ON THE BASIS OF COURSE & CREDIT SYSTEM DETAILS SYLLABI OF THE M.Sc. COURSES IN BIOCHEMISTRY AND BIOPHYSICS

SEMESTER	PAPER	FULL MARKS	CREDIT
Semester I	HCT-1.1, HCT-1.2 , ET-1.1 , ET-	400	4
	1.2 HCP-1.1 LAB		
Semester II	HCT-2.1, HCT-2.2 , ET-2.1 , ET-	400	4
	2.2 HCP-2.1 LAB		
Semester III	HCT-3.1, ET-3.1 , ET-3.2 , ET-3.3	400	4
	HCP-3.1 LAB		
Semester IV	HCT-4.1, HCP-4.1, HCP-4.2,	400	4
	HCP-4.3		
		Total =1600	Total = 16

HCT: HARD CORE THEORETICAL (Common for M.Sc. courses in Biochemistry & Biophysics)

HCP: HARD CORE PRACTICAL (Common for M.Sc. courses in Biochemistry and Biophysics)

ET: ELECTIVE THEORETICAL (Optional, Students may choose any one in Semester I and Semester II , any two in Semester III)

DEPARTMENT OF BIOCHEMISTRY AND BIOPHYSICS UNIVERSITY OF KALYANI KALYANI-741235

Details Syllabi for M.Sc. 1st Semester Courses in Biochemistry and Biophysics Names of the Courses : M.Sc. in Biochemistry & M.Sc. in Biophysics Description of each papers

Paper		Subject Content	Marks for	Full Marks for
HCT-1.1	Group A	Physicochemical Techniques Absorption spectroscopy, Fluorescence spectroscopy, Circular Dichroism and Light Scattering. Basic Crystallography. Mass spectroscopy, Microscopy	50	100
	Group B	Biomolecules and Micronutrient	50	
	Group A	Cell Biology and Fundamental of Metabolisms and Bioenergetics	50	
HCT-1.2	Group B	Enzymology	50	100
ET-1.1	Group A	Basic Biology, Basic Physiology and Basic Immunology	50	100
	Group B	Plant Biochemistry	30	
	Group C	Statistics	20	
	Group A	Basic Biology, Basic Physiology and Basic Immunology	50	
ET-1.2	Group B	Mathematical methods	30	100
	Group C	Statistics	20	
HCP-1.1	Unit 1	Physicochemical Techniques and General Biochemistry and Biophysics	50	
LAB	Unit 2	Enzymology and Immunology	50	100

Total Marks : 400

HCT : Hard Core Theoretical (Common for M.Sc. Courses in Biochemistry and Biophysics) ET: Elective Theoretical (Optional, Students may choose any one) HCP: Hard Core Practical (Common for M.Sc. Courses in Biochemistry and Biophysics)

Department of Biochemistry and Biophysics University of Kalyani Kalyani-741235

HCT-1.1

Group A

Physicochemical Techniques, Absorption spectroscopy, Fluorescence spectroscopy, Circular Dichroism and Light Scattering, Basic Crystallography, Mass spectroscopy and Microscopy.

- 1. Water and pH, physical properties and structure of water, ionization of water, pH scale, acids and 5 bases, Handerson-Haselbach equation, buffers, physiological buffers and their functions, measurement of pH.
- Chromatograph Paper, TLC, adsorption, partition, ion-exchange, reverse phase, gel filtration, 5 affinity, GLC, HPLC and FPLC
- 3. **Electrophoresis** Theory of electrophoresis and electrical parameters in electrophoresis, 5 paper electrophoresis, gel electrophoresis, SDS-PAGE, Disc gel, gradient gel, isoelectric focusing, gel electrophoresis of nucleic acids and its applications pulse field electrophoresis, continuous electron electrophoresis.
- 4. **Other Techniques** : Viscosity , dialysis , ultrafiltration, centrifugation, isoelectric precipitation, 4 solvent fractionation.

2

- 5. **Separation and Purification** : Proteins, Nuclecic acids and Lipidis.
- Radioisotope techniques Types of radiation used in biology, properties of α, β and 9 γ-rays, radioisotope tracer techniques, measurement of radioactivity (GM, scintillation and gamma counters), autoradiography,
 Radiation protection = safety measures radiation

Radiation protection- safety measures, radiation

Dose measurements-ionizing and nonionizing radiations, basic concepts of radiation biology.

- Spectroscopy Basic concepts of Absorption spectroscopy, fluorescence spectroscopy, 7 circular dichroism.
- Microscopy Light Microscopy: Bright , Dark Field and Phase contrast Microcopy, 5 Resolving power and Magnification Electron Microscopy – Working principle , Image formation process and Contrast , Image defects, Optimum resolution. Sample preparation and contrast enhancement techniques. Comparison between SEM, STEM, STM, Atomic force microscopy(AFM)
- Basic crystallography : Symmetry in Crystal, Point and Space Group, Miller Indices, Unit Cell, 8 Atomic Scattering Factor, Structure Factor.
 Laue and Bragg's Law of Diffraction, Ewald's Construction, Concept of Reciprocal Lattice and Fourier Transformation, Relation between Structure Factor and Electron Density, Phase problem

Group B

Biomolecules and Micronutrients

- Carbohydrate:
 Structure and Biological functions of mono and oligosaccharides,
 6

 Polysaccharides-Glycogen, Starch, Cellulose, Hetero- polysaccharides and Glycoproteins.
 6
- Lipids: fatty acids, fats and oils, phospholipids, sphingolipids, glycolipids, sphingolipids, 6 cholesterol, gangliosides, lipoproteins, rancidity, acid value, saponification value, lodine number, acetyl number, R.M. number
- Proteins: Amino acids-physical and chemical properties, titration of amino acids, separation and 15 identification of amino scids, classification of proteins based on chemical nature and conformation, ionic status, peptide, primary structure, determination of amino acid sequencing, Ramachandran plot, secondary structure (α-helix, β-strand, β-sheet, turns and loops),

tertiary structure (ion-ion, ion-dipole and dipole-dipole interactions)-structural domains and modules of tertiary structure, quaternary structure, globular and fibrous proteins, structure of haemoglobin and myoglobin.

Functional and evolutionary relationships among proteins.

- 4. **Nucleic acid:** Purine and pyrimidine bases, nucleosides and nucleotides, double helical structure of DNA,8 polymorphism of DNA (A, B, Z forms), RNA structure (primary, secondary and tertiary), ribozyme, denaturation and renaturation of DNA, DNA supercoiling, chromatin structure, Other structure like triple helix, ?
- 5. Vitamins : Biological functions of vitamins .

- 5
- Micronutrients: Ca ,Mg ,, Mn , Fe,Se, Co,Cr, Zn and Cu, Mo : sulfide and sulfate: 10 their implementation in physiology Zn fingers, Zn in the β cells of pancreas, absorption of Zn and Cu,. Metalopthionein and ceruloplasmin.

HCT-1.2

Croup A

Cell Biology and Fundamental Metabolisms and Bioenergetics Cell Biology:

- 1. Origin and evolution of cells. The first cell, evolution of metabolism, prokaryotes, 2 eucaryotes, development of multicellular organisms
- Subcellular organelle—their structure and functions, cell membrane, membrane lipids-and 5 their synthesis, membrane proteins-their synthesis, phospholipid bilayer, fluid mosaic model, membrane proteins, matrix adhesion proteins, glycoproteins, receptors.
 - Lipid mobility. Phospholipids, glycolipids and spingolipids in membranes. Transport of small molecules—passive diffusion, facilitated diffusion, carrier media
- Transport of small molecules—passive diffusion, facilitated diffusion, carrier mediated diffusion, 10 carrier proteins, symport-antiport and cotransport, ion channels, ionophores, liposomes, transport processes---P-type,

V-type, F type and drug transport ATPases ---their mechanism of actions and regulation. Multi drug transport protein, ATP dependent Cl⁻ channel, cystic fibrosis

- 4. Structure and organization of actin filaments, actin, myosin and cell movement, sarcoplasmic reticulum in muscle contraction, intermediate filaments, microtubules, microtubule motor and movement. Protein folding and processing, regulation of protein function, protein-protein interactions, protein degradation.
- 5. Protein sorting and processing and transport---*The endoplasmic reticulum* Endoplasmic reticulum— 8 ER and protein secretion, target of proteins to ER, insertion of proteins into the ER membrane, protein folding and processing in ER, quality control in the ER, the smooth muscle ER and lipid synthesis, export of proteins and lipids from the ER, the signal hypothesis.

Golgi apparatus- Organization of Golgi, protein glycosylation within the Golgi, Lipid and polysaccharide metabolism in the Golgi, protein sorting and export from the Golgi apparatus.

Vesicular transport- Understanding of vesicular transport, cargo selection, cont proteins and vesicle budding, vesicle fusion

Lysosomes- Lysosomal acid hydrolases, endocytosis and lysosome formation, phagocytosis and autophagy. Disorders resulting from defects in lysosomal function.

Peroxysomes Functions of peroxysomes, peroxysomes assembly. Diseases that result from abnormal mitochondrial and peroxysomal function.

- The cell cycle: Phases of cell cycle, M-phase: mitosis and cytokinesis, prophase, metaphase, 4
 anaphase, telophase, forces required for mitotic movements. Regulation of the cell cycle by growth factors
 and extracellular signals,
- 7. Concept of extracellular matrix and adhesion molecules. Cytoskeletal proteins and their functions, 3

the cytoskeleton, myofibrillar and their junction in cell shape and contraction. Details of the mechanism of muscle contraction.

Fundamental of Metabolisms:

- 1. Carbohydrate : Outlines of Glycolysis, TCA cycles and lipid metabolisms Bioenergetics :
- 1. Organization and function of mitochondria, endosymbioant hypothesis for the biogenesis of mitochondria, protein import and mitochondrial assembly. The electron transport chain, mechanism of oxidative phosphorylation.
- 2. Theories of oxidative phosphorylation, merits of chemiosmotic hypothesis over 5 chemical coupling and conformational coupling hypotheses, respiratory chain inhibitors and uncouplers of oxidative phosphorylation,

Group B

Enzymology

1to 7 = 41 classes

4

3

- 1. Classification-nomenclature-properties-cofactors-units-turnover of enzymes, free energy and enzyme-substrate reaction.
- 2. The catalytic site: lock and key or template model, induced fit model, ordered and random binding of substrates, enzyme as general acid or general base catalysts.
- 3. Role of metal ions, metalloenzymes and metal activated enzymes; ternary enzyme-metal substrate complexes, enzyme bridge complexs (M-Enz-S), substrate bridge complexes (Enz-S.M), metal-bridge-complexes (Enz-S.M), role of metal ions in catalysis, Vitamins as coenzymes.
- Factors affecting catalytic efficiency of enzymes (pH, Temperature etc.), Michaelis-Menten equation, activators, inhibitors, inhibition reactions and their kinetics, allosteric and feedback inhibition, competitive, noncompetitive, uncompetitive and mixed type inhibition, kcat/km – a measure of catalytic efficiency, Hill and scatchard plot,
- 5. Regulation of enzyme activity, flexibility and conformational mobility of enzymes, immobilized enzymes, multisubstrate reaction kinetics: ping-pong and ordered bi-bi reactions, multi enzyme system, Isoenzymes: lactate dehydrogenase of heart and muscle. Covalent modification that regulate enzyme activity: covalent modification through reversible phosphorylation, protein kinases—target recognition and intrstearic control; phosphorylation is not the only form of covalent modification that regulate protein function. Aspartate transcarbamylase—kinetics and inhibition.
- 6. Typical enzyme mechanisms and events at the active site: Serine proteases mechanisms 6 in detail---events at the active site, aspartic proteases, matrix metalloprotease, cysteine protease, thiol protease, puruvate dehydrogenase.
- Covalent activation of zymogens: Activation of enzymes by proteolytic cleavage, activation of trypsinogen, chymotrypsinogen and pepsinogen; Enzymes in clinical diagnosis

Group A Basic Biology, Basic Physiology and Basis Immunology **Basic Biology and Basic Physiology**

- 1. Adaptation, biorhythms---Circardian and annual 1 2. Concept of tissue, organ and systems---General anatomical interrelationship of organs. Muscle---different types, structures- organization of thick and thin filaments, mechanisms of muscle contraction and relaxation. 3. .Over view of the nutritional aspects in animals and plants, Autotrophy. Digestion and absorption of different components of food. 4. Excretion—nephron—mechanism of urine formation. Electrolyte and water balance of body, plant excretion. 4 5. Blood- Composition and function, mechanism of clotting, formation and maturation of RBC and WBC, different hematological parameters, immune system (outline) 5 6. Respiration-- Transport of oxygen and carbon dioxide in blood, regulation of acid-base balance 3 7. Cardiovascular system---Outline of cardiovascular system 5 8. Endocrine glands and their functions 4
- 9. Development and reproduction—Cell division cycle, outlines of reproduction and reproductive tract. Development of male and female gonads. Embryo transfer 5 4
- 10. Nervous system: Generalized view

Immunology:

- 1. Introduction to immune system: Cells and organs of immune system.
- 2. Lymphoid tissue, origin and development: Structure and function of lymphoid tissue.
- 3. Differentiation of lymphocytes, lymphocyte-sub-populations.
- 4. T and B cells and their antigens.
- 5. APC cells, Phagocytic cells, macrophage, dendritic cells, K and NK cells.
- 6. Types of immunity, innate, adaptive, passive and active, self vs nonself discrimination: An overview .
- 7. Antigenicity of molecules: Immunogen vs. antigen; Characteristics and types of antigens; Epitope.
- 8. Immunoglobulins: Molecular structure, classification and function; Class switch; Antigen- antibody reactions; Immunological techniques and assay: Hybridoma technique for monoclonal antibody production; ELISA, RIA, Immunoelectrophoretic techniques, agglutination, immunodiffusion, immunofluoresence, western blot, flow cytometry

Group B

Plant Biochemistry :

- 1. Photosynthesis: Structures of organelles involved in photosynthesis in plants and bacteria. Proton gradients and electron transfer in chloroplasts of plants and in purple bacteria- differences from mitochondria. Light receptors-chlorophyll, light harvesting complexes, bacteriorhodopsin, rhodopsin as ion pump. Photosystems I and II their location, mechanism of quantum capture and energy transfer between photosystemsferridoxin, plastocyanin, plastoquinone, carotenoid. The Hill reaction, photophotophosphorylation and reduction of CO2, C3, C4 and CAMmetabolism, light and dark reactions. Light activation of enzymes regulation of photosynthesis, photore spiration. 15
- Biological nitrogen fixation and am monia assimilation : Mechanism of biological nitrogen fixation, Nitrogen 2. fixing enzyme and its structure, Nif gene and Fix gene and its regulation in nitrogen fixation, ammonia assimilation. 5
- 3. Translocation of inorganic and organic substances.
- Plant hormones- Growth regulation substancesand their mode of action. Molecular effects of 5 4. auxin in regulation of cell extension and of gibberellic, abscisic acids and cytokynins in the regulation of seed dormancy, germination, growth and development, and embryogenesis

30

2

10

ET-1.1

5. Defense systems in plants

6. Tissue culture and transgenic plants

Group C

Statistics

- 1. Significance of Statistics Methods in Biological Investigation. Graphical representation of data 2
- 2. General Statistics Methods : Frequency distribution , Measures of central tendency , measures of dispersion , theoretical distributions (Binomial, Poission and Normal) Sampling variation.
- 3. Statistical evaluation of results : Estimation of standard error, confidence limits, significance tests, 10
- 4. simple tests based on normal distribution, normal approximation to binomial and Poission distribution, one and two -tailed tests, use of t-test for small samples, X^2 - test of goodness of fit, chi-square test, ANOVA

Correlation and linear regression, method of lest squares,

ET-1.2

Group A

Basic Biology, Basic Physiology and Basis Immunology **Basic Biology and Basic Physiology**

- 11. Adaptation, biorhythms---Circardian and annual
- 12. Concept of tissue, organ and systems---General anatomical interrelationship of organs. Muscle--different types, structures- organization of thick and thin filaments, mechanisms of muscle 5 contraction and relaxation.
- 13. .Over view of the nutritional aspects in animals and plants, Autotrophy. Digestion and absorption of different components of food. 4
- 14. Excretion—nephron—mechanism of urine formation. Electrolyte and water balance of body, plant excretion. Δ
- 15. Blood- Composition and function, mechanism of clotting, formation and maturation of RBC and WBC, different hematological parameters, immune system (outline) 5
- 16. Respiration-- Transport of oxygen and carbon dioxide in blood, regulation of acid-base balance 3
- 17. Cardiovascular system---Outline of cardiovascular system
- 18. Endocrine glands and their functions
- 19. Development and reproduction—Cell division cycle, outlines of reproduction and reproductive tract. Development of male and female gonads. Embryo transfer 5
- 20. Nervous system: Generalized view

Immunology:

- 9. Introduction to immune system: Cells and organs of immune system.
- 10. Lymphoid tissue, origin and development: Structure and function of lymphoid tissue .
- 11. Differentiation of lymphocytes, lymphocyte-sub-populations.
- 12. T and B cells and their antigens.
- 13. APC cells, Phagocytic cells, macrophage, dendritic cells, K and NK cells .
- 14. Types of immunity, innate, adaptive, passive and active, self vs nonself discrimination: An overview .
- 15. Antigenicity of molecules: Immunogen vs. antigen; Characteristics and types of antigens; Epitope.
- 16. Immunoglobulins: Molecular structure, classification and function; Class switch; Antigen- antibody reactions; Immunological techniques and assay: Hybridoma technique for monoclonal antibody production; ELISA, RIA, Immunoelectrophoretic techniques, agglutination, immunodiffusion, immunofluoresence, western blot, flow cytometry

Group B

Mathematical Methods

1. Functions and their Graphical Representation with Application in Biology: Linear-Power-Periodic-Logarithmic-**Exponential functions** 4

5 4

4

10

20

1

30

1

2

2. Properties of Function: Maxima – Minima – Pt. of inflection of the functions and applications in biology viz., pk value, Tm ; rate of change of function. 3

3. Differentiation and Integration: Simple differentiation, integration as a measure of area and simple integrals, statement of different biological and biophysical problems with their boundary conditions and setting up of differential equations, solution of 1st order and 2nd order differential equations, partial differentiation and Euler's criteria of exact differential.

4. Matrix Algebra: Determinants with examples from biology, matrix as operation of reflection- rotationinversion-magnification-translation-symmetry, applications in biology.

Group C

Statistics

20

- 1. Significance of Statistics Methods in Biological Investigation. Graphical representation of data 2
- General Statistics Methods : Frequency distribution , Measures of central tendency , measures of dispersion , theoretical distributions (Binomial , Poission and Normal) Sampling variation.
- 3. Statistical evaluation of results : Estimation of standard error, confidence limits, significance tests, 10
- 4. simple tests based on normal distribution , normal approximation to binomial and Poission distribution , one and two –tailed tests, use of t-test for small samples , X²- test of goodness of fit , chi-square test, ANOVA

Correlation and linear regression , method of lest squares,

Details Syllabi for M.Sc. 2nd Semester Courses in Biochemistry and Biophysics

Names of the Courses : M.Sc. in Biochemistry & M.Sc. in Biophysics Description of each papers

Paper		Subject Content	Marks for	Full Marks
			Each	for each
			Groups	Paper
	Group A	Microbiology and Virology	50	
HCT-2.1	Group B	Radiation Biology	25	100
	GroupC	Cancer Biology	25	
	Group A	Genetics (Classical and Human)	50	100
HCT-2.2	Group B	Molecular Biology	50	
ET-2.1	Group A	Advanced Immunology	50	100
	Group B	Neurochemistry and Reproductive Biology	50	
ET-2.2	Group A	Crystallography	50	
	Group B	Mathematical Modeling	20	100
	Group C	Microscopy	30	
	Part-I	Microbiology and Virology	40	
HCP-2.1	Part-II	Molecular Biology & Genetics	40	100
	Part-III	Crystallography	20	

Total Marks : 400

HCT : Hard Core Theoretical (Common for M.Sc. Courses in Biochemistry and Biophysics) ET: Elective Theoretical (Optional, Students may choose any one) HCP: Hard Core Practical (Common for M.Sc. Courses in Biochemistry and Biophysics)

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Microbiology and Virology

1. Microbiology in the 20th Century, Discovery of microorganisms, Classification of microorganisms, Microbial nutrition, Common nutrient requirements, Requirement for C, H and O, Requirement for n, P and S, Uptake of nutrients (Facilitated diffusion, Active transport) Group translocation, Synthetic or defined media, complex media, Types of media.

2. Microbial growth factors, Growth curve and equation, Measurment of microbial growth (spectrophotometrically), cell numbers (colony counts), cell mass., Environmental factors on growth (nutrient concentration , pH, temperature , oxygen concentration , pressure and radiation), Chemostat, Turbidostat

3. An overview of prokaryotic cell structure (cell wall : Peptidoglycan, Gram positive and Gram negative cell walls), Mechanism of Gram staining, Bacterial surface charge, Capsules, Pili and Fimbriae, Flagella and Motility, Chemotaxis, An overview of eukaryotic cell structure (External cell coverings, Cilia and Flagella), Comparision of prokaryotic and eukaryotic cells.

4. Microbial spore (endospores and exospores formation, their properties and germination),
Control of Microorganisms (Physical methods - Heat, filtration, radiation; Chemical methods - Phenolics,
Alcohols, Halogents, Heavy metals, aldehydes and sterilizing gases; Antibiotics - Definition and
Classification, basic mechanism of primary mode of action,.
Interaction between microbes (Symbiosis, Antibiosis and Commensulism).
2L + 1T

5. Extreme environment microbes: Anaerobes, Halophiles, Thermophiles , Acidophiles and Alkyliphiles; Biogeochemical roles of microbes:Carbon, nitrogen and sulfur cycles; Nitrogen fixation and its mechanism.

6. Biofertilisers, Microbiology of water, air, soil and Milk.

10. Microbial diseases : The epidemiology of infectious disease, Human diseases cause by Gram positive and Gram negative Bacteria- Airborne diseases, Direct contact Diseases, Food-borne and water borne diseases with names of infecting microorganisms, Human diseases caused by other bacteria and Human diseases caused by Fungi and Protozoa.

1L

Reference Books for Microbiology : 1. Microbiology - M.J.Pelczar, E.C.S.Chan & N.R.Kreig (Tata McGraw Hill)

2. General Microbiology - R.Y.Stanier, J.L.Ingraham, M.L.Wheelis & P.R.Painter (McMillan)

3. Microbiology - L.M.Prescott, J.P.Harley & D.A.Klein (Mcgraw Hill)

16. Fundamental Principles of Bacteriology - A.J. Salle (TATA McGRAW-HILL)

Virology:

 Bacteriophages: Discovery, Structures, Plaques, Host specificity, Life cycles of bacteriophages: Virulent phages (T4, T7, φX174, RNA phage), Lysogenic phages (λ, P1), Chronic phage (M13). 4L + 1T

 Eykaryotic Virus: Basic structures, Life cycles of RNA viruses (Vesicular Stomatitis Virus, Poliovirus, Reovirus, Retrovirus) and DNA viruses (Simian Virus 40, Adenovirus).
 2L + 1T

- 3. Viral Diseases: Human viral pathogens, Factors behind incidence and severity, Acute infection (gastrointestinal, respiratory, liver), Systemic spread, HIV and Aids, Tumor viruses and Oncogenes (Trnansformed cells, Detection of viral DNA, Viral oncogenes, Induction of cancers). 3L + 1T
- 4. Diagnosis, Vaccines and Antivirals: Culture system, Use of antibody, PCR and RT-PCR techniques, Live and killed vaccines, Peptide vaccines, Genetically engineered vaccines, antiviral drugs.

Marks :50

2L + 1T

3L + 1T

2L + 1T

1L

1L

5. Prion and Diseases.

1L Total: 24L + 8T

Reference Books for Virology:	1. Molecular Biology by Tropp
	2. Introduction to Modern Virology by Dimmock, Easton & Leppard.

Group B Radiation Biology

1.Principles of Radiologcal Physics: Properties and production of radiation-corpuscular and electromagnetic radiation, elementary process involving radiation and free particles, interaction of particulate radiation and em radiation with matter.

Dose: Exposure dose, absorbed dose, effectiveness of different radiation LET, RBE.

Effect of Radiation on Water: Direct and indirect action of radiation, chemical dosimetry.

2L+1T **2.General Biological Effect of Ionizing Radiation and Epigenetic effect:** Effect on whole organism, on cells, biomolecules, factors that modulate radiation response –temperature, oxygen effect, LET cell age, cell cycle, role of radiation protector and sensitizers, Bystander effect (Epigenetic effect) 3L+1T

3.Survival Curve and its Interpretation: Target theory and its validity its limitation determination of target size, explanation of shoulder of survival curve, implication of repair. sublethal damage and potentially lethal damage

Radiation Protection and Tumor Radio Therapy.

4L+1T

 4. Interaction of Non-ionizing Radiation with Matter: Ozone depletion , UV and visible light sources, action spectra, effects on cells, biomolecules.

 3L+1T

Total :12L +4T

Reference Books for Radiation Biology

- 1. Radiation Biophysics -- E. L. Alpen (Academic Press).
- 2. Radiation Detection & Measurement -- G. F. Knoll (John Willey & Sons).
- 3. Radiation Biology Dertinger and Jung

Marks: 25

Group C	
Cancer Biology	Marks:25
1.Nomenclatures of different types of cancers , Stages of cancer	1L
2. Immortalization of transformation of cells .	1L
3. Genetics of cancer : DNA damage , mutation nad cancer ,	
Virus induced cancer	
	2L+1T
4. Protooncogenes, Oncogenes, tumor suppressor genes, Molecular natur	e of oncogenes- growth factors,
receptors, transcription factors, apopotic genes, cytosolic regulator factors.	
	2L+1T
5. Regulation of cell death & regulation of cell cycle	2L
6. Multistage regulation of cancer like colon cancer.	1L
7.Epidemiology of cancer and diet.	1L+1T
8. Immunology and Cancer	1L
9. Different Therapeutic approaches to cancer	1L+ 1T

Reference Books for

Cancer Biology

1.TheBiology of Cancer by R.A. Weinberg

2. Molecular Biology of Cancer : Mechanisms, target and Therapeutics by L. Pecorino

Semster-2 (HCT-2.2)

Group A

Genetics (Classical and Human)

- Mendelian Genetics , Population Genetics, Evolution , Organization of Human chromosome , banding , karyotyping, chromosomal disorders, screening of Human genetic disorder. 5L+2T
- Gene Mutation and Polymorphism : Spontaneous mutation, Luria –Delbruck fluctuation test, origin of spontaneous mutation, different types of mutants, induced mutation, physical and chemical mutagens, mutator gene, mutational hot spots, selection –screening –enrichment of mutants (auxotroph, ts etc.), reversion, Ames test, suppression, hyper mutation , programmed mutation, SNP, length polymorphism and disease. 7L+2T
- DNA Repair: Different types of DNA damages, repair processes –damage reversal-photo reactivation , repair of alkylation damage , damage removal-nucleotide excision repair, base excision repair, mismatch repair, inducible repair pathways. Genetic diseases due to error in DNA repair.
 5L+1T
- 4. Recombination : Generalized homologous recombination , models (Holliday, Meselson-Radding, double- stranded break), proteins involved in homologous recombination in *E.coli*, homologous recombination of circular DNAs, site –specific recombination , transposition, IS and Tn elements, replicative and non-replicative transposition, Composite transposons. 6L+2T
- 5. Gene transfer : Transformation , Conjugation, Transduction

Full Marks:100

Total: 12L+4T

Total:24L+8T

Marks: 50

1L+1T

2. Genetics by Gardner 3. DNA repair by Friedberg.

Group B

Molecular Biology

- 1. DNA replication (both prokaryotic and eukaryotic): Different modes of replication (semiconservative. Bi-directional. Semi-discontinuous : Initiation (replication origin, associated proteins and enzymes, regulation of initiation); Elongation stage of replication (associated proteins and enzymes): Termination of replication (associated proteins and enzymes). 6L + 2T
- 2. Transcription (both prokaryotic and eukaryotic): Prokaryotic transcription, transcription cycle (initiation, elongation and termination), bacterial promoters, different σ factors, abortive initiation, processivity and editing functions of elongating polymerase, Rho-dependent and Rho-independent terminations. Eukaryotic transcription- RNA polymerases, transcription factors, processing of mRNA in eukarvotes.
- 3. Post-Transcriptional modification

2+3=6L+2T

- 4. Translation- Initiation, elongation and termination of translation (both pro- and eukaryotic).
- Post-Transcriptional modification 5.
- 6. Non -coding RNAs
- 7. Regulation of gene expression : Principles of transcriptional regulation, different operons and their regulation . Gene regulation at steps after transcription, Regulation of lamda phage. Eukaryotic gene regulation, Control of transcriptional regulator, Gene slicing, RNA in gene regulation, transcriptional control of gene expression.

5L+2T

4+5=6L+2T

11

References of Books for Molecular Biology; 1. "Molecular Biology of the Gene" by Watson-Baker-Bell-Gann-Levine-Losick, 5th Edn., Pearson Education

- "Molecular Biology" by D. Freifelder, Narosa Publishing House, New Delhi 2.
- "Genome" by T.A. Brown, John Wiley & Sons 3.
- "Microbial Genetics" by D. Freifelder, Narosa Publishing House, New Delhi 4.
- "Gene VII" by Lewin Benjamin (Oxford) 5.
- "Molecular Cell Biology" by J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.) 6

Semester-2 (ET-2.1)

Group A

Advanced Immunology

1. i) Antigens and immunogenicity, molecular differences in epitope structure

(i) Immunoglobulins, structure and function of specific immunoglobulins, antibody diversity, plasma cell dyscrasias, monoclonal and polyclonal antibody, abzymes

2.i) B cell development, activation, differentiation, B cell receptors, Immunoglobulin gene rearrangement ii) Macrophage activation, pattern recognition molecules (TLR, NLR, RIRs)

3L+ 2Tu

3. i)T-cell development, activation and differentiation, T-cell receptor expression and gene rearrangement, T- cell selection in thymus, T-cell receptor function

ii) Structure and role of Major Histocompatibility Complex, genetic organization, distribution of MHC antigens, Tissue typing, HLA disease association, MHC restriction

3L + 2Tu

4. i) Antigen processing and presentation : Antigen presenting cells, MHC class I processing pathway and MHC class II processing pathway, Antigen presentation to T Cells, TCR-Antigenic peptide interaction, super antigens

ii) Dendritic cells (DC) in immune system, discovery and identification with subsets, antigen presentation by dendritic cells, plasmacytoid dendritic cells, DC in immune tolerance

3L + 2Tu

5. i) Complement vs cell mediated lysis: Complement pathways, biologic consequence of complement activation, regulatory mechanisms, cell mediated cytotoxicity, necrosis, apoptosis ii) Cytokines and cell mediated immunity, Th subsets

3L + 2Tu

Full Marks:100

Marks: 50

Total : 24L+8T

Marks: 50

ii) Immediate hypersensitivity; allergic response, Type to Type IV hypersensitivity; Delayed type hypersensitivity: Cell mediated immunity, T cell subsets, antigen specific components of DTH, regulation of DTH

3L + 2Tu

6. i) Active and passive immunization, Types of vaccines, Attenuated and killed vaccines, macromolecular with reference to subunit vaccines, recombinant and DNA vaccines, strategies for new vaccine development, difficulties in vaccination of AIDS and malaria

ii) Microbial Immunity and immunoparasitology: Non specific immunity and specific immunity, bacterial, viral and parasitic infection, development of new treatments for human deseases related to immune dysfunction.

3L +2Tu

7. i) Autoimmunity: B tolerance, T cell tolerance, clonal deletion, clonal anargy, B cell associated autoimmune diseases, mechanism of breaking B cell tolerance, molecular mimicry
ii) Transplantation: Transplant rejection, tissue compatibility, histocompatibility antigens in transplantation, Graft vs host rejection, mediators of rejection, immunesuppression

3L + 2Tu

8. i) Tumor immunobiology: cancer and immune system, tumor specific antigens, immnuosuppresion in tumor microenvironments, immunotherapy of cancer using monoclonal antibody and cytokines, NK and dendrdritic cells in cancer

ii) Immune deficiency disorder: Phagocytic cell defects, B and T cell deficiency disorder, combined B and T cell deficiency disorder, secondary immunodeficiency conditions, complement deficiency

3L + 2Tu

Total : 24L +8T

Reference of Books for Advanced Immunology : 1. Immunology - Goldsby-Kindt-Osborne – Kuby, W.H Freeman & Co.

- 2. Cellular and Molecular Immunology- Abbas-Lichtman-Pober, W.B SAUDERS
- 3. Immunology Roitt
- 4. Immunology and Immunotechnology A.K Chakraborty, Oxford University Press, 2006
- 5. Annual Review of Immunology

Group B Neurochemistry and Reproductive Biology

Neurochemistry

- Meningis, blood brain barrier and glia, chemical composition of nerve tissue, carbohydrate and energy metabolism in brain, transport of amino acid, protein, nucleic acids, metabolites in brain, biochemistry of synaptic junctions, influence of different factors (gro wth factors, hormones, cytokines) in brain functions. 4L+2T
- 2. Neurotransmitters, neuromediater, neuromodulators and their molecular aspects, pharmacology of receptors, biochemical aspects of learning and memory, memory loss, biochemistry of mental disorder, biochemistry of aging and age related

disorders-Parkinson's disease, schizophrenia, Huntington's disease and Alziemers.

3. CNS active drugs-Their classification and mode of action .7L+2T2L+1T

Total: 13L+5T

Reference of Books for Neurochemistry : 1. Pharmacology and experimental therapy – Goodman & Gilmann

Reproductive Biology

- 1. Infertility in males and females and their remedial measures. 3L +1T
- 2. Role of antiestrogen and anti-androgen in induction of ovulation and spermiation. 2L
- 3. Fertility control :
 - i) Ovulation suppression by oral and injectable steroidal contraceptive.
- ii) Use of implants and IUDs.
- (iii) Induction of ovulation and spermiation :- Oocyte maturation and sperm maturation substances their probable mode of action.

8L+ 2T

(iv) Impact of temperature and photoperiod and other factors in the growth, development and function of gonad

Total: 11L +3T

Full Marks: 100

4L+2T

Marks: 50

Reference Books for Reproductive Biology :

- 1. Williams's Text Book of Endocrinology.
- 2. Text Book of Endocrinology by Turner

Semester :2 (ET-2.2)

Group A

Crystallography

- 1. Ewald construction, identification of different layer lines of reciprocal cell ,Indexing. 4L+ 2T
- 2. Crystalisation, Data Processing, Systematic absences, Wilson Plot
- 3. Phase Problem: Patterson Synthesis, Basics of Direct Methods, Molecular Replacement, Isomorphus replacement, Anomalous Scattering Method. 5 L+2T
- 4. Refinement: Residual Factor, Least squares Method ,Rigid body refinement, Energy refinement and simulated annealing method 4L+2T
- 5.Non Crystallographic Symmetry, Density Refinement2L6.Model Building, Ramachandran Plot in model building , Inclusion of water.2L
- 7. Area detector, Use of Synchrotron Radiation,
- Introduction to Neutron Crystallography, Location of hydrogens using neutrons.
 Icosahedral symmetry and small angle scattering.

Total:24L+8T

1L

Reference of Books for Crystallography : 1. "Fundamentals of Crystallography" by Giacovazzo-Monaco-Viterbo-Scordari-Gillo-Zanotto-Catti (Intnl. Union of Crystallography & Oxford Univ. Press). 2. "Principles of Protein X-ray Crystallography" by J. Drenth (Springer Verlag, N.Y., USA).

- 3. "X-ray Crystallography" by M. M. Wolfson (Cambridge Univ. Press).
- 4. "Protein Crystallography" by T. L. Blundell & L.N. Johnson (Academic Press).
- 5. "X-ray Diffraction Procedures" by Klug and Alexander.
- 6. "An introduction to Crystallography" by F. C. Philips.

Group B

Mathematical Modeling

- 1. Matrix Algebra : Determinants with examples from Biology , Matrix as operation of reflectionrotation-inversion-modification-translation –symmetry, applications in Biology. 3L+1T
- 2. Some simple models in Biology: Population dynamics of single and interacting species, infectious diseases, population genetics, biochemical kinetics, neural networks, Markov chain, 7L+2T

Total : 10L+3T

Reference of Books for Mathematical Modeling: 1. Introduction to Mathematics for Life Scientists--- E. Batschelet (Springer).

2. Biophysical Chemistry—Cantor & Schimme

Group C

Marks :30

Marks : 20

Microscopy

- 1.Light microscopy: Bright Field, dark field & phase contrast microscopy, resolving power & magnification. 4L+2T 2.Electron microscopy: Working Principle, Image formation process and Contrast, Image Defects, Optimum Resolution. 4L+2T 1L+1T
- 3.Sample preparation and contrast enhancement techniques.
- 4. Comparison between SEM, STEM, STM, Atomic force microscopy (AFM). 4L +2L 5. Fluorescence & Confocal microscopy 1L+1T

Total = 14L+8T

Reference of Books for Microscopy : 1. Introduction to Electron Microscopy - S. Wischnitzer. 2. Electron Microscopy in Biology - J.R.Harris (ed.).

3. The Principle and Practice of Electron Microscopy - I. M. Watt (Cambridge Univ. Press

Semester :2 (HCP-2.1)

100 Part-I

Microbiology and Virology

Marks: 40

1. Microbiological techniques: Sterilization, media preparation, preparation of slants and stabs, pouring of medium into plates, subcultureing.

2. Isolation of microorganisms from soil collected from different places. Serial dilution, plating for counting colonies. Single colony isolation techniques and its preservation.

3. Examination of microorganisms: Simple staining, Gram staining, Acid Fast Staining Endospore staining, staining of flagella, staining of caps ule, staining of fungi, localization of root nodule bacteria by staining.

4. Bacterial growth studies: Bacterial number counting by haemocytometer, colony counting, bacterial growth curve, determination of generation time.

5. Antibiotic sensitivity tests, antibiotic assay by paper disc / $\,$ cup method, MIC determination.

6.. Bacteriological examination of drinking water.

- 7. Preparation of Bacteriophage ØX 174 stock.
- 8. Assay of bacteriophage ØX 174 stock.

9. Lytic curve of *E.coli* by ØX 174.

10. UV-inactivation of bacteriophage ØX 174 .

11. Repair of UV-inactivated bacteriophage ØX 174.

Part-II Molecular Biology and Genetics

Marks:40

- 1. Time course of [?]-galactosidase induction in *E.coli*
- 2. Effect of membrane perturbants on Lac-permease activity.
- 3. Study of bacterial conjugation.
- 4. SDS-PAGE of protein.
- 5. Genetic mutation and isolation of auxotrophs.
- 6. Measurement of membrane potential (Bacteria and Cell lines)

Part-III Crystallography Crystallization and Indexing

Marks: 20

Full Marks :

Details Syllabi for M.Sc. 3rd Semester Courses in Biochemistry and Biophysics Names of the Courses : M.Sc. in Biochemistry & M.Sc. in Biophysics

Description of each papers

Pape	er	Subject Content	Marks for Each Groups	Full Marks for each Paper
	Group A	Biotechnology and Recombinant DNA Technology	50	100
НСТ-3.1	Group B	Cellular Signaling	50	100
	Group A	Medical Biochemistry	50	100
ET-3.1	Group B	Intermediary Metabolism	50	
	Group A	Medical Biophysics	50	100
ET-3.2	Group B	Spectroscopy	50	
	Group A	Structural Biology	50	
ET-3.3	Group B	Developmental Biology	50	100
	Unit 1	Recombinant DNA Technology	50	
HCP-3.1	Unit 2	Clinical Biochemistry and Biophysics	50	100

TotalMarks: 400 HCT: Hard Core Theoretical (Common for M.Sc. Courses in Biochemistry and Biophysics)

ET: Elective Theoretical (Optional, Students may choose any two)

HCP: Hard Core Practical (Common for M.Sc. Courses in Biochemistry and Biophysics)

Department of Biochemistry and Biophysics University of Kalyani Kalyani-741235

Semester 3 : (HCT-3.1)

Group A

Biotechnology and Recombinant DNA Technology

1. Tools : Plasmids (F, R & Col lasmids, copy number & its Control, replication of ColE1 plasmid, plasmid incompatibility, plasmid amplification), Restriction enzymes (nomenclature, types, characteristics of type II R.E, modification, restriction map), Cloning vectors (pBR322, pUC, λ -vectors, cosmid, M13 vectors, phagemid, shuttle vectors), brief overview of vectors based on plant & animal viruses, Artificial chromosomes (YAC, BAC, HAC etc.).

2. Techniques: Isolation & purification of plasmid & geomic DNA, Manipulation of DNA (by nucleases, ligases, polymerases, modifying enzymes), Construction of chimeric DNA (linker, adaptor, homo-polymer tailing), Introduction of DNA into cells (chemical method, electroporation, microinjection, gene gun etc.), Gel electrophoresis (polyacrylamide, agarose, pulse-field), Nucleic acid blotting (Southern, northern, western, South-western), Construction of libraries (genomic, cDNA, subtraction), Selection of a clone from library (screening by nucleic acid hybridization, immunoscreening, two-hybrid screening), DNA sequencing (manual & automated), RFLP, Genetic fingerprinting, Gel retardation & DNA footprinting, PCR (reaction conditions, thermostable DNA polymerases, characteristics of primers, cloning of PCR products, RT-PCR, real-time PCR, clinical diagnosis, RAPD), In vitro mutagenesis, protein engineering, Production of proteins from cloned genes (expression vectors, problems in E.coli, GST-MBP-His tagging for protein purification), Genetic mapping (SNPs, VNTRs, microsatellites), Microarray technique to study global gene expression, Gene Knock-out technique, Antisense & RNA interferece, brief overview of Protein array techniques. 7L+3T

3. Fermentation Technology: Batch - fed batch - continuous fermentation, Bioreactors, Largr-scale fermentation system, Harvesting and disrupting microbial cells, Down-stream processing. 31

4. Industrial Microbiology: Industrially important microbial strains, Biochemical principle for industrial production of primary metabolites (lysine, glutamic acid, vitamins, alcohol, butanol, acetone, glycerol and cirtic acid) and secondary metabolites (streptomycin and penicillin), Production of enzymes of industrial use (amylase, protease) Improvement of Microbial strains. 3I + 2T

5. Recombinant DNA in Medicine & Industry: Production of recombinant pharmaceuticals: Recombinant insulin. Human growth hormone, Complex human proteins, Antibiotics, Gene Therapy: Ex Vivo & In Vivo, Viral & non-viral gene delivery systems, Prodrug activation therapy, Nucleic acid therapeutic agents. 2L

6. Genetic Engineering of Plants: Cloning in plants: A. tumefaciens, direct nuclear transformation, chloroplast transformation. Commercial exploitation of plant transgenics: Delayed ripening, Insecticidal-herbicidal-viral-fungal resistance, Oxidative & salt-tolerant plants, Flower pigmentation, Modification of plant nutritional content (amino acids, lipids), Modification of taste & appearance (preventing discoloration, sweetness), Plants as bioreactors (antibodies, polymers, foreign proteins in seeds), Terminator technology. 3I +1T

7. Engineering Animals: Transgenic mice methodology (retroviral vector, DNA microinjection, Embryonic stem cell) & its application, transgenic cattle (sheep, goats, pigs), Transgenic birds & fish. 21

8. Ethical values, Regulation & Patenting Molecular Biotechnology

Total =24L+8T

Reference of the Books for Biotechnology and Recombinant DNA Technology

- Analysis of Genes and Genomes- Richard J Reece, JOHN WILEY & SONS, LTD., 2004. Gene Cloning : an introduction- T.A. Brown, CHAPMAN & HAL, 3rd Edition, 1995. 1.
- 2.
- Molecular Biotechnology : Principles and Applications of Recombinant DNA- B.R. Glick & J.J. Pasterak, ASM 3. PRESS, WASHINGTON, D.C., 1998.
- 4. Recombinant DNA- Watson-Gilman-Witkowski-Zoller, SCIENTIFIC AMERICAN BOOKS : W.H. FREEMAN

& COMPANY, NEW YORK, 2nd Edition, 1992.

5. Industrial Microbiology – Casida

6. Industrial Microbiology – Prescott and Dunn

Full Marks: 100

Marks: 50

3L+2T

1L

Group B Cellular Signaling

Marks : 50

1. Phosphoinositide signaling pathways, phospholipase C. Extracellular and intracellular signals, receptors, 2nd messengers, 3rd messengers, concept of transducers, effectors, GTP binding proteins---Gi, Gs, Go, Gp, Gq, Gβγ, ras, raf, rac etc. Different types of ion channels, cell junctions, structure and function of tight junctions, cell-cell adhesion, cell proliferation and gene expression, IP3 and ryanodine receptors. 4I +2T 2. Adenyl cycles, guanyl cyclase, phosphodiesterases, protein kinases--- PKC, PKA, tyrosine kinase, MAP kinases, phosphatidyl inositol kinase, phosphoinoside dependent kinase, calmodulin dependent kinase, stress activated kinase, ribosomal S6 kinase etc. Cross-talk between different signal transduction pathways. 3L+1T3. PLA₂ and its isoforms---nomenclature and pathophysiology. Arachidonic acid metabolism, eicosanoids, cyclooxygenase, liopoxygenase. Prostacycin and thrombaoxes---their role in regulating vascular tone, phospholipase D, inflammatory bowel disorders. 3L+1T 4. Endothelin, nitric oxide, transport of cytoskeletal proteins, oxidants as signal transducers. 21 5. Insulin receptor and regulation of blood glucose, transcriptional factors as signaling pathways coupled to G protein bound receptors and RTKs, activation of STATs by tyrosine kinase. 21 5. Action potential and conductance of electrical impulse, synapses and impulse transmission. Calpains and apoptosis 2L phenomena. 6. Sensory transduction--- the visual and olfactory system, memory and neurotransmitters. 7. Cell-Cell and cell-matrix interactions--- MMPs and their role. 11 8. Signal transduction pathways controlling morphogenesis and hematopoiesis. Signals controlling morphogenesis, transforming growth factor β , signals governing the differentiation of hematopoietic cell lines--- the cytokines, cytokine receptors, structure oif cytokine receptors, biological role and regulation of cytokines, chemotaxis. 3L+2T 9. Calcium signaling. Na/Ca exchangers, ATPases, Ca/H exchanger and Na/H exchanger. Capacitative Ca entry

mechanism, store operated Ca entry to a cell, receptor operated Ca entry in a cell, TRPC and CRAC channels, SERCA, cADPribose, Ca transport mechanisms in ER, mitochondria and nucleus. Mg as physiological Ca antagonist, Ca in necrosis and apoptosisn, Ca dynamics in cardiovascular and immune systems.

Total = 24L+8T

Reference of the Books for Cellular Biology

- 1. Molecular and cellular biology—Baltimore
- 2. Molecular cell biology—Darnell et al
- 3. Biochemistry--- Leninger, Cox, Nelson
- 4. Biochemistry--- Stryer
- 5. Trends in pharmacological sciences
- 6. Nature reviews

Semester 3 : (ET-3.1)

Group A

Medical Biochemistry

- In born errors in metabolism: Introduction, Metabolic disorders of carbohydrates- galactosemia, glycogen storage disease, deficiency of glucose-6-phosphate dehydrogenase, Hypoglycemia, Diabetes mellitus. Metabolic disorder of lipid: Tay-Sachs disease, Nieman Pick disease. Metabolic disorder of amino acid: phenylketonuria, alkaptonuria, Maple syrup urine disease. Metabolic disorder of nucleotides: gout, Lesch-Nyhan Syndrome.
- 2. Function of liver in health and disease: Jaundice, Hepatitis; liver function test. 4L+1T
- 3. Evaluation of organ function test: Assessment and clinical manifestation of renal, hepatic, pancreatic, gastric & intestinal function, enzyme of pancreatic origin and biliary tract, test of myocardial infarction. 3L+1T
- 4. Enzymes as clinical diagnostic tools.
- Endocrinal disturbance: protein hormones and hormones of hypothala mus, pituitary, thyroid and stero id hormones.
 3L+1T

Full Marks: 100

Marks : 50

1L

7. Antibiotics: Classification. Primary mode of action actinomycin D, mitomycin C, polyenes, mechanism	Antibiotics: Classification. Primary mode of action of penicillin, streptomycin, chloramphenicol, tetracycline, actinomycin D, mitomycin C, polyenes, mechanism of antibiotics resistance, multiple drug resistance. 5L+2T		
Reference of the Books for Medical Biochemistry	Total + 24L+8T		
 Notes on clinical chemistry- Whitby-Smith-Beekett Principle of internal Medicine- Harison T. R. McGro Antibiotics" Vol. I & II -Gotleib & Shaw. Text book of Medical Biochemistry- Ramakrishna e 	-Walker. Balackwell Sci, Inc. ow Hill, NY. et al.		
Group B			
Intermediary Metabolism	Marks: 50		
1. Energy exchange, energy rich compounds.	1L		
2. Carbohydrate metabolisms: Mechanism and regulatic glycogenesis and glycogenolysis and their regulatic metabolism of fructose, galactose etc, Entner-Doudoroff glucose homeostasis. Hormonal regulation of carbohydrat	on of glycolysis and TCA cycle pentose phosphate pathways, on, glyoxylate pathway, uronic acid pathway, R.L. cycle, pathway. Gluconeogenesis, Futile cycle. Regulation of blood e metabolism. 6L+2T		
3. Lipids: Lipid biosynthesis- biosynthesis of Triglycerid synthesis, desaturase and elongase. Fatty acid oxidatio utilization Degradation of lipid and role of phopholipase	es, phosphoglycerides and sphingolopids. Fatty acid n and lipid peroxidation. Ketone bodies- formation and 4L+1T		
4. Amino acids: Catabolic fate of 2-amino acids and t biosynthesis.	heir regulation, urea cycle and its regulation. Amino acid 4L +1T		
5. Nucleotides: Biosynthesis of purines and pyrimidine Catabolism of purines and pyrimidines. Structureand rep	es- De novo and salvage pathways and their regulation. gulation of		
ribonucleotide reductase. Biosynthesis of ribonucleotides	and deoxyribonucleotides. 6L+2T		
 Integration of different metabolic pathways. Organ spect conditions. 	ialization. Metabolism under different stress 3L+2T Total : 24L+8T		
Reference of the Books for Intermediary metabolism			
 Principles of Biochemistry - L. Stryer (W.H. Freeman & Principles of Biochemistry - A.L.Lehninger, D.W.Nelson (Macmillan) Biochemistry - D.Voet & J.G.Voet (John Willey) Harper's Illustrated Biochemistry - R.K.Murray et al. (Notematical Science) 	Со.) & M.M.Cox ЛсGraw Hill)		
Semester 3 : (ET-3.2)	Full Marks: 100		

Group A

Medical Biophysics

- 1. Mechanical properties of muscles: Muscle contractility & motility, mechanical properties of muscles, biomechanics of cardiovascular systems, respiratory pressure,, eye and ear pressures (tonometry), rheology of blood. 3L+1T
- 2. Medical Acoustics: Physical aspects of hearing, pressure amplification in the ear, the cochlea and basilar membrane as sound frequency analyzer. Hearing defects and aids. Audiometry. 4L+2T

Marks :50

3. Neurobiology: Mechanism of nerve conduction, resting and action potential, generator potential, biophysics of neural spikes, voltage clamp experiments, synaptic conduction. Electrical events in a cardiac cycle, electrical potential of the brain. Neural aspects of vision, colour vision. 4L+1T

3L+1T

- Medical Optics: Principles of optics, aberration of optical images, eye, vision, physical mechanism of image formation in retina, optical defects of the eye and their corrections. Fibre optics, principles of endoscopy and other uses of fibre optics in medical science. LASERS and Cryotopes, colonoscopy, Biometry 4L+1T
- 5. Nuclear Medicine: Application in diagnostic studies, dynamic function studies, use of radioisotopes and tracers, imaging and autoradiography in cardiology, neurology, thyroid imaging. Radiopharmaceuticals. 3L
- Non-ionizing Electromagnetic Radiations : Low frequency and high frequency effects, effects of microwaves, physiological effects of electricity Electrical properties of cells and tissues, dielectric properties of biological materials.
- 7. Medical Imaging Techniques: Basic principles and uses: X-rays, CT, USG, Eco cardiograph, MRI, PET, SPET.

3L+2T

8. Elementary concept of biosensor

1L Total : 24L+8T

Reference of the Books for Medical Biophysics

- 1. Medical Physics and Biomedical Engineering Brown, Smallwood, Barber, Lawford & Hose.
- 2. Textbook of Medical Physiology Guyton & Hall.
- 3. The Physics of Medical Imaging S.Webb(ed)
- 4. Ultrasonics: Theory and Applications G.L. Gooberman.
- 5. Intoduction to Health Physics H.Cember.
- 6. Principles of MRI Friedman, Jones, Munoz, Salmon & Merritt.
- 7. Biophysical Science Ackerman, Ellis & Williams.
- 8. Encyclopedia of Medical Devices and Instrumentation J.G.Webster(ed)
- 9. Physics in Nuclear Medicine Sorenson & Phelps.
- 10. Fundamentals of Biomechanics: Equilibrium, Motion and Deformation Ozkaya & Nordin.
- 11. Medical instrumentations: Khandeep

Group B Spectroscopy

Marks :50

- 1. Interaction of light with matter: Electromagnetic spectrum used in different spectroscopy; 2L
- Adsorption spectroscopy: Absorption spectra, Characteristic absorption spectra of some biologically important small molecules, DNA, RNA & Protein. Melting temperature of DNA; analysis of Cot curve and its implication in human diseases. Determination of binding constant of Protein-ligand or DNA-ligand interaction using absorption spectra.
- 3. Fluorescence Spectroscopy: singlet/triplet transitions, fluorescence and phosphorescence;electronic transitions, Characteristic fluorescence spectra of proteins; Quenching and quantum yield; Stern-volmer constant and determination of binding constant of protein-ligand or DNA-ligand interaction.,intrinsic and extrinsic fluorophors. ANS &bis-ANS binding of proteins and extraction of structural information of proteins.

5L+2T

- Circular dichroism: Polarization of light Plain, circular and elliptical polarization of light. Characteristic CD spectra of DNA & proteins. Measurement of 3-D conformational change of DNA and proteins using CD spectra. Interaction of protein-ligand or DNA-ligand using CD spectroscopy.
- 5. IR spectroscopy & Raman spectroscopy: Basic principles and application to biomolecules 2L
- 6. NMR spectroscopy: Nuclear magnetic moments, spin quantum number, restricted orientation of magnetic nuclei in applied field, chemical shifts, spin-spin coupling and their importance. Ring current, Application of NMR spectroscopy to - a) Small molecules and biomolecules, b) Hydrogen bonding, c) P31 NMR spectroscopy and its application in living organism, determination of ADP/ATP in the cell, PH of thecell etc. 5L+2T
- 7. ESR spectroscopy:Magnetic moment of unpaired electrons and para magnetic resonance,Hyperfine ESR spectroscopy, application to identification of radical; spin labeled probes, Fluid mosaic model of lipid bilayer and flip-flop movement 5L+2T

Total : 24L+8T

Reference of the Books for Spectroscopy

- 1. Organic Spectroscopy by William Kemp
- 2. Biophysics V. Pattabhi& N. Gautham (Narosa, New Delhi).
- 3. Quantum Chemistry- I.N. Levine, 4thEdn., (Prentice Hall, India)
- 4. Fundamentals of Molecular Spectroscopy C.N. Banwell, (Tata-McGraw Hill)
- 5. Biological Spectroscopy- I.D. Cambell& R.A. Durk, (Benjamin Cummings)
- 6. Physical Biochemistry D. Freifelder (W.H. Freeman & Co.)
- 7. Physical Biochemistry K.E. Van Holde (Prentice Hall)
- 8. Biophysical Chemistry, Vol.II C.R. Cantor & P.R. Schimmel, (W.H. Freeman & Co.)
- 9. Introduction to the Spectroscopy of Biological Polymers D.W. Jones (AcademicPress)

Semester 3 : (ET-3.3)

Group A

Structural Biology

Marks :50

Full Marks: 100

DNA Topology: Thermodynamics of DNA supercoiling, Theoretical approaches to DNA supercoiling, Knots and catenanes, DNA Bending.

Chromosome Structure: Bacterial chromatin, Nucleosome, Higher levels of eukaryotic chromatin organization. 10L + 3T

Protein analysis by mass spectrometry: Mass spectrometry (general and technical), Sample preparation, Interpretation of mass spectra, Mass analysis of intact proteins and peptides.

Peptide mapping: Cleavage of peptide bonds, Separation of peptide fragments, Electroblot procedure, Peptide sequencing strategies and tandem mass spectrometry.

Protein folding: Protein folding patterns, Thermodynamics of protein folding, Chevron plot, Molten globule, Folding funnel, Molecular chaperones.

Protein-protein and Protein-DNA interactions: Protein-protein interfaces and their properies, Structural themes in proteins-DNA binding, Protein-DNA complexes and genes regulation.

Determination of DNA-ligand interactions by: Fluorescence correlation spectroscopy (principle, instrumentation and method), Time-resolved fluorescence spectroscopy, Microcalorimetry (both DSC and ITC), Scanning force microscopy, Surface Plasmon resonance spectroscopy.

14L+5T

Total : 24 L + 8T

Total :24L+8T

Reference of the Books for Structural Biology

- 1. DNA Topology, by Andrew D Bates & Anthony Maxwell, Oxford Univ. Press
- 2. Protein Structure: A Practical Approach, Edited by T E Creighton, IRL Press.
- 3. DNA-Protein Interctions, Edited by Andrew Travers & Malcolm Buckle, Oxford Univ. Press.
- 4. Introduction to Protein Science, by Arthur M. Lesk, Oxford Univ. Press.

Group B Developmental Biology		Marks :50	
1.	Common Features of Development Gametogenesis [Meiosis, Oogenesis, Spermatogenesis]; Early Development: [Cleavage, Symmetry]; Morphogenic processes [Cell movement, cell adhesion, classification processes].	Gastrulation, Axes & of morphogenetic 4 L + 1 T	
2.	<u>Developmental commitment</u> Fate map, specification, determination, cytoplasmic determinant, Homeotic genes.	2 L + 1 T	
3.	<u>Techniques for study of Development</u> Study of gene expression by Biochemical and In Situ Methods, Cell labeling.	3 L + 1 T	
4.	Development of model organisms Drosophila, Xenopus, Zebra fish, Chick, Mouse, C. Elegans, Human.	10 L + 3 T	
5.	Organogenesis Tissue organization, Stem Cells.	4 L + 1 T	
6.	Regeneration of Missing Parts	1L+1T	

Reference Books for Developmental Biology:1. Essentials of Developmental BiologyJMW Slack2. Molecular and Cell BiologySchaum's Outlines.3. Principles of DevelopmentLewis Wolpert

Semester 3 : (HCP-3.1)

Unit 1

Recombinant DNA Technology

- 1. Artificial transformation of *E. coli* by a plasmid DNA.
- 2. Isolation of plasmid DNA from transformed bacterial cells.
- 3. Isolation of chromosomal DNA from E. coli cells.
- 4. Characterization of isolated DNAs by agarose gel electrophoresis technique.
- 5. DNA digestion by restriction endonuclease and characterization by gel electrophoresis.
- 6. Southern blotting and hybridization.
- 7. Amplification of DNA by PCR.

Unit 2 Clinical Biochemistry & Biophysics

- 1. Separation and isolation of serum and plasma from blood.
- 2. Determination of (i) blood group and (ii) Rh factor.
- 3. Determination of (i) Hemoglobin content, (ii) total count and differential count (TC/DC), (iii) erythrocyte sedimentation rate (ESR), (iv) packed cell volume (PCV).
- 4. Determination of number of RBC per mm³ in blood with standard error using a hemocytometer.
- 5. Measurement of viscosity & specific gravity of blood.
- 6. Estimation of blood glucose, Determination of serum (i) Urea, (ii) Creatinine, (iii) Uric acid, (iv) Creatinine, (v) Bilirubin (total and conjugated), (vi) Na⁺, K⁺, Mg²⁺ and Ca²⁺ content (vii) glycosylated haemoglobin.
- 7. Determination of lipid profiles: total cholesterol, LDL_c, HDL_c, Triglycerides and VLDL_c.
- 8. Estimation of serum (i) Alkaline phosphatase, (ii) LDH, (iii) GPT, (iv) GOT, and (v) Creatine kinase.
- 9. Analysis of ECG pattern.
- 10. Measurement of blood pressure under normal and stress condition.
- 11. Demonstration of exposed plates of X-ray, USG, echocardiography, CT scan, MRI, PET scan.
- 12. Determination of electrical axis of the heart from ECG tracing.
- 13. Measurement of cell diameter by Ocular micrometer.
- 14. Demonstration of fertilization process through CCTV arrangement.
- 15. Demonstration of biosensors through polygraph.

Reference of the Books for Clinical Biochemistry and Biophysics :

- 1. Experimental Biochemistry- B. S. Rao and V. Deshpande, I.K. International Pvt. Ltd.
- 2. Practical Biochemistry- David T Plummer, Tata McGraw-Hill, 1988.

Full Marks: 100

Marks; 50

Marks :50

Clinical Biochemistry & Biophysics

- 1. Separation and isolation of serum and plasma from blood.
- 2. Determination of (i) blood group and (ii) Rh factor.
- 3. Determination of (i) Hemoglobin content, (ii) total count and differential count (TC/DC), (iii) erythrocyte sedimentation rate (ESR), (iv) packed cell volume (PCV).
- 4. Determination of number of RBC per mm³ in blood with standard error using a hemocytometer.
- 5. Measurement of viscosity & specific gravity of blood.
- 6. Estimation of blood glucose, Determination of serum (i) Urea, (ii) Creatinine, (iii) Uric acid, (iv) Creatinine, (v) Bilirubin (total and conjugated), (vi) Na⁺, K⁺, Mg²⁺ and Ca²⁺ content (vii) glycosylated haemoglobin.
- 7. Determination of lipid profiles: total cholesterol, LDL_C , HDL_C , Triglycerides and

VLDL_C.

- 8. Estimation of serum (i) Alkaline phosphatase, (ii) LDH, (iii) GPT, (iv) GOT, and (v) Creatine kinase.
- 9. Analysis of ECG pattern.
- 10. Measurement of blood pressure under normal and stress condition.
- 11. Demonstration of exposed plates of X-ray, USG, echocardiography, CT scan, MRI, PET scan.
- 12. Determination of electrical axis of the heart from ECG tracing.
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Books recommended:

- 1. Experimental Biochemistry- B. S. Rao and V. Deshpande, I.K. International Pvt. Ltd.
 - 2. Practical Biochemistry- David T Plummer, Tata McGraw-Hill, 1988.

Details Syllabi for M.Sc. 4th Semester Courses in Biochemistry and Biophysics

Names of the Courses : M.Sc. in Biochemistry & M.Sc. in Biophysics

Description of each papers				
Paper		Subject Content	Marks for Each Groups	Full Marks for each Paper
	Group A	Computer Applications	50	
HCT-4.1	Group B	Bioinformatics	50	100
	Part-I	Computational Techniques	50	100
HCP-4.1	Part-II	Review Work	50	
HCP-4.2		Laboratory Work on the Project		100
	Part-I	Seminar/ Presentation on the Project work	50	100
HCP-4.3	Part-II	Grand Viva	50	

Description of each papers

Total Marks : 400

HCT : Hard Core Theoretical (Common for M.Sc. Courses in Biochemistry and Biophysics)

HCP: Hard Core Practical (Common for M.Sc. Courses in Biochemistry and Biophysics)

Department of Biochemistry and Biophysics University of Kalyani Kalyani-741235

Full Marks: 100

Marks : 50

Group A **Computational Applications**

Semester 4 : (HCT-4.1)

- Brief idea of operating systems DOS, UNIX : Definitions and Basic Commands . 6L+2T 1
- 2. Programming in FORTRAN : I/O system and CPU, Compiler, binary system, file definitions, Constants, Variables, format, Mathematical, Logical and Relational Operators, Conditional statements, DO Loops, Subroutine, arrays, arrayed variables .

18L+6T

Total =24L+8T

Reference of the Books for Computer Applications

1. Fundamentals of computers – V.Rajaraman

2. Your unix: The ultimate guide – Sumitabha Das

Group B

Bioinformatics

- 1. Biological databases: NCBI-GenBANK, PDB database
- 2. Biological sequence alignments ; pair wise and multiple sequence alignments; familiarity with BLAST, FASTA and CLUSTALW 6L+2T
- 3. Idea about Molecular Modeling and Docking

Reference of the Books for Bioinformatics

1. Bioinformatics - David W. Mount

2. Introduction to Bioinformatics - T.K. Attwood & D.J.Parry-Smith

Semester 4 : (HCP-4.1)

Part-I (Practical) **Computational Techniques** Marks: 50 Familiarity with Biological Databases- PDB, GEN Bank, Swiss Prot, Demonstrations of Sequence Alignment Techniques-BLAST, CLUSTALW Simple Programs in FORTRAN

Part-II **Review Work**

Semester 4 :(HCP-4.2)

Laboratory work on the Project

Semester 4 :(HCP-4.3)

Part-I Seminar/Presentation on the Project Work

Part-II **Grand Viva** Marks :50

Full Marks: 100

Full Marks: 100

Full Marks: 100 Marks:50

Marks:50

Marks: 50

10L+4T

8L+2T

Total: 24L+8T