ADIKAVI NANNAYA UNIVERSITY

RAJAMAHENDRAVARAM

M.Sc. Biochemistry

Course Structure and Syllabus

2016-17 Onwards

ADIKAVI NANNAYA UNIVERSITY

M.Sc. DEGREE EXAMINATION IN BIOCHEMISTRY - SYLLABUS
(Effective from 2016-2017 Batch)

Synoptic note

1) BoS meeting for all PG Courses with effect from 2016-17 admitted batches
2) Syllabi last revised in 2012-13
3) There are about 25 different courses
4) The syllabus is proposed to be revised in accordance to the emerging concepts, industry and market needs.

Proposed Guidelines:

5) All Arts and Commerce PG courses have 5 subjects in each of the four semesters, with 100 marks for each paper and a total of 2000 marks.
6) All Science PG courses have 4 subjects in each of the four semesters with theory and practical in each of 100 and 50 marks respectively for each of the four semesters, all of which makes a total of 2400 marks. An additional 100 marks are allotted for project dissertation and presentation in all PG courses [except MBA/MCA/MA (SW) and M.Tech]. Thus the grand total for the science PG courses is 2500 marks.
7) Out of 100 marks for each subject, 75 marks (75%) in each paper are assigned for Semester End Examinations and 25 marks (25%) for internal / continuous assessment for all PG courses.
8) Each subject will have four units of syllabi in all PG courses (except MBA, which will have five units of syllabus for each subject).
9) Each subject will have 4 - 5 periods of class per week with 5 credits.

10) Semester end examination question paper has two sections, viz. section A with four essay questions, with internal choice a) or b) - one question from each unit of syllabus; section B has eight short answer questions, two from each unit of syllabus, with choice to answer any five.

For MBA the question paper consist of 3 sections; viz. section 'A' has 8 short answer questions, with a choice to answer any five for 20 marks. Section 'B' consist of 5 long answer question with internal choice; one question from each unit of syllabus for 40 marks and section 'C' is case study with no choice for 15 marks.

11) For all PG courses including MBA, the brake up for 25 marks (25 %) of internal examination / continuous assessment is as follows;

    a) 15 marks for written examination; two written examinations are to be conducted and an average of both examinations is considered for awarding final score
    b) 5 marks for attendance
    c) 5 marks for assignment preparation and presentation

    (The proportionate may be followed for 50 marks paper / practical)

12) There will be project work for all PG courses except MBA, MCA, M.Tech and MA (Social work) for 100 marks (50 marks for dissertation and 50 marks for presentation and viva-voice. The project work is to be done during summer vacation i.e. after II semester and before III semester. The dissertation of the project work is to be submitted by the student to the respective department during 2nd year study. The presentation and viva-voce examination of the project work is to be conducted at IV semester end examination. The project presentation and vive-voce examination is to be conducted by external examiner. For affiliating colleges, University teachers will be the external examiner and for University Department, external examiner is to be invited from other university. MCA / MBA /M.Tech/ MA (SW) will continue the extant system. The external examiner TA / DA and remuneration will be borne by the respective College / Department strictly as per the approved norms to be notified from time to time.

13) There may be comprehensive Viva-Voce at the end of every semester being conducted by all subject teachers, together assigning suitable credit from internal marks to be taken. This is intending to prepare and boost the student interview facing skills and comprehension of subject. This is proposed for PG courses.

M.Sc. BIOCHEMISTRY
Scheme of Examination

Code	Title of the paper	Total Marks	Credits
I SEMESTER			
BC101	Cell Biology	100	4
BC102	Biomolecules	100	4
BC103	Microbiology	100	4
BC104	Analytical Techniques	100	4
	Lab Course		
BC105	Cell Biology lab	50	2
BC106	Biomolecules lab	50	2
BC107	Microbiology lab	50	2
BC108	Analytical Techniques lab	50	2
II SEMESTER			
BC201	Molecular Biology	100	4
BC202	Enzymology	100	4
BC203	Immunology	100	4
BC204	Biostatistics	100	4
	Lab Course		
BC205	Molecular Biology lab	50	2
BC206	Enzymology lab	50	2
BC207	Immunology lab	50	2
BC208	Biostatistics lab	50	2
III SEMESTER			
BC301	Endocrinology and Metabolism	100	4
BC302	Physiology and Bioenergetics	100	4
BC303	Intermediary Metabolism	100	4
BC304	Gene regulation and Genetic Engineering	100	4
	Lab Course		
BC305	Endocrinology and Metabolism lab	50	2
BC306	Physiology and Bioenergetics lab	50	2
BC307	Intermediary Metabolism lab	50	2
BC308	Gene regulation and Genetic Engineering lab	50	2
IV SEMESTER			
BC401	Plant and Environmental Biochemistry	100	4
BC402	Clinical Biochemistry and Human Nutrition	100	4
BC403	Applied Biochemistry	100	4
BC404	Bioinformatics, Omics and Research Methodology	100	4
	Lab Course		
BC405	Plant and Environmental Biochemistry lab	50	2
BC406	Clinical Biochemistry and Human Nutrition lab	50	2
BC407	Applied Biochemistry lab	50	2
BC408	Bioinformatics, Omics and Research Methodology lab	50	2
BC409	Project work	100	4
	Total	**2500**	**100**

ADIKAVI NANNAYA UNIVERSITY: RAJAMAHENDRAVARAM

BOARD OF BIOCHEMISTRY

Date: 08-07-2016

AGENDA:

1. Syllabus for theory papers
2. Syllabus for practicals
3. Number of teaching hours / Periods theory / Practicals
4. Credits / Evaluation
5. Eligibility and Entrance Examinations
6. Scheme of Valuation
7. List of Examiners for papers setting and Model Question Papers
8. List of Practical Examiners

Members present:

Dr. A. Matta Reddy

Dr. K. Sarala

Dr. M. Padmaja

Dr. Sunila Rani

Dr. P.Vijaya Nirmala

Dr. D. Kalyani

Dr. K. Satish Kumar

Dr. I.J.N.Padmavathi

RESOLUTION:

The common Board consisting of the above members have met in the Department of Zoology, Adikavi Nannaya University, Rajamahendravaram and considered the enclosed agenda. After thorough deliberations and discussions, the Board members have resolved as follows.

1. The members formulated the syllabus for M.Sc Biochemistry, 2 years course on par with other Universities in the Country to be implemented from 2016-17 academic year.
2. The syllabus for practical for the above courses formulated on par with UGC model curriculum.
3. There shall be 4 to 5 periods per week for each theory paper & 3 periods for each practical.
4. A B.Sc Graduate with any subject in biology is eligible to apply for admission into M.Sc Biochemistry.
5. I & II Semesters are common for M.Sc Biochemistry & M.Sc. Biotechnology. III & IV Semesters have separate syllabi for M.Sc Biochemistry & M.Sc. Biotechnology courses.
6. Marks and credits are allotted to theory & practical papers in each semester. There will be 100 marks for each theory and 50 marks for each practical and a total of 600 marks for each semester. So 2400 marks for the four semesters (600 x 4). 100 marks for Project work. A grand total of 2500 marks for the 2 year M.Sc. Biochemistry course.
7. **Examination pattern will be as follows.**
   a) 75% of marks for Semester end Examination while the remaining 25% of marks for continuous Internal assessment which includes 5 marks for attendance (5 marks 95 % above, 4 marks 85-94%, 3 marks 75 – 84%, 2 marks 65-74%, 1 mark 55-64%), 5 marks for Assignment and Presentation and 15 marks for Mid-Examination, with one essay (10 marks) & one short question (5 marks) with internal choice.
   b) The Semester End Examination question paper comprises of two sections –Section A & Section B. Section A consists of 4 questions, one question from each unit of syllabus with internal choice 'a' or 'b'. Section-B consists of 8 short questions two from each unit of the syllabus, with a choice to attempt only 5 out of 8 questions.
   c) In practical, 75% of marks for semester end examination (38 Marks) and Internal Semester Examination 25% (12 Marks) for continuous assessment for Practical paper (9 + Record-3).
8. There will be Project work for Biochemistry for 100 marks (50 marks for Dissertation & 50 marks for Presentation & Viva-voce). The Project work is to be done during summer vacation i.e. after II Semester & before III Semester. Dissertation should be submitted by the students, during 2nd year of study, Presentation and Viva-voce is to be conducted by External Examiner. For affiliating colleges, University teachers will be the external examiner and for University Department, external examiner is to be invited from other university. The External Examiner TA/DA & Remuneration will be borne by the respective College/Department as per the approved norms.
9. A comprehensive Viva-voce to be conducted for students at the end of every semester in the presence of all subject teachers with 20 marks in order to prepare & boost the students to face the interview in future. The marks are adjusted from the internal presentation marks (5 marks in each subject i.e. 4x5=20 marks).

ADIKAVI NANNAYA UNIVERSITY

M.Sc. BIOCHEMISTRY

Examination pattern:

Theory: 75% is End Semester Examination

25% is Internal Assessment

Practical: 75% is End Semester Examination

25% is Internal Assessment – Continuous Assessment

ADIKAVI NANNAYA UNIVERSITY
M.Sc. BIOCHEMISTRY
SEMESTER END EXAMINATION

Model question paper

Time: 3 hrs Max. Marks: 75

Section-A **4x15=60**

Answer all the questions. Each question carries 15 marks

Q1. **Unit-1**

a or b

Q2. **Unit-2**

a or b

Q3. **Unit-3**

a or b

Q4. **Unit-4**

a or b

Section-B **5x3=15**

Q5. It contains 8 short note questions with at least two from each unit, carrying 3 marks. 5 questions are to be answered at least one from each unit.

I SEMESTER
BC101 Cell Biology

Unit I:

Structure of a typical cell, Differences between prokaryotic and eukaryotic cells, animal and plant cells, Nucleus - structure and function of nuclear membrane, nucleolus, chromosome and its high resolution organization, DNA-histone interactions - formation of chromatin fibers - Hetero/ Euchromatin, endoplasmic reticulum, golgi, lysosomes, vacuole, microbodies, ribosomes, cytoskeleton, extracellular matrix.

Unit II:

Biomembranes - Chemical composition of membranes of animal and plant cells, Distribution of membrane lipids, assembly of membrane components, molecular structure of membranes, micelles and liposomes, symmetry of the membrane; membrane fluidity; fluid mosaic model of biological membranes; membrane Transport - Donnan membrane equilibrium, Diffusion across cellular membranes mediated transport; Energetics of transport systems; Passive transport - anion exchange proteins; active transport; active transport of Na^+ K^+ (Sodium potassium ATPase) Ca^{2+} (Ca^{2+}-ATPase); active transport of sugars coupled to phosphorylation; group translocation (γ-Glutamyl cycle); proton motive force in bacterial transport processes; ionophores, gap junctions; endocytosis, exocytosis; nature of receptors.

Unit III:

Mitochondria - structure, biogenesis and enzymatic compartmentation; organization of mitochondrial respiratory chain; mechanism of oxidative of phosphorylation; ultrastructure of the chloroplast; Photosynthesis – photophosphorylation; Carbon dioxide fixation in C3, C4 and CAM plants; Photorespiration.

Unit IV:

Cell division and chromosomal variations: Mechanism of cell division - mitotic apparatus, cytokinesis, chromosome movement; Meiotic process - stages, chromosome pairing, chiasma formation molecular mechanisms of recombination, synaptonemal complex; Nondisjunction, regulation of eukaryotic cell cycle - Molecular events including cell cycle check points and CDK – cyclin complexes; Chromosomal abnormalities - euploidy, haploidy - their fundamental and practical significance, polyploidy - induction - aneuploidy - type and genetic significance.

Recommended Books:

1. Cell and Molecular Biology by EDP de Robertis and EMF de Robertis.
2. Cell and Molecular Biology by Baltimore.L
3. The Cell - Hooper
4. Molecular Biology of the Cell by B.Alberts, Garland publications incorporation.
5. Molecular Cell Biology by J. Darnell, Scientific American Books.
6. Cell and Molecular Biology by P.K.Gupta, Rastogi Publ.

BC102 Biomolecules

Unit I:

Chemical foundations of biology – pH, pK, acids, bases, ionization of water, buffers - buffering in biological systems, chemical bonding – various forces and interactions in biological systems; Amino acids – classification, structure and physicochemical properties, non-protein amino acids, Peptide bond – Structure and conformation, Naturally occurring peptides; Proteins – classification, purification, isolation and criteria of homogeneity; sequence determination and characterization of proteins, physicochemical properties, structural organization of proteins, Elucidation of primary structure, secondary structure, tertiary structure, quaternary structure, Denaturation & renaturation of proteins.

Unit II:

Carbohydrates: Definition and classification of carbohydrates, nomenclature, Reaction of Mono-saccharides, Acid derivatives of Monosaccharides amino-sugars, Oligo saccharides, structure, and properties, Chemistry and biological roles of homo and heteropolysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.

Unit III:

Classification of Lipids, Fatty acids and their physicochemical properties, physicochemical properties and characterization of fats and oil; Structure, properties and biological roles of triacylglycerol, phospholipids, sphingolipids, Gangliosides, Prostaglandins, Thromboxanes, Leukotrienes and steroids.

Unit IV:

Nucleic acids – bases, nucleosides, nucleotides, purine and pyrimidine bases physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non enzymatic transformation of nucleotides and nucleic acids, chemical synthesis of DNA; Nucleic acid sequencing – Higher orders of DNA & RNA Structure, chromatin structure; Three dimensional structure of DNA; Types of RNA, Structure of RNAs – Secondary and Tertiary structure; DNA denaturation and renaturation kinetics.

Recommended Books:

1. Nelson.D.L, Cox. M. M. Lehninger's Principle of Biochemistry. Freeman.
2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper's Biochemistry, McGraw Hill.
3. Fundamentals of Biochemistry by Donald Voet.
4. Textbook of Biochemistry West, E.S., Todd, Mason &Vanbruggen, Macmillian&Co.
5. Biochemistry, Lubert Stryer.

BC103 Microbiology

Unit I:

History and Scope of Microbiology; Classification of Microorganisms-Bacteria, Fungi, Virus, Alga, Protozoa, phenotype, numerical and phylogenetic tree - rRNA, DNA and Proteins, Microbial diversity, Major characteristics used in taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations- (protein, nucleic acid composition); sterilization techniques, disinfectant and antiseptic agents; Major groups of bacteria- Archaebacteria, Actinomycetes, Chemoautotrophs, Eubacteria, Pseudomonads, cyanobacteria; Bacterial cell- structure and functions of cellular components-cell wall composition of Gram positive and Gram negative bacteria, sub-cellular organizations, flagella, capsule and spores.

Unit II:

Modes of nutrition – phototrophy, chemotrophy, methylotrophy, organotrophy, mixotrophy, saprophytic, symbiotic and parasitic modes of nutrition; Isolation of microorganisms – Direct and indirect; Methods of maintenance of culture, composition of culture media - solid and liquid media, chemically defined media, complex and differential media; Growth and kinetics of bacterial cells; batch and continuous cultures, chemostat; Effect of pH, temperature and radiation on microbial growth; Preservation of cultures (glycerol stocks, freeze drying); staining techniques, differences between Gram-positive and Gram-negative bacteria.

Unit III:

Introduction to Virology: Classification, Morphology, size, ultra structure and life cycle of some representative viruses (ØX174, t4, SV40, Phage λ, m13 and HIV); Methods of culturing of viruses, Biology of subviral agents – Viroids, Prions, Satellite viruses, Antiviral agents-chemical and biological agents; Molds – characteristics, classification and reproduction; Yeasts – morphology, characteristics and reproduction; General characteristics of Actinomycetes, Rickettsia, Spirochaetes and mycoplasma; Economical and industrial uses of algae.

Unit IV:

Role of microorganisms in domestic and industrial sewage; Microbes and Diseases - Diseases of the respiratory tract-diphtheria, tuberculosis, pneumonia, influenza, mumps; Diseases of the skin- systemic mycoses, candidiasis; herpes viral infections, chicken pox, and small pox; Genitourinary infections- Gonorrhea, syphilis; Diseases of GIT- Cholera, Typhoid; Hepatitis; Major human protozoan diseases- Malaria, Trypanosomiasis, meningoencephalitis, Viral diseases – Dengue, Hepatitis, HIV, Polio, Rabies, SARS; Inactivation of viruses – photodynamic inactivation.

Recommended Books:

1. Prescott, Harley and Klein, Microbiology Publisher: McGraw Hill Science
2. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, Microbiology: An Introduction Benjamin Cummings Publisher.
3. Microbiology by Pelczar, Chan and Krieg Mc Grew- Hill.
4. A Textbook of Microbiology, R.C.Dubey and D.K.Maheswari, S.Chand Co.
5. Fundamentals of Microbiology – M. Frebisher.

BC104 Analytical Techniques

Unit I:

Microscopy- Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy; Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, ORD, CD, NMR spectroscopy; Spectrofluorimetry and mass spectrometry, X-ray diffraction; Flow cytometer.

Unit II:

Chromatography - Principles and applications of gel-filtration, ion-exchange and affinity chromatography; TLC, GLC and HPLC; Centrifugation - Basic principles of centrifugation, types of centrifuges, Applications of preparative and analytical ultra-centrifuges, Principles and applications of sedimentation and lyophilization.

Unit III:

Electrophoresis - Principle of electrophoretic techniques, Poly Acryl amide Gel Electrophoresis, Isoelectric focusing, Isotachophoresis, 2-D Electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis of DNA and RNA, Blotting techniques.

Unit IV:

Stable and radioactive isotopes, Detection and measurement of radioactivity, Applications of radioisotopes in biological sciences, Autoradiography, Non-isotopic tracer techniques; Principles and range of electrochemical techniques, Operation of pH electrodes, Principles and applications of Ion-selective and gas sensing electrodes, Oxygen electrodes.

Recommended Books:

1. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker.
2. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya publishing).
3. A Biologists guide to Principles and techniques of practical Biochemistry. By B.D.williams (Edward Arnold).
4. Modern experimental Biochemistry by Rodney Boyer (Pearson Education).

I SEMESTER PRACTICALS

BC105 Cell Biology Lab

1. Light Microscopic examination of tissues
2. Preparation of different cell types–hepatic parenchymal cells, adipocytes,macrophages, neuronal cells, epithelial cells.
3. Stages of mitosis and meiosis
4. Mitosis in onion root tip cells: All phases (Squash method).
5. Meiosis in onion flower buds: All phases including zygotene, diplotene and diakinesis of prophase I (Smear method).
6. Arrest and observation of chromosomes after colchicine treatment in onion roots.
7. Blood smear preparation and identification of cells.
8. Isolation of cellular organelles by differential centrifugation.

BC106 Biomolecules Lab

1. Estimation of glycine by formal titration.
2. Estimation of proteins by Lowry and Bradford methods.
3. Analysis and identification of monosaccharides.
4. Estimation of Maltose by DNS method.
5. Determination of Iodine value of oils.
6. Estimation of cholesterol.
7. Estimation of DNA by DPA method.
8. Estimation of RNA by orcinol method.

BC107 Microbiology Lab

1. Introduction to sterilization techniques.
2. Preparation of liquid and solid media for growth of microorganisms.
3. Isolation of Bacteria from soil –serial dilution technique.
4. Simple Staining, acid fast staining, spore staining, Grams staining.
5. Biochemical tests for bacteria.
6. Pure culture techniques-streak plate, spread plate and pour plate.
7. Bacterial growth curve.
8. Isolation of viruses.

BC108 Analytical Techniques Lab

1. Microscopic examination.
2. Spectroscopic determination of nucleic acids and proteins.
3. Separation of biomolecules by paper chromatography and Thin Layer Chromatography
4. Subcellular fractionation by differential centrifugation.
5. Polyacrylamide gel electrophoresis of proteins.
6. Qualitative determination of nucleic acids by agarose gel electrophoresis.
7. Preparation of buffers and pH determination by pH meter.
8. Measurement of radioactivity by Geiger Muller Counter.

II SEMESTER
BC201 Molecular Biology

Unit I:

Models of DNA Replication, Origin and direction of replication, Semi discontinuous replication, DNA polymerases of prokaryotes and their mechanism of action, Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases, Replication strategies for replicating circular DNA: φ mode replication, σ mode or rolling circle replication and D-loop replication; Eukaryotic DNA polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and processivity of replication, Inhibitors of replication.

Unit II:

DNA Repair mechanisms, Photoreactivation, Excision repair mechanism, Post replication repair mechanisms - recombination repair, mismatch repair system, SOS response, transcription-repair coupling. Recombination - models of general recombination; Holliday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination; Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

Unit III:

Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiation of transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes, Post transcriptional processing of pre-mRNA - addition of Cap to the 5' end, Polyadenylation to the 3' end, mechanism of intron removal and exon splicing, Processing of r-RNA, Self-splicing of introns, Processing of tRNA, Inhibitors of RNA synthesis.

Unit IV:

General features of genetic code, Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes - aminoacylation of tRNA, protein synthesis - initiation, elongation and chain termination, Protein synthesis inhibitors, Post translational modifications of proteins, role in targeting (isoprenylation); Signal peptide (ERLS), role of SRP in translation of secreted proteins; molecular chaperones, HSPs in protein folding; Lysosomal pathways (endocytosis, macroautophagy, microautophagy, direct translocation from cytosol), Ubiquitin-proteosome pathway.

Recommended Books:

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson. Publisher New York: Garland Science
3. Biochemistry, Donald Voet, Judith G. Voet, Publisher John Wiley & Sons
4. Molecular Biology of the gene by Watson
5. Molecular Cell Biology by Harvey Lodish, David Baltimore, W. H. Freeman Publisher.
6. Molecular Biology by D Friefelder

BC202 Enzymology

Unit I:

Classification of enzymes, Remarkable properties of enzymes – catalytic power, specificity, Transformation of different forms of energy, Enzyme localization and assay, Units of enzyme activity, Active site – Fisher and Koshland models, formation of enzyme – substrate complex and experimental evidences, Nature of active site, mapping of enzyme active site through chemical procedures and site directed mutagenesis, Factors affecting enzyme activity, Modern concepts of evolution of catalysis, ribozymes, abzyme and synzymes.

Unit II:

Kinetics of single substrate enzyme catalyzed reactions, Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots, Significance of Vmax, Km, Kcat specificity constant (Kcat/Km), Kinetics of multisubstrate reaction, Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms, Use of initial velocity, Inhibition and exchange studies, Flexibility and conformational mobility of enzymes, Enzyme inhibitions – reversible inhibition – competitive, non-competitive, uncompetitive inhibition, irreversible inhibition, Determination of KI values.

Unit III:

Types of reaction catalysis – General acid – base, electrostatic, covalent, intermolecular, metal – ion catalysis, Proximity and orientation, Mechanism of reaction catalyzed by serine proteases – trypsin and chymotrypsin, carboxypeptidase, lysozyme, triose phosphate isomerase, ribonuclease, Rotational catalysis in ATPase, Mechanism of catalysis with coenzymes – pyridoxal phosphate, flavin nucleotides, thiamine pyrophosphate, biotin, tetrahydrofolate, lipoic acid.

Unit IV:

Enzyme regulation – general mechanisms of enzyme regulation, Allosteric enzymes (ATCase), Cooperativity phenomenon, Hill and Scatchard plots, Sigmoidal kinetics and their physiological significance, Symmetric and sequential models of action of allosteric enzymes and their significance, Feedback inhibition and feed forward stimulation, Control of enzymatic activity by products and substrates, Reversible and irreversible activation, Isoenzymes, Multifunctional enzymes, Multienzyme systems – properties, mechanism of action and regulation of Pyruvate dehydrogenase and Fatty acid synthase complex; Enzyme purification - Methods of isolation, purification, Recovery and yield of enzymes, Criteria for testing purity of enzyme preparations; Immobilized enzymes - Methods of immobilization, Applications of immobilized enzymes.

Recommended Books:

1. Understanding enzymes: Palmer T., Ellis Harwood ltd.
2. Enzyme structure and mechanism. Alan Fersht, Freeman & Co.
3. Principles of enzymology for food sciences: Whitaker Marc Dekker.
4. Methods in enzymology Ed. Colowick and Kaplan, Academic Press
5. Text book of Biochemistry with clinical correlations-Thomas M.Devlin.
6. Biological chemistry; H.R. Mehler & E.H Cordes Harper & Rev.
7. Enzyme kinetics Siegel interscience – Wiley.
8. Biochemistry chemical reactions of living cells David E.Matzler.

BC203 Immunology

Unit I:

Types of immunity – Innate and adaptive; Antigens, Super antigens, Adjuvants; Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node; T and B lymphocytes – Origin, activation, differentiation, characteristics and functions, Nature of T and B cell surface receptors; Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules, MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens.

Unit II:

Structure of immunoglobulins, Immunoglobulin classes and biological activities, Isotypes, Allotypes, Idiotypes; Antibody diversity: Mini gene theory, Mutation theory, Germ line theory, Somatic recombination, V (D) J recombination, Combinatorial diversity, Junctional diversity, Class switching; Immunological memory; Humoral and cell-mediated immune responses, Cytokines, Interleukins, Interferons; Complement components and biological consequences of complement activation.

Unit III:

Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions-Heme agglutination and complement fixation, Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications; Development of Vaccines-conventional vaccines- attenuated, killed organisms and subunit vaccines; modern vaccines-recombinant vaccines and DNA vaccines.

Unit IV:

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayed hypersensitivity reactions; Immunodeficiencies - SCID and AIDS; Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases; Tissue transplantation - auto, allo, iso and xenograft, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents; Cancer immunology – Tumor associated antigens, Immunological surveillance of cancer.

Recommended Books:

1. Essential immunology- Ivan M. Roitt.
2. Introduction to Immunology – John W.Kinball.
3. Immunology – D.M. Weir.
4. Immunology – Janis Kuby.

BC204 Biostatistics

Unit I:

Introduction- definition of statistics-population and universe, the sample and population, statistical inference parameter and statistics, Handling of bulky data, construction of a histogram, interpretation of histogram, the normal distribution, the mean, mode and standard deviation representing the normal curve as straight line, uncertainties in estimating a mean.

Unit II:

Measures of variation, Range, quartile deviation, mean deviation and standard deviation, Coefficient of variation; Probability - Addition and multiplication theories, conditional probability and probability distributors; Proportion data- Examples of Proportion data – testing of medicines, animal toxicity, infection and immunization studies e.g., LD_{50}, ED_{50}, PD_{50} statistical treatment to proportion data; normal distribution; Count data- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.), Statistical treatment to count data - Poisson distribution, standard error, confidence limits of counts.

Unit III:

Simple linear regression and correlation, Correlation regression and line fitting through graph points, standard curves, correlation - linear regression (fitting the best straight line through series of points)- standards curves and interpolations of unknown y-values, Regression coefficients and properties.

Unit IV:

Types of errors and levels of significance, Parametric tests of significance– F & t tests, chi-square tests, Analysis of variance (ANOVA); Non parametric tests- sign test, Wilcoxon signed rank test, Mann-Whitney test, Kruskal-Wallis test and Friedman tests; computer aided statistics- STATVIEW, SPSS, STATISTICA, STATSOFT.

Recommended Books:

1. Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India
2. An Introduction to statistical methods and data analysis by Lyman Ott PWS-Kent publication Co-Boston
3. Methods in Biostatistics Mahajan B K and Srimathi
4. Pollard, J H. A handbook of Numerical and statistical techniques with examples mainly from the life sciences. Cambridge University, Cambridge.
5. J medhi statistical methods. An introductory text. New international (P) Ltd. Publishers.
6. P S S Sudar Rao & J Richard. An introduction to biostatistics and Research Methods, Phi Learning Publisher.

II SEMESTER PRACTICALS
BC205 Molecular Biology Lab

1. Isolation of DNA from bacterial, plant and animal cells.
2. Isolation of RNA from yeast cells.
3. Estimation of DNA and RNA by UV absorption method and determination of purity of nucleic acids.
4. Agarose gel for RNA, DNA, blot the gel
5. Determination of sugar and phosphate ratios in DNA and RNA samples.
6. Determination of melting temperature (Tm) of DNA.

BC206 Enzymology Lab

1. Assay of Amylase from saliva
2. Assay of Acid phosphatase from potato
3. Assay of Trypsin
4. Alkaline phosphatase from Serum.
5. Assay of urease from Horse gram
6. Assay of Succinate dehydrogenase from the liver
7. Isoenzymes of LDH – electrophoretic separation and specific staining technique
8. Time course of enzyme activity
9. Effect of pH and temperature on enzyme activity
10. Immobilization of enzymes (demonstration).

BC207 Immunology Lab

1. Determination of A, B, O and Rh blood groups in human beings
2. Diagnostic test for typhoid fever
3. VDRL Test
4. Pregnancy Test
5. Ouchterlony immunodiffusion for detection of Antigens
6. Radial Immunodiffusion
7. Immunoprecipitation and precipitin curve
8. Rocket immunoelectrophoresis
9. Enzyme Linked Immuno Sorbent Assay (ELISA)

BC208 Biostatistics Lab

1. Classification of data, computation of mean and standard deviation.
2. Simple statistical analysis with Excel.
3. Correlation and regression coefficients.
4. Binomial distribution
5. Poisson distribution
6. Normal distribution
7. Analysis of data using Student’s "t" test using any statistical tool
8. One way ANOVA with equal number of observations and with unequal number of observations and ANOVA with two way classified data using any statistical tool.

III SEMESTER
BC301 Endocrinology and Metabolism

Unit I:

History and Introduction to Endocrinology; Classification, chemistry, biosynthesis, secretion, regulation, transport and general mechanisms of actions of Hormones, bio-assay, chemical, RIA, ELISA; Structure, secretion and actions of hypothalamic releasing hormones and inhibitory hormone;. Pineal hormones: Melatonin and serotonin; Hormones of the Thyroid and parathyroid gland: Biosynthesis of thyroid hormones, regulation of secretion, Iodine metabolism, Possible mechanism of action and general functions, Metabolism at target cells and excretion; Calcitonin and parathyroid hormone - Role of calcitonin in calcium and phosphate homeostasis in blood, Disorders of thyroid and parathyroid.

Unit II:

Hormones of Pancreas and Gastro intestinal hormones - Chemistry, biosynthesis and secretion of insulin and glucagon, Actions of insulin and glucagon on Carbohydrate, lipid and protein metabolism, Gastrin, secretin, pancreozymin Cholecystokinin; Adrenal hormones - Structure, biosynthesis, metabolism, excretion and actions of adrenaline and noradrenaline; Corticosteroids - Biosynthesis, secretion, actions, metabolism and excretion of cortisone, Cortisol, corticosterone, deoxycorticosterone and aldosterone; Disorders of pancreas and adrenal glands.

Unit III:

Hormones of Reproduction - Testosterone and inhibin, Estrogens, Progesterone and Relaxin, Human chorionic gonadotropin, Human placental lactogen, Hormonal regulation of menstrual cycle, contraceptions, Disorders associated with Gonadal hormones; Thymosin – synthesis and actions; Insect molting hormones – ecdysone; Plant hormones – auxins, gibberellins, cytokinins, ethylene and abscisic acid; Pheromones.

Unit IV:

Signal transduction: Autocrine, paracrine & endocrine systems; Growth factors – EGF, PDGF, VEGF, IGF; Second messengers – Ca, calmodulin, inositol, NO, cAMP, cGMP; Receptors tyrosine kinases (Insulin signaling), MAPK pathway, Ras pathway ; Role of post-translational .modification of proteins in signaling – phosphorylation, Acylation, methylation, glycosylation, ADP ribosylation; Signal cascades, Inhibitors of signal cascades.

Recommended Books:

1. The Biochemistry of Cell Signaling, Helmreich JM, Oxford Press
2. Cell signaling – John T Hancock, Oxford University press
3. Cell biology by C A Smith and E J Wood. Chapman & Hall publ
4. Molecular Cell Biology, Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. New York: W. H Freeman
5. Text book of Endocrinology – William, Saunders Elsevier
6. Metabolic and endocrine physiology by Jay Teppermann,

BC302 Physiology and Bioenergetics

Unit I:

Introduction- Internal environment and homeostasis- coordinated body functions; Digestion- digestive processes at various regions of digestive system, regulation of gastric secretion and motility, intestinal secretion and motility, role of gastrointestinal hormones; Renal physiology- structure of nephron, glomerular filtration, tubular reabsorption and secretion, formation of urine, regulation of water and mineral excretion, counter current multiplier and exchanger, renal role in acid base balance.

Unit II:

Nerve physiology-Structure of neuron and synapse, excitability, action potential, conduction of never impulse, synaptic transmission, neurotransmitter systems, Blood brain barrier; Muscle physiology- skeletal and smooth muscle, electrical properties and ionic properties, types of muscle contraction, Neuromuscular transmission.

Unit III:

Circulatory physiology - Formation and composition of blood, total and differential counts in blood, Development of erythrocytes, leukocytes and platelets, Plasma proteins and blood clotting mechanism, Erythrocyte Sedimentation Rate; Cardio physiology- functional anatomy of heart, genesis and spread of cardiac impulses, cardiac cycle, heart sound, cardiac output, cardiovascular regulatory mechanisms, basic E.C.G; Respiratory physiology- functional anatomy of air passages and lung, respiratory muscles, mechanism of respiration, lung volumes and capacities, gas exchange in the lungs, regulation of respiration.

Unit IV:

Elements of importance in biochemistry (H, C, N, O, P, S), types and energy of bonds and interactions (ionic, covalent, coordinate, H-bonds, van der waals, hydrophobic interactions); Laws of thermodynamics, Gibbs free energy, relevance of entropy and enthalpy in biological systems and reactions; first and second-order reactions; Log and ln scales in exponential growth curves, radioactive decay; Biological oxidation, high energy compounds, High energy bonds, redox and phosphate potential; forces stabilizing membranes; Formation of ion gradients across a membrane (proton gradients), role of transporters and channels; ETC in mitochondria and chloroplasts, uncouplers and inhibitors of energy transfer; Polarization of cell, resting potential, action potential, propagation of impulse; Biological fluorescence, Bioluminescence.

Recommended Books:

1. Pal, G.K. Textbook of Medical Physiology, Ahuja Publishing House, Delhi.
2. Guyton and Hall Textbook of Medical Physiology, Elsevier Publisher
3. Barrett KE, Brooks HL, Boitano S and Barman SM, Ganong's Review of Medical Physiology, McGraw-Hill Medical.
4. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman
5. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson. Publisher New York: Garland Science.
6. The Cell: A Molecular Approach by Geoffrey M. Cooper and Robert E. Hausman, published by ASM Press.

BC303 Intermediary Metabolism

Unit I:

Approaches for studying intermediary metabolism; Glucose as fuel, glucose transporters, Glycolysis and its regulation, Substrate cycling, TCA cycle – function and regulation; Glyoxylate cycle, Gluconeogenesis and its regulation; HMP shunt and its significance; Uronic acid pathway, Glycogen metabolism; Metabolism of fructose, galactose and lactose; Biogenesis of amino sugars, peptidoglycans, glycosylaminoglycans and glycoproteins; In born errors of carbohydrate metabolism.

Unit II:

Proteins turn over – Role of ubiquitin; General metabolic reactions of amino acids, Metabolic breakdown of individual amino acids, Ketogenic and glycogenic amino acids, Formation of creatinine, ammonia and urea, Regulation of urea cycle; Essential and nonessential amino acids, Biosynthesis and regulation of branched chain amino acids, aromatic amino acids, histidine and methionine; In born errors of amino acid metabolism.

Unit III:

Fats as energy stores, Oxidation of fatty acids, Formation and utilization of ketone bodies, Biosynthesis of fatty acids and regulation; Metabolism of arachidonic acid; formation of prostaglandins, thromboxanes, leukotrienes, Biosynthesis of triglycerides; Metabolism of phospholipids, sphingolipids; Biosynthesis of cholesterol and its regulation; Formation of bile acids; Role of liver and adipose tissue in lipid metabolism; In born errors of lipid metabolism.

Unit IV:

Biosynthesis and degradation of purines and pyrimidines and their regulation; Structure and regulation of ribonucleotide reductase; Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides; Inhibitors of nucleic acid biosynthesis; In born errors of nucleic acid metabolism.

Recommended Books:

1. Principles of Biochemistry, White. A, Handler, P and Smith.
2. Biochemistry, Lehninger A.L.
3. Biochemistry, David E. Metzler.
4. Biochemistry, Lubert Stryer.
5. Text of Biochemistry, West and Todd.

BC304 Gene regulation and Genetic Engineering

Unit I:

Structure and function of *lac* operon, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system, Function and regulation of *trp* operon, Attenuation of *trp* operon, *ara* operon - dual functions of the repressor, Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis,* Heat-shock response in *E.coli,* Regulation of phage variation in *Salmonella;* Regulation of lytic phase and lysogenic phase of Bacteriophage λ.

Unit II:

Structural changes in the eukaryotic active chromatin - hypersensitive sites, chromatin remodeling, Levels of eukaryote gene control - Control at the level of transcription, processing of RNA, mRNA stabilization in the cytoplasm and translation of mRNA; Eukaryote promoter and enhancer sequence organization, Interaction of eukaryote transcriptional factors with DNA - helix-turn-helix motif, zinc-finger motif, leucine zipper, helix-loop-helix motif; Regulation of galactose metabolism in yeast; Steroid hormone induced gene expression; Regulation of gene expression by anti-sense RNA.

Unit III:

Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing; Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, Hosts - Prokaryotic: *E.coli, B.subtilis,* Eukaryotic: Yeast and mammalian cell lines; Ligation of fragments - Cohesive and blunt ends, Homopolymer tailing; Gene transfer techniques, Biological and artificial delivery system, knockout mice.

Unit IV:

Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria; Genomic and cDNA libraries, Identification of recombinants - structural and functional analysis of recombinants; Design and preparation of DNA and RNA probes for hybridization, Southern and Northern blotting, South-Western blotting, PCR, DNA fingerprinting; Expression of cloned genes in bacteria, yeast, animal and plant cells; Biological, Medical and Industrial applications of recombinant DNA technology, Transgenics - Making Golden rice and Dolly.

Recommended Books:

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

III SEMESTER PRACTICALS

BC305 Endocrinology and Metabolism Lab

1. Estimation of lipase C
2. Estimation of h HCG
3. Estimation of FSH
4. Estimation LH
5. Estimation Estrogen, Estradiol
6. T3, T4, TSH Tests (demonstration)
7. Pregnancy Test (strip method)
8. Estimation of C Peptide

BC306 Physiology and Bioenergetics Lab

1. Microscopy
2. RBC count & WBC count
3. Differential leucocyte count by Leishman' s staining
4. Estimation of Haemoglobin by Sahli's acid haematin method
5. Determination of Packed cell volume (PCV)
6. Determination of Erythrocyte sedimentation rate (ESR)
7. Determination of Coagulation time & Bleeding time
8. Determination of blood group

BC307 Intermediary Metabolism Lab

1. Preparation of lactalbumin from milk
2. Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method
3. Estimation of glucose by Benedict's method
4. Estimation of urea by Diacetyl monoxime method
5. Estimation of uric acid
6. Estimation of creatinine in urine
7. Estimation of cholesterol by ZAK's method
8. Estimation of pyruvate by DPNH (2,4-dinitrophenylhydrazine) method

BC308 Gene regulation and Genetic Engineering Lab

1. Culture of *E.coli* cells & plasmid isolation
2. Preparation of competent cells
3. Calcium chloride mediated transformation
4. Primer design for PCR
5. Polymerase chain reaction
6. Restriction fragment length polymorphism

IV SEMESTER
BC401 Plant and Environmental Biochemistry

Unit I:

Photosynthesis – Light and Dark reactions, Hill reaction, Cyclic and Non-cyclic photophosphorylation mechanisms; Light receptors – photo systems I and II, their location, mechanism of quantum capture and energy transfer between photo systems, Proton gradient and ATP synthesis, CO_2 fixation in C3, C4 and CAM plants; Quantum efficiency and regulation of photosynthesis; Mechanism of photorespiration and its significance.

Unit II:

Nitrogen cycle, Symbiotic N_2 fixation, nitrate reduction and assimilation in plants; Seed germination and dormancy, Factors effecting seed germination and biochemical changes during seed germination; Secondary metabolites in plants – Nature, distribution, biosynthesis and function of plant phenolics, alkaloids, lignins, terpenoids and lectins; Structure, physiological function and mechanism of action of phytohormones – auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Unit III:

Definition, scope and importance, need for public awareness on renewable and non-renewable resources, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Role of an individual in conservation of natural resources; Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, food chains, food webs and ecological pyramids, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems; Biodiversity and its conservation.

Unit IV:

Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management - Causes, effects and control measures of urban and industrial wastes, Role of an individual in the prevention of pollution; Population growth and explosion, Role of Information Technology in Environment and human health.

Recommended Books:

1. Mukherji, S and Gosh A. K., Plant Physiology, New Central Book Agency, Kolkata.
2. Slater A, NW Scott, MR Fowler, Plant bio technology, Oxford University Press.
3. Hopkins, W. G and Huner, N. P. A. Introduction to Plant Physiology, John Wiley & Sons Inc. New York.
4. Plant Biochemistry, Hans-Walter Heldt and Birgit Piechulla
5. Plant Biochemistry by Dr. V.Arun Kumar, Dr.K.Siva Kumar, Dr. N. Senthil Kumar.
6. Environmental Biochemistry by Neelima Rajvaidya, Dilip Kumar Markandey.
7. Environmental and Ecological Biochemistry by P.W. Hochachka T.P. Mommsen.

BC402 Clinical Biochemistry and Human Nutrition

Unit I:

Introduction to Clinical Biochemistry - Introduction and maintenance of clinical biochemistry laboratory, hazards in clinical biochemistry laboratory, units, 'normal range', reference values, Factors affecting reference values, quality control in laboratory, use of external and internal standards, use of WHO standards, Selection of analytical methods, Automation in clinical laboratory, Collection and preservation of specimens; Pancreas function tests, renal function tests - osmolality and free water clearances, Liver function tests - bile pigments level, plasma changes, prothrombin time; Gastric function tests - gastric residuum examination, FTM, tubeless gastric analysis.

Unit II:

Prenatal Diagnosis - Newborn screening for PKU, cystic fibrosis and sweat tests, Prenatal diagnosis of diseases, Acetylcholinesterase test in amniotic fluid and fetal blood examination, Chromosomal abnormalities by cytogenetics; Molecular diagnosis of genetic defects Diagnosis of genetic diseases by molecular biology techniques (Hemochromatosis, thalassemia, sickle cell diseases), DNA probes, restriction fragment length polymorphism (RFLP), polymerase chain reaction (PCR), amplification of mRNA, AIDS - Clinical diagnosis.

Unit III:

Animal and vegetative foods – chemical composition, Nutrients – Essential Nutrients and their classification, Digestibility, absorption and biochemical functions of macronutrients, Carbohydrates dietary requirements; Nitrogen balance studies for Proteins, Biological values of proteins, protein quality improvement by supplementation and fortification; Dietary needs of lipids, essential fatty acids; Calorific values of foods, Basal metabolic rate, factors influencing BMR; role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin in regulation of body mass, Protein sparing treatment during fasting, malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and aged people.

Unit IV:

Biological effects of non nutrients, dietary fibre, physiological actions, Antinutrients – Protease inhibitors, hemagglutinins, hepatotoxin, goitrogens, cyanogenic glycosides, methyl xanthines, oxalates, toxins from mushrooms; Biological effects of food contaminants – hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives - saccharin and sodium nitrite; Food allergy – role of allergens, diagnosis and management of food allergy; Food processing and loss of nutrients during processing and cooking; Vitamins - sources, physiological role and deficiency disorders of water soluble and fat soluble vitamins; functions and deficiency disorders of minerals.

Recommended Books:

1. Essentials of Food and Nutrition, Vol. I & II, M.S. Swaminathan.
2. Text Book of Biochemistry with clinical correlations. Thomas M. Devlin (John Wiley).
3. Biochemical aspects of human disease – R.S. Elkeles and A.S. Tavil. (Blackwell Scientific Publications).
4. Varley's Practical clinical Biochemistry – Ed. Alan W. Gowenlock (Heinemann Medical Books, London).

BC403 Applied Biochemistry

Unit I:

Methods for measuring nucleic acid and protein interactions – foot printing, CAT assay, gel shift analysis; DNA markers in genetic analysis – RFLP, Minisatellites, Microsatellites, PCR based RAPD markers, Chromosomal Walking, Chromosomal jumping, DNA fingerprinting, SNPs; Mapping Genes – Somatic cell hybridization mapping, FISH, Transposon tagging; RNA silencing by siRNAs and antisense RNAs, their design and applications; shRNA, epigenetic gene silencing; Microarrays and biochips, principle and applications of metabolic engineering; principle and applications of Nanotechnology.

Unit II:

Plant and animal cell culture: Culture media, Composition and preparation for plant and animal cells; Totipotency, Organogenesis and plant regeneration, Somatic embryogenesis, Artificial seeds, Micropropagation, Isolation and culture of protoplasts, Somatic hybridization, Plant cell cultures, Plating efficiency, Production of secondary metabolites through in vitro culture; Primary cultures, continuous cell lines, Tissue and organ culture, Stem cells – embryonic and adult stem cells, cord blood stem cells, Generation of stem cells by cloning, stem cell differentiation, stem cell plasticity, preservation of stem cells, Organogenesis through stem cells for transplantation, Applications of stem cell therapy, Production of transgenic plants, animals and their applications.

Unit III:

Fermentation Technology- Batch, continuous culture techniques, principle types of fermenters, Industrial production of chemicals - alcohol, acids (citric, lactic and acetic acids), solvents (acetone and butanol), antibiotics (penicillin and streptomycin), Vitamins (Riboflavin and Vitamin B12), amino acids (lysine and glutamic acid), Single Cell Protein (SCP) and Biopesticides; Enzyme Technology- Immobilization of enzymes and cells, different methods, Industrial applications in production of glucose from starch, use of glucose isomerase in confectionary industry, use of lactase in Dairy Industry, production of invert sugar from sucrose, use of protease in food, detergent and leather industries, medical applications of enzymes, Low calorie sweeteners.

Unit IV:

Immunotechnology - Hybridoma technique, monoclonal antibodies production, myeloma cell lines, fusion of myeloma cells, selection of hybridomas, protoplast fusion and HAT medium, Screening, purification and application of monoclonal antibodies; Design of vaccines, Conventional vaccines – Whole organism, live and attenuated, purified macromolecules, New generation vaccines- Recombinant antigen vaccines, recombinant vector antigens, DNA vaccines, synthetic vaccines, edible vaccines; Gene therapy –Types and use of rDNA constructs for gene therapy.

Recommended Books:

1. Fermentation Technology, Standury (Pergman press)
2. Biotechnology: Textbook of Industrial microbiology by Crueger and Crueger.
3. Principles of Gene manipulation: An Introduction to genetic Engineering. R.V.Old and S.B.Primrose (Blackwell Scientific Publications).
4. Principles of Biotechnology, Alen Weisman, Surrey University Press.
5. Concepts in Biotechnology, D.Balasubramaian, K.Dharmalingam, J.Green and K.Jayaraman (University Press).
6. Industrial Microbiology, L.E.Casida, JR. New Age International.

BC404 Bioinformatics, Omics and Research Methodology

Unit I:

Origin of bioinformatics biological data (genome projects), Disciplines of bioinformatics, transcriptomics, functional genomics, structural genomics, metabolomics, pharmacogenomics, structure prediction; Human Genome Project (HGP) - Science behind HGP, benefits of HGP, Ethical, Legal and Social Implications (ELSI) of HGP; Biological databases - Introduction of database (DB), need, organization, search of DB, NCBI, EMBL, DDBJ, SWISS-PROT, PDB, KEGG, Decoding of the genome (Nathan blow study), Nucleotide Sequence Database, GenBank, Tr- EMBL, PIR, Uniprot and Pfam, PDB, CATH, SCOP, MMDB.

Unit II:

Proteomics - Introduction, principle, technique, 2-D data base. Gel analysis, post gel analysis, MALDI-TOF, Significance and applications of proteomics in modern biology, Molecular Modeling – Structure of protein at Primary, secondary, tertiary and quaternary level, Understanding Molegro Molecular viewer for protein 3D visualization – RASMOL, Protein secondary structure prediction – Chou Fasman method, Homology modeling and docking studies (Using Molegro Virtual Docker), Drug Designing.

Unit III:

Genomics- Whole genome analysis, Preparation of cosmid libraries, bacterial artificial chromosomal libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert Methods), automated sequencing, Sequence analysis -Computational methods, homology algorithms (BLAST) for nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function (PROSITE, PFAM, Pro Scan), Genome annotation; Functional Genomics, Comparative genomics - Orthologs, paralogs, and homologs, Concepts of sequence alignments and its importance, Pairwise and multiple sequence alignment, Molecular phylogeny concept.

Unit IV:

Basics of Research Methodology - Literature survey, origin and identification of problem, Formulation hypothesis based on existing information, Validation of hypothesis, Designing experimental techniques for validating the hypothesis, Execution of designed experiments, Analysis of data, Interpretation of research findings; Methodology for writing science report and projects - Compilation of experimental record, program of writing, use of vocabulary, art of illustration, technical report writing, editing and correcting, manuscript writing for publication in peer reviewed scientific journals; Preparation of project proposal, submission of technical report, Patenting and intellectual property rights.

Recommended Books:

1. Primrose SB. Principles of Genome Analysis: a guide to mapping and sequencing DNA from different organisms, Blackwell Science: Oxford.
2. Genome Mapping: A practical approach. Dear P (Editor), Oxford University Press: Oxford.
3. Developing Bioinformatics Skills, Alfonso Valencia and Blaschke. L Oreille Publication.
4. Bioinformatics sequence, structure and data banks by Des Higgins Willie Taylor.

IV SEMESTER PRACTICALS

BC405 Plant and Environmental Biochemistry Lab

1. Estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments from the leaves.
2. Estimation of starch content by Anthrone reagent.
3. Spectrophotometric estimation of Indole acetic acid in plant tissues.
4. Determination of Gibberllic acid by half seed method.
5. Determination of protein under abiotic stress.
6. Isolation of chloroplast DNA

BC406 Clinical Biochemistry and Human Nutrition Lab

1. Estimation of blood glucose.
2. Estimation of blood urea.
3. Estimation of creatinine in serum.
4. Estimation of uric acid in serum.
5. Estimation of serum total protein.
6. Estimation of Serum albumin.
7. Estimation of Serum cholesterol.
8. Estimation of serum calcium.
9. Estimation of serum phosphate.
10. Estimation of serum bilirubin.

BC 407 Applied Biochemistry Lab

1. Purification of bovine serum IgG by ammonium sulphate precipitation
2. TLC of Plant compounds
3. Isolation of plant genomic DNA
4. Agarose gel electrophoresis of Genomic DNA
5. SDS PAGE of serum proteins.
6. Southern Blotting (Demonstration)

BC408 Bioinformatics, Omics and Research Methodology Lab

1. Databases
1. OMIM database and human genetic disorders
2. Retrieve DNA sequence from database (NCBI)
3. Retrieve protein sequence from database (NCBI)
4. Retrieve protein structure from database(PDB)
5. KEGG database for pathways
6. Local alignment of DNA, protein
7. Global alignment of DNA, protein
8. Multiple sequence alignments
9. *In silico* restriction mapping

Adikavi Nannaya University, Rajamahendravaram

M.Sc Biochemistry I Semester
Model Question Paper: Paper-I
BC101-Cell Biology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Explain in detail about nucleus, its organization and its biological role.

(OR)

b) Describe the structure, and application of ER, Golgibody, lysosomes and ribosomes.

2. a) Give the complete information about plasma membrane composition and various theories.

(OR)

b) Explain various transport mechanisms performed by plasma membrane.

3. a) Write about mitochondrial structural organization and its applications.

(OR)

b) Explain the structure, composition, and functions of chloroplast.

4. a) Discuss the mechanism of meiotic cell division and its regulation.

(OR)

b) List out the chromosomal aberrations and explain with example.

Section-B

5. Answer any **FIVE** of the following:

a) Nucleosome
b) Vacuole
c) Ionophores
d) Liposomes
e) Photorespiration
f) Oxidative phosphorylation
g) Aneuploidy
h) CDK – cyclin

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry I Semester
Model Question Paper: Paper-II
BC102-Biomolecules

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Describe the structure, classification and properties of amino acids.

   (OR)

   b) Explain the characterization and determination of proteins.
2. a) Write about the classification, structure, properties and functions of monosaccharides.

   (OR)

   b) Explain about polysaccharides and their occurrence in nature.
3. a) Discuss about the classification, structures, properties and biological functions of fatty acids.

   (OR)

   b) Explain about phospholipids, sphingolipids, prostaglandins, and steroids with their biological role.
4. a) Explain about the structure, types and physicochemical properties of Nucleic acids.

   (OR)

   b) Write in detail about RNA and its functions.

Section-B

5. Answer any **FIVE** of the following:

a) Vander waal's interaction
b) Stereo isomerism
c) Isoelectric pH
d) Chitin
e) Wax
f) Leukotrienes
g) mRNA
h) Denaturation

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry I Semester
Model Question Paper: Paper-III
BC103-Microbiology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a**) Write about the history and classification criteria of microorganisms.

   (OR)

   b) Explain the sterilization techniques and anti-microbial agents.
2. a) Discuss different methods of isolation of microorganisms and their maintenance.

   (OR)

   b) Explain the growth kinetics of bacterial cells.
3. a) Write about the classification, morphology, ultra structure and life cycle of viruses.

   (OR)

   b) Give the general characteristics of algae with their economical and industrial uses.
4. a) Explain about the causative organism, mode of infection and symptoms of respiratory tract.

   (OR)

   b) Give detailed information about viral diseases infecting humans.

Section-B

5. Answer any **FIVE** of the following:

a) Chemoautotrophs
b) Spores
c) Symbiosis
d) Chemostat culture
e) Prions
f) Influenza
g) Mycoplasma
h) Rabies

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry I Semester
Model Question Paper: Paper-IV
BC101-Analytical Techniques

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Explain the principle, instrumentation, and applications of Microscopy.

(OR)

b) Write the principle, instrumentation, and uses of UV, visible, infrared spectroscopy

2. a) Describe the principle, and application of ion exchange and affinity chromatography.

(OR)

b) What is centrifugation? Describe the application of preparative and analytical ultra-centrifugation.

3. a) Write the principle, instrumentation, and applications of horizontal electrophoresis.

(OR)

b) Describe the different blotting techniques procedure and their applications.

4. a) What is radioactive? Explain about liquid scintillation counter.

(OR)

b) Discuss the working methods of pH electrodes and their applications.

Section-B

5. Answer any **FIVE** of the following:

a) Fluorescence
b) X-ray diffraction
c) TLC
d) Lyophilization
e) Agarose
f) Isoelectric focusing
g) Isotope
h) Buffer

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry II Semester
Model Question Paper: Paper-I
BC201-Molecular Biology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Describe the various modes of replication in Prokaryotes.

   (OR)

   b) List out the proteins involved in replication and explain the mechanism of their action in replication process.
2. a) Write about DNA repair mechanisms.

   (OR)

   b) What is DNA recombination? Explain the different recombination mechanisms of DNA.
3. a) Explain the process of RNA synthesis and list out the differences of RNA synthesis between prokaryotes and eukaryotes.

   (OR)

   b) Write about splicing process of synthesized RNA.
4. a) Discuss protein synthesis with a note on post translational modifications.

   (OR)

   b) Explain ubiquitin proteasome pathway and its occurrence.

Section-B

5. Answer any **FIVE** of the following:

a) Helicase
b) Semi conservative replication
c) SOS
d) Transposons
e) Promoters
f) Exons and Introns
g) Genetic code
h) Signal peptide

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry II Semester
Model Question Paper: Paper-I
BC202-Enzymology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Explain enzyme classification, nomenclature and the characterization of active site.

   (OR)

   b) What is enzyme activity? Explain the factors effecting enzyme activity and its measurement.
2. a) Discuss enzyme kinetics and the significance of Km and Vmax.

   (OR)

   b) Explain enzyme inhibitions with their mechanism of action.
3. a) Write about the mechanism of serine protease catalysis.

   (OR)

   b) Describe the covalent catalysis mechanism of enzyme substrate interaction.
4. a) Explain about allosteric enzymes and cooperativity phenomenon.

   (OR)

   b) What are immobilized enzymes? Explain the methods of Immobilization and their applications.

Section-B

5. Answer any **FIVE** of the following:

   a) Specific activity
   b) Abzymes
   c) Kcat
   d) Irreversible inhibition
   e) Metal ion catalysis
   f) Biotin
   g) Isoenzymes
   h) Feedback inhibition

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry II Semester
Model Question Paper: Paper-III
BC203-Immunology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Write about various immune cells and organs of the body.

   (OR)

   b) What is major histocompatibility complex? Describe the antigen presentation and processing mechanism by MHC molecules.
2. a) Explain various classes of immunoglobulins and their biological role.

   (OR)

   b) Discuss the theories and recombination process of antibody diversity.
3. a) Mention the antigen – antibody interactions and various techniques and reactions involved.

   (OR)

   b) Explain vaccine preparation and types of vaccines developed for defence mechanism.
4. a) What are the different types of hypersensitivity? Describe them with examples.

   (OR)

   b) Explain the mechanism involved in autoimmune disorders.

Section-B

5. Answer any **FIVE** of the following:

   a) Adjuvant
   b) Lymph node
   c) Idiotype
   d) Interleukins
   e) Agglutination
   f) ELISA
   g) Immunological tolerance
   h) Xenograft

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry II Semester
Model Question Paper: Paper-IV
BC204-Biostatistics

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Define Biostatistics. Explain about histogram and its interpretation.

   (OR)

   b) Write about normal distribution and normal curve in estimating the mean.
2. a) What is probability? Explain the theories of probability.

   (OR)

   b) How is the data measured in terms of variation?
3. a) Write about linear regression and its applications in analyzing the data.

   (OR)

   b) What is correlation? Mention its mode of analysis.
4. a) Explain students t test with various levels of significance used in analysis of the data.

   (OR)

   b) Discuss various parametric tests used for testing more than two groups of the experiment.

Section-B

5. Answer any **FIVE** of the following:

   a) Sample size
   b) Bell shaped curve
   c) Standard deviation
   d) Poisson distribution
   e) Chi square test
   f) Regression
   g) SPSS
   h) Mann Whitney U test

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry III Semester
Model Question Paper: Paper-I
BC301- Endocrinology and Metabolism

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Describe the general mechanism of action of hormones and their analysis.

   (OR)

   b) Explain the metabolism and function of thyroid hormone
2. a) Write then biosynthesis, secretion and action of insulin hormone on glucose metabolism.

   (OR)

   b) Explain the metabolism of corticosteroids and their deficiency disorders.
3. a) Give the complete information on reproductive hormones.

   (OR)

   b) Discuss the synthesis and action of plant hormones.
4. a) What is signal transduction? Explain briefly about any one of the signaling pathways.

   (OR)

   b) Describe the post translational modifications and their role in cell-cell signaling.

Section-B

5. Answer any **FIVE** of the following:

a) Parathyroid hormone
b) Ligand-receptor action
c) Glucagon
d) Adrenal gland
e) Ecdysone
f) Second messengers
g) Methylation
h) Progesterone

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry III Semester
Model Question Paper: Paper-II
BC302- Physiology and Bioenergetics

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Explain the process of digestion and adsorption of foods.

   (OR)

   b) Explain the physiology of renal system.
2. a) Describe the structure of nerve and its function in the body.

   (OR)

   b) Write about the muscle physiology.
3. a) Discuss the composition of blood and the mechanism of blood clotting.

   (OR)

   b) Explain the regulation mechanism of respiration by lungs.
4. a) Write about various reactions involving high energy compounds.

   (OR)

   b) Explain the mechanism of proton motive force and energy changes in ETC.

Section-B

5. Answer any **FIVE** of the following:

a) Chymotrypsin
b) Acid base homeostasis
c) Synaptic transmission
d) Muscle proteins
e) Platelets
f) ECG
g) Gibb's free energy
h) Luminescence

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry III Semester
Model Question Paper: Paper-III
BC303-Intermediary Metabolism

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Describe the path way of glucose metabolism
   (OR)
   b) Explain the metabolism of glycogen in the tissues.
2. a) Write the biosynthesis of methionine.
   (OR)
   b) Discuss the metabolism of urea.
3. a) Explain the fatty acid oxidation and its regulation.
   (OR)
   b) Describe the metabolism of triglycerides.
4. a) Explain the metabolism of purines and its regulation.
   (OR)
   b) Describe the various inhibitors of nucleic acid biosynthesis and inborn errors of nucleic acid metabolism

Section-B

5. Answer any **FIVE** of the following:

a) Fructose metabolism
b) Glyoxylate cycle
c) Ubiquitin
d) Essential amino acids
e) Ketone bodies
f) Gaucher disease
g) Salvage pathway
h) Rifampicin

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry III Semester
Model Question Paper: Paper-IV
BC304-Gene regulation and Genetic Engineering

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Explain the *lac* operon concept in prokaryotes.

   (OR)

   b) Discuss the reproductive cycles of virus.
2. a) Write the gene regulation in eukaryotic cells.

   (OR)

   b) Explain the regulation of galactose metabolism in yeast.
3. a) What are restriction endonucleases? Explain their role in genetic engineering.

   (OR)

   b) Explain different cloning vectors involved in gene modification.
4. a) Describe the construction of genomic and cDNA libraries.

   (OR)

   b) Explain the principle and applications of PCR technology.

Section-B

5. Answer any **FIVE** of the following:

   a) Attenuation
   b) Enhancers and repressors
   c) Zinc finger motif
   d) Chromatin remodeling
   e) Ti plasmid
   f) Knockout
   g) RNA probe
   h) Western Blot

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry IV Semester
Model Question Paper: Paper-I
BC401-Plant and Environmental Biochemistry

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Explain the process of cyclic and non-cyclic photophosphorylation.

   (OR)

   b) Describe the Calvin cycle process in plants.
2. a) Describe the nitrogen cycle, assimilation of nitrogen in plants.

   (OR)

   b) Discuss the structure, physiological function and mechanism of action of phytohormones.
3. **a)** Explain the scope and importance of renewable and non renewable resources.

   (OR)

   b) Describe the energy flow in aquatic ecosystem and their conservation.
4. a) Explain the sources and causes of environmental pollution and suggest some remedial strategies for environment protection.

   (OR)

   b) Describe the causes and effects of urban and industrial wastes and explain solid waste management.

Section-B

5. Answer any **FIVE** of the following:

a) Hill reaction
b) Quantum efficiency
c) Lectins
d) Seed dormancy
e) Mineral resources
f) Biodiversity
g) Nuclear hazards
h) Marine pollution

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry IV Semester
Model Question Paper: Paper-II
BC402-Clinical Biochemistry and Human Nutrition

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Discuss the scope and maintenance of biochemical laboratory assays.

   (OR)

   b) Explain the pancreatic and gastric function tests.
2. a) Describe the various prenatal diagnostic tests for screening genetic disorders.

   (OR)

   b) Explain the molecular markers for identifying the genetic defects.
3. a) Write the dietary requirements and bioavailability of macro and micronutrients for humans.

   (OR)

   b) Discuss the nutritional treatment for the prevention of non communicable adult diseases.
4. a) Explain the biological effects of food contaminants, non nutrients and anti nutrients.

   (OR)

   b) Write about the biological effects of vitamins and their deficiency disorders.

Section-B

5. Answer any **FIVE** of the following:

a) Quality control
b) Glucose tolerance test
c) RFLP
d) AIDS
e) BMR
f) Marasmus
g) Hemagglutinins
h) Pellagra

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry IV Semester
Model Question Paper: Paper-III
BC403-Applied Biochemistry

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Discuss the molecular markers used for gene manipulation.

   (OR)

   b) Explain the principle, instrumentation and applications of Microarray.
2. a) Describe the isolation, propagation and maintenance of plant tissue culture.

   (OR)

   b) Write about stem cell technology and stem cell therapy.
3. a) Write the methodology for the production of various molecules with the help of fermentation technology.

   (OR)

   b) Describe the process and production of different biomolecules utilizing enzyme technology.
4. a) Explain the screening, purification and application of monoclonal antibodies with the use of Hybridoma technology.

   (OR)

   b) What is gene therapy? Explain the methods and applications of gene therapy.

Section-B

5. Answer any **FIVE** of the following:

a) Chromosomal walking
b) RNA silencing
c) Totipotency
d) Embryonic stem cells
e) pencillin
f) Synthetic sweetners
g) HAT medium
h) Edible vaccines

Adikavi Nannaya University, Rajamahendravaram
M.Sc Biochemistry IV Semester
Model Question Paper: Paper-IV
BC404-Bioinformatics, Omics and Research Methodology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A

1. **a)** Explain the Human Genome Project with its benefits, legal, ethical and social implications.

   (OR)

   b) Mention briefly the various databases for predicting the structures and sequences of proteins and genes.
2. a) What is MALDI-TOF? Mention its methodology, significance and applications in proteomics.

   (OR)

   b) Explain protein structure prediction by Homology modeling.
3. a) Describe the steps involved in whole genome analysis.

   (OR)

   b) Explain the concept of comparative genomics with molecular phylogeny.
4. a) Write the methodology for conducting research programme.

   (OR)

   b) Explain the research paper writing and communication to peer reviewed research journals.

Section-B

5. Answer any **FIVE** of the following:

a) NCBI
b) PDB
c) RASMOL
d) Molecular docking
e) Cosmid library
f) Genome annotation
g) Impact factor
h) Research article model