SYLLABUS FOR TWO YEARS

Master's Programme

In

Biochemistry and Biophysics

2021

List of Abbreviations

COR: Core Courses

AECC: Ability Enhancement Compulsory Courses

DSE: Discipline Specific Elective

SEC: Skill Enhancement Courses

GEC: Generic Elective Courses

UNIVERSITY OF KALYANI

Semester-based Curriculum Structure under CBCS (w.e.f. Academic Session 2021-2022)

SEMESTER I

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 101	Molecular Interactions & Physicochemical techniques	Theory	4	50
COR 102	Biomolecules		4	50
COR 103	Molecular Biology		4	50
COR 104	Microbiology and Virology		4	50
COR 105	Cell Biology (I) Enzymology		2 2	25 25
COR 106	Bioenergetics and Fundamental Metabolism Statistics		2 2	25 25
COR 107	Unit1 : Physico-chemical Techniques Unit2 : Microbiology Unit3 : Virology Unit4 : Grand Viva	Practical	8	25 25 25 25
AECC	AECC		2	25
	Total		**34**	**425**

SEMESTER II

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 208	Human Physiology Cell Biology (II)	Theory	2 2	25 25
COR 209	Immunology Spectroscopy		2 2	25 25
COR 210	Unit1:Enzymology Unit2 Molecular Biology Unit3:General Biochemistry and Biophysics Unit4: Grand Viva	Practical	8	25 25 25 25
GEC (CBCS)	CBCS	Theory	4	50
DSE201	**Biochemistry (Any 2)** Advanced Metabolism Medical Biochemistry Neurobiochemistry Radiation Biology	Theory	2+2 = 4	50
	Total		**24**	**300**

SEMESTER III

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 311	Genetics	Theory	4	50
COR 312	Biotechnology & Recombinant DNA Technology		4	50
COR 313	Microscopy Cellular Signalling		2 2	25 25
COR 314	Unit1: Recombinant DNA Technology Unit2: Clinical Biochemistry and Biophysics Unit3: Immunotechniques Unit4: Grand Viva	Practical	2 2 2 2	25 25 25 25
DSE 302	**Biochemistry (Any 2)** Advanced Cell Signaling Advanced Immunology Plant Biochemistry Developmental Biology	Theory	2+2 = 4	50
SEC	Bioinformatics and Computational Biology	Theory and Practical	2	25
	Total		**26**	**325**

SEMESTER IV

Paper code	Paper	Theory/ Practical	Credit	Marks
DSE 403	Internal review work, thesis submission & presentation		8	100
DSE 404	External project work, thesis submission		8	100
DSE 405	Defense and presentation		2+2 = 4	50
	Total		**20**	**250**
	Grand Total		**104**	**1300**

COR: Core Courses, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, GEC: Generic Elective Courses, DSE: Discipline Specific Elective.

Minimum Credit must be **84 points**.

SEMESTER I

COR101

Molecular Interactions & Physicochemical Techniques Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Chemical bonds and stabilizing interactions:** Overview of atomic structure & molecular structures and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.) in biomolecules	6
2	**Water:** Properties, Structure, ionization, pKw	2
3.	**Acids and Bases:** Concept of pH, pKa, pKb, buffer solutions. Handerson-Haselbach equation. Measurement of pH.	4
4.	**Chromatography:** Overview of: Paper, TLC, partition, affinity, ion-exchange, reverse phase, gel filtration, GLC, HPLC	5
5.	**Electrophoresis**: Overview of: paper electrophoresis, agarose gel electrophoresis, SDS-PAGE, Native PAGE, capillary gel electrophoresis, Disc gel, iso-electric focusing, gradient gel, pulse field gel electrophoresis	5
6.	**Other Techniques:** Overview of: Viscosity, Dialysis, Centrifugation, Solvent fractionation, X-ray diffraction.	5
7.	**Radioisotope techniques:** Radioisotope tracer techniques, measurement of radio activity (Geiger-Muller, scintillation and gamma counters), autoradiography, safety measures.	5

Recommended Books:

1. Biochemistry — L. Stryer
2. Lehninger Principles of Biochemistry — D. L. Nelson & M.M. Cox
3. Biophysical Chemistry — D. Freifelder
4. Physical Biochemistry — van Holde
5. Biochemistry — D. Das

COR102

Biomolecules Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Carbohydrate:** Structures and biological functions of mono, polysaccharides (glycogen, starch, cellulose, Hetero polysaccharides: chondroitin sulphate, glycosamine, proteoglycan, glycoproteins).	4
2	**Lipid:** fatty acids, fats and oils, phospholipids, sphingolipids, glycolipids, cholesterol, gangliosides, lipoproteins, rancidity, acid value, saponification value, Iodine number, acetyl number, R.M. number.	4
3.	**Proteins:** Amino acids and their physico-chemical properties, Peptide bond, Primary Secondary-(Ramachandran plot, α-helix, ß-strand, ß-sheet, turns and loops)-Tertiary (ion-ion, ion-dipole and dipole-dipole, interactions)-Quaternary structures of proteins, domains, motif and folds.	9
4.	**Nucleic acid:** Nucleotides and their physico-chemical properties, double helical structure of DNA, A-B-Z forms of DNA, Repeat sequences and loops, RNA structure (primary, secondary and tertiary), ribozyme, denaturation and renaturation of DNA, chromosome structure.	9
5.	**Vitamins (Fat and water soluble):** Structure and Biological functions.	2
6.	**Micronutrients:** Physiological implications of Ca, Mg, Mn, Fe, Se, Co, Cr, Zn, Cu, Mo, sulfide and sulfate with special emphasis on Metalothionein, ceruloplasmin, ferritin, transferrin and their biological functions.	4

Recommended Books:

1. Biochemistry — L. Stryer
2. Lehninger Principles of Biochemistry — D. L. Nelson & M.M. Cox
3. Biochemistry — Harper

COR103

Molecular Biology Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**DNA replication (both prokaryotic and eukaryotic):** Different modes of replication (semi-conservative, 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).	7
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 eukaryotes.	7
3.	**Post-Transcriptional modification:** RNA splicing, Spliceosome machinery, Splicing pathway, Alternative splicing, Exon shuffling, RNA editing, m-RNA transport.	4
4.	**Translation (both pro- and eukaryotic):** m-RNA, t-RNA, Attachment of amino acids to t-RNA, Ribosome, Initiation, elongation and termination of translation, Post-translational modification.	7
5.	**Regulation of gene expression:** Principles of transcriptional regulation, different operons and their regulation. Gene regulation at steps after transcription, Regulation of lambda phage. Eukaryotic gene regulation, Control of transcriptional regulator, Gene slicing, RNA in gene regulation, transcriptional control of gene expression, epigenetic regulation.	7

Recommended Books:

1. Molecular biology of the Gene — J.D. Watson, Baker, Bell, Levine & Losick
2. Molecular Biology: Genes to proteins — B.E. Tropp
3. Molecular Biology — R. Weiver
4. Gene IX & X — L. Benjamin

COR104

Microbiology and Virology Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Micro-organisms:** 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	4
2	**Microbial growth:** Growth curve and equation, cell numbers (colony counts), cell mass., Environmental factors on growth (nutrient concentration, pH, temperature, oxygen concentration, pressure and radiation), Chemostat, Turbidostat.	3
3.	**Pro- & Eukaryotes:** 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, eukaryotic cell structure (External cell coverings, Cilia and Flagella), Comparison of prokaryotic and eukaryotic cells	2
4.	**Microbial spores:** Endospores and exospores, their properties and germination.	1
5.	**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 commensalism).	3
6.	**Extreme environment microbes:** Anaerobes, Halophiles, Thermophiles, Acidophiles and Alkyliphiles.	1
7.	**Biogeochemical roles of microbes:** Carbon, nitrogen and sulfur cycles; Nitrogen fixation and its mechanism.	2
8.	**Microbiology of water, air, soil and milk.**	1
9.	**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.	3
10.	**Bacteriophages:** Discovery, Structures, Plaques, Host specificity, Life cycles of bacteriophages: Virulent phages (T4, T7, ϕX174, RNA phage), Lysogenic phages (λ, P1), Chronic phage (M13).	6

11.	**Eukaryotic Virus:** Basic structures, Life cycles of RNA viruses (Vesicular Stomatitis Virus, Poliovirus, Reovirus, Retrovirus) and DNA viruses (Simian Virus 40, Adenovirus).	2
12.	**Viral Diseases:** Human viral pathogens, Factors behind incidence and severity, Acute infection (gastrointestinal, respiratory, liver), Systemic spread, HIV and Aids, Viral oncogenes.	2
13.	**Diagnosis, Vaccines and Antivirals**	2

Recommended Books:

1. Microbiology — M.J. Pelczar
2. Microbiology — L.M. Prescott
3. Fundamental Principles of Bacteriology — A. J. Salle
4. Molecular Biology: Genes to proteins — B. E. Tropp
5. Molecular Biology — D. Freifelder

COR105

Cell Biology (I) Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Origin and evolution of Cell:** Prokaryotes, eukaryotes, development of multicellular organisms	1
2	**Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	4
3.	**Cell membrane:** Membrane lipids & proteins, matrix adhesion proteins, glycoproteins, receptors. Lipid mobility. Phospholipids, glycolipids and spingolipids in membranes. Membrane carbohydrate, liposome.	3
4.	**Transport of small molecules:** Passive-facilitated-carrier mediated diffusion, symport, antiport and co-transport, ion channels, ionophores, 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.	5
5.	**Cytoskeleton**: Structure and organization of actin filaments, actin, myosin and cell movement, sarcoplasmic reticulum in muscle contraction, intermediate filaments, microtubules, microtubule motor and movement.	3

Recommended Books:

1. Molecular Cell Biology — H. Lodish & D. Baltimore
2. The Cell — B. Alberts
3. Molecular Cell Biology — Karp
4. Cell Biology — Cooper
5. Cell Biology — Pollard

COR105

Enzymology Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Overview of enzymes:** Classification and nomenclature of enzymes, properties of enzymes and the use of cofactors. Enzyme units and turnover of enzymes.	3
2	**Catalytic site:** Lock and key or template model, induced fit model, Role of metal ions, metalloenzymes and metal activated enzymes; ternary enzyme-metal substrate complexes, enzyme bridge complexes (M-Enz-S), substrate bridge complexes (Enz-S.M), metal-bridge-complexes (Enz-S.M), role of metal ions in catalysis, Vitamins as coenzymes.	4
3.	**Catalysis:** Factors affecting catalytic efficiency of enzymes (pH, Temperature etc.) Michaelis-Menten equation, activators, inhibitors, inhibition reactions and their kinetics, allosteric and feedback inhibition, competitive, non-competitive, un-competitive and mixed type inhibition, kcat/km – a measure of catalytic efficiency.	6
4.	**Specialized Enzymes:** Isoenzymes, regulatory enzymes, regulation of enzyme activity, trypsinogen –chymotrypsinogen – pepsinogen. Carboxyanhydrase.	3

Recommended Books:

1. Biochemistry L. Stryer
2. Lehninger Principles of Biochemistry D. L. Nelson & M.M. Cox

COR106

Bioenergetics and Fundamental Metabolism Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Bioenergetics:** Organization and function of mitochondria, endosymbioant hypothesis for the biogenesis of mitochondria, electron transport chain, mechanism of oxidative phosphorylation, chemiosmotic hypothesis, respiratory chain inhibitors, coupled reaction, uncouplers, biological energy transducers.	8
2	**Fundamentals of metabolisms:** Metabolism of carbohydrates, amino acids, lipids and nucleotides. Outlines of glycolysis and TCA cycle.	8

Recommended Books:

1. Biochemistry L. Stryer
2. Lehninger Principles of Biochemistry D. L. Nelson & M.M. Cox

COR106

Unit – 8: Statistics Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**General Statistical Methods:** Frequency Distribution. Measures of central tendency. Measures of dispersion. Theoretical distributions (Binomial, Poisson and Normal), Sampling variation.	6
2	**Statistical evaluation of results:** Estimation of standard error, confidence limits, significance tests	4
3	**Tests:** 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, χ^2 –test of goodness of fit, chi-square test, ANNOVA, Correlation and linear regression, method of least squares.	6

Recommended Books:

1. Statistics Goon & Goon
2. Statistics Goon & Das
3. Biostatistics D. Das

COR107 (Practical)

Unit – 1: Physico-chemical Techniques Credit: 2, Marks: 25

Sl. No.	Courses and Coverage
1	**pH metric titration of Glycine to determine its isoelectric point**
2	**Conductometric titration of KCl with $AgNO_3$ to determine unknown strength of solution**
3	**Verification of Beer's laws using crystal violet solution**
4	**Actinometric determination of dose rate of a Ultraviolet light source**
5	**To draw the characteristic curve of a GM Counter to determine its plateau characteristics**
6	**To isolate hemoglobin from blood and draw its absorption spectrum**

Unit – 2 : Microbiology Credit:2, Marks:25

Sl. No.	Courses and Coverage
1	**Microbial techniques:** Sterilization, media preparation, preparation of slants and stabs, pouring of medium into plates, subculturing
2	**Isolation of microorganisms:** From soil & water of different places. Serial dilution, plating for counting colonies. Single colony isolation techniques and its prevention.
3	**Examination of microorganisms:** Simple staining, Gram staining, Acid Fast Staining. Endospore staining, staining of flagella, staining of capsule, staning of fungi, localization of root nodule bacteria by staining
4	**Bacterial growth studies:** Bacterial number counting by haemocytometer and colony counting, bacterial growth curve by spectrophotometry, determination of germination time
5	**Antibiotic sensitivity tests:** Paper disc/cup method, MIC determination

Recommended Books
Experiments in Molecular Genetics J. H. Miller

Unit– 3: Virology Credit:2, Marks:25

Sl. No.	Courses and Coverage
1	**Preparation of bacteriophage ϕX 174 stock**
2	**Assay of bacteriophage ϕX 174 stock**
3	**Lytic curve of *E.coli* by ϕX 174**
4	**UV inactivation of bacteriophage ϕX 174**
5	**Repair of UV-inactivated bacteriophage ϕX 174**

Recommended Books
Experiments in Molecular Genetics J. H. Miller

Unit – 4: Grand Viva Credit: 2, Marks: 25

AECC- Credit: 2, Marks: 25

Semester-II

COR208

Human Physiology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**General anatomical interrelationship of organs**	**2**
2	**Nutrition:** Autotrophy, Digestion of food, BMR	**1**
3	**Excretion**: Nephron, Urine formation, Micturition, Electrolyte balance.	**2**
4	**Respiration:** Transport of oxygen and carbon dioxide in blood, regulation of acid-base balance.	**2**
5	**Cardiovascular system:** Cardiac cycle, neural and chemical regulation	**2**
6	**Blood circulation:** Blood composition and functions, Blood corpuscles, haemopoiesis, plasma function, blood volume, blood group, hemoglobin, Mechanism of blood clotting, formation and maturation of WBC and RBC,	**3**
7	**Endocrine glands and their functions**	**2**
8	**Reproduction**	**2**

Recommended Books:

1. **Human physiology** **Guyton & Hall**
2. **Physiology** **Berne and Levy**
3. **A text book of medical physiology** **Indu Khurana**
4. **A text book of medical physiology** **W F Ganong**

COR208

Cell Biology (II) **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**The cell cycle**: Phases of cell cycle, M-phase: mitosis and cytokinesis, prophase, metaphase, anaphase, telophase. Regulation of the cell cycle by growth factors and extracellular signals, Cyclins and CDKs in cell cycle regulation. Cell cycle Checkpoints and its activation. Apoptosis; Caspases, pro and antiapoptotic genes, Mitochondria dependent and independent pathways, regulation of apoptosis, senescence. **Cancer:** Defective control of cell death and differentiation, metastasis, communication of cancer cells with normal cells.	**4**
2	**Endoplasmic reticulum (ER):** Protein secretion from ER, 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.	**2**
3	**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.	**2**
4	**Vesicular transport**: Understanding of vesicular transport, cargo selection, cont proteins and vesicle budding, vesicle fusion.	**2**
5	**Lysosomes**: Lysosomal acid hydrolases, endocytosis and lysosome formation, phagocytosis and autophagy. Disorders resulting from defects in lysosomal function.	**2**
6	**Peroxysomes**: Functions of peroxysomes, peroxysomes assembly. Diseases that result from abnormal mitochondrial and peroxysomal function.	**2**
7	**Extracellular matrix and adhesion molecules:** Cytoskeletal proteins and their functions**,** myofibrillar and their junction in cell shape and contraction, mechanism of muscle contraction.	**2**

Recommended Books:

1.	**Molecular Cell Biology**	**H. Lodish & D. Baltimore**
2.	**The Cell**	**B. Alberts**
3.	**Molecular Cell Biology**	**Karp**
4.	**Cell Biology**	**Cooper**
5.	**Cell Biology**	**Pollard**

COR209

Immunology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Introduction of immune systems:** Cells and organs of immune system.	**1**
2	**Lymphocytes:** Differentiation, lymphocyte-sub-populations. T and B cells and their antigens	**1**
3	**APC cells, Phagocytic cells, macrophage, dendritic cells, K and NK cells.** Macrophage activation, pattern recognition molecules (TLR, NLR, RIRs)	**2**
4	**Types of immunity:** Innate-adaptive-passive-active immunity, self-vs. Non-self-discrimination. An overview	**2**
5	**Antigenicity of molecules:** immunogen vs. Antigen, characteristics and types of antigens, Epitope.	**2**
6	**Immunoglobulins:** Molecular structure, Classification and function, Antigen-antibody reactions.	**2**
7	**MHC molecules :** Structure , function, MHC polymorphism	**2**
8	**Immunological techniques:** Hybridoma technique for monoclonal antibody production; Precipitation reactions, Radial immunodiffusion, double immunodiffusion, Immunoelectrophoresis, agglutination reaction, ELISA, RIA, Immunoelectrophoretic techniques, agglutination, immunodiffusion, immunofluoresence, western blot, immunohistochemistry, flow cytometry.	**2**
9.	**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	**2**

Recommended Books:

1. Immunology - Goldsby-Kindt-Osborne –Kuby

2. Cellular and Molecular Immunology- Abbas-Lichtman-Pober, W.B Sauders

3. Immunology – Roitt

COR209

Spectroscopy **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Interaction of light with matter**: Electromagnetic spectrum used in different spectroscopy.	**1**
2	**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.	**6**
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.	**6**
4	**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.	**3**

Recommended Books:

1. **Organic Spectroscopy** — **W. Kemp**
2. **Physical Biochemistry** — **D. Freifelder**
3. **Fundamentals of Molecular Spectroscopy** — **C.N. Banwell**
4. **Biological Spectroscopy** — **I.D. Cambell et al**
5. **Introduction to the Spectroscopy of Biological Polymers -** — **D.W. Jones**

COR210

Unit1: Enzymology **Credit-2 Marks – 25**

Sl. No.	Courses and
1	**Kinetic characteristics of phosphatase**
2	**Progress curve of Alkaline Phosphatase.**
3	**Effect of temperature on the activity of Alkaline Phosphatase.**
4	**Determination of pH optimum for Alkaline Phosphatase.**
5	**Determination of Km and Vmax of Alkaline Phosphatase.**
6	**Determination of specific activity of Alkaline Phosphatase.**
7	**Assay of Lactate Dehydrogenase (LDH)**

Recommended Books:

Practical Enzymology **Hans Bisswanger**

Unit2: Molecular Biology **Credit-2 Marks – 25**

Sl. No.	Courses and
1	**Time course of beta-galactosidase induction in *E.coli***
2	**Effect of membrane perturbants on Lac-permease activity**
3	**SDS-PAGE of protein**
4	**Measurement of membrane potential (Bacteria and Cell lines)**

Recommended Books:

Molecular Biology Experiments **Slater et al.**

Unit3: General Biochemistry & Biophysics **Credit-2 Marks – 25**

Sl. No.	Courses and
1	**Estimation of protein by a) Lowry, BCA, Bradford and UV methods.**
2	**Estimation of DNA by diphenylamine.**
3	**Estimation of RNA by orcinol reagent.**
4	**Separation, identification and estimation of lipids by TLC.**
5	**Separation, identification and estimation of free amino acids by paper chromatography.**
6	**Sub-cellular fractionation of different sub-organelles from tissues such as liver and heart.**
7	**Marker enzyme studies of different sub-organelles.**
8	**Separation of proteins by SDS-PAGE.**
9	**Estimation of ascorbic acid.**
10	**Purification of I_g from blood sample**

Recommended Books:

Practical Biochemistry **D. T. Plummer**

Unit4: Grand Viva **Credit-2 Marks – 25**

GEC (CBCS) **Credit-4 Marks – 50**

DSE201 **Any two from the following** **Credit-4, Marks: 50**

Advanced metabolism **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Energy exchange, energy rich compounds.**	**1**
2	**Carbohydrate metabolisms:** Mechanism and regulation of glycolysis and TCA cycle pentose phosphate pathways, glycogenesis and glycogenolysis and their regulation, glyoxylate pathway, uronic acid pathway, R.L. cycle, metabolism of fructose, galactose etc, Entner-Doudoroff pathway. Gluconeogenesis, Futile cycle. Regulation of blood glucose homeostasis. Hormonal regulation of carbohydrate metabolism.	**4**
3	**Lipids:** Lipid biosynthesis- biosynthesis of Triglycerides, phosphoglycerides and sphingolopids. Fatty acid synthesis, desaturase and elongase. Fatty acid oxidation and lipid peroxidation. Ketone bodies- formation and utilization. Degradation of lipid and role of phopholipase.	**3**
4	**Amino acids:** Catabolic fate of □-amino acids and their regulation, urea cycle and its regulation. Amino acid biosynthesis.	**3**
5	**Nucleotides:** Biosynthesis of purines and pyrimidines- De novo and salvage pathways and their regulation. Catabolism of purines and pyrimidines. Structure and regulation of ribonucleotide reductase, Biosynthesis of ribonucleotides and deoxyribonucleotides.	**3**
6	**Integration of different metabolic pathways. Organ specialization. Metabolism under different stress conditions.**	**2**

Recommended Books:

1. **Principles of Biochemistry** **D. L. Nelson & M.M. Cox**
2. **Biochemistry** **Harper**
3. **Molecular Cell Biology** **H. Lodish & D. Baltimore**

Medical Biochemistry **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Metabolic disorders of –** **Carbohydrates:** Galactosemia, glycogen storage disease, deficiency of glucose-6- phosphate dehydrogenase, Hypoglycemia, Diabetes mellitus. **Lipids:** Tay-Sachs disease, Nieman Pick disease. **Amino acids:** Phenylketonuria, alkaptonuria, Maple syrup urine disease. **Nucleotides:** Gout, Lesch-Nyhan Syndrome.	**5**
2	**Function of liver in health and disease:** Jaundice, Hepatitis; liver function test.	**1**
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. Test of myocardial infarction.	**2**
4	**Enzymes as clinical diagnostic tools.**	**1**
5	**Endocrinal disturbance:** Protein hormones and hormones of hypothalamus, pituitary, thyroid and steroid hormones.	**2**
6	**Different types of anemia and mechanisms of their pathogenesis.**	**2**
7	**Antibiotics: Classification:** Primary mode of action of penicillin, streptomycin, chloramphenicol, tetracycline, actino mycin D, mitomycin C, polyenes, mechanism of antibiotics resistance, And multiple drug resistance.	**3**

Recommended Books:

1. **Pharmacology and Experimental Therapy:** **Goodman & Gilmann**
2. **Textbook of Medical Physiology** **Guyton & Hall**

Neurochemistry **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Nervous system: Different parts of neuron and its function, types of glia and their function, chemical composition of myelin and differences in myelinated and unmyelinated neurons, blood brain barrier, different nerve fibers in mammalian system. Brain organization -CNS, PNS.	**3**
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, schizophrenia, Huntington's, Alzheimer's), Cerebrovascular disease (stroke).	**5**
3	Meninges, carbohydrate and energy metabolism in brain, transport of amino acid, protein, nucleic acids, metabolites in brain, biochemistry of synaptic junctions, influence of different factors (growth factors, hormones, cytokines) in brain functions.	**4**
4	Reflexes and Sensation pain & temperature	**2**
5	CNS active drugs-Their classification and mode of action.	**2**

Recommended Books:

1. **Pharmacology and Experimental Therapy:** **Goodman & Gilmann**
2. **Textbook of Medical Physiology** **Guyton & Hall**

Radiation Biology Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
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.	**2**
2	**Dose:** Exposure dose, absorbed dose, effectiveness of different radiation LET, RBE.	**1**
3	**Effect of Radiation on Water:** Direct and indirect action of rradiation, chemical dosimetry.	**2**
4	**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).	**4**
5	**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.	**3**
6	**Radiation Protection and Tumor Radio Therapy.**	**2**
7	**Interaction of Non-ionizing Radiation with Matter:** Ozone depletion**,** UV and visible light sources, action spectra, effects on cells, biomolecules.	**2**

Recommended Books:

1. **Radiation Biophysics** — **E. L. Alpen**
2. **Radiation Detection & Measurement** — **G. F. Knoll**
3. **Radiation Biology** — **Dertinger and Jung**

SEMESTER III

COR 311

Genetics Credit-4 Marks – 50

Sl. No.	Courses and Coverage	Class Allotted
1	Mendelian Genetics, Population Genetics, Evolution, speciation Organization of Human	**8**
2	**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.	**6**
3	**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**.**	**7**
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.	**7**
5	**Gene transfer :** Transformation , Conjugation, Transduction	**4**

Recommended Books:

1. **Microbial Genetics** — **D. Freifelder**
2. **New Chemical Genetics** — **Read &**
3. **DNA repair** — **Friedberg**
4. **Genetics** — **Gardner**

COR312

Biotechnology and Recombinant DNA Technology **Credit-4 Marks – 50**

Sl. No.	Courses and Coverage	Class Allotted
1	**Tools :** Plasmids (F, R & Col plasmids, 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.).	**8**
2	**Techniques**: Isolation & purification of plasmid & genomic 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 interference, brief overview of Protein array techniques.	**12**
3	**Fermentation Technology:** Batch – fed batch – continuous fermentation, Bioreactors, Large-scale fermentation system, Harvesting and disrupting microbial cells, Down- stream processing.	**3**
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.	**4**
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.	**3**
6	**Engineering Animals:** Transgenic mice methodology (retroviral vector, DNA	**2**

Recommended Books:

1.	**Gene Cloning**	**T.A. Brown**
2.	**Molecular Biology: Genes to Proteins**	**B. E. Tropp**
3.	**Industrial Microbiology**	**Casida**
4.	**Industrial Microbiology**	**Prescott and Dunn**

COR313

Microscopy Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
1	**Light microscopy:** Bright Field, dark field & phase contrast microscopy, resolving power & magnification.	**4**
2	**Fluorescence & Confocal Microscopy**	**3**
3	**Electron microscopy:** Working Principle, Image formation process and Contrast, Image Defects, Optimum Resolution, Sample preparation and contrast enhancement techniques.	**5**
4	**Working principles of SEM, STEM, STM, AFM**	**4**

Recommended Books:

Introduction to Electron microscopy **Saul Wischnitzer**

COR313

Cellular Signaling Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
1	Introduction of cell signaling**:** cAMP pathway: second messenger and protein phosphorylation. InsP3 and protein kinase C. InsP3 receptor and ryanodine receptors. Hormones and their receptors. Cell surface receptors, signaling through G-protein coupled receptors. Receptor tyrosine kinases, cytokine receptors and non-receptor tyrosine kinases.	**4**
2	Mechanisms of action of cholera toxin and pertussis toxin. cGMP and nitric oxide. Cross-talk between different signaling systems. Redox and nitrosylation switches in signal transduction. Phosphodiesterases and phosphatases as regulators of signal transduction. Protein kinase families in vertebrates: an overview. Steroid hormones and nuclear receptor superfamily.	**4**
3	Regulation of phospholipase A2, phospholipase C and phospholipase D activity. Role of ADP ribosylationm factor, guanine nucleotide exchange factor and guaninine nucleotide activating protein in regulating phospholipase D activity.	**4**
4	Cellular Ca^{2+} regulation**.** Ca^{2+} as intracellular messenger, Integration of receptor, non-receptor and store operated Ca^{2+} entry mechanism. Cellular Ca^{2+} entry and efflux mechanisms involving plasma membrane Na/K-ATPase, plasma membrane Ca^{2+} ATPase, sarco (endo)plasmic reticular Ca^{2+} ATPase, Na^{+}/H^{+} exchanger, Na^{+}/ Ca^{2+} exchanger and voltage gated Na^{+}, K^{+} and Ca^{2+} channels in regulating intracellular Ca2+ dynamics. Regulation of mitochondrial Ca^{2+} dynamics. Concepts of redox regulation and pore formation in mitochondrial Ca^{2+} dynamics. Regulation of intracellular Ca^{2+} by cADP ribose.	**4**

Recommended Books:

1. Calcium in signal regulation:	**Edited by E. Carafoli and C. Klee**
2. Cellular signaling:	**F. Merks, U. Klingmuller, K.M. Decker**
3. Signal transduction:	**Edited by C. H. Heldin, M. Ourton**
4. Current topics in cellular regulation—Vol 31:	**Edited by B. L. Horecker, E.R. Stadtman, B. Chocks and B. Chocksand**
5. Biochemistry:	**J. M. Berg, J. L. Tymoczko**
6. Molecular Cell Biology	**Darnell-Lodhis-Baltimore**
7. Biochemistry:	**L. Stryer**
8. The cell:	**B. Alberts**
9. The cell molecular approach:	**Geoffrey Cooper**
10. Cell:	**B. Lewin, L. Cassimeris, V. R. Lingappa, G. Plopper**

COR314

Unit1: Recombinant DNA Technology Credit-2 Marks – 25

Sl. No.	Courses and
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	**Amplification of DNA by PCR.**

Recommended Books:

Molecular Cloning **J. Sambrook & D. W. Russell**

Unit2: Clinical Biochemistry & Clinical Biophysics Credit-2 Marks – 25

Sl. No.	Courses and
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 mm^3 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^+ Mg^{2+}, and Ca^{2+} 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 and determination of electrical axis of the heart from ECG tracing.**
10	**Measurement of blood pressure under normal and stress condition.**

Recommended Books:

1.	**Experimental Biochemistry**	**B. S. Rao and V. Deshpande**
2.	**Practical Biochemistry**	**D. T. Plummer**

Unit3: Immunotechniques Credit-2 Marks – 25

Sl. No.	Courses and
1	**Ouchterlony double diffusion**
2	**Radial immunodiffusion**
3	**Rocket immunoelectrophoresis**
4	**Agglutination assay**
5	**ELISA**
6	**Western Blot**

Recommended Books:

Immunology and Immunotechnology **A. K Chakraborty**

Unit4: Grand Viva **Credit-2 Marks – 25**

DSE 302 **Any two from the following** **Credit-4, Marks: 50**

Advanced cell signaling **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Signaling by growth factors—epidermal growth factor, nerve growth factor, platelet derived growth factor, insulin growth factor and fibroblast growth factor.	**3**
2	Glycogen synthase kinase (GSK), AMP kinase, PI-3 kinase, Akt and mTOR pathways in signal transduction and their relevance in different disease pathogenesis.	**3**
3	Molecular and cellular basis of oxidants-mediated cardiovascular, pulmonary and neuronal systems. Protective role of Mg^{2+} in cardiovascular diseases. the competition between sympathetic and parasympathetic signals. Alpha-adrenergic and beta- adrenergic receptors. Muscarinic acetylcholine receptor, Cytokine receptors associated tyrosine kinase in JAK/STAT and TGF/Smad pathways. Hedgehog, Wnt and Notch pathways	**5**
4	Protein acetylation and protein ubiquitinylation. Integrins sensors of signals for the extracellular matrix. Transcription factors as hormone receptor, The nuclear receptor family and activation of gene transcription. Ligand controlled transcription factor- Xenosomes of the toxic stress response. Peroxysome proliferator activated receptors. Antioxidant response element. Activation of steroid hormone receptors by HSP70 and HSP 90. eiF2 kinase. Ras subfamily of G proteins. Control of gene transcription by Ca^{2+}.	**5**

Recommended Books:

1. **Molecular Cell Biology** — **H. Lodish & D. Baltimore**
2. **Principles of Biochemistry** — **D. L. Nelson & M.M. Cox**
3. **Biochemistry** — **L. Stryer Recommended Books**
4. **Calcium in signal regulation:** — **Edited by E. Carafoli and C. Klee**
5. **Cellular signaling:** — **F.Merks, U. Klingmuller, K.M. Decker**
6. **Signal transduction:** — **Edited by C.H.Heldin, M. Ourton**
7. **Current topics in cellular regulation—Vol 31:** — **Edited by B.L.Horecker, E.R.Stadtman et al.**
8. **Biochemistry:** — **J.M.Berg, J.L.Tymoczko**
9. **The cell:** — **B. Alberts**
10. **The cell molecular approach:** — **Geoffrey Cooper**

11. Cell:	**B. Lewin, L. Cassimeris, V. R. Lingappa, G. Plopper**

Advanced Immunology Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
1	**B cell development, activation, differentiation**: Antibody gene expression and antibody diversity, B cell receptor, monoclonal and polyclonal antibody, abzymes. T-cell development, activation and differentiation, T-cell receptor expression and gene rearrangement, T- cell selection in thymus, T-cell receptor function, TCR-Antigenic peptide interaction, super antigens.	**4**
2	**Antigen processing and presentation:** Antigen presenting cells, MHC class I processing pathway and MHC class II processing pathway, Antigen presentation to T Cells.	**1**
3	**Complement vs. cell mediated lysis:** Complement pathways, biologic consequence of complement activation, regulatory mechanisms, cell mediated cytotoxicity, necrosis, apoptosis, Cytokines and cell mediated immunity, Th subsets, Immediate hypersensitivity, allergic response, TypeI to Type IV hypersensitivity, Delayed type hypersensitivity; Cell mediated immunity, T cell subsets, antigen specific components of DTH, regulation of DTH	**4**
4	Microbial Immunity and immunoparasitology, Non-specific immunity and specific immunity, bacterial, viral and parasitic infection, development of new treatments for human diseases related to immune dysfunction.	**2**
5	**Autoimmunity & Transplantation Immunology:** B cell tolerance, T cell tolerance, clonal deletion, clonal anargy, B cell associated autoimmune diseases, mechanism of breaking B cell tolerance, molecular mimicry, Transplantation, Transplant rejection, tissue compatibility, histocompatibility antigens in transplantation, Graft vs host rejection, mediators of rejection, immunesuppression.	**3**
6	**Tumor immunobiology:** Cancer and immune system, tumor specific antigens, immnuosuppresion in tumor microenvironments, immunotherapy of cancer using monoclonal antibody and cytokines, NK and dendritic cells in cancer, Immune deficiency disorder – Phagocytic cell defects, B and T cell deficiency disorder, combined B and T cell deficiency disorder, secondary immunodeficiency conditions, complement deficiency.	**2**

Recommended Books:

1. **Immunology** — **Goldsby-Kindt-Osborne–Kuby**
2. **Cellular and Molecular Immunology** — **Abbas-Lichtman-Pober, W.B Sauders**
3. **Immunology** — **Roitt**

Plant Biochemistry Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
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, photosystems I and II, energy transfer between photosystems-ferridoxin, plastocyanin, plastoquinone, and carotenoid. The Hill reaction, photophotophosphorylation and reduction of CO2, C3, C4 and CAM metabolism, light and dark reactions. Light activation of enzymes regulation of photosynthesis, photorespiration.	**4**
2	**Biological nitrogen fixation and ammonia assimilation:** Mechanism of biological nitrogen fixation, Nitrogen fixing enzyme and its structure , Nif gene and Fix gene and its regulation in nitrogen fixation, ammonia assimilation.	**2**
3	**Translocation of inorganic and organic substances**	**2**
4	**Plant hormones:** Growth regulation substances and their mode of action. Molecular effects of 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.	**3**
5	**Defense systems in plants.**	**2**
6	**Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.	**3**

Recommended Books:

Plant Biochemistry & Molecular Biology H. W. Heldt

Developmental Biology Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
1	**Features of Development:** Gametogenesis [Meiosis, Oogenesis, Spermatogenesis]; Early Development [Cleavage, Gastrulation, Axes & Symmetry]; Morphogenic processes [Cell movement, cell adhesion, classification of morphogenetic processes].	**4**
2	**Developmental commitment:** Fate map, specification, determination, cytoplasmic determinant, homeotic genes.	**2**
3	**Techniques for study of Development:** Study of gene expression by Biochemical and In Situ Methods, Cell labeling.	**3**
4	**Development of model organisms:** Drosophila, Xenopus, Mouse, C. elegans	**4**
5	**Organogenesis:** Tissue organization, Stem Cells.	**3**

Recommended Books:

1. **Essential Developmental Biology J. M. W. Slack**

SEC Bioinformatics and Computational Biology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Biological databases: NCBI-GenBank, PDB database, Uniprot, Pubmed	**2**
2	Biological sequence alignments; pair wise and multiple sequence alignments; familiarity with BLAST, FASTA and CLUSTALW.	**6**
3	Overview of molecular modeling: Basic principles of molecular modeling; Overview of QSAR	**6**
4	Idea of docking: Basic principles, rigid body and flexible docking	**2**

Recommended Books:

1. Bioinformatics- David W Mount
2. Introduction to Bioinformatics- Angshuman Bagchi

SEMESTER IV

Paper code	Paper	Practical	Credit	Marks
DSE 403	Internal review work, thesis submission & presentation		8	100
DSE 404	External project work, thesis submission		8	100
DSE 405	Defense and presentation		2+2 = 4	50
	Total		**20**	**250**

UNIVERSITY OF KALYANI

Semester-based Curriculum Structure under CBCS (w.e.f. Academic Session 2021-2022)

SEMESTER I

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 101	Molecular Interactions & Physicochemical techniques	Theory	4	50
COR 102	Biomolecules		4	50
COR 103	Molecular Biology		4	50
COR 104	Microbiology and Virology		4	50
COR 105	Cell Biology (I) Enzymology		2 2	25 25
COR 106	Bioenergetics and Fundamental Metabolism Statistics		2 2	25 25
COR 107	Unit1 : Physico-chemical Techniques Unit2 : Microbiology Unit3 : Virology Unit4 : Grand Viva	Practical	8	25 25 25 25
AECC	AECC		2	25
	Total		**34**	**425**

SEMESTER II

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 208	Human Physiology Cell Biology (II)	Theory	2 2	25 25
COR 209	Immunology Spectroscopy		2 2	25 25
COR 210	Unit1:Enzymology Unit2 Molecular Biology Unit3:General Biochemistry and Biophysics Unit4: Grand Viva	Practical	8	25 25 25 25
GEC (CBCS)	CBCS		4	50
DSE201	**Biophysics (Any 2)** Crystallography Mathematical Methods Medical Biophysics Radiation Biology	Theory	2+2 = 4	50
	Total		**24**	**300**

SEMESTER III

Paper code	Paper	Theory/ Practical	Credit	Marks
COR 311	Genetics	Theory	4	50
COR 312	Biotechnology & Recombinant DNA Technology		4	50
COR 313	Microscopy Cellular Signaling		2 2	25 25
COR 314	Unit1: Recombinant DNA Technology Unit2: Clinical Biochemistry and Biophysics Unit3: Immunotechniques Unit4: Grand Viva	Practical	2 2 2 2	25 25 25 25
DSE 302	**Biophysics (Any 2)** Advanced Spectroscopy Biostatistical methods Structural Biology Developmental Biology	Theory	2+2 = 4	50
SEC	Bioinformatics and Computational Biology	Theory and Practical	2	25
	Total		**26**	**325**

SEMESTER IV

Paper code	Paper	Theory/ Practical	Credit	Marks
DSE 403	Internal review work, thesis submission & presentation		8	100
DSE 404	External project work, thesis submission		8	100
DSE 405	Defense and presentation		2+2 = 4	50
	Total		**20**	**250**
	Grand Total		**104**	**1300**

COR: Core Courses, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, GEC: Generic Elective Courses, DSE: Discipline Specific Elective.

Minimum Credit must be **84 points**.

SEMESTER-I

COR101

Molecular Interactions & Physicochemical Techniques Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Chemical bonds and stabilizing interactions:** Overview of atomic structure & molecular structures and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.) in biomolecules	6
2	**Water:** Properties, Structure, ionization, pKw	2
3.	**Acids and Bases:** Concept of pH, pKa, pKb, buffer solutions. Handerson-Haselbach equation. Measurement of pH.	4
4.	**Chromatography:** Overview of: Paper, TLC, partition, affinity, ion-exchange, reverse phase, gel filtration, GLC, HPLC	5
5.	**Electrophoresis**: Overview of: paper electrophoresis, agarose gel electrophoresis, SDS-PAGE, Native PAGE, capillary gel electrophoresis, Disc gel, iso-electric focusing, gradient gel, pulse field gel electrophoresis	5
6.	**Other Techniques:** Overview of: Viscosity, Dialysis, Centrifugation, Solvent fractionation, X-ray diffraction.	5
7.	**Radioisotope techniques:** Radioisotope tracer techniques, measurement of radio activity (Geiger-Muller, scintillation and gamma counters), autoradiography, safety measures.	5

Recommended Books:

1. Biochemistry — L. Stryer
2. Lehninger Principles of Biochemistry — D. L. Nelson & M.M. Cox
3. Biophysical Chemistry — D. Freifelder
4. Physical Biochemistry — van Holde
5. Biochemistry — D. Das

COR102

Biomolecules Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Carbohydrate:** Structures and biological functions of mono, polysaccharides (glycogen, starch, cellulose, Hetero polysaccharides: chondroitin sulphate, glycosamine, proteoglycan, glycoproteins).	4
2	**Lipid:** fatty acids, fats and oils, phospholipids, sphingolipids, glycolipids, cholesterol, gangliosides, lipoproteins, rancidity, acid value, saponification value, Iodine number, acetyl number, R.M. number.	4
3.	**Proteins:** Amino acids and their physico-chemical properties, Peptide bond, Primary Secondary-(Ramachandran plot, α-helix, ß-strand, ß-sheet, turns and loops)-Tertiary (ion-ion, ion-dipole and dipole-dipole, interactions)-Quaternary structures of proteins, domains, motif and folds.	9
4.	**Nucleic acid:** Nucleotides and their physico-chemical properties, double helical structure of DNA, A-B-Z forms of DNA, Repeat sequences and loops, RNA structure (primary, secondary and tertiary), ribozyme, denaturation and renaturation of DNA, chromosome structure.	9
5.	**Vitamins (Fat and water soluble):** Structure and Biological functions.	2
6.	**Micronutrients:** Physiological implications of Ca, Mg, Mn, Fe, Se, Co, Cr, Zn, Cu, Mo, sulfide and sulfate with special emphasis on Metalothionein, ceruloplasmin, ferritin, transferrin and their biological functions.	4

Recommended Books:

1. Biochemistry — L. Stryer
2. Lehninger Principles of Biochemistry — D. L. Nelson & M.M. Cox
3. Biochemistry — Harper

COR103

Molecular Biology Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**DNA replication (both prokaryotic and eukaryotic):** Different modes of replication (semi-conservative, 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).	7
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 eukaryotes.	7
3.	**Post-Transcriptional modification:** RNA splicing, Spliceosome machinery, Splicing pathway, Alternative splicing, Exon shuffling, RNA editing, m-RNA transport.	4
4.	**Translation (both pro- and eukaryotic):** m-RNA, t-RNA, Attachment of amino acids to t-RNA, Ribosome, Initiation, elongation and termination of translation, Post-translational modification.	7
5.	**Regulation of gene expression:** Principles of transcriptional regulation, different operons and their regulation. Gene regulation at steps after transcription, Regulation of lambda phage. Eukaryotic gene regulation, Control of transcriptional regulator, Gene slicing, RNA in gene regulation, transcriptional control of gene expression, epigenetic regulation.	7

Recommended Books:

1. Molecular biology of the Gene — J.D. Watson, Baker, Bell, Levine & Losick
2. Molecular Biology: Genes to proteins — B.E. Tropp
3. Molecular Biology — R. Weiver
4. Gene IX & X — L. Benjamin

COR104

Microbiology and Virology Credit: 4, Marks: 50

Sl. no	Courses and Coverage	Classes allotted
1	**Micro-organisms:** 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	4
2	**Microbial growth:** Growth curve and equation, cell numbers (colony counts), cell mass., Environmental factors on growth (nutrient concentration, pH, temperature, oxygen concentration, pressure and radiation), Chemostat, Turbidostat.	3
3.	**Pro- & Eukaryotes:** 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, eukaryotic cell structure (External cell coverings, Cilia and Flagella), Comparison of prokaryotic and eukaryotic cells	2
4.	**Microbial spores:** Endospores and exospores, their properties and germination.	1
5.	**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 commensalism).	3
6.	**Extreme environment microbes:** Anaerobes, Halophiles, Thermophiles, Acidophiles and Alkyliphiles.	1
7.	**Biogeochemical roles of microbes:** Carbon, nitrogen and sulfur cycles; Nitrogen fixation and its mechanism.	2
8.	**Microbiology of water, air, soil and milk.**	1
9.	**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.	3
10.	**Bacteriophages:** Discovery, Structures, Plaques, Host specificity, Life cycles of bacteriophages: Virulent phages (T4, T7, ϕX174, RNA phage), Lysogenic phages (λ, P1), Chronic phage (M13).	6

11.	**Eukaryotic Virus:** Basic structures, Life cycles of RNA viruses (Vesicular Stomatitis Virus, Poliovirus, Reovirus, Retrovirus) and DNA viruses (Simian Virus 40, Adenovirus).	2
12.	**Viral Diseases:** Human viral pathogens, Factors behind incidence and severity, Acute infection (gastrointestinal, respiratory, liver), Systemic spread, HIV and Aids, Viral oncogenes.	2
13.	**Diagnosis, Vaccines and Antivirals**	2

Recommended Books:

1. Microbiology — M.J. Pelczar
2. Microbiology — L.M. Prescott
3. Fundamental Principles of Bacteriology — A. J. Salle
4. Molecular Biology: Genes to proteins — B. E. Tropp
5. Molecular Biology — D. Freifelder

COR105

Cell Biology (I) Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Origin and evolution of Cell:** Prokaryotes, eukaryotes, development of multicellular organisms	1
2	**Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	4
3.	**Cell membrane:** Membrane lipids & proteins, matrix adhesion proteins, glycoproteins, receptors. Lipid mobility. Phospholipids, glycolipids and spingolipids in membranes. Membrane carbohydrate, liposome.	3
4.	**Transport of small molecules:** Passive-facilitated-carrier mediated diffusion, symport, antiport and co-transport, ion channels, ionophores, 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.	5
5.	**Cytoskeleton**: Structure and organization of actin filaments, actin, myosin and cell movement, sarcoplasmic reticulum in muscle contraction, intermediate filaments, microtubules, microtubule motor and movement.	3

Recommended Books:

1. Molecular Cell Biology — H. Lodish & D. Baltimore
2. The Cell — B. Alberts
3. Molecular Cell Biology — Karp
4. Cell Biology — Cooper
5. Cell Biology — Pollard

COR105

Enzymology Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Overview of enzymes:** Classification and nomenclature of enzymes, properties of enzymes and the use of cofactors. Enzyme units and turnover of enzymes.	3
2	**Catalytic site:** Lock and key or template model, induced fit model, Role of metal ions, metalloenzymes and metal activated enzymes; ternary enzyme-metal substrate complexes, enzyme bridge complexes (M-Enz-S), substrate bridge complexes (Enz-S.M), metal-bridge-complexes (Enz-S.M), role of metal ions in catalysis, Vitamins as coenzymes.	4
3.	**Catalysis:** Factors affecting catalytic efficiency of enzymes (pH, Temperature etc.) Michaelis-Menten equation, activators, inhibitors, inhibition reactions and their kinetics, allosteric and feedback inhibition, competitive, non-competitive, un-competitive and mixed type inhibition, kcat/km – a measure of catalytic efficiency.	6
4.	**Specialized Enzymes:** Isoenzymes, regulatory enzymes, regulation of enzyme activity, trypsinogen –chymotrypsinogen – pepsinogen. Carboxyanhydrase.	3

Recommended Books:

1. Biochemistry L. Stryer
2. Lehninger Principles of Biochemistry D. L. Nelson & M.M. Cox

COR106

Bioenergetics and Fundamental Metabolism Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**Bioenergetics:** Organization and function of mitochondria, endosymbioant hypothesis for the biogenesis of mitochondria, electron transport chain, mechanism of oxidative phosphorylation, chemiosmotic hypothesis, respiratory chain inhibitors, coupled reaction, uncouplers, biological energy transducers.	8
2	**Fundamentals of metabolisms:** Metabolism of carbohydrates, amino acids, lipids and nucleotides. Outlines of glycolysis and TCA cycle.	8

Recommended Books:

1. Biochemistry L. Stryer
2. Lehninger Principles of Biochemistry D. L. Nelson & M.M. Cox

COR106

Unit – 8: Statistics Credit: 2, Marks: 25

Sl. no	Courses and Coverage	Classes allotted
1	**General Statistical Methods:** Frequency Distribution. Measures of central tendency. Measures of dispersion. Theoretical distributions (Binomial, Poisson and Normal), Sampling variation.	6
2	**Statistical evaluation of results:** Estimation of standard error, confidence limits, significance tests	4
3	**Tests:** 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, χ^2 –test of goodness of fit, chi-square test, ANNOVA, Correlation and linear regression, method of least squares.	6

Recommended Books:

1. Statistics Goon & Goon
2. Statistics Goon & Das
3. Biostatistics D. Das

COR107 (Practical)

Unit – 1: Physico-chemical Techniques Credit: 2, Marks: 25

Sl. No.	Courses and Coverage
1	**pH metric titration of Glycine to determine its isoelectric point**
2	**Conductometric titration of KCl with $AgNO_3$ to determine unknown strength of solution**
3	**Verification of Beer's laws using crystal violet solution**
4	**Actinometric determination of dose rate of a Ultraviolet light source**
5	**To draw the characteristic curve of a GM Counter to determine its plateau characteristics**
6	**To isolate hemoglobin from blood and draw its absorption spectrum**

Unit – 2 : Microbiology Credit:2, Marks:25

Sl. No.	Courses and Coverage
1	**Microbial techniques:** Sterilization, media preparation, preparation of slants and stabs, pouring of medium into plates, subculturing
2	**Isolation of microorganisms:** From soil & water of different places. Serial dilution, plating for counting colonies. Single colony isolation techniques and its prevention.
3	**Examination of microorganisms:** Simple staining, Gram staining, Acid Fast Staining. Endospore staining, staining of flagella, staining of capsule, staning of fungi, localization of root nodule bacteria by staining
4	**Bacterial growth studies:** Bacterial number counting by haemocytometer and colony counting, bacterial growth curve by spectrophotometry, determination of germination time
5	**Antibiotic sensitivity tests:** Paper disc/cup method, MIC determination

Recommended Books
Experiments in Molecular Genetics J. H. Miller

Unit– 3: Virology Credit:2, Marks:25

Sl. No.	Courses and Coverage
1	**Preparation of bacteriophage ϕX 174 stock**
2	**Assay of bacteriophage ϕX 174 stock**
3	**Lytic curve of *E.coli* by ϕX 174**
4	**UV inactivation of bacteriophage ϕX 174**
5	**Repair of UV-inactivated bacteriophage ϕX 174**

Recommended Books
Experiments in Molecular Genetics J. H. Miller

Unit – 4: Grand Viva Credit: 2, Marks: 25

AECC- Credit: 2, Marks: 25

Semester-2

COR208

Human Physiology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**General anatomical interrelationship of organs**	**2**
2	**Nutrition:** Autotrophy, Digestion of food, BMR	**1**
3	**Excretion**: Nephron, Urine formation, Micturition, Electrolyte balance.	**2**
4	**Respiration:** Transport of oxygen and carbon dioxide in blood, regulation of acid-base balance.	**2**
5	**Cardiovascular system:** Cardiac cycle, neural and chemical regulation	**2**
6	**Blood circulation:** Blood composition and functions, Blood corpuscles, haemopoiesis, plasma function, blood volume, blood group, haemoglobin, Mechanism of blood clotting, formation and maturation of WBC and RBC, Different haematological parameters.	**3**
7	**Endocrine glands and their functions**	**2**
8	**Reproduction**	**2**

Recommended Books:

1. **Human physiology** **Guyton & Hall**
2. **Physiology** **Berne and Levy**
3. **A text book of medical physiology** **Indu Khurana**
4. **A text book of medical physiology** **W F Ganong**

COR208

Cell Biology (II) **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**The cell cycle**: Phases of cell cycle, M-phase: mitosis and cytokinesis, prophase, metaphase, anaphase, telophase. Regulation of the cell cycle by growth factors and extracellular signals, Cyclins and CDKs in cell cycle regulation. Cell cycle Checkpoints and its activation. Apoptosis; Caspases, pro and antiapoptotic genes, Mitochondria dependent and independent pathways, regulation of apoptosis, senescence.	**4**
2	**Endoplasmic reticulum (ER):** Protein secretion from ER, 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.	**2**
3	**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.	**2**
4	**Vesicular transport**: Understanding of vesicular transport, cargo selection, cont proteins and vesicle budding, vesicle fusion.	**2**
5	**Lysosomes**: Lysosomal acid hydrolases, endocytosis and lysosome formation, phagocytosis and autophagy. Disorders resulting from defects in lysosomal function.	**2**
6	**Peroxysomes**: Functions of peroxysomes, peroxysomes assembly. Diseases that result from abnormal mitochondrial and peroxysomal function.	**2**
7	**Extracellular matrix and adhesion molecules:** Cytoskeletal proteins and their functions**,** myofibrillar and their junction in cell shape and contraction, mechanism of muscle contraction.	**2**

Recommended Books:

1.	**Molecular Cell Biology**	**H. Lodish & D. Baltimore**
2.	**The Cell**	**B. Alberts**
3.	**Molecular cell Biology**	**Karp**
4.	**Cell Biology**	**Cooper**
5.	**Cell Biology**	**Pollard**

COR209

Immunology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Introduction of immune systems:** Cells and organs of immune system.	**1**
2	**Lymphocytes:** Differentiation, lymphocyte-sub-populations. T and B cells and their antigens	**1**
3	**APC cells, Phagocytic cells, macrophage, dendritic cells, K and NK cells.** Macrophage	**2**
4	**Types of immunity:** Innate-adaptive-passive-active immunity, self-vs. Non-self-discrimination. An overview	**2**
5	**Antigenicity of molecules:** immunogen vs. antigen, characteristics and types of antigens, Epitope.	**2**
6	**Immunoglobulins:** Molecular structure, Classification and function, Antigen-antibody reactions.	**2**
7	**MHC molecules :** Structure , function, MHC polymorphism	**2**
8	**Immunological techniques:** Hybridoma technique for monoclonal antibody production; Precipitation reactions, Radial immunodiffusion, double immunodiffusion, Immunoelectrophoresis, agglutination reaction, ELISA, RIA, Immunoelectrophoretic techniques, agglutination, immunodiffusion, immunofluoresence, western blot, immunohistochemistry, flow cytometry.	**2**
9.	**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	**2**

Recommended Books:

1. Immunology - Goldsby-Kindt-Osborne –Kuby

2. Cellular and Molecular Immunology- Abbas-Lichtman-Pober, W.B Sauders

3. Immunology – Roitt

COR209

Spectroscopy **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Interaction of light with matter**: Electromagnetic spectrum used in different spectroscopy.	**1**
2	**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.	**6**
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.	**6**
4	**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.	**3**

Recommended Books:

1. **Organic Spectroscopy** — **W. Kemp**
2. **Physical Biochemistry** — **D. Freifelder**
3. **Fundamentals of Molecular Spectroscopy** — **C.N. Banwell**
4. **Biological Spectroscopy** — **I.D. Cambell et al**
5. **Introduction to the Spectroscopy of Biological Polymers -** — **D.W. Jones**

COR210

Unit1: Enzymology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage
1	**Kinetic characteristics of phosphatase**
2	**Progress curve of Alkaline Phosphatase.**
3	**Effect of temperature on the activity of Alkaline Phosphatase.**
4	**Determination of pH optimum for Alkaline Phosphatase.**
5	**Determination of Km and Vmax of Alkaline Phosphatase.**
6	**Determination of specific activity of Alkaline Phosphatase.**
7	**Assay of Lactate Dehydrogenase (LDH)**

Recommended Books:

Practical Enzymology **Hans Bisswanger**

Unit2: Molecular Biology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage
1	**Time course of beta-galactosidase induction in *E.coli***
2	**Effect of membrane perturbants on Lac-permease activity**
3	**SDS-PAGE of protein**
4	**Measurement of membrane potential (Bacteria and Cell lines)**

Recommended Books:

Molecular Biology Experiments **Slater et al.**

Unit3: General Biochemistry & Biophysics **Credit-2 Marks – 25**

Sl. No.	Courses and
1	**Estimation of protein by a) Lowry, BCA, Bradford and UV methods.**
2	**Estimation of DNA by diphenylamine.**
3	**Estimation of RNA by orcinol reagent.**
4	**Separation, identification and estimation of lipids by TLC.**
5	**Separation, identification and estimation of free amino acids by paper chromatography.**
6	**Sub-cellular fractionation of different sub-organelles from tissues such as liver and heart.**
7	**Marker enzyme studies of different sub-organelles.**
8	**Separation of proteins by SDS-PAGE.**
9	**Estimation of ascorbic acid.**
10	**Purification of I_g from blood sample**

Recommended Books:

Practical Biochemistry **D. T. Plummer**

Unit4: Grand Viva **Credit-2 Marks – 25**

GEC (CBCS) **Credit-4 Marks – 50**

DSE201 **Any two from the following** **Credit-4, Marks: 50**

Crystallography Credit-2 Marks – 25

Sl. No.	Courses and Coverage	Class Allotted
1	Symmetry in Crystal, Point and Space Group, Law of Constancy of Angles, Law of Rational Indices, Miller Indices, Unit Cell, Atomic Scattering Factor, Structure Factor.	**5**
2	Laue and Bragg's Law of Diffraction, Ewald's Construction, Concept of Reciprocal Lattice and Fourier Transform, Relation between Structure Factor and Electron Density.	**2**
3	Crystallization and Experimental methods - Outline of data collection and indexing the data, Wilson plot and Temperature Factor, Correction factors, Data Reduction, Asymmetric unit, Enantiomorph, Friedel & Bijvoet pair.	**4**
4	Phase problem: Direct and Patterson method, Outlines of Molecular Replacement, Isomorphous Replacement and Anomalous Dispersion method.	**3**
5	Refinement: Least square, Rigid body and Energy refinement, Map Fitting and Use of Ramachandran plot, Resolution, Density modification, Non crystallographic Symmetry.	**2**

Recommended Books:

1. **Fundamentals of Crystallography** — **Giacovazzo-Monaco-Viterbo-Scordari-Gillo-Zanotto-Catti**
2. **Principles of Protein X-ray Crystallography** — **J. Drenth**
3. **X-ray Crystallography** — **M. M. Wolfson**
4. **Protein Crystallography** — **T. L. Blundell & L.N. Johnson**
5. **X-ray Diffraction Procedures** — **Klug and Alexander.**
6. **An introduction to Crystallography** — **F. C. Philips.**

Mathematical Methods **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Functions and their graphical representation with application in biology:** Linear-Power-Periodic-Logarithmic-Exponential functions.	**3**
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.	**6**
4	**Matrix Algebra:** Determinants with examples from biology, matrix as operation of reflection-rotation-inversion-magnification-translation-symmetry, applications in Biology	**4**

Recommended Books:

Introduction to Mathematics for Life Scientist **E. Batschelet**

Medical Biophysics **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
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.	
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.	**2**
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.	**3**
4	**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. Fiber optics, principles of endoscopy and other uses of fiber optics in medical science. LASERS and Cryotopes, colonoscopy, Biometry.	**4**
5	**Nuclear Medicine:** Application in diagnostic studies, dynamic function studies, use of radioisotopes and tracers, imaging and autoradiography in cardiology, neurology, thyroid imaging. Radio pharmaceuticals.	**2**
6	**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.	**2**
7	**Medical Imaging Techniques:** Basic principles and uses: X-rays, CT, USG, Eco cardiograph, MRI, PET, SPET.	**3**

Recommended Books:

1. **Medical Physics and Biomedical** — **Brown, Smallwood, Barber, Lawford &**
2. **Textbook of Medical Physiology** — **Guyton & Hall**
3. **Intoduction to Health Physics** — **H. Cember**
4. **Biophysical Science** — **Ackerman, Ellis & Williams.**

5.	**Physics in Nuclear Medicine**	**Sorenson & Phelps.**
6.	**Fundamentals of Biomechanics Equilibrium, Motion and Deformation**	**Ozkaya & Nordin.**
7.	**Medical instrumentations**	**Khandeep.**

Radiation Biology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
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.	**2**
2	**Dose:** Exposure dose, absorbed dose, effectiveness of different radiation LET, RBE.	**1**
3	**Effect of Radiation on Water:** Direct and indirect action of radiation, chemical dosimetry.	**2**
4	**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).	**4**
5	**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.	**3**
6	**Radiation Protection and Tumor Radio Therapy.**	**2**
7	**Interaction of Non-ionizing Radiation with Matter:** Ozone depletion**,** UV and visible light sources, action spectra, effects on cells, biomolecules.	**2**

Recommended Books:

1. **Radiation Biophysics** **E. L. Alpen**
2. **Radiation Detection & Measurement** **G. F. Knoll**
3. **Radiation Biology** **Dertinger and Jung**

SEMESTER III

COR 311

Genetics **Credit-4 Marks – 50**

Sl. No.	Courses and Coverage	Class Allotted
1	Mendelian Genetics, Population Genetics, Evolution, speciation Organization of Human chromosome, banding, karyotyping, chromosomal disorders, screening of human genetic disorder.	**8**
2	**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.	**6**
3	**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**.**	**7**
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.	**7**
5	**Gene transfer :** Transformation , Conjugation, Transduction	**4**

Recommended Books:

1. **Microbial Genetics** — **D. Freifelder**
2. **New Chemical Genetics** — **Read & Donnai**
3. **DNA repair** — **Friedberg**
4. **Genetics** — **Gardner**

COR312

Biotechnology and Recombinant DNA Technology Credit-4 Marks – 50

Sl. No.	Courses and Coverage	Class Allotted
1	**Tools :** Plasmids (F, R & Col plasmids, 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.).	**8**
2	**Techniques**: Isolation & purification of plasmid & genomic 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 interference, brief overview of Protein array techniques.	**12**
3	**Fermentation Technology:** Batch – fed batch – continuous fermentation, Bioreactors,	**3**
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.	**4**
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.	**3**
6	**Engineering Animals:** Transgenic mice methodology (retroviral vector, DNA	**2**

Recommended Books:

1.	**Gene Cloning**	**T.A. Brown**
2.	**Molecular Biology: Genes to proteins**	**B. E. Tropp**
3.	**Industrial Microbiology**	**Casida**
4.	**Industrial Microbiology**	**Prescott and Dunn**

COR313

Microscopy **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Light microscopy:** Bright Field, dark field & phase contrast microscopy, resolving power & magnification.	**4**
2	**Fluorescence & Confocal Microscopy**	**3**
3	**Electron microscopy:** Working Principle, Image formation process and Contrast, Image Defects, Optimum Resolution, Sample preparation and contrast enhancement techniques.	**5**
4	**Working principle of SEM, STEM, STM, AFM**	**4**

Recommended Books:

Introduction to Electron microscopy **Saul Wischnitzer**

COR313

Cellular Signaling **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Introduction of cell signaling**:** cAMP pathway: second messenger and protein phosphorylation. InsP3 and protein kinase C. InsP3 receptor and ryanodine receptors. Hormones and their receptors. Cell surface receptors, signaling through G-protein coupled receptors. receptor tyrosine kinases, cytokine receptors and non-receptor tyrosine kinases.	**4**
2	Mechanisms of action of cholera toxin and pertussis toxin. cGMP and nitric oxide. Cross-talk between different signaling systems. Redox and nitrosylation switches in signal transduction. Phosphodiesterases and phosphatases as regulators of signal transduction. Protein kinase families in vertebrates: an overview. Steroid hormones and nuclear receptor superfamily.	**4**
3	Regulation of phospholipase A2, phospholipase C and phospholipase D activity. Role of ADP ribosylationm factor, guanine nucleotide exchange factor and guaninine nucleotide activating protein in regulating phospholipase D activity.	**4**
4	Cellular Ca^{2+} regulation**.** Ca^{2+} as intracellular messenger, Integration of receptor, non-receptor and store operated Ca^{2+} entry mechanism. Cellular Ca^{2+} entry and efflux mechanisms involving plasma membrane Na/K-ATPase, plasma membrane Ca^{2+} ATPase, sarco-endo)plasmic reticular Ca^{2+} ATPase, Na^{+}/H^{+} exchanger, Na^{+}/ Ca^{2+}exchanger and voltage gated Na^{+}, K^{+} and Ca^{2+} channels in regulating intracellular Ca^{2+} dynamics. Regulation of mitochondrial Ca^{2+} dynamics. Concepts of redox regulation and pore formation in mitochondrial Ca^{2+} dynamics. Regulation of intracellular Ca^{2+} by cADP ribose.	**4**

Recommended Books:

1. Calcium in signal regulation:	**Edited by E. Carafoli and C. Klee**
2. Cellular signaling:	**F.Merks, U. Klingmuller, K.M. Decker**
3. Signal transduction:	**Edited by C.H.Heldin, M.Ourton**
4. Current topics in cellular regulation—Vol 31:	**Edited by B. L. Horecker, E. R. Stadtman, B. Chocksand**
5. Biochemistry:	**J.M.Berg, J.L.Tymoczko**
6. Molecular Cell Biology	**Darnell-Lodhis-Baltimore**
7. Biochemistry:	**L. Stryer**
8. The cell:	**B. Alberts**
9. The cell molecular approach:	**Geoffrey Cooper**
10. Cell:	**B. Lewin, L. Cassimeris, V.R. Lingappa, G. Plopper**

COR314

Unit1: Recombinant DNA Technology Credit-2 Marks – 25

Sl. No.	Courses and
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	**Amplification of DNA by PCR.**

Recommended Books:

Molecular Cloning **J. Sambrook & D. W. Russell**

Unit2: Clinical Biochemistry & Clinical Biophysics Credit-2 Marks – 25

Sl. No.	Courses and
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)**
4	**Determination of number of RBC per mm^3 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^+, Mg^{2+} and Ca^{2+} content (vii) glycosylated hemoglobin.**
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 and determination of electrical axis of the heart from ECG tracing.**
10	**Measurement of blood pressure under normal and stress condition.**

Recommended Books:

1. **Experimental Biochemistry** **B. S. Rao and V. Deshpande**
2. **Practical Biochemistry** **D. T. Plummer**

Unit3: Immunotechniques Credit-2 Marks – 25

Sl. No.	Courses and Coverage
1	**Ouchterlony double diffusion**
2	**Radial immunodiffusion**
3	**Rocket immunoelectrophoresis**
4	**Agglutination assay**
5	**ELISA**
6	**Western Blot**

Recommended Books:

Immunology and Immunotechnology **A.K Chakraborty**

Unit4: Grand Viva **Credit-2 Marks – 25**

DSE 302 **Any two from the following** **Credit-4, Marks: 50**

Advanced Spectroscopy **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**IR spectroscopy & Raman spectroscopy:** Basic principles and application to biomolecules.	**4**
2	**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 the cell etc.	**6**
3	**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	**4**
4	**Surface Plasmon resonance**	**2**

Recommended Books:

1.	**Organic Spectroscopy**	**W. Kemp**
2.	**Physical Biochemistry**	**D. Freifelder**
3.	**Fundamentals of Molecular Spectroscopy**	**C.N. Banwell**
4.	**Biological Spectroscopy**	**I.D. Cambell & R.A. Durk**
5.	**Introduction to the Spectroscopy of Biological Polymers -**	**D.W. Jones**

Biostatistical Methods **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Sampling distribution and its significance, estimation of population parameters, testing of statistical hypothesis, type I & type II errors, Tests of significance, Z - test (one-tailed & two - tailed)	**6**
2	Significance of the difference in means, Standard error(SE) of mean and its calculation,, uses of SE of mean in large samples, standard error of differences between two means of large samples and its calculation, applications of SE of differences, significance of differences between means of small samples by students' t -test, application of t-test (unpaired and paired t- test), variance test ration and analysis of variance (ANOVA) test.	**8**
3	Chi-square test, Test of proportion, test of association, test of goodness-of-fit	**2**

Recommended Books:

1. Statistics Goon & Goon
2. Statistics Goon & Das
3. Biostatistics D. Das

Structural Biology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**DNA Topology:** Thermodynamics of DNA supercoiling, Theoretical approaches to DNAsupercoiling, Knots and catenanes, DNA Bending.	**2**
2	**Protein analysis by mass spectrometry:** Mass spectrometry (general and technical), Sample preparation, Interpretation of mass spectra, Mass analysis of intact proteins and peptides.	**3**
3	**Peptide mapping:** Cleavage of peptide bonds, Separation of peptide fragments, Electroblot procedure, Peptide sequencing strategies and tandem mass spectrometry.	**3**
4	**Protein folding**: Protein folding patterns, Thermodynamics of protein folding, Molten globule, Folding funnel, Molecular chaperones.	**2**
5	**Protein-protein and Protein-DNA interactions:** Protein-protein interfaces and their properties, Structural themes in proteins-DNA binding, Protein-DNA complexes and genes regulation.	**2**
6	**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.	**4**

Recommended Books:

1. **DNA Topology** — **A. D Bates & A. Maxwell**
2. **Protein Structure: A Practical Approach** — **T E Creighton**
3. **DNA-Protein Interactions** — **A. Travers & M. Buckle**

Developmental Biology **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	**Features of Development:** Gametogenesis [Meiosis, Oogenesis, Spermatogenesis]; Early Development [Cleavage, Gastrulation, Axes & Symmetry]; Morphogenic processes [Cell movement, cell adhesion, classification of morphogenetic processes].	**4**
2	**Developmental commitment:** Fate map, specification, determination, cytoplasmic determinant, homeotic genes.	**2**
3	**Techniques for study of Development:** Study of gene expression by Biochemical and In Situ Methods, Cell labeling.	**3**
4	**Development of model organisms:** Drosophila, Xenopus, Mouse, C. elegans	**4**
5	**Organogenesis:** Tissue organization, Stem Cells.	**3**

Recommended Books:

1. **Essential Developmental Biology** **J. M. W. Slack**

SEC **Bioinformatics and Computational Biology** **Credit-2 Marks – 25**

Sl. No.	Courses and Coverage	Class Allotted
1	Biological databases: NCBI-GenBank, PDB database, Uniprot, Pubmed	**2**
2	Biological sequence alignments; pair wise and multiple sequence alignments; familiarity with BLAST, FASTA and CLUSTALW.	**6**
3	Overview of molecular modeling: Basic principles of molecular modeling; Overview of QSAR	**6**
4	Idea of docking: Basic principles, rigid body and flexible docking	**2**

Recommended Books:

1. **Bioinformatics- David W Mount**
2. **Introduction to Bioinformatics- Angshuman Bagchi**

SEMESTER IV

Paper code	Paper	Theory/ Practical	Credit	Marks
DSE 403	Internal review work, thesis submission & presentation		8	100
DSE 404	External project work, thesis submission		8	100
DSE 405	Defense and presentation		2+2 = 4	50
	Total		**20**	**250**

Choice-based Course offered by the department to the students of other departments

'Methods in Cellular and Molecular Biology'

Credit – 4 Marks - 50

Sl. No.	Courses and Coverage	Class Allotted
1	**Methods for separation of biomolecules:** **Chromatography –** Paper, TLC, adsorption, partition, ion-exchange, reverse phase, gel filtration, affinity, GLC, HPLC. **Electrophoresis** – Theory of electrophoresis and electrical parameters in electrophoresis, paper electrophoresis, gel electrophoresis, SDS-PAGE, Disc gel, gradient gel, isoelectric focusing, gel electrophoresis of nucleic acids and its applications. **Centrifugation –** Basic principle of boundary and zonal centrifugation, gradient centrifugation, Instrumentation, ultracentrifugation. **Dialysis –** Basic principle of Dialysis and its use in biological sciences.	**10**
2	**Biophysical methods to study biomolecules:** **Crystallography:** Brief introduction of Crystallography as a structure determination tool: Crystal symmetry, Bragg's Law of Diffraction and Concept of Reciprocal Lattice, Steps of structure determination in brief. **Microscopy:** Light Microscopy (working principle, magnification and resolution, bright field, dark field and phase contrast technique); Electron Microscopy (working principles and applications of SEM, TEM). **Spectroscopy:** Working principle of UV-Vis spectroscopy, DNA melting curve, basic principle of fluorescence spectroscopy, quantum yield, quenching, intrinsic and extrinsic fluorophor, ANS & bis-ANS binding of proteins and extraction of structural information of proteins, Protein-ligand interaction, drug-DNA interaction, basic principle of circular dichroism (CD), three dimensional structural information from CD spectra of DNA and protein. CD analysis to understand Drug-DNA and protein-ligand interaction.	**18**
3	**Radio isotope and Immunotechniques:** Properties of α, β and γ-rays, measurement of radioactivity (GM, scintillation and gamma counters), radioisotope tracer techniques, autoradiography, Radiation protection–safety measures.	**08**

	Hybridoma technique for monoclonal antibody production; ELISA, RIA, Immunoelectrophoretic techniques, agglutination, immunodiffusion, immunofluoresence, western blot, flow cytometry.	
4	**Recombinant DNA Methods:** Restriction enzymes and manipulation of DNA, Vectors and Construction of chimeric DNA, Introduction of DNA into cells, Nucleic acid blotting, Construction of gene libraries, Selection of a clone from library, DNA sequencing, RFLP, PCR & real-time PCR, Use of PCR (clinical diagnosis).	**12**
5	**Bio-statistical Method:** Introduction and uses of Biostatistics, Data presentation, measures of averages, measures of dispersion, theoretical distributions (Binomial, Poisson and Normal).	**06**
6	**Bio-computational Method:** Introduction of Biocomputing; Fundamental aspects and Usefulness of the subject; Overview of biological databases. Fundamental aspects of NCBI-Uniprot-PDB; Fundamentals of sequence alignments(Introduction, Overview of the methodologies of sequence alignment).	**04**

Recommended Books:

1. Biochemistry — L. Stryer
2. Lehninger Principles of Biochemistry — D. L. Nelson & M.M. Cox
3. Biophysical Chemistry — D. Freifelder
4. Biochemistry — D. Das
5. Organic Spectroscopy — W. Kemp
6. Physical Biochemistry — D. Freifelder
7. Fundamentals of Molecular Spectroscopy — C.N. Banwell
8. Biological Spectroscopy — I.D. Cambell & R.A. Durk
9. Introduction to the Spectroscopy of Biological Polymers — D.W. Jones
10. GeneCloning — T.A.Brown
11. Statistical Methods — N G Das
12. Methods in Biostatistics — B K Mahajan
13. Introduction to Bioinformatics — Angshuman Bagchi
14. Fundamentals of Bioinformatics — S. Harisha
15. Essential Bioinformatics — JinXiong
16. Basic Immunology - 6th Edition — Abul Abbas et al
17. Immunology — Kuby, Fifth edition,
18. Immunology: An Introductory Textbook, — Anil K. Sharma, 1st Edition 2019
19. Introduction to Electron microscopy — Saul Wischnitzer
20. The Microscope, Past and Present — S. Bradbury
21. Modern Experimental Biochemistry — R. Boyer