

SEMESTER V

Paper I MBCR4501

Part A: Human Physiology II (50 marks)

Unit I: The Nervous System: Action potentials and their transmission; synaptic transmission. The central nervous system: the brain, the forebrain (thalamus, hypothalamus, cerebrum and cerebral hemispheres), midbrain and hindbrain (cerebellum, pons, medulla oblongata), functions of different regions of the brain. The spinal cord, its functions and the reflex arc. The autonomic nervous system and the peripheral nervous system. (6 lectures)

Unit II: The Special Senses: (a) Vision – The eye, the physiology of rod and colour vision, light and dark adaptations, colour blindness, errors of refraction.

(b) Hearing – the ear, transmission of sound waves, physiology of hearing, determination of frequency and loudness.

(c) Taste and olfaction. (5 lectures)

Unit III: The Skin: Epidermis and dermis, sweat and sebaceous glands. (1 lecture)

Unit IV: The Endocrine system: Overview of endocrine glands and their major secretions (pituitary gland, thyroid gland, parathyroid gland, endocrine pancreas, adrenal gland, pineal gland), major physiological actions of the hormones, special notes on pathophysiological aspects.

(11 lectures)

Unit V: The Reproductive System: Overview of the male and female reproductive system, spermatogenesis and oogenesis, physiological actions of testosterone, oestrogen and progesterone, concept of reproductive cycle and menopause. (10 lectures)

Unit VI: Physiological Adaptations: Basic physiological adaptations to high altitude and deep sea diving. (3 lectures)

Teachers involved:

Dr. A. Banerji (Units I, II, III)

Dr. P. De (Units IV, V, VI)

Recommended texts:

- 1) Textbook of Medical Physiology. A.C. Guyton, J.E. Hall (11th ed.). Chapters 5, 55, 57, 58, 60, 61 (Unit I), 49-53 (Unit II), 46 (Unit III), 43, 44, 74–82 (Unit IV, V, VI)
- 2) Berne and Levy Physiology. B.M. Koeppen, B.A. Stanton (6th ed.). Chapters 10, 11 (Unit I), 37–43 (Unit IV, V).
- 3) Neurobiology. G.G. Matthews (2nd ed.). Chapters 11, 12 (Unit I).
- 4) Lehninger Principles of Biochemistry. M.M. Cox, D.L. Nelson (5th ed.). Chapter 23 (Unit IV).
- 5) Harper's Illustrated Biochemistry. R.K. Murray, D.K. Granner, V.W. Rodwell, (29th ed.). Chapters 41, 42 (Unit IV).
- 6) Biochemistry-Mathwes, Van Holde (3rd ed.) Chapter 23 (Unit IV, V)

Part B: Virology (50 marks)

General Introduction – definition, general properties, Ellis and Delbruck's experiment, virus assays, cultivation of viruses, detection

Structure of viruses – filamentous and isometric viruses, enveloped viruses, viruses with head-tail morphology

Classification of viruses – Baltimore's classification, satellites, viroids and prions (just mention)

Process of Infection:

1. Attachment and entry of viral genomes – bacteriophages (T-even, filamentous like M13) and animal viruses (general methods, naked Adenovirus and enveloped Retrovirus)

2. Replication of viral genome

(i) dsDNA – T-even bacteriophage (terminal redundancy and circular permutation), λ bacteriophage (ϕ model followed by rolling circle mode of replication), SV40 (ϕ model of replication), HSV1 (probably ϕ model followed by rolling circle mode of replication), Adenovirus (unique)

(ii) ssDNA – M13, ϕ x174 (looped rolling circle mode of replication), adeno-associated virus (unique)

(iii) RNA viruses with a DNA intermediate – Retrovirus (reverse transcription), Hepadnavirus

Gene expression of viral genomes – T-odd and even bacteriophages, bacteriophage λ (transcriptional control of lytic and lysogenic cycles), Adenovirus, Herpesvirus, Retrovirus

Assembly, egression and maturation – simple filamentous TMV, complex T-even bacteriophages, naked Adenovirus and enveloped HSV

Virus interaction with host – different types of infections (cytopathogenic, persistent, latent, transforming, abortive, null)

Transmission of viruses – horizontal, vertical, zoonoses

Evolution of viruses – antigenic drift and antigenic shift (eg. Influenza virus)

Viral diseases and host immune response – viral diseases (just mention) and host's immune response (interferon, neutralizing antibodies, antiviral vaccines)

Oncogenic viruses – DNA tumor viruses (Adenovirus, Papilloma, Herpes), RNA tumor viruses (Retrovirus and Hepatitis)

Recombinant viruses as gene therapy viruses – adenoviral and retroviral vectors

(36 lectures)

Teachers involved:

Dr. U. Siddhanta

Recommended texts:

Introduction to Modern Virology. Dimmock, Easton and Leppard (6th ed.). Chapters 1 – 9, 20, 22

Basic Virology. Wagner & Hewlett (2nd ed.). (Reference)

Principles of Virology. Flint, Enquist, Racaniello & Skalka (3rd ed.). (Reference)

Paper II

MBCR4502

Part A: Plant Biology II (50 marks)

Unit I: (Embryology): Microsporangium, Microsporogenesis, Development of male gametophyte; Megasporangium- Different types, Megasporogenesis, Development of female gametophyte; Gametic fusion; Triple fusion; Development of dicot embryo- *Capsella*, Development of monocot embryo – *Luzula*; Endosperm -Definition, different types - free nuclear, cellular, helobial endosperm; haustoria, Apomixis - Definition and types. (7 lectures)

Unit II: (Plant Pathology): Disease concept; Symptoms; Etiology and causal complex; Primary and secondary inocula; Infection, Pathogenicity and Pathogenesis; Endemic, Epidemic, Pandemic and Sporadic disease; Host pathogen interaction: Pre-penetration, Penetration and Post Penetration; Defence mechanisms; Resistance- Systemic acquired resistance and Induced systemic resistance; Plant disease management- Quarantine, Chemical, Biological and Integrated; Some plant pathogens and diseases with special reference to occurrence, symptoms, disease cycle and control measures - Blast disease of rice, brown spot of rice, black stem rust of wheat, early blight of potato, late blight of potato, wilt of pigeon pea, stem rot of jute, red rot of sugarcane. (7 lectures)

Unit III: Cytogenetics and Cell biology: Plant Cell wall: structure and formation; Plant cell vacuole; Plant two-component signaling systems; Chromosome banding technique; Application of FISH and GISH in plants; Plant chromosome painting (brief outline); Floral developmental genes in *Arabidopsis* and their role; Inheritance of chloroplast genes (brief outline); Amphidiploidy and applications of polyploids in crop improvement; Signaling and gene regulation in plant immune response (12 lectures)

Unit IV: Plant Physiology: Plant pigments – types, Chlorophyll biosynthesis, Structure of chlorophyll; Photosynthesis, Photorespiration, C₄ and CAM pathway; Solute transport across the membrane, Long distance transport through xylem and phloem; mechanisms of loading and unloading of photoassimilates; transpiration; Biological nitrogen fixation; Plant growth regulators: Mode of action, biosynthesis, storage, breakdown, transport and application; Phytochrome, cryptochrome, phototropins, photoperiodism, vernalization, Seed dormancy, Senescence (outline only). (26 lectures)

Teachers involved:

Dr. D. Chakrabarti (Unit I, II)

Dr. A. Roy Choudhury (Unit III)

Dr. R. Nag Chaudhuri (Unit IV)

Recommended texts:

Unit I: The Embryology of Angiosperms, Bhojwani and Bhatnagar, Chapter 3, 4, 6-9, 11, 13,14

Unit II: Plant Pathology, 5th edition, Agrios, Chapter 2, 4, 6, 9, 11

Unit III: Plant Physiology (4th Edition) Taiz & Zeiger - Chapters 21 and 25; Plant Breeding by B.D. Singh (7th Edition) – Chapter 33; iGenetics by Peter J. Russell – Chapter 23; Research papers on selected topics

Unit IV: 1) Plant Physiology- Taiz & Zeiger Chapters- 6-10; 17-23 2) Biochemistry & Molecular Biology of Plants – Buchanan- Chapter 12,13

Part B: Animal Biology (50 marks)

Unit I: The Animal Kingdom: Symmetry and coelom (outline only); Salient features and outline classification of major non-chordate and chordate phyla (upto subphyla/class): Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata. Salient features of Cephalochordata, Urochordata and Vertebrata; Classification of Mammals (upto order). (9 lectures)

Unit II: Comparative anatomy and structural organization in vertebrates: Comparative account and structural organization of

(a) heart and aortic arches: types of hearts, comparative account of heart and development of aortic arches and their evolutionary significance.

(b) digestive system: dentition, comparative account of stomach, the ruminant stomach.

(c) brain: primary divisions of the brain, comparative account of brain.

(d) respiratory organs: comparative account of types of gills and types of lungs, accessory organs for respiration (with special reference to fishes).

(e) kidney: pro, meso and metanephric kidneys and their development, comparative account of kidneys. (17 lectures)

Unit III: Special topics on animal biology: (a) coral reefs: types, formation, distribution and conservation

(b) Paedomorphosis: with special reference to axolotl larva

(c) Venom and biting mechanisms in snakes: venom apparatus, types of venom, difference between poisonous and non-poisonous snakes with Indian examples, therapeutic uses of venom

(d) Migration: types of migration in birds, stimulation of migration and navigation in birds, migration in fish

(e) Thermoregulation: body temperature and its regulation. (12 lectures)

Teachers involved:

Dr. A. Banerji (Unit II, Unit III c & d)

Dr. P. De (Unit I, Unit III a, b and e)

Recommended texts:

1) Biology of Animals Vol. 1. B.B. Ganguly, A.K. Sinha, S. Adhikari. (3rd ed.). Chapters 9–18. (Unit I)

2) Biology of Animals Vol. 2. B.B. Ganguly, A.K. Sinha, S. Adhikari, B.C.B. Goswami (7th ed.). Chapters 1–10. (Unit I), Chapters 6, 8, 9 (Unit III c & d)

3) The Life of Vertebrate. J.Z. Young. (3rd ed.). Chapters 14, 16. (Unit III c & d)

4) Invertebrate Zoology. E.E. Ruppert, R.S. Fox, R.B. Barnes (7th ed.). Chapters 4-19, 27-29. (Unit I)

5) Vertebrates – Comparative Anatomy, Function, Evolution. K.V. Kardong (5th ed.). Chapters 11–16. (Unit II)

Paper III
MBCR4503

Part A: Metabolism II (50 marks)

Unit I: Amino acid metabolism: Metabolism of nitrogen compounds; protein turnover; flow of nitrogen during biosynthesis and catabolism of amino acids (with reference to representative examples phenylalanine, tyrosine, tryptophan, arginine, alanine, glycine, glutamic acid, glutamine); central role of glutamine; urea cycle and the excretion of nitrogen, metabolic disorders. (12 lectures)

Unit II: Fatty acid metabolism: Oxidation of fatty acids, β -oxidation, oxidation of mono- and polyunsaturated fatty acids, oxidation of odd-number fatty acids, fate of glycerol, α -oxidation, ω -oxidation; outline of biosynthesis of fatty acids, cholesterol, ketone bodies; metabolic disorders. (14 lectures)

Unit III: Metabolism of nucleotides (purines and pyrimidines): Biosynthesis of nucleotides, de novo and salvage pathways, regulation of nucleotide biosynthesis, degradation of purines and pyrimidines, chemotherapeutic agents that affect nucleotide synthesis and metabolic disorders. (14 lectures)

Teachers involved:

Dr. A. Roy Choudhury (Unit I)

Dr. P. De (Unit II and III)

Recommended texts:

Principles of biochemistry-Lehninger Nelson & Cox, 5th Ed, Ch-17, 18, 21, 22

Biochemistry – J.M. Berg, J.L. Tymoczko, L. Stryer , 7th Ed, Ch- 21, 23, 24, 25, 27

Harper's Illustrated Biochemistry – R.K. Murray, D.K. Granner, V.W. Rodwell, 29th Ed, Ch-22, 23, 25, 26, 27-31, 33.

Biochemistry-Voet & Voet, 4th Edn, Ch-25, 28.

Biochemistry-Mathwes, Van Holde, 3rd Ed, Ch-18, 19, 22.

Part B: Bioinformatics I (50 marks)

Introduction: The chemical nature of polypeptides, the polypeptide chain, amino acids and their side chains, covalent modifications of the polypeptide chain, forces that determine protein structure. Structural properties of proteins, Regular conformations of polypeptides: α -helices and β -sheets, Secondary, tertiary and quaternary structure.

Structural Bioinformatics: Protein Tertiary Structure Prediction (Homology Modeling, Threading and Fold Recognition, Ab Initio Protein Structural Prediction, CASP), Protein Structure Database (PDB), Protein Structural Visualization, Comparison, Classification.

Databanks of protein families, Homology between molecules: Evolutionary relationship, Example: the globin family, Conservation of protein core and active site.

Switches: Identical sequences that adopt different structures, Structure similarity without sequence similarity.

Introduction to Biological Databases: Types of Biological Databases & Information Retrieval.

Sequence Search, Alignment and Analysis: Global & Local alignment: Overview of Needleman–Wunsch & Smith–Waterman methods, introduction to software like BLAST, FASTA, GCG package, multiple sequence alignment: ClustalW, Scoring matrices for similarity searches: PAM250 & BLOSUM62. (? Lectures)

Practical: Exposure to different databases, BLAST search, Sequence retrieval, Pairwise and multiple sequences analysis using Multalin, ClusalW etc, data analysis.

Teachers involved:

Dr. J. Dasgupta

Recommended texts:

1) Instant notes in Bioinformatics by DR Westhead, JH Parish, RM Twyman (First Indian Reprint, 2010). Sections: C, D, E, F, I.

Paper IV**MBCR4504****Immunology I (50 marks)**

Unit I: Overview of the Immune system – historical perspective; early studies of humoral and cellular immunity; theoretical challenges; infection and immunity; innate and adaptive immunity; immune dysfunction and its consequences. **(5 lectures)**

Unit II: Cells and Organs of the Immune system – hematopoiesis; cells of the immune system; organs of the immune system. **(5 lectures)**

Unit III: Innate Immunity – anatomical barriers; inflammation; soluble molecules and membrane-associated receptors; Toll-like receptors; cell types of innate immunity (neutrophils and macrophages); signal transduction pathways. **(4 lectures)**

Unit IV: (A) Antigens and Antibodies – immunogenicity versus antigenicity; epitopes; basic structure of antibodies; antibody binding site; antibody-mediated effector functions; antibody classes and biological activity; antigenic determinants on immunoglobulins; monoclonal antibodies. **(5 lectures)**

(B) Organization and expression of immunoglobulin gene – antibody diversity by VDJ recombination. **(5 lectures)**

Unit V: Antigen-Antibody Interactions: Principles and Applications – strength of antigen-antibody interactions; cross-reactivity; precipitation reactions; agglutination reactions; radioimmunoassay; ELISA; Western Blotting; immunoprecipitation; immunofluorescence; Flow cytometry and Fluorescence; alternatives to antigen-antibody reactions; immunoelectron microscopy. **(5 lectures)**

Unit VI: Complement system - components, activation and biological functions. **(3 lectures)**

Unit VII: B-cell generation, activation and differentiation - B cell receptor signaling. **(4 lectures)**

Teachers involved:

Prof. S. Roy (Units I, II, III, IVA, V)

Dr. U. Siddhanta (Units III - Toll-like receptors and signal transduction pathways, IVB, VI, VII)

Recommended text:

Kuby Immunology - Kindt, Goldsby & Osborne (6th Edition): Ch. 1; 2; 3; 4; 5; 6; 7; 11.

MBCR4554

Enzymology Practical (50 marks)

1. Standard curve of para-nitrophenol
2. Time saturation kinetics of calf-intestinal alkaline phosphatase (CIAP) using p-nitrophenyl phosphate as substrate – calculation of specific activity of the enzyme
3. Substrate saturation kinetics of CIAP – determination of K_M and V_{max} from Michaelis-Menten's hyperbolic saturation curve and Lineweaver-Burk plot
4. Determination of pH optimum for alkaline phosphatase
5. Determination of K_{cat} (turnover number) of CIAP

6. Inhibition kinetics with inhibitors like Zn^{2+} , EDTA or phenylalanine.
7. Isolation of an amylase secreting microorganisms from soil

Teachers involved:

Dr. U. Siddhanta

Dr. J. Dasgupta

Paper V

MBCH4505

Chemistry V (50 marks)

Unit I: Molecular Spectroscopy-III: Nuclear Magnetic Resonance spectroscopy- Nuclear spin, Principle of proton magnetic resonance, Equivalent and non-equivalent protons, Chemical shifts, Shielding and deshielding protons, upfield and downfield shifts, Spin-spin and spin-lattice relaxation, Coupling constants, Ring currents, Relative peak positions of different kinds of protons (alkyl halides, olefins, alkynes, aldehyde H) and substituted benzenes (toluene, anisole, nitrobenzene, halobenzene, dinitrobenzenes, chloronitrobenzene), Intensity of NMR peak, Applications of NMR spectroscopy.

Electron Spin Resonance Spectroscopy- Principle of electron spin resonance, Interaction with nuclei, Hyperfine interactions, Intensity of ESR signals, Applications of ESR. (8 lectures)

Unit II: Chemical Bonding-III: Structure and bonding in co-ordination compounds- Valence bond theory and its limitations; Elementary crystal field theory- Splitting of d^n configurations in octahedral, square planar and tetrahedral fields; Crystal Field Stabilisation Energy in weak and strong fields; Pairing energy; Jahn-Teller distortion; Applications of crystal field theory, Molecular orbital theory (elementary idea)- σ - and π -bonding in octahedral complexes (qualitative pictorial approach). (16 lectures)

Unit III: Addition Reactions: Electrophilic addition to $C=C$ - Mechanism; Reactivity; Electrophilic addition of halogens; Electrophilic addition of hydrogen halides; Hydration of alkenes; Hydration of alkynes; Nucleophilic addition to carbon-carbon multiple bonds- Mechanism; Reactivity; Cyanoethylation; Michael addition; Nucleophilic addition to $C=O$ bond- Addition of HCN, acetylides, $NaHSO_3$, alcohols; Formation of acetal, ketal; Cannizzaro reaction; Internal Cannizzaro reaction; Aldol condensation; Claisen condensation. (12 lectures)

Teachers involved:

Dr. S. Saha

Recommended texts:

1. Spectroscopy of Organic Compounds. P. S. Kalsi (6th Edition), Chapter 4 (UnitI).
2. Organic Spectroscopy. William Kemp (3rd Edition), Chapter 3 (UnitI).
3. Physical Methods in Inorganic Chemistry. Russell S. Drago, Chapter 10 (UnitI).
4. General and Inorganic Chemistry (Part-II). R. P. Sarkar (1st Edition), Chapter 27 (UnitII).
5. Concise Inorganic Chemistry. J. D. Lee (5th Edition), Chapter 7 (UnitII).
6. Advanced General Organic Chemistry- A Modern Approach (Part-I). Sachin Kr. Ghosh (3rd Edition), Chapter 13, 16 (UnitIII).

7. A Guide Book to Mechanism in Organic Chemistry. Peter Sykes (5th Edition), Chapter 7, 8 (UnitIII).

MBCR4555

Analytical Biochemistry Practical II (50 marks)

Analytical techniques in biochemistry and biophysics: Chromatographic methods for macromolecules separation (gel permeation, ion exchange, hydrophobic, reverse phase and affinity chromatography), HPLC and FPLC, Criteria of protein purity, Electrophoretic techniques, Radiotracer techniques, absorption and emission spectroscopy.

- (i) Spectrophotometric quantitation of protein (UV) and preparation of standard curves.
- (ii) Spectrophotometric quantitation of DNA and determination of purity of DNA
- (iii) Isolation of plasmid DNA (demonstration)
- (iv) Agarose gel electrophoresis
- (v) SDS-PAGE (Commassie Blue and silver staining) and calculation of molecular weight

Teachers involved:

Dr. C. Barat

Dr. S. Saha