light energy General features of photophosphorylation, Light absorption, Reaction centers organization of photosystems in the thylakoid membrane. Hill reaction, The central photochemical event: Light-driven electron flow ATP synthesis by photophosphorylation, A proton gradient couples electron flow and Phosphorylation, Chloroplasts Evolved from endosymbiotic bacteria, Carbohydrate biosynthesis in plants and bacteria, Photorespiration, Calvin cycle (C3) and Hatch-Slack pathway, (C4) CAM pathways, Biosynthesis of starch and sucrose ,Synthesis of cell wall polysaccharides. | **15 Hrs** |
| **Unit III** | Types of nitrogen fixation, Symbiotic and non-symbiotic nitrogen fixation. Nitrogen cycle Root nodule formation,Nitrogenase enzyme complex - azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, Nif genes and its regulation, Microbial fertilizers. Marine nitrogen fixation. | **15 Hrs** |
| **Unit IV** | Biotransformation of toxicants, Uptake and excretion of hydrophilic and lipophillic compounds, reactions phase I (modifications) phase II (conjugation) and phase III (transport) and their interrelationships, Monooxygenases, Cytochrome P450 (CYP) enzymes and Mixed function oxidases, biotranformation in animals, biotranformation in microorganisms, biotranformation in fungi, biotranformation in plants, modifications in biotransformation, syndromes associated. | **15 Hrs** |

**Suggested Readings**:

- Biochemistry by Lubert Stryer 4th Edition.
- Lehningers Principles of Biochemistry by Nelson and Cox.
- Biological nitrogen fixation by Frans J. de Bruijn.
- Detoxication Mechanisms by R.T.Williams 2 nd Edition.

| CC -204: Tools and Techniques in Bioscience | | 60 Hrs |
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| **Unit I** | **Technology Fundamentals (Life Science)**<br>General scheme for purification of bio-components. Methods for studying cells and organelles. Sub-cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins. | **15 Hrs** |
| **Unit II** | **Chromatography**<br>Basic principles and applications of ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing.<br>**Centrifugation**<br>Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination. | **15 Hrs** |
| **Unit III** | **Electrophoresis**<br>Basic techniques, poly acrylamide/ starch/ agarose gel electrophoresis, use of SDS/urea, isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis.<br>**Tracer Techniques**<br>Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation dosimetry, Radioactive isotopes and half life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry. | **15 Hrs** |
| **Unit IV** | Principles and Biological Applications of Biophysical Techniques:<br>X-ray diffraction, fluorescence, UV, visible, CD/ORD, NMR and Mass spectroscopy, atomic absorption spectroscopy. plasma emission spectroscopy, scanning and transmission electron microscopy, Atomic force microscopy<br>**Plant Tissue Culture**<br>Media requirements, sterilization and role of growth regulators. Requirements of a plant tissue culture laboratory.<br>Caulogenesis and rhizogenesis, Micropropogation, Somatic cell hybridization, Haploid (anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis Somaclonal variations, Cybrides and Allopheny. Cell suspension and callus culture. *Agrobacterium* mediated hairy root culture. Production of industrially important secondary plant metabolites like taxol, bioinsecticides, pigments, etc. Conditioning of tissue culture plants (weaning and hardening). Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance. | **15 Hrs** |

**Suggested Readings:**


- Protein Purification by Robert Scopes, Springer Verlag Publication, 1982
- Tools in Biochemistry David Cooper
- Methods of Protein and Nucleic acid Research, Osterman Vol I – III
- Centrifugation D. Rickwood
- Practical Biochemistry, V th edition, Keith, Wilson and Walker.
- Wetter L.R and Canstabel eds. (1982) Plant Tissue Culture methods. Natl. Res. Council, Canada.
- Marris. P., Scragg, A.H., Standford, A and Fowlew M.W eds. (1986) Secondary metabolism in plant tissue cultures. Cambridge UnivPress, Cambridge.
- Komamine A., Misawa M and Dicosmo F eds. (1991) Plant cell culture in Japan. CMC Co. Ltd, Tokyo.


| **CCPR- 205: Laboratory Course** | **(120 Hrs)** |
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| **A** | **100 Marks** |
| • | Separation and identification of amino acid mixture by<br>• Paper chromatography technique.<br>• Paper electrophoresis technique |
| • | Thin layer chromatographic separation of sugars and membrane lipids |
| • | Separation and identification of serum proteins by polyacrylamide/agarose gel Electrophoresis (BSA/Hb). |
| • | Separation of proteins (hemoglobin & cytochrome c) using molecular sieve chromatography. |
| • | Determination of capacity of ion exchange resin (Dowex- 50) |
| • | Purification of protein by ion exchange chromatography.<br>(DEAE cellulose chromatography) |
| • | Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae* |
| • | Isolation and charcterization of glycogen. |
| • | Isolation and characterization of Glycogen from rat liver. |
| **B** | **100 Marks** |
| • | Identification and quantitation of activity of amylase/ amylase /cellulase/amyloglucosidase/invertase/alkaline phosphatase/Urease (salivary/microbial/animal/plant source). |

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| • | Determination of specific activity. |
| • | Determination of activity in presence of activators. |
| • | Determination of activity in presence of inhibitors. |
| • | Determination of optimum pH. |
| • | Determination of optimum temperature. |
| • | Determination of Km. |
| • | Determination of Competitive, non-competitive inhibitors. |

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| **SEC 206** | **Mandatory Non-CGPA compulsory**<br>**Skill Enhancement Course** | **30 Hrs** |