Bharatiya Vidya Bhavan

BHAVAN'S VIVEKANANDA COLLEGE
OF SCIENCE, HUMANITIES & COMMERCE
Sainikpuri, Secunderabad – 500094
Autonomous College - Affiliated to Osmania University
(Accredited with 'A' grade by NAAC)
Department of Biochemistry

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

PAPERS	Code	SEMESTER I TITLE	Course Type	Teaching hrs/week	Credits	Internal marks	Final exam marks	Total
		Theory						
1	BI101T	Chemistry and Metabolism of Proteins, Lipids and Porphyrins	DSC	4	4	30	70	100
2	B1102T	Chemistry and Metabolism of Carbohydrates, Nucleic Acidsand Vitamins	DSC	4	4	30	70	100
3	BI103T	Bio-Analytical Techniques	DSC	4	4	30	70	100
4	BI104T	Bioenergetics and Photosynthesis	DSC	4	4	30	70	100
		Practicals						
5	BI151P	Amino acid and protein analysis		8	4	--	100	100
6	BI152P	Carbohydrate and lipid analysis		8	4	--	100	100
		Total		**32**	**24**	**120**	**480**	**600**

PAPERS		SEMESTER II TITLE		Teaching hrs/week	Credits	Internal marks	Final exam marks	Total
		Theory						
1	BI201T	Enzymology	DSC	4	4	30	70	100
2	BI202T	Molecular Biology	DSC	4	4	30	70	100
3	BI203T	Biochemical Genetics and Model Organisms	DSC	4	4	30	70	100
4	BI204T	Biostatistics and Clinical Biochemistry	DSC	4	4	30	70	100
		Practicals						
5	BI 251P	Enzymology and Biochemical Preparations		8	4	--	100	100
6	BI 252P	Molecular Biology, Genetics and Clinical Biochemistry		8	4	--	100	100
		Total		**32**	**24**	**120**	**480**	**600**

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: CHEMISTRY AND METABOLISM OF PROTEINS, LIPIDS & PORPHYRINS

PAPER CODE : BI101T
YEAR/SEMESTER: I/I

PPW :4
NO OF CREDITS:4

COURSE OBJECTIVE: To explain the chemistry and metabolism of proteins, lipids and porphyrins.

UNIT-WISE COURSE OBJECTIVES:

COb1 To describe the structure, classification and properties of aminoacids and proteins.
COb2 To discuss the metabolism of amino acids and related genetic defects.
COb3 To explain the structure, classification and properties of lipids and porphyrins.
COb4 To discuss the metabolism of lipids and porphyrins in relation to disease.

UNIT–I: Chemistry of Amino Acids &Proteins

1. Classification and structure of 20 amino acids, essential, non–essential, unusualand non-protein aminoacids.
2. General properties of amino acids, acid–base titrations, pKa.
3. Peptide bond–stability and formation, Primary structure, GN Ramachandran plots.
4. Secondary structure and motifs, α helix, β sheet, 3-10helix.
5. Leucine zipper, Zinc finger, Trans-membrane regions, β LHL.
6. Tertiary &Quaternary structure (myoglobin, hemoglobin).
7. Protein-protein interactions (actin, tubulin).
8. Small peptides (glutathione, peptide hormones), Cyclicpeptides (Gramicidin).
9. Classification of proteins-globular, fibrous, membrane, metallo-proteins, SCOP, CATH.
10. Denaturation (pH, temperature, chaotropic agents), refolding, Role of chaperones in folding.

UNIT–II: Metabolism of Amino acids & Proteins

1. Metabolic fate of dietary proteins and aminoacids.
2. Degradations to glucose and ketone bodies.
3. Amino acids degraded to Pyruvate, Oxaloacetate.
4. Amino acids degraded to Acetyl-CoA, Succinyl-CoA.
5. Metabolism of branched chain aminoacids.
6. Role of glutamate cycle in formation &circulation of ammonia.
7. Glucose alanine cycle, urea cycle.
8. Linking of citric acid and urea cycles, regulation of urea cycle.
9. Genetic defects in metabolism of aminoacids (albinism, Phenylketonuria, maple syrup urine disease,homocystinuria,alkaptonuria, methylmalonicAcidemia.
10. Genetic defects in metabolism of urea (Argininemia, arginosuccinicacidemia, CarbamoylPhosphate Synthetase-deficiency).

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UNIT–III: Chemistry of Lipids & Porphyrins

1. Classification &biological significance of lipids &fatty acids.
2. Steroids, Sterols, relation to Vitamin D and steroid hormones.
3. Bile acids and salts, Phospholipids.
4. Oils, waxes, isoprene units.
5. Lipoproteins.
6. Glycolipids, Sphingolipids.
7. Structure &function of porphyrins (e.g.,Heme, Chlorophyll).
8. Cerebrosides, Gangliosides.
9. Prostaglandins, Prostacyclins.
10. Thromboxanes, Leukotrienes.

UNIT–IV: Metabolism of Lipids & Porphyrins

1. Fate of dietary lipids and Apo- lipoproteins.
2. Fatty acid biosynthesis, Desaturation of fatty acids.
3. Beta oxidation, breakdownof odd chain fatty acids, energy yields.
4. Regulation of β–oxidation, ώ–oxidation & α–oxidation.
5. Metabolism of phospholipids &Sphingolipids.
6. Regulation and Biosynthesis of cholesterol and other steroids.
7. Fate of acetyl CoA, formation of ketone bodies and ketosis.
8. Biosynthesis of prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes.
9. Role of HDL, LDL and Very-low-density lipoprotein (VLDL) and cholesterollevels in body.
10. Catabolism of Porphyrins, Genetic defects in lipid and nucleotide metabolism, Medium chain acyl coenzymeA dehydrogenase deficiency (MCAD), Long-chain 3-hydroxy acyl-CoA dehydrogenase (LCHAD) deficiency, Familial hypercholesterolemia, Gout.

REFERENCES:

1. Lehninger's Principles of Biochemistry, DavidL. Nelson, Michael M Cox Publisher: W H Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko, and LubertStryer.: W H Freeman
3. Biochemistry,4thEdition-Donald Voet, Judith G. Voet. –Publisher John Wiley &Sons.

COURSE OUTCOMES:

At the end of the course students will be able to:

BI101.CO1 relate structural organization of proteins with their properties and functions.
BI101.CO2 correlatethe genetic defects with impaired amino acid metabolism.
BI101.CO3 associate the different classes of lipids with their tissue distribution.
BI101.CO4 relate the genetic defects with altered lipid metabolism.

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PROGRAM NAME: M. Sc BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: CHEMISTRY, METABOLISM OF CARBOHYDRATES, NUCLEIC ACIDS AND VITAMINS

PAPER CODE: BI102T
YEAR/SEMESTER: I/I

PPW: 4
NO.OF CREDITS: 4

COURSE OBJECTIVE: To familiarize students with structural features, occurrence, regulation and interrelationship of metabolic pathways of carbohydrates, nucleic acids and vitamins.

UNIT-WISE COURSE OBJECTIVES:

COb1 To describe structural features, types and properties of carbohydrates.
COb2 To explain various types of metabolic pathways of carbohydrates.
COb3 To discuss the structural features and metabolism of nucleic acids.
COb4 To explainthe importance of vitamins in human health.

UNIT – I: Chemistry of Carbohydrates

1. Classification, monosaccharides (aldoses & ketoses).
2. Configuration and conformation of monosaccharides (pyranose & furanose, chair & boat).
3. Reducing and optical properties of sugars.
4. Stability of glycosidic bond, disaccharides, oligosaccharides.
5. Structural polysaccharides-cellulose, hemicellulose, pectin, lignin, chitin, chitosan.
6. Storage polysaccharides; starch, glycogen, inulin.
7. Steric factors in polysaccharides folding, sugar code and lectin.
8. Glycosaminoglycans, mucopolysaccharides, hyaluronic acid.
9. Chondriotin sulfate, keratan sulfate, dermatan sulfate.
10. Bacterial cell wall – proteoglycans and peptidoglycans.

UNIT – II: Metabolism of Carbohydrates

1. Reactions, energy balance and regulation of Glycolysis.
2. Reactions, energy balance and regulation of Gluconeogenesis.
3. Pyruvate dehydrogenase complex.
4. Reactions, energy balance and regulation of TCA cycle.
5. Pentose phosphate pathway, regulation and significance.
6. Pasteur and Crabtree effect.
7. Anapleurotic reactions.
8. Glyoxylate cycle.
9. Glucuronic acid cycle.
10. Glycogen metabolism.

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UNIT – III: Chemistry and Metabolism of Nucleic Acids

1. Purines, pyrimidines, nucleosides, nucleotides, unusual bases.
2. Structure of DNA – Watson Crick Model, A- and Z- forms.
3. Supercoiling of DNA – negative and positive, linking number.
4. Structure of mRNA, tRNA, rRNA, siRNA / miRNA.
5. Properties of NA – denaturation and renaturation.
6. Tm (factors affecting Tm) and Cot curves.
7. Hetero duplex mapping – D loops and R loops.
8. Biosynthesis of purines and pyrimidines.
9. Degradation of purines and pyrimidines.
10. Regulation: *de novo*, salvation, nucleotide analogs.

UNIT – IV: Chemistry and Metabolism of Vitamins

1. Discovery of vitamins, classification, RDA.
2. Vitamin A – source, biological role, deficiency.
3. Vitamin B1 – Thiamine – source, biological role, deficiency.
4. Vitamin B2 – Riboflavin – source, biological role, deficiency.
5. Vitamin B3 – Niacin – and B5 – Pantothenic acid – sources, biological role, deficiency.
6. Vitamin B6 – Pyridoxamine – and B7 – Biotin – source, biological role, deficiency.
7. Vitamin B9 – Folic acid – and B12 – Cobalamine – source, biological role, deficiency.
8. Vitamin C – Ascorbic acid – source. Biological role, deficiency.
9. Vitamin D – Calciferol – source, biological role, biological role, deficiency.
10. Vitamin E, Vitamin K – source, biological role, deficiency.

REFERENCES:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko, and LubertStryer.: W H Freeman.
3. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, White A, McGraw Hill

COURSE OUTCOMES:

At the end of the course students will be able to:

BI102.CO1 differentiate the structural features and properties of various carbohydrates.
BI102.CO2 relate various metabolic events of carbohydrates and their significance.
BI102.CO3 distinguish the structural features, properties and metabolism of nucleic acids.
BI102.CO4 implement the importance of vitamins in daily health.

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PROGRAM NAME: M. Sc BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: BIO-ANALYTICAL TECHNIQUES

PAPER CODE: BI103T
YEAR/ SEMESTER: I/I

PPW: 4
NO OF CREDITS: 4

COURSE OBJECTIVE: To explain the principle, instrumentation and applications of various bio-analytical techniques.

UNIT-WISE COURSE OBJECTIVES:

COb1 To familiarize with principle, instrumentation and applications of various spectroscopic techniques.
COb2 To discuss the principles and applications of different chromatographic techniques.
COb3 To explain centrifugation and electrophoresis techniques with their applications.
COb4 To describe different isotopes and their applications in biology.

UNIT – I: Spectroscopy

1. Beer Lambert's Law, Molar extinction coefficient, Absorption maximum.
2. UV-Vis: Spectroscopy, Colorimetry – principle, instrumentation, application.
3. Fluorescence Spectroscopy – principle, instrumentation, application.
4. Atomic Absorption Spectrometry – principle, instrumentation, application.
5. NMR – principle, instrumentation application.
6. ESR – principle, instrumentation application.
7. CD – principle, instrumentation, application.
8. ORD – principle, instrumentation, application.
9. Mass spectroscopy – principle, instrumentation, application.
10. X-ray crystallography.

UNIT – II: Chromatography

1. Partitioning and counter current distribution.
2. PC – principle, instrumentation, application.
3. TLC – principle, instrumentation, application.
4. GC – principle, instrumentation, application.
5. Ion–exchange – principle, instrumentation, application.
6. Gel filtration (Gel exclusion chromatography) – principle, application.
7. Affinity chromatography – principle, instrumentation, application; immune precipitation.
8. HPLC and RP-HPLC – principle, instrumentation, application.
9. FPLC, LC – principle, instrumentation, application.
10. Peptide mapping and N-terminal sequencing of proteins.

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UNIT – III: Centrifugation and Electrophoresis

1. Centrifugation, RCF and types of rotors.
2. Ultracentrifugation – principle, instrumentation, application.
3. CsCl density gradient and sucrose gradient centrifugation – principle, application.
4. Electrophoresis – moving boundary and zonal electrophoresis.
5. Native and SDS-PAGE, IEF and 2D PAGE.
6. Agarose Gels, PFGE.
7. Zymography, PAGE for DNA sequencing.
8. DNase-I hypersensitivity mapping.
9. DNA-Foot-printing and Chromatin IP methods.
10. Denaturing gels for RNA, Southern and Northern Blots.

UNIT – IV: Tracer Techniques

1. Stable and radioactive isotopes, Radioactivity theory, half-life and emission spectra of half-life of Biologically useful isotopes - ^{2}H, ^{3}H, ^{14}C, ^{18}O, ^{32}P, ^{35}S, ^{125}I
2. Isotopes used for labeling proteins (^{3}H ^{14}C, ^{35}S, ^{125}I) and nucleic acids (^{3}H, ^{32}P)
3. Detection of radioactivity by Scintillation counting
4. Autoradiography, Fluorography, Phosphor-imaging, applications
5. GM counter, gamma counter
6. Radiation hazards and safe disposal of radioactivity waste; luxometry and chemi luminescence as alternative to radioactivity
7. Isotope dilution method – pulse chase
8. Historic examples- ^{14}C and ^{18}O to study photosynthesis
9. Historic examples- ^{32}P and ^{35}S to study viral replication (Hershey-Chase experiment)
10. Historic examples- ^{14}N and ^{15}N in DNA replication (Meselson and Stahl experiment)

REFERENCES:

1. Principles and Techniques of Practical Biochemistry- Wilson. K. And Walker. J. Pub: Cambridge Press
2. Physical Biochemistry- Friefelder, Publisher D. W.H. Freeman Press
3. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. Himalaya Publishing House, Delhi.

COURSE OUTCOMES:

At the end of the course students will be able to:

BI103.CO1apply relevant spectroscopic method in study of molecular mass and structure ofbiomolecules.

BI103.CO2analyse various biomolecules based on their physical and chemical properties by different chromatographic methods.

BI103.CO3design protocolfor separating and identifying proteins or nucleic acids using centrifugation and electrophoresis methods.

BI103.CO4interpret the use of specific isotope for a particular study.

COURSE NAME: BIOENERGETICS AND PHOTOSYNTHESIS

PAPER CODE: BI104T **PPW: 4**
YEAR/SEMESTER: I/I **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To familiarize the students with the concepts of Bioenergetics, Biomembranesand Photosynthesis.

UNIT-WISE COURSE OBJECTIVES:

COb1 To explain the concepts of thermodynamics and its relevance to biological energy production.
COb2 To describe the composition and organization of biomembranes.
COb3 Todiscuss various membrane transport mechanisms.
COb4 Todescribe various photosynthetic processesand their regulation.

UNIT – I: Bioenergetics

1. Elements of importance in biochemistry (H, C, N, O, P, S), types and energy of bonds and interactions (ionic, covalent, coordinate, H-bonds, Van der Waal's, hydrophobic interactions).
2. Law of thermodynamics, Gibbs free energy.
3. Relevance of entropy and enthalpy in biological system and reactions.
4. Biological oxidation, free energy changes, redox potential & phosphate potential.
5. High energy bonds and high energy compounds.
6. Electron transport chain, components & importance.
7. Mechanisms of oxidative phosphorylation.
8. Uncouplers& inhibitors of energy transfer.
9. Substrate level & oxidative phosphorylation.
10. Bioluminescence.

UNIT – II: Biomembranes

1. Composition of plasma membrane and organelle membranes of plant and animal cells.
2. Membrane dynamics. Forces stabilizing the membranes.
3. Membrane asymmetry- Membrane Lipids and proteins.
4. Fluid mosaic model of membrane.
5. Integral membrane proteins and their secondary structures-α helices and β barrels.
6. Methods of detecting transmembrane proteins, hydropathy plots.
7. Lipid anchored membrane proteins-acyl, prenyl and GPI anchors.
8. Artificial membranes: Liposome, micelles and vesicles.
9. Reconstitution of functional membrane systems from purified components.
10. RBC membrane.

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UNIT – III: Membrane Transport

1. Transport across cell membranes. Fick's law.
2. Types of transport- simple diffusion, passive & facilitated diffusion.
3. Active transport-primary & secondary active transport systems.
4. Formation of ion gradients across membrane (proton gradients in organelles)
5. Aquaporins and ionophores.
6. Gated channels (voltage & chemical).
7. Group translocation. Transport ATPases, Na^+/K^+ATPases.
8. ABC transporters; MDR1, CFTR Channels and pores.
9. Bulk transport-endocytosis & exocytosis.
10. Bacterial transport systems; Lactose permease, Phosphotransferase.

UNIT – IV: Photosynthesis

1. Photosynthesis-structure of organelles involved in photosynthesis in plants & bacteria.
2. Light& dark reactions, Hill reaction.
3. Light receptors-chlorophyll; light harvesting complexes, bacteriorhodopsin.
4. Photosystem I & II and their location.
5. Mechanism of quantum capture & energy transfer between photosystems.
6. Proton gradients & electron transfer in chloroplasts.
7. Cyclic and non-cyclic Photophosphorylation.
8. C3 pathway of carbon metabolism.
9. C4 pathway & CAM metabolism. Regulation of photosynthesis.
10. Photorespiration.

REFERENCES:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Biochemistry-Jeremy M Berg, John L Tymoczko, and LubertStryer.: W H Freeman
3. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, … White A, McGraw Hill

COURSE OUTCOMES:

At the end of thecourse students will be able to:

BI104.CO1 relate the concepts of Thermodynamics to biological oxidation and energy production.
BI104.CO2differentiate the structural organization of various biomembranes.
BI104.CO3 relate different membrane transport mechanisms with their functions.
BI104.CO4distinguish the different pathways of photosynthesis and their regulation.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)
PRACTICAL SYLLABUS
COURSE NAME: AMINO ACID AND PROTEIN ANALYSIS

PAPER CODE:BI 151P **PPW:8**
YEAR/SEMESTER: I/I **NO OF CREDITS:4**

COURSE OBJECTIVES:

COb1 To explain the importance of good laboratory practices and instrumentation.
COb2 To describe the preparation of buffers and standard solutions.
COb3 To explain the qualitative and quantitative methods for the analysis of amino acids and proteins.
COb4 To demonstrate bioanalytical techniques for separation of amino acids and proteins.

1. Good laboratory practices and care in handling instruments (pH-meter, Spectrophotometer, centrifuges, colorimeter, analytical balance etc).
2. Calculations and preparation of standard solutions.
3. Preparation of buffers, use of balance and pH meter.
4. Qualitative analysis of amino acids.
5. Determine pKaand pIof acidic, basic, and neutral amino acids.
6. Estimate amino acids by Ninhydrin method.
7. Quantify glycine by formal titration.
8. Estimate tryptophan by Spies and Chambers method.
9. Absorption spectrum of tyrosine and determination of molar extinction coefficient.
10. Estimate tyrosine by nitroso-naphthol method.
11. Estimate protein by Biuret method.
12. Estimate protein by Lowry method.
13. Anion-exchange capacity of resin.
14. Cation-exchange capacity of resin.
15. SDS- PAGE of proteins.
16. Separate amino acids by ion-exchange chromatography.
17. 1-D PC of amino acids.
18. 2-D PC of amino acids.
19. Desalting proteins by dialysis.
20. Gel filtration (size exclusion)

COURSE OUTCOMES:

At the end of the course students will be able to

BI151P.CO1 implement the knowledge of good laboratory practices and instrumentation in research/ industry.
BI151P.CO2 select suitable buffers for biochemical experiments.
BI151P.CO3 analyse amino acids and proteins qualitatively and quantitatively in research methodology/industries.
BI151P.CO4 Apply different techniques for analysis of aminoacids and proteins in biological samples.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)
COURSE NAME: CARBOHYDRATE AND LIPID ANALYSIS

PAPER CODE:BI152P **PPW: 8**
YEAR/SEMESTER: I/I **NO OF CREDITS:4**

COURSE OBJECTIVES:
COb1 To explain the qualitative and quantitative methods for the analysis ofcarbohydrates
COb2 To describe qualitative and quantitative methods for analysis of lipids.
COb3 To describe the methods to characterize fats and oils.
COb4 To explain different methods for estimation of vitamins, minerals and metals.

1. Qualitative analysis of carbohydrates.
2. Estimate total sugars by phenol sulfuric acid method.
3. Estimate reducing sugars by DNS.
4. Estimate fructose by Roe's method.
5. Titrimetric determination ofsugars by Benedict's.
6. Paper chromatography of sugars.
7. Qualitative analysis of lipids.
8. Saponification value of fats.
9. Iodine number of oil.
10. Peroxide value of fats.
11. Acid value of fats.
12. TLC of lipids.
13. Estimate of cholesterol by Zak's method.
14. Estimate inorganic phosphate by Fiske-Subbarow method.
15. Titrate calcium in milk.
16. Titrate vitamin C.
17. Photometric analysis of iron.
18. AAS analysis of metals.
19. TLC of plant pigments.

COURSE OUTCOMES:
At the end of the course students will be able to:
BI152P.CO1 apply the knowledge of qualitative and quantitative analysis of carbohydrates from various samples in research/industry.
BI152P.CO2 apply the knowledge of qualitative and quantitative analysis of lipids from various samples in research/industry.
BI152P.CO3 categorize the fats and oils in food samples based on their various properties and apply it in food industries.
BI152P.CO4 analyse the concentrations of vitamins, minerals and metals in various samples in research/ food industry.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: ENZYMOLOGY

PAPER CODE: BI201T
YEAR/SEMESTER: I/II

PPW: 4
NO.OF CREDITS: 4

COURSE OBJECTIVE: To explain concepts of enzymes, their role and regulation in cellular metabolism.

UNIT-WISE COURSE OBJECTIVES:

COb1 To explain the concepts of energetics, classification and assay of enzymes.
COb2 To discuss enzyme kinetics of single and bi-substrate reactions and enzyme inhibitors.
COb3 To make understand various catalytic mechanisms of enzymes.
COb4 To summarize various regulatory mechanisms of enzyme activity.

UNIT – I: Basic Enzymology

1. Properties of enzymes, protein conformation & catalyses.
2. Thermodynamics of catalysis, Energy of activation, Relation of ΔG and Keq.
3. Coupled reactions (endergonic and exergonic) in biochemical pathways.
4. Nomenclature and classification of enzymes.
5. Metal, co-factor, and co-enzyme requirements.
6. Methods to isolate and purify enzymes.
7. Assays, Activity Units and Specific activity.
8. High-Throughput enzyme assays.
9. Chemicals to identify active site residues: Arg, Cys, Lys, His.
10. Site-directed mutagenesis to identify active site residues: Triose Phosphate Isomerase.

UNIT – II: Enzyme Kinetics

1. Single substrate assumptions, Michaelis-Menten kinetics (derive equation and transformations).
2. Steady state, Briggs -Haldane equation.
3. Lineweavar Burk, Eadie-Hofstee, Hanes plots.
4. Bi-substrate reactions: sequential mechanism, compulsory order and random order mechanism.
5. Non – sequential mechanisms, ping – pong mechanisms.
6. Distinction between ordered and random addition of substrates and products release.
7. Factors affecting catalysis (pH, temperature, pressure, enzyme and substrate concentration).
8. Enzyme inhibition: Types of reversible inhibitions – competitive, non-competitive, un – competitive and mixed inhibition.
9. Irreversible inhibition-covalent modification (suicide inhibition).
10. Substrate inhibition, feedback inhibition and allosteric inhibition.

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UNIT – III: Catalytic Mechanisms

1. Chemical nature of enzyme catalysis: General acid – base, Covalent and metal ion catalysis.
2. Transition state, proximity and orientation.
3. Mechanism of co-enzymes: pyridoxal phosphate and flavin nucleotides.
4. Catalytic mechanism of RNase.
5. Catalytic mechanism of Chymotrypsin, Trypsin.
6. Catalytic mechanism of Lysozyme.
7. Catalytic mechanism of Carboxypeptidase, Subtilisin.
8. Slow transition and Hysteretic behavior in enzymes.
9. Catalytic RNA and catalytic antibodies.
10. Enzyme inhibitors as drugs: RT and Protease inhibitors as anti-HIV drugs.

UNIT – IV: Enzyme Regulation

1. Convergent and divergent evolution of enzymes.
2. Reversible and irreversible activation of enzymes (phosphorylation, pro-enzymes).
3. Enzymes activation by ligand binding and dimerization (protein tyrosine kinase receptors).
4. Allosteric enzymes; binding of ligands to proteins, co-operativity.
5. Hill plot for Myoglobin and Hemoglobin, sigmoidal kinetics.
6. MWC and KNF models. Significance of sigmoidal behavior.
7. Study of ATCase as a typical allosteric enzyme.
8. Regulation of Glutamine Synthetase.
9. Multiple forms of enzymes -Lactate dehydrogenase.
10. Multi-enzyme complexes& significance -Fatty acid synthase complex.

REFERENCES:

1. Fundamentals of Enzymology, Price.NC. And Stevens. L., Oxford University Press
2. Enzymes- Biochemistry, Biotechnology, Clinical chemistry- Palmer, T., Affiliated East-West press
3. Fundamentals of Enzyme Kinetics, Segel I H; Wiley Inter science
4. Biochemical calculations, 2nd Edition by Irwin H. Segel. John Wiley & Sons
5. Lehninger's Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman

COURSE OUTCOMES:

At the end of the course students will be able to:

BI201.CO1 interpret the concepts of enzyme catalysis.

BI201.CO2 differentiate kinetic behaviour of single and bi-substrate reactions, in presence and absenc of inhibitors.

BI201.CO3 demonstrate the knowledge of enzyme catalytic mechanisms in further research.

BI201.CO4 value the importance of enzyme regulation in cellular homeostasis.

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Department of Biochemistry

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: MOLECULAR BIOLOGY

PAPER CODE: BI202T **PPW: 4**
YEAR/SEMESTER: I/II **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To describe the basic events related to replication, repair, transcription and translation in prokaryotic and eukaryotic cells.

UNIT-WISE COURSE OBJECTIVES:

COb1 To explain the mechanism of prokaryotic and eukaryotic DNA replication
COb2 To discuss various DNA repair mechanisms
COb3 To describe prokaryotic and eukaryotic transcription mechanisms.
COb4 To discuss translational mechanisms and controls in prokaryotes and eukaryotes.

UNIT – I: DNA Replication

1. Models of replication – random, conservative, semiconservative.
2. Prokaryotic and eukaryotic DNA polymerases, helicases, ligases, topoisomerases.
3. Initiation – primosome, ori-sequences, accessory proteins.
4. Elongation – replisome, leading and lagging strands, Okazaki fragments.
5. Termination, Inhibitors of replication.
6. Replication of circular chromosomes by theta model -E. coli, ϕ X 174.
7. Replication of circular chromosomes by rolling circle (lambda phage) and strand displacement models (mt-DNA).
8. Replication of linear chromosomes, telomeres, telomerase.
9. Amplification – Polytene and double minute chromosomes.
10. *In vitro* replication – PCR.

UNIT – II: DNA Repair

1. Types of damage – oxidation, deamination, alkylation, adducts, breaks.
2. Direct repair – MGMT, photo-reactivation, AlkB.
3. Base Excision Repair (Short and Long Patch).
4. Nucleotide Excision Repair.
5. Mismatch Repair.
6. Repair of DSBs by NHEJ and Homologous recombination.
7. Holiday junctions and repair of collapsed forks.
8. SOS and bypass repair.
9. Diseases due to defects in DNA repair.
10. Roles of ATM, BRCA in DNA repair.

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UNIT – III: Transcription

1. Principles of transcription, prokaryotic RNA polymerases.
2. Bacterial transcription -Initiation – promoter sequences.
3. Elongation and termination of transcription– rho dependent and independent.
4. Basal, Constitutive and regulatory levels of transcription.
5. Eukaryotic DNA dependent RNA polymerase -I (ribosomal repeats).
6. Polymerase –II, Promoters and enhancers.
7. Polymerase-III, 5s and tRNA.
8. Post-transcriptional modifications - capping, Poly A addition.
9. Splicing and RNA editing.
10. Inhibitors of transcription.

UNIT – IV: Translation

1. Nature of genetic code, Wobble hypothesis.
2. Ribosomes, structure, functional domain and subunit assembly.
3. Components and mechanism of translation.
4. Initiation, elongation and termination of translation in Prokaryotes.
5. Initiation, elongation and termination of translation in Eukaryotes.
6. Inhibitors of protein synthesis.
7. Translational controls.
8. Non-ribosomal protein synthesis- antibiotic peptide.
9. *In vitro* translational systems -Wheat germ, rabbit reticulocyte lysate and *Xenopus* Oocyte.
10. Post translational modifications of proteins. Role in targeting (isoprenylation).

REFERENCES:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Molecular Biology of the Cell, 3rd edition. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff.
3. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
4. The Cell: A Molecular Approach, by Geoffrey M. Cooper and Robert E. Hausman, pub. ASM Press.

COURSE OUTCOMES:

At the end of the course students will be able to:

BI202.CO1 differentiate between prokaryotic and eukaryotic DNA replication.
BI202.CO2 use the concepts of DNA repair mechanisms to maintain genetic stability.
BI202.CO3 compare the role of proteins involved in prokaryotic and eukaryotic transcription.
BI202.CO4 distinguish the different types of translation and translational systems.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: BIOCHEMICAL GENETICS AND MODEL ORGANISMS

PAPER CODE: BI203T
YEAR/ SEMESTER: I/II

PPW: 4
No of Credits: 4

COURSE OBJECTIVE: To familiarize the students with the concepts of inheritance, linkage, bacterial genetics and use of model organisms.

UNITWISE COURSE OBJECTIVES:

COb1 To discuss the patterns of inheritance and types of mutations.
COb2 To explain the concept of linkage, mapping and pedigree analysis.
COb3 To describe mapping of genes with gene transfer mechanisms.
COb4 To discuss the use of model organisms to study various biological processes.

UNIT – I: Mendelian Genetics

1. Mendel's Laws, Importance of meiosis in heredity.
2. Non-Mendelian Inheritance – Maternal effect, Maternal influence, Cytoplasmic inheritance.
3. Gene interactions - Epistasis, Expressivity, Penetrance.
4. Sex linked, sex limited, and sex influenced genes; Polygenic inheritance and polyploidy.
5. Mutations (spontaneous / induced, somatic / germinal, forward / reverse, transition / transversions).
6. Mutations (Silent, missense, nonsense, and frame shift mutations, conditional, leaky).
7. Detection, selection & isolation of microbial mutants, Estimation of mutation rates.
8. Reversion and suppression of mutations.
9. Mutagens – physical, chemical.
10. Transposon mutagenesis, site-directed mutagenesis.

UNIT – II: Linkage and Mapping

1. Discovery of linkage, Morgan's experiments
2. Cytological proof of crossing over
3. 2- and 3- point crosses
4. Recombination, Interference
5. Tetrad analysis
6. Mapping human genes by pedigree analysis; Fundamentals of population genetics (HW Law)
7. Pedigrees of AR, AD, XR, and XD inherited traits.
8. Mobile genetic elements – Zea Ac, Ds and Spm elements.
9. *Drosophila copia*, Yeast Ty elements.
10. Using recombination to make knockout cells / organisms.

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UNIT – III: Bacterial Genetics

1. Discovery of conjugation.
2. Mapping bacterial genes by conjugation.
3. Discovery of transformation.
4. Mapping bacterial genes by transformation.
5. Discovery of transduction.
6. Mapping bacterial genes by transduction.
7. Discovery of transposition.
8. Structure of transposons, replicative and conservative transposition, use as mutagens.
9. Mapping phage genes – Fine structure of rII locus: Complementation analysis.
10. Fine structure of rII locus: Deletion mapping.

UNIT – IV: Model Organisms

1. *Dictyostelium* to study cell – cell communication and differentiation.
2. *Saccharomyces* to study homologous recombination in mating type switch; site of formation of buds.
3. *Neurospora* to study one gene – one enzyme hypothesis.
4. *Drosophila* to study embryonic development (homeotic mutations).
5. *C. elegans* to study development and nervous system.
6. *Danio* to study vertebrate development, GLO fish.
7. *Xenopus* to study embryogenesis.
8. *Mus* inbred and knockout strains, NOD and nude mice.
9. *Zea mays* to demonstrate cytological proof of crossing over.
10. *Arabidopsis* to study flower development.

REFERENCES:

1. Microbiology –Prescott LM, Harley JP. & Klein DA, McGraw-Hill
2. Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley
3. Modern Genetic Analysis Anthony JF Griffiths, William M Gilbert, Jeffrey H Miller, and Richard C Lewontin. Pub. W. H. Freeman;

COURSE OUTCOMES:

At the end of the course students will be able to

BI203.CO1 interpret the chemical basis of heredity and the importance of mutations.
BI203.CO2 demonstrate the concept of linkage and mapping genes by pedigree analysis.
BI203.CO3 predict bacterial gene mapping to different gene transfer mechanisms.
BI203.CO4 relate the biological processes of a model organism to higher organisms.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: BIOSTATISTICS AND CLINICAL BIOCHEMISTRY

PAPER CODE:BI204T **PPW:4**
YEAR/SEMESTER: I/II **NO OF CREDITS:4**

COURSE OBJECTIVE: To explain the concepts of biostatistics and the methods of diagnosis of biochemical defects.

UNIT-WISE COURSE OBJECTIVES:

COb1 To discuss the appropriate statistical method for data analysis.
COb2 To select suitable specimen for clinical tests.
COb3 To describe the biochemical basis for disease.
COb4 To discuss relevant methods of molecular diagnosis for genetic defects.

UNIT - I: Biostatistics-I

1. Biostatistics fundamentals (sample, population, variable); Types of variables, Measurement and measurement scales.
2. Measures of central tendency (mean, median, mode).
3. Measurement of dispersion (range, variance, standard distribution).
4. Study of bivariate data: correlation and regression.
5. Graphical methods to depict data (histograms, bar-plots, pie charts, line graphs).
6. Probability and probability distribution (Normal, Binomial, Poisson).
7. Student's t – test.
8. Chi – square test; Contingency tests.
9. CRD: Completely Randomized Design; 1-way ANOVA.
10. RCBD: Randomized Complete Block Design; 2-way ANOVA.

UNIT-II: Introduction to Clinical Biochemistry

1. Precision, reliability, reproducibility and other factors in quality control.
2. Normal values in health and diseases.
3. Radio isotopes in diagnosis.
4. Specimen collection. Automation and QA in clinical laboratories.
5. Examination of Urine, Blood, Sputum & CSF.
6. Storage of specimens.
7. Clinical laboratory informatics.
8. Renal function tests osmolarity and free water clearances, acute and chronic renal failure.
9. Liver function tests.
10. Gastric function tests and pancreatic function tests.

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UNIT III: Pathophysiology

1. Free radical metabolism, ROS in disease.
2. Plasma proteins in health and disease.
3. Para proteinemias, proteinuria.
4. Hyper lipoproteinemias and lipidemias.
5. Clinical application of plasma enzyme assays in cardiac, liver and skeletal diseases.
6. Jaundice- classification and differential diagnosis.
7. Nutritional assessment therapy and monitoring.
8. Cholesterol, sodium and blood pressure.
9. Eating disorders: anorexia and bulimia.
10. Physiological interrelationship between cardiovascular, respiratory and renal systems.

UNIT IV: Molecular diagnosis of genetic defects

1. Pregnancy test, prenatal diagnosis & genetic counseling.
2. Diagnosis of anemia, thalassemia.
3. Diagnosis of genetic diseases by molecular biology techniques (cystic fibrosis, hemochromatosis, thalassemias, sickle cell diseases).
4. DNA probes; restriction fragment length polymorphism (RFLP); polymerase chain reaction (PCR).
5. Amplification of mRNA.
6. AIDS, Clinical diagnosis.
7. Oncogenic enzymology: acid phosphatase, alkaline phosphatase, lactate dehydrogenase.
8. Body fluid constituents of use in oncology.
9. Newborn screening: PKU, tyrosinemia, aminoacidurias, organic acidurias, porphyrias.
10. Acetylcholinesterase and other tests on amniotic fluid; chromosomal abnormalities by cytogenetics.

REFERENCES:

1. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India.
2.Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R.Ashwood. W.B.Saunders Company, 2nd edition.

COURSE OUTCOMES:

At the end of the course the students will be able to:

BI204.CO1 use and interpret results of statistical analysis.
BI204.CO2 categorize and examine samples for normal and abnormal values.
BI204.CO3 analyze the underlying biochemical defect in various disease conditions.
BI204.CO4 appreciate the role and importance of molecular diagnostics.

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DEPARTMENT OF BIOCHEMISTRY

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

PRACTICAL SYLLABUS

COURSE NAME: ENZYMOLOGY AND BIOCHEMICAL PREPARATIONS

PAPER CODE:BI251P **PPW:8**
YEAR/SEMESTER: I/II **NO OF CREDITS:4**

COURSE OBJECTIVES:

COb1 To demonstrate the methods of isolation and characterization of proteins
COb2 To describe various isolation procedures of carbohydrates and lipids.
COb3 To explain various enzyme assays.
COb4 To demonstrate various factors affecting enzyme activity.

1. N-terminal residue of proteins.
2. Isolate casein from milk.
3. Isolate albumin from egg.
4. Fractionate BSA by salt precipitation.
5. Isolate starch from Potato.
6. Isolate cellulose from plants.
7. Isolate cholesterol from egg yolk.
8. Qualitative test for amylase activity.
9. Assay of α amylase (saliva).
10. Assay of urease (horse gram / any source).
11. Assay of β amylase (sweet potato).
12. Assay of catalase (liver / any source).
13. Assay of alkaline phosphatase.
14. Assay of Invertase.
15. Purify the enzyme; calculate yield, total activity and specific activity at each stage.

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16. Time course and enzyme concentration (salivary amylase).
17. Effect of pH on enzyme activity.
18. Effect of temperature on enzyme activity.
19. Effect of [S], determine K_m and V_{max}.
20. Competitive inhibition

COURSE OUTCOMES:

At the end of the course students will be able to:

BI251P.CO1 choose appropriate methods for isolation of proteins from biological samples and apply knowledge in research/industries.

BI251P.CO2 distinguish the different isolation procedures for carbohydrates and lipids.

BI251P.CO3 select suitable assay method for specific enzyme in biological sample.

BI251P.CO4 determine optimal conditions and various factors influencing the enzyme activity and apply in research/ industry.

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Department of Biochemistry

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2019-20)

COURSE NAME: MOLECULAR BIOLOGY, GENETICS AND CLINICAL BIOCHEMISTRY

PAPER CODE:BI252P **PPW:8**
YEAR/SEMESTER: I/II **NO OF CREDITS:4**

COURSE OBJECTIVES

COb1 To explain the qualitative and quantitative methods for analysis of nucleic acids.
COb2 To explain the inheritance of traits using monohybrid and dihybrid crosses.
COb3 To demonstrate the methods for quantitative analysis ofbloodand urine constituents.
COb4 To discuss various assays for diagnostic enzymes.

1. Absorption spectrum, molar extinction coefficient of purine/pyrimidine.
2. Separation of purines and pyrimidines by paper chromatography.
3. Isolate DNA (onion/thymus/other source), absorption spectrum to assess purity (A_{260}/A_{280} ratio).
4. Prepare RNA (yeast/other source).
5. Estimate DNA by DPA method.
6. Estimate RNA by Orcinol Method.
7. Agarose gel for RNA, DNA, blot the gel.
8. Problems in monohybrid crosses.
9. Problems in dihybrid crosses.
10. Qualitative analysis of normal and abnormal constituents in urine.
11. Determine PCV, ESR, differential count.
12. Determine osmotic fragility of RBC.
13. Determine urinary glucose, creatinine.
14. Determine blood hemoglobin and glycosylated hemoglobin.
15. Determine blood urea.
16. Determine blood glucose (POD-GOD method, enzymatic method).

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17. Determine A: G ratio.
18. Assay serum alkaline phosphatase.
19. Assay of serum transaminases.
20. Serum lipid profile.

COURSE OUTCOMES:

At the end of the course students will be able to:

BI252P.CO1 identify and analyse nucleic acids qualitatively and quantitatively in molecular biology/ biotech labs or industry.
BI252P.CO2 solve problems on monohybrid and dihybrid crosses to understand the inheritance of traits in plant breeding.
BI252P.CO3 utilize the quantitative methods of blood and urine analysis in diagnostic labs and correlate the results of biochemical investigations with the general health profile.
BI252P.CO4 interpret the diagnostic results of serum enzyme assays with health and disease.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

		SEMESTER III						
PAPERS	Code	TITLE	Course Type	Teaching hrs/week	Credits	Internal marks	Final exam marks	Total
Theory								
1	BI 301T	Gene Regulation and Genetic Engineering	DSC	4	4	30	70	100
2	B1 302T	Immunology and Immunotechnology	DSC	4	4	30	70	100
3	BI 303 A/ BI303B	Cell Signaling, differentiation and Protein targeting/ Cell Signaling, differentiation and Methods of cell study	DSE	4	4	30	70	100
4	BI 304T	Microbiology	DSE	2	2	15	35	50
5	BI305	MOOCS course in allied subjects		2	2		50	50
Practicals								
6	BI 351P	Recombinant DNA and Immunotechnology		6	3	--	75	75
7	BI 352P	Cell biology and Microbiology		6	3	--	75	75
8	BI353P	Project Course work		4	2		50	50
	Total			**32**	**24**	**105**	**495**	**600**
		SEMESTER IV						
PAPERS		TITLE		Teaching hrs/week	Credits	Internal marks	Final exam marks	Total
Theory								
1	BI 401T	Physiology and Xenobiotics	DSC	4	4	30	70	100
2	BI 402T	Bioinformatics	DSC	4	4	30	70	100
3	BI 403T	Biotechnology	DSE	4	4	30	70	100
4	BI 404T	Endocrinology and metabolic disorders	DSE	4	4	30	70	100
Practicals								
5	BI451P	Bioinformatics and Endocrinology		8	4	--	100	100
6	BI452P	Project		8	4	--	100	100
	Total			**32**	**24**	**120**	**480**	**600**
	Grand Total			**128**	**96**	**465**	**1935**	**2400**

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: GENE REGULATION AND GENETIC ENGINEERING

PAPER CODE: BI301T **PPW : 4**
YEAR/SEMESTER: II/III **NO.OFCREDITS: 4**

COURSE OBJECTIVE: To familiarize the students with gene regulation in prokaryotes and eukaryotes and also to learn various tools and techniques involved in recombinant DNA technology.

UNIT-WISE COURSE OBJECTIVES

COb1 To explain operon concept and various regulatory mechanisms of gene expression in prokaryotes.
COb2 To discuss structural features of chromatin and transcriptional control of eukaryotic genes and mechanisms of gene silencing.
COb3 To discuss about various tools and techniques of recombinant DNA technology.
COb4 To outline the concepts of heterologous protein expression in different host systems.

Unit – I: Gene Regulation in Prokaryotes and Viruses

1. Operon concept for gene regulation
2. Positive (+ve) &Negative (-ve) control – Lac operon
3. Attenuation – Trp operon
4. Dual promoters – gal operon: Dual function of repressor – ara operon
5. Phase variation in *Salmonella* flagellar protein synthesis
6. Sporulation gene expression in *Bacillus*
7. Riboswitch
8. Anti – termination in lambda phage
9. Lytic / lysogenic switch in lambda phage
10. Control of plasmid copy number

Unit – II: Gene Regulation in Eukaryotes

1. Chromatin structure in active and inactive regions – DNA methylation.
2. Eu-chromatin, histone acetylation, H2AX foci, histone code
3. Transcriptional control – cell specific expression – promoters, enhancers, Transcription factors
4. Post- transcriptional control – alternative splicing, RNA editing.
5. RNA transport and stability.
6. Translational feedback.
7. Gene silencing – inactivation of mammalian X chromosome.
8. Regulation by siRNA
9. Gal operon of yeast.
10. MAT locus and mating type switch in yeast, Antigenic variation in *Trypanosoma*

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Unit – III: Recombinant DNA Technology

1. Enzymes in rDNA technology: Restriction endonucleases (discovery, properties)
2. Enzymes in rDNA technology: DNA and RNA polymerases
3. Enzymes in rDNA technology: Nucleases, Kinases. Phosphatases, and Ligases
4. Prokaryotic vectors (plasmids, cosmids, phage, phagemid, BAC)
5. Eukaryotic vector-YAC and Expression vectors (insect, plant, mammalian cells)
6. Shuttle vectors, Targeting vectors
7. Construction of cDNA and genomic DNA libraries
8. Screening a library (+ve) & (-ve) selection strategies, Preparation of probes
9. Southern blotting, Northern blotting, South-Western blotting.
10. Creating KO cells, Cre – Lox systems.

Unit – IV: Genetic Engineering

1. Yeast 2 hybrid.
2. Phage display.
3. Reporter genes – GFP, b – gal, luciferase.
4. Expression in heterologous systems – bacteria.
5. Expression in heterologous system – yeast cells.
6. Expression in heterologous system – insect cells.
7. Expression in heterologous system – mammalian cells.
8. Molecular markers – RFLP, AFLP.
9. Random amplification of polymorphic DNA (RAPD), Short tandem repeat.
10. Single-nucleotide polymorphism (SNP), Ribotyping.

References:

1. Genes VIII, Lewin, B, Publish Oxford University Press
2. Principles of Gene Manipulation: An introduction to GE – Old, R. and Primrose, S.B. Blackwell Sci. Pub
3. Molecular Biotechnology Glick, BR and Pasternak, JJ. Publish ASM Press
4. Molecular Biology of the Gene by Watson JD, Losick R. Pub Pearson Education

COURSE OUTCOMES:

At the end of the course students will be able to:

BI301.CO1 illustrate various regulatory strategies employed in prokaryotic systems.
BI301.CO2 compare various concepts of eukaryotic gene regulation.
BI301.CO3 apply the knowledge to construct genomic libraries and screening methods in biotech projects and companies.
BI301.CO4 apply genetic engineering methods in expression of heterologous proteins and in genetic profiling.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: IMMUNOLOGY AND IMMUNOTECHNOLOGY

PAPER CODE :BI302T **PPW : 4**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To provide a basic understanding of the components and mechanism of immune system and the techniques for production of antibodies and vaccines.

UNIT-WISE COURSE OBJECTIVES

COb1 To identify the structural features and functions of various components of the immune system.
COb2 To discuss the mechanisms involved in immune response.
COb3 To explain the basis of autoimmunity and the therapeutic methods against autoimmunity.
COb4 To discuss the various immunological techniques and vaccine development methods.

Unit – I: Components of the Immune System

1. History of immunology
2. Natural & acquired immunity, Specific & non-specific immune response.
3. Cells & organs of immune system
4. Antigenic determinants, Epitopes, Haptens, Properties of strong antigens
5. Adjuvants – types, mode of action, and applications.
6. Classification, structure, and biological properties of immunoglobulins
7. Isotypes, allotype, idiotypes.
8. Theories of antibody formation, Generation of antibody diversity
9. Genomic rearrangements of light and heavy – chain loci in B-cells
10. Genomic rearrangements in T-cell receptor, structure of CD3, CD4, CD8

Unit – II: Events in Immune Response

1. Humoral & cell-mediated immune response
2. Activation of T cells & B cells
3. Kinetics and regulation of primary and secondary immune response
4. MHC proteins structure & functions
5. Antigen processing & presentation
6. Transplantation immunology; Graft Versus Host Disease
7. Complement fixation: pathways and biological consequences
8. Discovery and action of Interferons
9. Cytokines; Inflammation; Role in obesity, cancer
10. Tumor immunology

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Unit – III: Immune Disorders

1. Hypersensitivity; Coombs classification
2. Type I-IV hypersensitivity
3. Tests for diagnosis of hypersensitivity (Coombs), Tuberculin test
4. Auto immune diseases; classification
5. Study of selected auto – immune disorders of types I – V
6. Immuno- deficiency disorders – primary and secondary deficiencies
7. Gene therapy for ADA deficiency
8. Immunology of AIDS
9. Immunosuppressive drugs/agents & their mechanism of action
10. Immune evasion by bacteria and viruses

Unit – IV: Immunotechnology

1. Production of polyclonal antibodies; Animals models for production of antibodies
2. Methods of antibody purification: Salt precipitation, Affinity chromatography
3. Antigen-antibody binding (Equilibrium dialysis, Surface Plasmon Resonance); Affinity, Avidity
4. Immunoprecipitation methods - gel diffusion (Ouchterlony; Mancini); Immune-electrophoresis (Rocket, counter-, 2-D)
5. Agglutination tests (Direct and indirect), Inhibition of Agglutination, Complement fixation test, Inhibition of complement fixation
6. ELISA, RIA Western Blots; use of antibody staining for FACS
7. Hybridoma technology – production of monoclonal antibodies; applications in research and immunotherapy; antibody engineering
8. History and types of Vaccines; Conventional vaccines - killed, attenuated, and subunit vaccines
9. Modern vaccines; peptide, DNA, recombinant / vector, and anti-idiotypic vaccines
10. Schedules of common vaccination, Benefits and adverse consequences of vaccination.

References:

1. Kuby Immunology – Edited Thomas J. Kindt, Richard A Goldsby, Publisher WH Freeman & Co
2. Roitt's Essential Immunology, Tenth Edition, Ivan Roitt, Peter Delves
3. Veterinary Immunology: Ian R. Tizard, I.R. Thomson press
4. The Immune System. By Peter Parham Publisher Garland publishing

COURSE OUTCOMES:

At the end of the course students will be able to:

BI302.CO1 identify the components of immune system
BI302.CO2 interpret cellular processes involved in transplantation and tumor formation.
BI302.CO3 interpret the causes of hypersensitive reaction and response to immunosuppressive drugs.
BI302.CO4 apply the principles of antigen-antibody interactions in immunological methods including diagnostics and also provides awareness on significance of vaccination.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: (Elective-1): CELL SIGNALING, DIFFERENTIATION AND PROTEIN TARGETING

PAPER CODE : BI303A **PPW : 4**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To explain the structural organisation of cells, cell differentiation, protein targeting and signalling events in normal and cancer cells.

UNIT-WISE COURSE OBJECTIVES

COb1 To discuss the structural organization and differentiation of cells.
COb2 To classify the types of signalling molecules in cell-cell communication.
COb3 To discuss the molecular mechanisms underlying carcinogenesis.
COb4 To explain the targeting of proteins and their degradation.

UNIT-I: Cell and Differentiation-I

1. Structural organization of prokaryotic & eukaryotic cells (Plant/animal cells)
2. Ultra structure of mitochondria, chloroplast, nucleus. ER. Golgi etc).
3. Extracellular matrix-collagen, elastin, figrillin, fibronectin, laminin & proteoglycans. Integrins.
4. Cell junctions
5. Cell adhesions.
6. Cytoskeleton-microtubules, microfilaments and myosin.
7. Growth factors – EGF, PDGF, VEGF, IGF
8. General strategies of cell cycle.
9. Early embryonic cell cycle & M-phase maturation factor & cyclins.
10. Regulation of cell cycle in multicellular organisms

UNIT-II: Cell Signalling & Transduction

1. Cell communication and types of signalling molecules.
2. Types of receptors and their structure.
3. Monomeric and trimeric G-proteins and their role.
4. Second messengers – cAMP, cGMP,
5. Ca^{+2}, calmodulin, inositol, NO.
6. Receptors tyrosine kinases (Insulin signalling)
7. MAPK pathway, role in signaling
8. Plants hormones and their mechanism of action
9. Stress signaling in plants (biotic)
10. Stress signaling in plants (abiotic)

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UNIT- III: Gene Regulation & Carcinogenesis

1. Oncogenesis with reference to proto-oncogenes.
2. Oncogene families and molecular mechanisms of oncogenes
3. Protein kinases (src, erbB, fms),
4. GTP binding proteins (H-Ras. k-Ras)
5. Growth factors (sis), transcription factors (Fos, Jun. AP. 1. Verb A & thyroid hormone receptor).
6. Discovery of tumor suppressor genes
7. RB and retinoblastoma, APC and colon cancer.
8. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN)
9. p53/Bcl2 and cancer risk
10. c-Myc and leukemia

Unit – IV: Protein Sorting, Targeting and degradation

1. Signal peptide (ERLS), role of SRP in translocation of secreted proteins.
2. Protein transport from golgi to lysosomes.
3. Lysosomal pathways (endocytosis, crinophagy, macroautophagy, microautophagy, direct translocation from cytosol)
4. Protein targeting to Mitochondria.
5. Protein targeting to chloroplast.
6. Protein targeting to nucleus.
7. Ubiquitin-proteasome pathway,
8. N-end rule, PEST sequences and proteolysis
9. Chaperones, HSPs in protein folding
10. Immuno-proteasomes, Misfolded proteins in neurodegenerative diseases

References:

1. The Biochemistry of Cell Signalling, Helmreich JM, Oxford Press
2. Cell signalling – John T Hancock, Oxford University press
3. Cell biology. Second edition: Edited by C A Smith and E J Wood. Chapman & Hall publ
4. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman

COURSE OUTCOMES:

At the end of the course students will be able to:

BI303A.CO1 illustrate the structural organisation of cell and differentiation of cell types.
BI303A.CO2 explain the different cellular signalling pathways.
BI303A.CO3 analyse the various pathways for carcinogenesis.
BI303A.CO4 correlate the different types of protein targeting.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME(Elective-2): CELL SIGNALING, DIFFERENTIATION AND METHODS OF CELL STUDY

PAPER CODE : BI303B **PPW : 4**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 4**

COURSE OBJECTIVE: The objective of this course isto explain the structural organisation of cells, the methods of cell study and molecules of cell signalling.

UNIT-WISE COURSE OBJECTIVES

COb1 To discuss the structural organization of cells.
COb2 To explain the principles and working of various analytical tools to study cell structure and function.
COb3 To understand the types of signalling molecules in cell-cell communication.
COb4 To explain the process of cell differentiation and apoptosis.

UNIT I- Ultra structure of Cell

1. Structural organization of prokaryotic cells
2. Structural organization of eukaryotic cells (Plant/animal cells)
3. Ultrastructure of mitochondria, chloroplast, nucleus. ER. Golgi etc
4. Extracellular matrix-collagen, elastin, figrillin, fibronectin, laminin & proteoglycans. Integrins.
5. Cell junctions
6. Cell adhesions.
7. Cytoskeleton-microtubules, microfilaments and myosin.
8. Totipotency.
9. General strategies of cell cycle and its regulation
10. Early embryonic cell cycle & M-phase maturation factor

Unit – II: Methods of Cell Study

1. Simple and compound microscope.
2. Phase contrast, dark field and polarization microscopy.
3. Electron microscopy, SEM, TEM; freeze fracture.
4. Fluorescence and Confocal microscopy; imaging live cells.
5. FRET and FRAP.
6. Atomic force microscopy.
7. Flow-Cytometry and cell sorting (FACS).
8. Plant tissue culture.
9. Animal and insect tissue culture.
10. Methods of cell disruption and fractionation, isolation of organelles.

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Unit III: Cell Signalling

1. Cell communication and types of signaling molecules.
2. Types of receptors and their structure.
3. Monomeric and trimeric G-proteins and their role.
4. Second messengers – cAMP, cGMP, Ca^{+2}, calmodulin, inositol, NO
5. Introduction of signaling components in bacteria
6. Chemotaxis
7. Plant signaling system an over view
8. Stress signaling in plants (biotic)
9. Stress signaling in plants (abiotic)
10. Plants hormones and their mechanism of action

Unit IV: Cell & Differentiation

1. Overview of developmental regulation.
2. Platelet derived growth factor (PDGF); Epidermal growth factor (EGF).
3. Insulin like growth factor (IGF).
4. Nerve growth factor, Vascular endothelial growth factor (VEGF).
5. Tumor necrosis factor (TNF) & erythropoietin.
6. Fibroblast & muscle cell differentiation.
7. Formation of body pattern in Drosophila.
8. Apoptosis and apoptosome.
9. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN)
10. p53 and c-Myc

References:

1. The Biochemistry of Cell Signaling, Helmreich JM, Oxford Press
2. Cell signaling – John T Hancock, Oxford University press
3. Cell biology. Second edition: Edited by C A Smith and E J Wood. Chapman & Hall publ
4. Molecular Cell Biology, 4th edition. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman

COURSE OUTCOMES:

At the end of the course students will be able to:

BI303B.CO1 interpret the structural organisation of different cell types.
BI303B.CO2 identify suitable methods to study cells.
BI303B.CO3 interpret the different cellular signalling pathways.
BI303B.CO4 correlate the role of growth factors in cell differentiation.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME(ELECTIVE): MICROBIOLOGY

PAPER CODE : BI304T **PPW : 2**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 2**

COURSE OBJECTIVE: This course gives an overview of the fundamentals related to bacterial and viral growth, culture methods, their classification, purification and life cycles.

UNIT-WISE COURSE OBJECTIVES

COb1 To outline the classification, isolation and preservation of bacterial cultures.
COb2 To discuss the characteristics, assay methods, purification methods, cultivation and life cycles of viruses.

Unit – I: Fundamental Microbiology

1. Classification of bacteria, morphological types, distribution in nature.
2. Isolation methods: Pure culture techniques & enriched cultures.
3. Motility of bacteria, bacterial films, isolation of bacteria from natural sources.
4. Staining methods (Gram's staining acid-fast & spore staining).
5. Sterilization methods: Autoclaving, dry heat, filtration; Chemical disinfectants, and irradiation by gamma rays.
6. Growth Media: Supplemented media, Selective media & minimal salts media. Maintenance and preservation of microbial cultures
7. Batch and continuous growth of bacteria, Chemostat & synchronous cultures.
8. Bacterial Growth: Growth curve doubling time. Factors affecting growth (pH, temperature, oxygen & agitation)
9. Bacteria of industrial importance, development of commercially valuable strains
10. Discovery of antibiotics, mode of action of various classes of antibiotics, antibiotic resistance

Unit – II: Viruses

1.Discovery, classification and general characteristics of plant and animal viruses
2.Structure of viruses, viroids, virusoids &prions
3.Structure & composition of TMV, Cauliflower mosaic virus.
4.One-step growth, single burst & eclipse experiments.
5.General features of host-virus interactions- permissive and non-permissive hosts.
6.Lytic verses lysogenic life cycles of λ Phage.
7.Assay methods (Plaque assay, Pock assay, heme agglutination assay, transformation assay)
8.Purification methods (ultrafiltration, ultracentrifugation & affinity methods).

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9.Cultivation of viruses in animals & tissue culture.
10. Life cycles of animal viruses (Poliovirus, Retroviruses (RSV/ HIV).

References:

1.Microbiology- Prescott. L. M., HARLEY.JP & Klein. D A, McGraw –Hill.
2. Microbiology: An Introduction –Tortora, G. J. Funke, B.R. and Case, C.L., Pearson-Benjamin-Cummings Co.
3. Microbiology- Pelczar Jr., M.J., Chan ECS and Krieg .NR., Tata McGraw-Hill.
4. Principles of Virology, (Vol I & II) Flint SJ, Enquist LW, Racaniello VR, Skalka AM Pub ASN Press

COURSE OUTCOMES:

At the end of the course students will be able to:

BI304.CO1 categorize the bacteria and identify appropriate bacterial culturing methods.
BI304.CO2 categorize the viruses and identify suitable purification and assay methods for isolation of viruses.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: RECOMBINANT DNA AND IMMUNOTECHNOLOGY

PAPER CODE: BI 351P **PPW : 6**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 3**

COURSE OBJECTIVES

COb1 To demonstrate various recombinant DNA techniques.
COb2 To describe the steps involved in isolation, purification and characterization of IgG.
COb3 To demonstrate various methods of antigen-antibody interaction.

1. Isolation of plasmid DNA
2. Restriction mapping of DNA (experiment and problems)
3. Preparation of competent cells
4. Transformation of competent cells
5. PCR
6. Gene cloning (demonstration)
7. RFLP (experiment and problems)
8. Isolate IgG from serum (human/bovine)
9. Purify IgG by affinity chromatography
10. SDS PAGE of IgG fractions.
11. Characterize IgG by specific antibody (Western blot)
12. Agglutination: ABO and D Ag typing
13. RID
14. ODD
15. Rocket Immunoelectrophoresis
16. ELISA, sandwich ELISA

Course Outcomes
At the end of the course the student will be able:

BI 351P.CO1 apply the recombinant DNA tools for gene expression studies in research/biotech labs.
BI 351P.CO2 make use of the purified IgG in various immunological applications in research/ industry.
BI 351P.CO3 choose suitable immunodiffusion methods to study antigen antibody interactions.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: CELL BIOLOGY AND MICROBIOLOGY

PAPER CODE: BI352P **PPW : 6**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 3**

COURSE OBJECTIVES

COb1 To explain the methods for isolation and identification of subcellular organelles.
COb2 To demonstrate the methods for culturing and isolation of bacteria.
COb3 To explain characteristics of bacteria using various procedures.

1. Cell fractionation by differential centrifugation.
2. Identification of nuclear fraction by DNA estimation.
3. Determination of marker enzymes of mitochondria.
4. Determination of marker enzymes of cytoplasm.
5. Study of cell viability /death assay by use of trypan blue and MTT assay.
6. Preparation of culture media: Solid/Liquid.
7. Sterilization techniques: Autoclave, Hot air oven and filtration.
8. Isolation of bacteria by pure cultures methods- serial dilution, streak, spread and pour plate techniques.
9. Preservation of microbial cultures- Slant, Stab, mineral oil overlay and glycerol stocks.
10. Simple and differential staining (Gram staining), Spore staining, capsule staining and flagellar staining.
11. Microscopic observation of bacteria (Gram positive bacilli and cocci, Gram negative bacilli), cyanobacteria (Nostoc, Spirulina), fungi (Saccharomyces, Rhizopus, Aspergillus, Penicillium)
12. Bacterial motility: hanging drop method.
13. Determination of viable count of bacteria.
14. Turbidometric measurement of bacterial growth curve.
15. Antibiotic sensitivity test by Paper disc method.

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Course Outcomes

At the end of the course the student will be able to:

BI352P.CO1 utilise cell fractionation methods to isolate specific organelles for further studies in research.

BI352P.CO2 employ the methods of isolation and identification of bacteria from various sources in biotech lab/ industry or in research.

BI352P.CO3 identify and characterize the bacteria, isolated from various samples.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: PROJECT COURSE WORK

PAPER CODE: BI353P **PPW : 4**
YEAR/SEMESTER: II/III **NO.OF CREDITS: 2**

COURSE OBJECTIVES

COb1 To explain the retrieval of research articles from literature databases.
COb2 To demonstrate the use of MS office tools to prepare various types of scientific documents.

1. Students will be asked their choice for Project work at the beginning of III semester and topic and mentor selection will be completed.
2. Number of students who will be offered project work will vary batch to batch depending upon the infrastructural facilities and may vary each year (Not exceeding 4 students per group).
3. Exploring various websites and search engines for collecting quality literature related to project work.
4. Practical knowledge of MS Word to type script, insert tables, figures and graphs to prepare project thesis.
5. Practical knowledge of MS Excel to construct spread sheets from the experimental data, preparation of graphs, histograms, charts and diagrams.
6. Practical knowledge of MS power point to prepare presentation of research topic and scientific posters.
7. Preparing different kinds of scientific documents-research paper, review paper and project reports.
8. Writing a review of literature related to the chosen research problem followed by presentation of data.
9. Awareness on research ethics and plagiarism.

COURSE OUTCOME

At the end of the course students will be able to

BI353P.CO1 analyse and interpret the literature data for preparing project reports, scientific documents and for project proposals.

BI353P.CO2 implement the MS office tools to prepare scientific presentations, documents and project reports.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: PHYSIOLOGY AND XENOBIOTICS

PAPER CODE: BI401T	**PPW :4**
YEAR/SEMESTER: II/IV	**NO.OF CREDITS :4**

COURSE OBJECTIVE: To provide basic understanding of nerve, muscle and reproductive physiology in humans and the process of drug detoxification by liver in humans.

UNIT-WISE COURSE OBJECTIVES

COb1 To outline the physiology of neurotransmission
COb2 To explain the physiology of muscle contraction.
COb3 To discuss reproductive biology in humans
COb4 To explain the functions of liver in drug detoxification process.

Unit–I: Neurophysiology

1. Types of neuronal cells – Neuroglia, microglia, astrocytes, oligo dendrocytes, Schwann, satellite and epididymal cells
2. Nerves: regeneration of nerve fibers, generation of nerve impulse, all or none principle.
3. Mechanism of synaptic transmission, transmission of nerve impulse.
4. Types of neurotransmitters and their receptors, mode of signaling
5. Electrical synapse and giant neurons
6. Division of vertebrate nervous system: CNS, PNS, ANS, regions of the brain
7. Sensory organs – eye, ear, skin, tongue
8. Vision: visual system, rhodopsin and classical GPCR mechanism, termination of visual signal
9. Cone cells, specialization in color vision, physiology of colour blindness
10. Similarity between vision, olfaction and gustation

Unit–II: Structure and Physiology of Muscle

1. Structure of various types of muscle: striated, cardiac, smooth, fast twitch, slow twitch
2. Mechanism of muscle contraction, regulation of contraction
3. Role of actin and myosin in non-muscle cells.
4. Cytochalasins and cytokinesis.
5. Muscle gene expression, regulation at transcriptional and posttranscriptional level.
6. Role of muscle proteins in cell locomotion
7. Neuro-muscular transmission

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8. Electromyography, Sherrington starling Kymograph (recording drum)
9. Disorders of muscle (dystrophy, myopathy, monocytisis, myotonia, paralysis, Myasthenia gravis)
10. Detection and treatment of muscle disorders

Unit – III: Human Reproductive Biology

1. Female reproductive system: anatomy and endocrinology
2. Causes of female infertility (acquired and genetic), treatments
3. Male reproductive system: anatomy and endocrinology
4. Causes of male infertility (environmental and genetic), treatments
5. Puberty, reproductive aging (menopause and andropause)
6. Gametogenesis and fertilization (natural and assisted (*in vitro*)),
7. Implantation and placenta
8. Endocrinology of pregnancy, parturition and lactation
9. Methods of Birth control
10. Placenta as source of stem cells, cord banking

Unit – IV: Liver and Xenobiotics

1. Liver functions, pharmacopeia drug deposition and mechanisms of drug detoxification
2. Cytochrome P450 enzymes, molecular biology, catalytic cycle, isozymes, inhibitors
3. Dose response relationship, drug-receptors interactions
4. Pharmacodynamics; pharmacokinetics
5. Phase I reactions - modifications
6. Phase II reactions - conjugation
7. Phase III reactions - modifications and elimination,
8. Environmental factors influencing drug metabolism
9. Effects and metabolism of model toxins: aflatoxins, bacterial exotoxins (types I, II, and III)
10. Nutrient drug interactions – I and II

References:

1. Human Physiology by Guyton and Hall Press Pub Saunders
2. Biochemistry, 4th Edition - Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
3. Human reproductive Biology by Jones and Lopez Pub
4. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, White A, McGraw Hill

COURSE OUTCOMES:

At the end of the course students will be able to:

BI401.CO1 apply the understanding of the physiological process of neurotransmission.
BI401.CO2 apply the knowledge of muscle physiology to muscle disorders.
BI401.CO3 correlate the knowledge of the human reproductive system to fertility and pregnancy.
BI401.CO4 apply the knowledge of liver detoxification to drug metabolism.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: BIOINFORMATICS

PAPER CODE: BI402T **PPW: 4**
YEAR/SEMESTER: II/IV **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To familiarize students with various tools of bioinformatics relevant to genomics, transcriptomics, proteomics and synthetic biology.

UNIT-WISE COURSE OBJECTIVES
COb1 To explain the tools used in the analysis of genome sequences.
COb2 To describe the methods of transcriptome analysis.
COb3 To discuss the methods of studying proteomes.
COb4 To explain the methods for metabolome analysis

Unit – I: Genomics

1. Genomics and branches of genomics (Why study a genome?)
2. HGP and Strategies for sequencing genomes (shotgun and hierarchical sequencing)
3. 1st generation sequencing methods (Maxam and Gilbert Method; Sanger's method)
4. 2nd and 3rd Generation DNA sequencing methods (Next Generation Sequencing)
5. Genetic and Physical maps of the genome, EST, STS
6. DNA sequence databases, Use of databases; data mining
7. Comparing DNA sequences, pairwise local and global alignment
8. BLAST, FASTA, PAM and BLOSUM matrices
9. Multiple sequence alignments (Phylogenetic trees, Clustal-W, COBALT)
10. Epigenomics and metagenomics

Unit – II: Transcriptomics

1. Relation of transcriptome to genome and proteome (Why study a transcriptome?)
2. Tools of transcriptomics: Northern blots, RNase protection assays, RT-PCR and Q-PCR
3. HT tools of transcriptomics: Microarrays for expression profiling, alternate sequencing
4. HT RNA sequencing: SAGE, MPSS, RNA-Seq, GIGA
5. Identifying expressed sequences by ChIP-seq, DNase-seq
6. ENCODE Project (Encyclopedia of DNA Elements)
7. Design and analysis of siRNA / RNAi for expression analysis; siRNA libraries
8. Anti–sense oligos for regulating transcriptome, Regulation by miRNA
9. Extent and role of ncRNA, GWAS association with phenotypes
10. Transcriptome databases (ESTs, Transcriptome Shotgun Assembly, Array Express)

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Unit – III: Proteomics

1. Relation of proteome to genome and transcriptome (Why study a proteome?)
2. HUPO goals and accomplishments
3. Methods for sequencing proteins: Edman degradation
4. 2D gels and peptide maps
5. MS – MALDI. LC-MS, Tandem MS (MS-MS)
6. Micro-arrays for proteins
7. Proteins motifs, sequences, and structure databases; Peptide sequence and MS profiles databases
8. Comparing protein sequences, alignment
9. Predicting secondary structure-*ab initio*, Homology folding, threading
10. Post-translational modification (kinome, glycosylation)

Unit – IV: Metabolomics

1. Introduction to Metabolomics
2. Sample preparation for metabolomic investigation
3. Tools for imaging and analysing metabolomics data
4. Analytical methods for metabolomics: NMR, LC, MS, High resolution MS, ICPMS and GC
5. Metabolite Profiling of Blood Plasma
6. Integrative Profiling of Metabolites, Biomarkers
7. Microfluidic and single cell analysis
8. Metabolome of plant and animal tissues, Microbial and Nutritional metabolomics
9. Metabolomics-Edited Transcriptomics Analysis (META), Metabolic flux and its analysis
10. Tracer based metabolomics in cancer (*in vitro/ in vivo*).

References:

1. Introduction to Bioinformatics- Attwood T K and Parry –Smith, D.J. Pearson Eduction
2. Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH
3. Discovering Genomics, Proteomics and Bioinformatics – Campell &Heyer, Benjamin / Cummings pub
4. Metabolomics in practice: Successful strategies to generate and analyse metabolic data by Michael Lammerhofer and Wolfram Weckwerth, WILEY-VCH
5. The hand book of metabolomics by Teresa Whei-Mei Fan, Andrew N. Lane, Richard M. Higashi, Springer protocols, Humana press
6. Metabolomics – Methods and protocols by Wolfram Weckwerth, Springer protocols, Humana press
7. Mass spectrometry based metabolomics – A practical guide by Sastia Prama Putri, Eiichiro Fukusaki, CRC Press

COURSE OUTCOMES:

At the end of the course students will be able to:

BI402.CO1 Apply the tools of genomics to compare different genome sequences.
BI402.CO2 Determine the appropriate methods for transcriptome analysis.
BI402.CO3 Apply the knowledge of proteomics methods for proteome analysis.
BI402.CO4 Apply the tools of metabolomics for analysis of metabolomes

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: BIOTECHNOLOGY

PAPER CODE: BI403T **PPW: 4**
YEAR/SEMESTER: II/IV **NO.OF CREDITS: 4**

COURSE OBJECTIVE: To describe various resources available in the production of biotechnological products for the welfare of human life.

UNIT-WISE COURSE OBJECTIVES:
COb1 To outline the protocols involved in production of small and large metabolites using microbes.
COb2 To explain strategies in genetic engineering of plants and its use as bioreactors.
COb3 To describe the tools and techniques in engineering animal cells for the production of biotechnological products
COb4 To understand the latest developments in the field of protein engineering and nanotechnology

Unit – I: Microbial Biotechnology

1. Large scale cultivation of microbes; Fermenter design and control of growth
2. Downstream processing, Production of biomass, single cell protein
3. Production of low molecular weight primary and secondary metabolites, Microbial insecticides
4. Production of enzymes for research (restriction enzymes)
5. Production of enzymes for industry (high fructose corn syrup, cheese, food processing)
6. Microbial Polysaccharides-Xanthan gum, Dextran, Pullulan, Mannan, Curdlan, Alginate
7. Microbial mining (heavy metal mining, mineral leaching, Sulfur cycle)
8. Microbial production of human insulin, human growth hormone
9. Microbial production of interferon, tissue plasminogen activator
10. Superbug and microbial degradation of oil (bioremediation)

Unit – II: Plant Biotechnology

1. Plant cell culture: calli, protoplast fusion, differentiation into plantlets
2. Plant vectors, Ti plasmids
3. GM plants, GM foods, IPR and farmers' rights in GM plants
4. Terminator technology
5. Anti sense RNA and DNA
6. Plantibodies (example dental caries)
7. Case studies (genes involved, commercial value, problems) of StarLink corn, Bt cotton
8. Case studies of Zeneca tomato paste, FlavrSavr tomato
9. Case studies of Golden rice, Herbicide resistant plants (Roundup Ready)
10. Virus resistant plants (papaya)

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Unit – III: Animal Biotechnology

1. Development, maintenance and growth of animal cell lines
2. Cloning of mammalian and non-mammalian species (Polly, Molly, and Dolly)
3. Production of viral vaccines
4. Production high value therapeutics, interferon
5. Plasminogen activator, urokinase
6. Monoclonal antibodies, chimeric antibodies
7. Immunotoxins as therapeutic agents
8. Gene knockouts and transgenic animals
9. Human gene therapy
10. "Humanized" animals as organ farms

Unit – IV: Protein Engineering and Nanotechnology

1. Methods and applications of immobilized cells & immobilized enzymes
2. Large-scale and site-directed mutagenesis, high throughput screening tools in protein engineering
3. Rational protein design and Directed enzyme evolution
4. Altering kinetic properties and pH dependence of enzymes
5. Increasing stability, enhancing specific activity of enzymes
6. Methods of drug design and delivery
7. Nanomaterials-Structure, properties. Types of nanomaterials
8. Chemical and green synthesis of nanomaterials
9. Nanobiotechnology and its applications.
10. Nanoencapsulation for medical applications; nanomedicine
11. Nanosensors and their applications.

References

1. Introduction to Biotechnology, William J. Thieman, Michael A. Palladino, Benjamin Cummings, Publications.
2. Biotechnology- Arora, Himalaya pub. House
3. Principles of Gene Manipulation, by R.W. Old, S.B. Primrose, Wiley-Blackwell Publications
4. Text book of Nanoscience and Nanotechnology by Murty B.S., Shankar, P., Raj, B., Rath, B.B and Murday, J. Springer
5. Text book of Nanoscience and Nanotechnology by T. Pradeep, McGraw Hill Education (India) Private Limited

COURSE OUTCOMES:

At the end of the course students will be able to:

BI403.CO1 Identify the various stages of downstream processing.
BI403.CO2 Apply genetic engineering methods to use plants as bioreactors.
BI403.CO3 Design protocols for the production of biotechnological products using animal systems.
BI403.CO4 Apply the knowledge of protein engineering and nanotechnology in development of novel proteins or drugs.

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Department of Biochemistry& Nutrition

PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: ENDOCRINOLOGY AND METABOLIC DISORDERS.

PAPER CODE : BI404T **PPW : 4**
YEAR/SEMESTER: II/IV **NO.OFCREDITS:4**

COURSE OBJECTIVE: To understand the physiology of endocrine systems and the basis of metabolic disorders.

UNIT-WISE COURSE OBJECTIVES

COb1 To outline the organization, chemistry, mechanism of action and physiological functions of endocrine system.
COb2 To discuss endocrine regulation of various physiological processes.
COb3 To describe the disorders of amino acid and carbohydrate metabolism.
COb4 To describe the disorders of lipid and nucleotide metabolism.

Unit – I: Hormones and Endocrine glands

1. History of endocrinology, Organization and classification of hormones and endocrine systems
2. Basic mechanism of action of peptide hormones and receptors
3. Basic mechanism of action of steroid hormones and receptors
4. Chemistry, physiology, and disorders related to Hypothalamus-Pituitary axis
5. Chemistry, physiology, and disorders related to thyroid and parathyroid glands
6. Glycoprotein hormones (LH, FSH, TSH, hCG, POMC)
7. Growth hormone family (GH, hCS, Prolactin)
8. Adrenal hormones
9. Gonadal hormones
10. Xenoestrogens and Phytoestrogens

Unit – II: Endocrine regulation

1. Regulatory pathways (positive, negative, feedback loops), Regulation of biosynthesis of steroid hormones by peptide hormones (LH, FSH, ACTH)
2. Endocrine regulation of growth
3. Endocrine regulation of stress
4. Endocrinology of Ca homeostasis
5. Endocrinology of blood sugar, hunger, digestion, and obesity
6. Endocrine regulation of renal function
7. Endocrine regulation of cardiovascular system (angiotensin, BNP, ET1)
8. Endocrinology of fertility (changes in menstruation, pregnancy, and menopause)
9. Medical uses of steroid hormones (contraception, HRT, hydrocortisone, anabolic steroids)
10. Erythropoietin, Adipo-cytokines, Orexins

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Unit – III: Disorders of Amino Acid and Carbohydrate Metabolism

1. Disorders of aromatic amino acid metabolism.
2. Disorders of proline and hydroxyproline metabolism.
3. Disorders of lysine metabolism.
4. Hemoglobinopathies; Thalassemia., porphyrias
5. Genetic defects in metabolism of amino acids (alkaptonuria, albinism, maple syrup urine disease, homocystinuria, methyl malonic acidemia).
6. Genetic defects in metabolism of urea (Argininemia, Arginosuccinicacidemia, Carbamoyl Phosphate Synthetase-I deficiency).
7. Disorders of glycogen storage.
8. Disorders of fructose and Galactose metabolism.
9. Pentosuria.
10. Diabetes.

Unit – IV: Disorders of Lipids and Nucleic Acids Metabolism

1. Disorders of acid Lipase deficiency
2. Farber's disease
3. Neiman-Pick's disease
4. Gaucher's disease
5. Krabbe's disease
6. Sulphatide- lipidosis disease
7. Fabry's disease
8. Down's and Turner's syndrome
9. Hyperuricemia and Gout
10. Hereditary Xanthinuria and Lesch- Nyhan syndrome

References:

` 1. Williams Textbook of Endocrinology –Larsen, R.P. Korenberg, H. N. Melmed, S. and Polensky, K. S. Saunders.
2. Human Physiology –Chatterjee. C.C, Medical Allied Agency
3. Principles of Biochemistry: Mammalian Biochemistry: Smith EL, Hill RL, White A, McGraw Hill
4. The metabolic basis of Inherited diseases (Vol I & II) Scriver C R. Valle D, Pub McGraw Hill

COURSE OUTCOMES:

At the end of the course students will be able to:

BI404.CO1 categorize the types of hormones and their physiology.
BI404.CO2 analyse the process of endocrine regulation.
BI404.CO3 interpret metabolic disorders associated with amino acid and carbohydrate metabolism.
BI404.CO4 interpret metabolic disorders associated with lipid and nucleotide metabolism.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: BIOINFORMATICS & ENDOCRINOLOGY

PAPER CODE : BI451P **PPW : 8**
YEAR/SEMESTER: II/IV **NO.OF CREDITS: 4**

Course Objectives

COb1 To explain the use of databases for identifying human genetic disorders and metabolic pathways
COb2 To demonstrate the methods for retrieving protein and nucleic acid sequences from databases.
COb3 To outline the tools for *in silico* analysis of nucleotide sequences.
COb4 To demonstrate the methods to quantitate hormone levels in serum samples.

1. OMIM database and human genetic disorders
2. Retrieve DNA sequence and protein sequence from database (NCBI)
3. KEGG database for pathways
4. Local and Global alignment of DNA, protein
5. Multiple sequence alignments
6. Primer design for PCR, *insilico*PCR
7. *In silico* restriction mapping.
8. *In silico* translation.
9. T3, T4, TSH Tests.
10. Estimation of HCG
11. Estimation of FSH
12. Estimation LH
13. Pregnancy Test (strip method)
14. Analysis of nanomaterials by spectrophotometry
15. Human metabolome databases

COURSE OUTCOMES

At the end of the course students will be able to

BI451P.CO1 identify inheritance pattern in genetic disorders and compare the metabolic pathways in a cell/organism for further research analysis.
BI451P. CO2 analyse the similarities between sequences from different species using sequence alignment tools for phylogenetic tree construction
BI451P.CO3 identify suitable primers for amplification and restriction digestion sites for analysis of genes in research labs/ biotech company
BI451P.CO4 employ appropriate hormone assays to diagnose endocrine disorders in diagnostic labs.

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PROGRAM NAME: M.Sc. BIOCHEMISTRY (w.e.f 2022-23)

COURSE NAME: PROJECT

PAPER CODE : BI452P **PPW : 8**
YEAR/SEMESTER: II/IV **NO.OF CREDITS: 4**

COURSE OBJECTIVES:

COb1 To select suitable research topics to carry out the project work.
COb2 To execute the planned work and present the data in the form of project report.

1. Project work will involve experimental work and the student will have to complete this in stipulated time.
2. Project work will be offered as per the expertise and infrastructural facilities available in the department.
3. The project work may be allotted to the students as individual or as a group project (Not exceeding 4 students per group)
4. The completed work and compiled data would be presented in the form of results and submitted in the form of a dissertation or project report.
5. The final evaluation of the project work will be through a panel involving internal and external examiners.
6. Guidelines provided for executing and evaluation of project work will be final.
7. The grading would be based on evaluation that include punctuality, experimental work, record keeping, intellectual inputs, data presentation, interpretation etc.

COURSE OUTCOME

At the end of the course students will be able to
BI452P.CO1 Choose the suitable project work and execute it effectively.
BI452P.CO2 interpret the results with scientific conclusion and present in seminars and conferences.

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