

**RAJAH SERFOJI GOVT COLLEGE,
(AUTONOMOUS)
THANJAVUR -05**



DEPARTMENT OF BIOCHEMISTRY

SYLLABUS

(For the students admitted from 2015 -2016 onwards)

M.Sc. BIOCHEMISTRY SYLLABUS

M.Sc BIOCHEMISTRY COURSE STRUCTURE

(Applicable for the candidates admitted from the academic year 2015-2016 onwards)

Sem	Course	Code	Course Title	Ins Hrs/ week	Credit	Exam Hours	Marks		Total	
							Int	Ext		
I	CC1	RR1PBC1	Chemistry of Biomolecules	6	5	3	25	75	100	
	CC2	RR1PBC2	Analytical Biochemistry	6	5	3	25	75	100	
	CC3	RR1PBC3	Cell biology and Physiology	6	5	3	25	75	100	
	CC4	RR1PBCP1	Practical –I	6	5	6	40	60	100	
	EC1	RR1PBCEL1	Environmental Biology	6	4	3	25	75	100	
				Total	30	24				500
			II SEMESTER							
II	CC5	RR2PBC4	Metabolism and Regulation	6	5	3	25	75	100	
	CC6	RR2PBC5	Enzymes and Enzyme technology	6	5	3	25	75	100	
	CC7	RR2PBC6	Microbiology	6	5	3	25	75	100	
	CC8	RR2PBCP2	Practical-2	6	5	6	40	60	100	
	EC2	RR2PBCEL2	Endocrinology	6	4	3	25	75	100	
			Total	30	24				500	
			III SEMESTER							
III	CC9	RR3PBC7	Immunology	6	5	3	25	75	100	
	CC10	RR3PBC8	Clinical Biochemistry	6	5	3	25	75	100	
	CC11	RR3PBC9	Molecular Biology	6	5	3	25	75	100	
	CC12	RR3PBCP3	Practical-3	6	5	6	40	60	100	
	EC3	RR3PBCEL3	Genetic engineering	6	4	3	25	75	100	
				Total	30	24				500
			IV SEMESTER							
IV	CC13	RR4PBC10	Advanced Pharmaceutical Chemistry	6	5	3	25	75	100	
	CC14	RR4PBCPW	Project work	12	5	3	40	60	100	
	EC4	RR4PBCEL4	Biotechnology	6	4	3	25	75	100	
	EC5	RR4PBCEL5	Biostatistics and Research Methodology	6	4	3	25	75	100	
				Total	30	18				400
			Grand total	120	90				1900	

No of Papers	Credits
Core Course 14 x 5	70
Elective 5 x 4	20
Total number of courses- 19	90

Signature of HOD

Credit :5

Code - RR1PBC1

Hours / week :6

Medium : English

SEMESTER – I
(For the students admitted from 2015 onwards)

CORE COURSE -1 –CHEMISTRY OF BIOMOLECULES

Unit 1- Carbohydrates

Definition, structure and biological functions, - mono, oligosaccharides. Homopolysaccharide- chitin, fructans, mannans, xylans, and galactans. Heteropolysaccharides. Structure and biological importance of sugar derivatives- glycosaminoglycans, proteoglycans. Glycoprotein – Blood group and bacterial cell wall polysaccharides, O- linked and N- linked oligosaccharides.

Unit 2-Proteins

Proteins– Peptide bond ,general properties, denaturation and renaturation. Orders of protein structure – Primary structure – Ramachandran plot, Secondary structure– the α -helix, β - pleated sheet. Collagen triple helix, Super secondary structure– helix– loop helix, the hairpin β -motif and the β - α - β -motif. Forces stabilizing tertiary and quaternary structure. Structure of haemoglobin– oxygen binding and changes in conformation. Tertiary Structure of myoglobin.

Unit 3- Lipids

Lipids- general properties, Types of Fatty acids-Essential, Non essential. Structure and biological functions of phospholipids, sphingolipids, glycolipids. Steroids–functions of cholesterol, bile acids, sex hormones, ergosterol. Structure and biological role of prostaglandins, thromboxanes and leukotrienes. Lipoproteins- classification and composition.

Unit 4- Nucleic acids

Structure of purines, pyrimidines, nucleosides and nucleotides. DNA double helical structure. A, B and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, hypochromicity, denaturation and renaturation– the cot curve. RNA– types and biological role. Secondary, tertiary structures of RNA.

Unit 5- Minerals, Vitamins and antioxidants

Minerals in Biological systems and its importance –Iron, calcium, Phosphorous, Iodine, Copper, Zinc. Fat and water soluble Vitamins – Sources, function and deficiency diseases. Antioxidants- enzymic and nonenzymic antioxidants. Alkaloids and flavanoids- types and their biological importance.

Books recommended

1. Biochemistry Zubay 4th edition 1998 William C.Brown Publication.
2. Harper's Biochemistry 25th edition McGraw Hill.
3. Biochemistry Stryer 4th edition Freeman.
4. Principles of Biochemistry. Lehninger Nelson Cox Macmillan worth, Publishers, 2000.
5. Biochemistry. Davidson and Sittmann, NMS 4th ed. Lippincott Williams and Wilkins, 1999
6. Biochemistry – Voet and Voet.
7. Biochemistry – David Rawn.
8. Natural products– Chatwal Anand.

Question paper Pattern

Maximum marks -75 (Exam duration – 3 hours)

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code - RR1PBC2

Hours / week :6

Medium : English

SEMESTER – I
(For the students admitted from 2015 onwards)

CORE COURSE-2– ANALYTICAL BIOCHEMISTRY

Unit 1- Centrifugation and Radio isotope techniques

Ultracentrifuges– Analytical ultracentrifuge– instrumentation and applications. Preparative ultracentrifuge– types, instrumentation and applications of preparative rotors. Analysis of subcellular fractions and determination of relative molecular mass– sedimentation velocity and sedimentation equilibrium.

Units of radioactivity. Detection and measurement of radioactivity– solid and liquid scintillation counting, Autoradiography. Applications of radioisotopes in biology. Radiation hazards and safety measures.

Unit 2 – Chromatography

Principle, instrumentation and applications of thin layer, gas chromatography, Ion-exchange chromatography, Column chromatography-packing, loading, eluting and detection., Chromatofocusing. Molecular exclusion chromatography-principle, gel preparation, operation and applications. Affinity chromatography– principle, materials, procedure and applications. HPLC– principle, materials, instrumentation and applications.

Unit 3- Spectroscopic techniques

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-Visible spectrophotometry, IR, Mass spectrometry, NMR, ESR and spectrofluorimetry. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Plasma emission spectroscopy.

Unit 4 -Electrophoresis and Electrochemical techniques

Electrophoresis: General principles. Support media. Electrophoresis of proteins– SDS-PAGE, native gels, gradient gels, isoelectric focusing, 2-D PAGE. Detection, estimation and recovery of

proteins in gels. Electrophoresis of nucleic acids– agarose gel electrophoresis, pulsed field gel electrophoresis. Capillary electrophoresis and its applications.

Unit 5 – Molecular techniques

PCR– basic principle, RT-PCR, quantitative PCR and in situ PCR. Diagnostic and laboratory applications of PCR. Comet assay. Mutagenicity testing– Ames test. DNA finger printing, DNA foot printing. Membrane blotting and hybridization of nucleic acids- southern, western , northern dot blot and fluorescent insitu hybridization.

Books recommended

1. Wilson and Walker. A biologist's guide to principles and techniques of Practical biochemistry. 5th ed. Cambridge University Press 2000.
2. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Wesley , Longman, 2000.
3. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 1997.
4. Simpson CFA & Whittacker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2001.
6. Friefelder and Friefelder. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. WH Freeman & Co. 1994.
7. Pavia et al. Introduction to Spectroscopy. 3rd ed. Brooks/Cole Pub Co., 2000.

Question paper Pattern
Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code - RR1PBC3

Hours / week :6

Medium : English

SEMESTER – I
(For the students admitted from 2015 onwards)

CORE COURSE -3 – CELL BIOLOGY AND HUMAN PHYSIOLOGY

Unit I – Cell – Cell interaction

Major classes of cell junctions – anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) – the cadherins (classical and desmosomal). The integrins, connexins. The extracellular matrix of epithelial and nonepithelial tissues. ECM components – collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

Unit II- Biomembranes, Cell cycle, Cell death

Membrane assembly – importins and exportins. Membrane transport. Diffusion (passive and facilitated) active transport (symport, antiport, Na⁺ K⁺ ATPase), ion gradients, ion selective channels, group translocations, porins, endocytosis and exocytosis. Programmed cell death – Brief outline of apoptosis. Differences between apoptosis and necrosis.

Unit III- Blood and blood components

Composition and functions of blood. Separation of plasma and serum. Plasma proteins in health and disease. Red blood cells – formation and destruction. The RBC membrane – principle proteins (spectrin, ankyrin, glycophorins). Anaemias. Composition and functions of WBCs. Types of Blood groups . Blood coagulation – mechanism and regulation. Fibrinolysis. Anticoagulants.

Unit IV – Physiology of body Fluids

Lymph – composition and functions. CSF – composition and clinical significance. Formation of urine – structure of nephron, glomerular filtration, tubular reabsorption of glucose, water and

electrolytes. Countercurrent multiplication, tubular secretion. Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions.

Unit- V Neuromuscular System

Structure of neuron. Propagation of action potential: structure of voltage – gated ion channels. Neurotransmitters-examples, release and cycling of neurotransmitters. The neuromuscular junction – activation of gated ion channels. The acetylcholine receptor. Structure of skeletal muscle. Muscle proteins – myosin, actin, troponin and tropomyosin and other proteins. Source of energy for muscle contraction.

Books Recommended :

1. Lodish et.al. Molecular Cell Biology 5th ed. 2003, WH Freeman (for unit 1,2,5).
2. Murray et al. Harper's Biochemistry 26th ed. McGraw Hill 2003
3. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. McGraw, Hill 7th ed.

References:

1. De Robertis and De Robertis. Cell and Molecular Biology. Lea and Febiger 8th ed.
2. Alberts et al. Molecular Biology of the Cell 4th ed. Garland Sci. 2002.

Question paper pattern
Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code -RR1PBCP1

Hours / week :6

Medium : English

SEMESTER – I

(For the students admitted from 2015 onwards)

CORE COURSE -4- PRACTICALS-I

Estimation

1. Isolation and estimation of starch from potato.
2. Isolation and estimation of glycogen from liver.
3. Estimation of ascorbic acid from fruit.
4. Estimation of β -Carotene from carrot.
5. Estimation of thiamine from cereals/fruits.
6. Estimation of riboflavin.
7. Estimation of lactose from milk.
8. Estimation of lecithin from egg Yolk.
9. Estimation of maltose by calorimetric method.
10. Estimation of RNA –UV and visible methods.
11. Estimation of DNA from spleen /liver – UV and visible methods.
12. Estimation of fructose in fruits.

Demonstration

1. Separation of amino acids by circular , ascending and descending chromatography.
2. Separation of plant pigments by column chromatography.
3. Separation of lipids by TLC.

**Question paper pattern
Maximum marks-60
Exam duration – 6 hours**

Signature of HOD

Credit :4

Code- RR1PBCEL1

Hours / week :6

Medium : English

SEMESTER – I

(For the students admitted from 2015 onwards)

ELECTIVE –1 - ENVIRONMENTAL BIOLOGY

UNIT-1

Evolutionary biology: Origin of life, concepts of evolution, theories of organic evolution- Lamarchism theory and Darwins theory, Natural resources – Forest resources, Afforestation, Deforestation, Hazards of deforestation, Water resources, Terrestrial resources, Soil fertility, conservation of soil fertility.

UNIT -2

Environmental Biology - basic concepts, atmosphere, hydrosphere, lithosphere and biosphere.: Concepts of ecosystem, components, food chain and Food web, types of ecosystems, Ecological pyramids, population ecology and biological control, economic importance of microbes, plants and animals.

UNIT-3

Biodiversity:- Definition, megabiodiversity of India, hots spots of biodiversity in India, value of biodiversity, distribution and threats to biodiversity, benefits of biodiversity, conservation of biodiversity – insitu and ex situ conservation methods, cryopreservation.

UNIT-4

Environmental Pollution- causes, effects and control of soil, air, water, noise and radioactive pollution. E – waste and its management.

Pollution monitoring and measurements, Bioassays in environmental monitoring, Biosensors in environmental monitoring, biotechnological methods for management of pollution, management of metal pollution.

UNIT-5

Biogeological cycles - nitrogen, carbon, phosphorus and sulphur cycles. Heavy metal toxicity – sources, effects of cadmium, lead and mercury. Global environmental problems- Green house

gases, Green House effect and global warming and its impact on biodiversity, Role of human to control green house effect, Problem of ozone, effects of ozone depletion, acid rain.

References:

1. Environmental biology by P.D. Sharma.
2. Text book of environmental science by Richard.
3. Text book for environmental studies by Erach bharucha.
4. Environmental science by Daniel.
5. Environmental science by William P. Cunningha.
6. Environmetal science by Arvind kumar.

Question paper pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code- RR2PBC4

Hours / week :6

Medium : English

SEMESTER – II

(For the students admitted from 2015 onwards)

CORE COURSE –5- METABOLISM AND REGULATION

Unit 1- Bioenergetics

Free energy and entropy. Oxidation and reduction reactions. Enzymes involved in redox reactions. High energy phosphate compounds.

Overview of intermediary metabolism . Glycolysis and gluconeogenesis– pathway, key enzymes and co-ordinate regulation. Mechanism of pyruvate dehydrogenase multienzyme complex and the regulation of this enzyme through reversible covalent modification. The citric acid cycle and regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation

Unit 2- Carbohydrate metabolism

The electron transport chain– organization and role in electron capture. Oxidative phosphorylation- electron transfer reactions in mitochondria. F₁-F₀ ATPase- structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and oxidative phosphorylation- uncouplers, ionophores. Mitochondrial transport systems- ATP/ADP exchange, malate / glycerophosphate shuttle.

Unit 3- Lipid metabolism

Fatty acid biosynthesis and its regulation. Synthesis and Regulation of triacylglycerol, phospholipids and cholesterol. α , β , γ , Oxidation of fatty acids– Role of carnitine cycle in the regulation of β - oxidation. Ketogenesis and its control. Lipoprotein metabolism - exogenous and endogenous pathways.

Unit 4- Metabolism of amino acids, purines and pyrimidines

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acids- transamination, deamination, ammonia formation, the urea cycle and its regulation Importance of glutamate dehydrogenase. Metabolism of purines- de novo and salvage pathways for purine biosynthesis,. Purine catabolic pathway. Metabolism of pyrimidines biosynthesis and catabolism. regulation of biosynthesis of Purine and pyrimidine nucleotides.

Unit 5- Metabolic integration and Hormonal regulation

Key junctions in metabolism– glucose-6-phosphate, pyruvate and acetyl CoA. Metabolic profiles of brain, muscle, liver, kidney and adipose tissue. Metabolic inter relationships in various nutritional and hormonal states– obesity, aerobic, anaerobic endurance, exercise, pregnancy, lactation, IDDM, NIDDM and starvation.

Books recommended

1. Stryer. Biochemistry. Freeman. 5th ed. 2002.
2. Murray et al. Harper's Biochemistry. 5th ed. Mc. GrawHill, 2000.
3. Nelson Cox. Lehninger's Principles of Biochemistry. 3rd ed. McMillan Worth, 2000.
4. Donald Voet, J.G. Voet, John Wiley, Biochemistry, 1995.
5. Kuchel and Ralston. Biochemistry. 2nd ed. Schaum's Outlines Mc Graw Hill, 1998.
6. Davidson and Sittman. Biochemistry NMS. 4th ed. Lippincott. Williams and Wilkins, 1999.
7. Campbell and Farrell. Biochemistry 4th ed. Brooks/Cole Pub Co. 2002.

Question Paper Pattern
Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code- RR2PBC5

Hours / week :6

Medium : English

SEMESTER – II

(For the students admitted from 2015 onwards)

CORE COURSE -6-ENZYMES AND ENZYME TECHNOLOGY

Unit 1- Introduction

Enzymes- Nomenclature and classification of enzymes, Active site. Enzyme modification using chemicals. multienzyme complexes. Lock and Key model of enzyme action. Enzyme Specificity. Turnover number of enzymes. Measurement of enzymatic reactions - Spectrophotometry and radio assay. Units of enzyme activity. Affinity labeling.

Unit 2- Kinetics of enzyme

Enzyme kinetics- Factors affecting enzyme activity.- Effect of Substrate concentration, pH, temperature, activators. Derivation of Michaelis- Menten equation. Lineweaver- Burk plot. Significance of K_m and V_{max} . Allosteric enzymes- MWC and KNF models. Bisubstrate reactions- Types and mechanism . Covalent modification of enzymes.

Unit 3- Enzyme purification and Enzyme inhibition.

Source of enzymes – Microbial source, plant and animal source. Methods of Extraction of enzymes, Enzyme purification by ion exchange, gel filtration and affinity chromatography. Bulk enzyme production in industry.

Enzyme inhibition- irreversible enzyme inhibition, Reversible enzyme inhibition - competitive, noncompetitive, uncompetitive. Mechanism of enzyme action- acid base catalysis (Lysozyme) covalent catalysis, (Chymotrypsin).

Unit 4- Coenzymes and immobilization

Coenzymes -Structure and functions of FAD, NAD, TPP, Biotin , pyridoxal phosphate. Isoenzymes. *Enzyme regulation*: General mechanism of enzyme regulation, feedback inhibition and feed forward stimulation. Zymogens – examples and activation. Immobilized enzymes – Techniques and applications . Biosensors – Types and Applications. Antioxidant enzymes.

Unit 5- Enzymes in industry

Enzymes as diagnostic reagents, Sale value of industrial enzymes, Applications of proteolytic enzymes in detergent industry, cheese manufacturing, meat tenderization, leather industry .

Enzyme electrodes, Sources and applications of amylases, glucoamylase, glucose isomerases, cellulose, Enzymes as thrombolytic agents, anti-inflammatory agents, debriding agents, digestive aids. Therapeutic use of enzymes.

Books recommended

1. T.Palmer. Understanding enzymes. Prentice Hall.
2. Principles of Biochemistry – Zubay 4th ed. 1998, William C.Brown Publ.
3. Ratledge and Kristiansen. Basic Biotechnology. 2nd ed. Cambridge Univ. Press, 2001.
4. Dixon and Webb. Enzymes 3rd ed. Longmans, 1979.
5. Stryer. Biochemistry 5th ed. Freeman, 2002.
6. Whitehurst RJ. Enzymes in Food Technology. CRC Press, 2001.
7. Uhlig H. Industrial enzymes and their applications. John Wiley, 1998.
8. Marangoni AG. Enzyme Kinetics. A modern approach. John Wiley & Sons,2002.
9. Balasubramanian et al. Concepts in Biotechnology Universities Press (India)

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code- RR2PBC6

Hours / week :6

Medium : English

SEMESTER – II

(For the students admitted from 2015 onwards)

CORE COURSE -7- MICROBIOLOGY

Unit 1- Morphology and Ultrastructure

Ultrastructure of bacteria, fungi, algae and protozoa. Classification of microbes, molecular taxonomy. Cell membrane of gram positive and gram– negative bacteria. Cell wall and cell membrane synthesis, flagella and motility, cell inclusions like endospores, gas vesicles. Microscopy- types of microscope, and their application- simple, compound, phase contrast and SEM microscope.

Unit 2 - Microbial growth and metabolism

Microbial growth– definition. Mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth. Microbial metabolism– overview. Role of chlorophylls, carotenoids and phycobilins, Chemolithotrophy, methanogenesis and acetogenesis, nitrogen fixation- mechanism and its importance.

Unit 3- Microbiological Techniques

Methods in microbiology. Current methods in microbial identification. Pure culture techniques. Theory and practice of sterilization. Principles of microbial nutrition, Preparation of culture media, Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes. Staining techniques.

Unit 4 -Viruses

Bacterial, plant, animal and tumor viruses. Classification and structure of viruses. Lytic cycle and lysogeny. DNA viruses; positive and negative strand, Double stranded RNA viruses. Replication- example of Herpes, pox, adenoviruses, Retroviruses. Viroids and prions.

Unit 5 - Medical Microbiology

Disease reservoirs; Epidemiological terminologies. Infectious disease transmissions. Respiratory infections caused by bacteria and viruses; Tuberculosis, sexually transmitted diseases including AIDS; Vector borne diseases, Water borne diseases. Public health and water quality. Pathogenic fungi. Antimicrobial agent - Penicillins, Streptomycin, Tetracyclin and cephalosporins,

Books recommended

1. Madigan et al. Brock Biology of microorganisms 10th ed. Prentice Hall, 2002.
2. Davis et al Microbiology 4th ed. Lippincott Williams and Wilkins, 1989.
3. Joklik et al. Zinsser's Microbiology Mc Graw-Hill Professional, 1995.
4. Pelczar et al. Microbiology 5th ed. Mc Graw Hill, 2000.
5. Stainer Ry et al. General Microbiology 5th ed. Prentice Hall 1986.
6. Brooks et al. Jawetz, Melnick and Adelberg's Medical Microbiology. Lange Med. 1998.
7. Prescott et al. Microbiology. Mc Graw Hill, 1999.
8. Encyclopedia Microbiology– 2nd ed. Lederberg Vol. 1 to 4. Acad. Press 2000

Question Paper Pattern

**Maximum marks -75
Exam duration – 3 hours**

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR2PBCP2

Hours / week :6

Medium : English

SEMESTER – II

(For the students admitted from 2015 onwards)

CORE COURSE -8-PRACTICAL 2

Enzyme kinetics

1. Determination of total and specific activity of amylase.
2. Effect of pH on Amylase activity
3. Effect of temperature on Amylase activity .
4. Effect of substrate concentration on amylase activity and determination of Km value.
5. Effect of enzyme concentration on amylase activity.
6. Effect of inhibitor on activity of amylase/urease.
7. Effect of activator on activity of amylase/urease.
8. Determination of total and specific activity of alkaline phosphatase.
9. Determination of total and specific activity of acid phosphatase.

Demonstration:

1. Isolation of pure culture- serial dilution , pour plate , spread plate, and streak plate.
2. Staining techniques- simple, gram and acid fast staining.
3. Antibiotic sensitivity and assay of different microbes.

Credit :5

Code-RR2PBCEL2

Hours / week :6

Medium : English

SEMESTER – II

(For the students admitted from 2015 onwards)

ELECTIVE 2 – ENDOCRINOLOGY

Unit I- Hypothalamic and pituitary hormones

Hormones – classification, biosynthesis, circulation in blood, modification and degradation. Hormone receptors – structure and regulation. Mechanism of hormone action. Hypothalamic and pituitary hormones. Hypothalamic releasing factors. Anterior pituitary hormones : biological actions, and disorders of growth hormones, ACTH, gonadotrophins and prolactin. Posterior pituitary hormones – biological actions and regulation of vasopressin.Oxytocin. Hypopituitarism.

Unit II -Thyroid and Parathyroid hormones

Thyroid hormones – synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid functions tests. Hyper and hypothyroidism. Hormonal regulation of calcium and phosphate metabolism. Secretion and biological actions of PTH, calcitonin and calcitriol. Hypercalcemia and hypocalcemia.

Unit III -Adrenal hormones

Adrenal cortical hormones. Synthesis, regulation, transport, metabolism and biological effects. Adrenal function tests. Cushing's syndrome, aldosteronism, congenial adrenal hyperplasia, adrenal cortical insufficiency. Adrenal medullary hormones – synthesis, secretion, metabolism, regulation and biological effects of catecholamines. Pheochromocytoma.

Unit IV- Sex hormones and Pancreatic hormones

Gonadal hormones : Biosynthesis, regulation, transport, metabolism and biological actions of androgens. Hypogonadism and gynecomastia. Biosynthesis, regulation, transport, metabolism and biological effects of oestrogen and progesterone. Pregnancy – diagnostic tests and biochemical changes. Amenorrhoea. Pancreatic hormones – synthesis, regulation, biological effects and mechanism of action of glucagons, and insulin.

Unit V Signal transduction

Fundamentals concepts and definitions of signals, ligands and receptors, endocrine, paracrine and autocrine signaling. Receptors and signaling pathways – cell surface receptors, ion channels, G-protein coupled receptors, receptor kinasases (tyr, ser/thr). Signal transduction through cytoplasmic and nuclear receptors. The Ras-raf MAP kinase cascade, second messengers – cyclic AMP, cyclic GMP, phosphatidyl inositol and calcium ions.

Books recommended :

1. Williams Textbook of Endocrinology – Wilson and Foster 8th ed.
2. Mechanisms of hormone action – Autind and Short.
3. Harper's Biochemistry – Murray et al. 26th ed. McGraw Hill, 2003.
4. Principles of Biochemistry – Mammalian Biochemistry – Smith et al. McGraw Hill 7th ed.

Question Paper Pattern

**Maximum marks -75
Exam duration – 3 hours**

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR3PBC7

Hours / week :6

Medium : English

SEMESTER – III

(For the students admitted from 2015 onwards)

CORE COURSE–9 - IMMUNOLOGY

Unit 1- Elements of Immunology

Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs- Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues- GALT. Cells of the immune system- lymphocytes, mononuclear phagocytes dendritic cells, granulocytes, NK cells and mast cells, cytokines. Lymphokines, and interleukins. Antigens vs immunogens, Haptens. Factors influencing immunogenicity.

Unit 2- Immunoglobins and Complement system

Complement activation and its biological consequences. Clonal selection theory. T-cell, B-cell receptors, Antigen recognition- processing and presentation to T cells. Immunological memory. Cell mediated cytotoxicity, immunotolerance, immunosuppression. Immunoglobulins structure, classification and functions. Isotypes, allotypes and idiotypes.

Unit 3- MHC genes and products

MHC - Role of MHC antigens in immune response, MHC antigens in transplantation. Transplantation types and mechanism. Immune responses to infectious diseases- Viral, bacterial and protozoal. Hypersensitivity- types and mechanisms

Unit 4- Immunization Practice and Autoimmunity.

Immunization practices- active and passive immunization. Vaccines- killed, attenuated- toxoids. DNA vaccines, synthetic peptide vaccines. Production of polyclonal and monoclonal antibodies- hybridoma technology. Principles, techniques and application. Genetically engineered antibodies. Autoimmunity- autoimmune disease in human and animal models.

Unit 5- Immunotechniques

Immuno-electrophoresis, RIA, immunoblotting, Avidin- biotin mediated immuno assay. Immunohistochemistry- immunofluorescence, Fluorescent immunoassay. ELISA and ELISPOT. Abzymes. Experimental animal models: inbred strains, SCID mice, nude mice, knock out Mice.

Books recommended

1. Roitt et al. Roitt's. Essential Immunology. 10th ed. Blackwell Sci. 2001.
2. Richard A. Goldsby et al. Kuby Immunology. 4th ed. WH Freeman & Co. 2003.
3. Abbas et al. Cellular and Molecular Immunology. W.B. Saunders Company, 2000. 16

4. Janeway, C. (Ed), Paul Travers. Immunobiology. 5th ed. Garland Publ. 2001.
5. Eli Benjamini AU et al. Immunology: A short course. 4th ed. Wiley-Liss, 2000.
6. NMS Series in Immunology. 3rd ed. Lippincott Williams & Wilkins.
7. Bier et al. Fundamentals of immunology Springer Verlag, 1986.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR3PBC8

Hours / week :6

Medium : English

SEMESTER – III

(For the students admitted from 2015 onwards)

CORE COURSE – 10- CLINICAL BIOCHEMISTRY

Unit 1-Disorder of carbohydrate and lipid metabolism

Disorders of carbohydrate metabolism– glycogen storage diseases, galactosemia, fructose intolerance and fructosuria. Blood sugar homeostasis: Role of tissues and hormones in the maintenance of blood sugar. Hypoglycemia, hyperglycemia, glycosuria. Diabetes mellitus – classification, metabolic abnormalities, diagnosis and management. Disorders of lipid metabolism – lipoproteinaemias. Lipid storage diseases – Gaucher’s, Tay Sach’s Niemann Pick disease. Fatty liver. Atherosclerosis.

Unit – 2- Disorders of amino acid and nucleic acid metabolism

Disorders of amino acid metabolism– amino aciduria, Phenylketonuria, Hartnup disease, alkaptonuria, albinism, cystinuria, cystinosis, homocystinuria and maple syrup urine disease. Disorders of purine, pyrimidine metabolism: Hyperuricemia and gout. Hypouricemia. Orotic aciduria. Serology: C reactive protein test, Rheumatoid arthritis (RA) test.

Unit 3-Liver function test and gastric function test

Jaundice- Causes, consequences, biochemical findings, treatment in jaundice, hepatitis and cirrhosis. Liver function test. Tests related to excretory (bile pigments) synthetic (plasma proteins, prothrombin time) detoxifying (hippuric acid, NH₃, aminopyrine) and metabolic (galactose) functions. Gall stones. Gastric function tests- Stimulation tests – insulin and pentagastrin. Peptic ulcer, gastritis and Zollinger Ellison syndrome.

Unit 4- Kidney function test and Clinical enzymology

Kidney function- Biochemical findings in glomerulonephritis, renal failure and nephritic syndrome. Nephrolithiasis. Kidney function tests - Glomerular function tests – inulin, urea and creatinine clearance tests, renal plasma flow, plasma α_2 -microglobulin. Tubular function tests – water load, concentration and acid excretion tests. Abnormal constituents of urine.

Clinical enzymology - Serum enzymes and isoenzymes in health and disease – Transaminases (AST, ALT) acid . alkaline phosphatases, amylase, LDH and CK.

Unit 5- Oncology

Oncology: Cancer cell – morphology and growth characteristics. Biochemical changes in tumor cells. Differences between benign and malignant tumors. Tumor markers – AFP, CEA and HcG Agents causing cancer – radiation, viruses, chemicals. Multistep carcinogenesis – initiation, promotion, progression. Oncogenes and proto-oncogenes – mechanisms of proto-oncogene activation. Tumor suppressor genes – p53.

Books recommended

1. Clinical Chemistry in diagnosis and treatment Mayne ELBS.
2. Clinical Chemistry Marshall 3rd edition Mosby.
3. TietZ textbook of Clinical Chemistry – 1998 3rd edition Saunders.
4. Principles of Internal Medicine. Harrison's Vol 1 & 2, 14th edition Mc Graw Hill.
5. Biochemistry and disease. Cohn and Roth. 1996, Williams and Wilkins.
6. Harper's Biochemistry McGraw Hill, 2000.
7. Biochemistry – A case oriented approach. Montgomery et al. Mosby.
8. Clinical Chemistry – Principles, procedures, correlations – Bishop, Lippincott, 2000.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR3PBC9

Hours / week :6

Medium : English

SEMESTER – III

(For the students admitted from 2015 onwards)

CORE COURSE -11 – MOLECULAR BIOLOGY

Unit 1-Molecular structure of genes and chromosomes

Chromosomal organization of genes , Mobile elements (Transposons) - bacterial transposons, viral transposons, viral retro transposons, structural organization of eukaryotic chromosomes, histone proteins, chromatin , Telomeres and telomerase. Gene mutation and chromosomal aberration. DNA damage and DNA repair.

Unit- 2- DNA Replication and DNA repair

Replication of DNA: DNA in prokaryotes and eukaryotes. Enzymes involved in replication, events on the replication fork and termination, mechanism of replication. Inhibitors of DNA replication. Mutation - point mutation and frame shift mutation, Suppressor mutations , nonsense and missense mutation.

Unit-3 - Transcription and regulation

Basic principles of transcription- initiation, elongation and termination in prokaryotes. Inhibitors of transcription. Regulation of transcription in prokaryotes- Lac, Tryp and Ara operon. Eukaryotic RNA polymerases- structure and functions of RNA pol I, II and III. Post transcriptional processing of mRNA, rRNA and t-RNA. Alternative splicing.

Unit 4- Genetic code and translation

The genetic code- general features. Components of protein synthesis, Mechanism of protein synthesis in bacteria and eukaryotes- amino acid activation, initiation, elongation and termination. Inhibition of protein synthesis. protein glycosylation in ER and Golgi complex. Protein targeting- the signal sequence hypothesis, targeting proteins to membranes, nucleus and intracellular organelles. Protein degradation: the ubiquitine pathway. Protein folding- models, molecular chaperones.

Unit 5- Gene expression and regulation

Levels of gene expression. Principles of gene regulation, Upregulation, downregulation, induction, gene regulation by DNA methylation. Methods to study gene expression.

Cytotoxicity and viability assays, molecular markers – markers based on DNA hybridization, Basic principle, Restriction fragment length polymorphism (RFLP), Random Amplified polymorphic DNA (RAPD), Cytogenetic bioassays- chromosomal damage micronuclease test, ames test.

Books recommended

1. Lewin. Genes VII. Oxford University Press 2000.
2. Twyman. Advanced Molecular Biology Viva Publ. 2nd ed 1998.
3. Alberts. Molecular Biology of the Cell. 4th ed. Garland Sci. 2002.
4. Lodish et al. Molecular Cell Biology. 4th ed. Freeman 2000
5. Pitot HC. Fundamentals of Oncology. Marcel Dekker, 2002.
6. Stansfield et al. Molecular Cell Biology. Schaum's Outlines. McGraw Hill, 1996.

Question Paper Pattern

**Maximum marks -75
Exam duration – 3 hours**

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR3PBCP3

Hours / week :6

Medium : English

SEMESTER – III

(For the students admitted from 2015 onwards)

CORE COURSE – 12- PRACTICALS-3

CLINICAL BIOCHEMISTRY

1. Preparation and preservation of blood and urine samples.
2. Estimation of HDL Cholesterol in serum
3. Estimation of triglycerides in serum
4. Estimation of LDH in serum
5. Estimation of Hemoglobin in Blood.
6. Estimation of ceruloplasmin in serum.
7. Estimation of blood sugar.
8. Estimation of urine creatinine.
9. Estimation of urine urea
10. Estimation of chloride in urine.
11. Estimation of serum total bilirubin.
12. Estimation of TBARS, Catalase and SOD in liver.

Demonstration:

1. Purification of enzyme by ammonium sulphate precipitation.
2. Separation of DNA by agarose gel electrophoresis.
3. Separation of protein by SDS-PAGE

Credit :4

Code-RR3PBCEL3

Hours / week :6

Medium : English

SEMESTER – III

(For the students admitted from 2015 onwards)

ELECTIVE 3 - GENETIC ENGINEERING

UNIT 1

Introduction to gene cloning : Isolation and purification of plasmid DNA, bacteriophage DNA, restriction enzymes, ligases, basic principles of rDNA technology.

UNIT-2

Cloning and expression vectors: Plasmids, PBR322, bacteriophages, M13, Lambda and PUC vectors. Cosmid vectors, YAC, BAC, HAC , Ti plasmids.

UNIT-3

Cloning and expression strategies: DNA cloning, genomic library, cDNA library, expression of cloned genes in E.Coli and Yeast.

UNIT-4

Gene transfer methods: Electrophoration, microinjection, liposome mediated methods, calcium phosphate method, nature gene transfer methods: transformation, transduction and conjugation.

UNIT-5

Applications of genetic engineering in agriculture, health and industry, stem cell and its applications. Gene therapy. GM Foods.

Recommended Books

1. Primrose.S.B, Twyman and Old. Principles of gene manipulation, Blackwell Scientific Publications, 6th Edition, 2001.
2. Glick,B and Pasternack,J.J. Molecular Biotechnology, ASM Press, Third Edition, 2003.
3. Brown,T.A. Gene Cloning and DNA analysis –An introduction, Blackwell Science, Fourth Edition, 1995.

Reference Books

1. Tom Strachan and Andrew P. Read, Human Molecular Genetics, BIOS Scientific publishers, 1996.
2. Watson, J. D. *et al.*, Recombinant DNA, Scientific American Books, Second Edition, 1998.
3. Ernst L. Winnacker, From Genes to clones, Panima Educational Book Agency, New Delhi, 1987.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :5

Code-RR4PBC10

Hours / week :6

Medium : English

SEMESTER – IV

(For the students admitted from 2015 onwards)

CORE COURSE -13- ADVANCED PHARMACEUTICAL CHEMISTRY

Unit 1

Drugs –Sources and classification of drugs, dosage forms and routes of administration . Drugs – structural features and prodrug concept. Absorption , factors modifying drug absorption. Distribution of drugs. Mechanism of action of drugs. Different types of Dosage forms - Factors modifying drug action. Rational therapy & P drugs

Unit 2

Drug metabolism – General pathways of drug metabolism , reactions in Phase I and Phase II reactions, Role of Cytochrome P450 in Metabolism of Drugs. Excretion of drugs. Factors affecting drug metabolism.

Drug receptors- types, model and theories. G-protein coupled receptors and ion channel linked receptors. Drug receptors interations. Agonist and antagonists.

Unit III

Mechanism of action of drugs in therapy of

- a. Respiratory systems – cough, bronchial, asthma and tuberculosis.
- b. Antimicrobial drugs – sulfonamides, penicillins, tetracyclins, streptomycin, and chloramphenicol.
- c. Cancer chemotherapy - uses, mechanism of action , and side effects of Methotrexate, Vincristin, Cisplatin
- d. Thyroid and antithyroid drugs, insulin and oral antidiabetic drugs, drug therapy in Alzheimers disease and infertility.

Unit IV

History and Importance of medicinal plants, Use of herbs in our daily life. Principles and Development of drug discovery. Extraction and purification of active principles (alkaloids, flavonoids) from medicinal plants, Role of medicinal plants in drug industry.

Genetically engineered protein and peptides. Novel drug delivery systems, Anti AIDS drug development, oncogenes as target for drugs, Production of secondary metabolites . Drugs prescribing in old age, infants and children, pregnancy.

Unit V

General and local anaesthetics, Preservatives and antiinfectants, Antihypertensive drugs, Psychotropic drugs, antidepressant drugs, Parkinsons disease and drugs therapy for parkinsons disease, Antiinflammatory drugs, Treatment of acute poisoning, Method of prescription writing with examples.

Heavy metal poisoning – Sources, harmful effects and management of cadmium, mercury and lead. Patenting of drug.

Reference Books :

1. Text Book of pharmaceutical chemistry by Jayashree Ghosh , S.Chand publishers (2010) (For Unit 1 , 2 & 3)
2. Pharmaceutical chemistry by Tripathi, Jaypee Publishers, 6th edition (2008) (For Unit 4 &5)
3. Pharmacology by satorkar, Elsevier Publications (2008).
4. Principles of medicinal chemistry by W.O.Foye, Lippincott Publications (2007).
5. Pharmacology by S.P.Maity and R.N.Chatterjee, Books and Allied (P) Ltd, 2004 edition.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :4

Code-RR4PBCEL4

Hours / week :6

Medium : English

SEMESTER – IV
(For the students admitted from 2015 onwards)

ELECTIVE -4 - BIOTECHNOLOGY

UNIT1- Bioprocess technology

Bioreactors : types, operation of conventional bioreactor, fermentor, fermentation- solid substrate fermentation, media for industrial fermentation, sterilization of culture media and gases. Safety measures of reactors.

Types of culture. Downstream processing - solid-liquid separation, release of intracellular products, concentration, purification and formulation.

UNIT 2 - Microbial Biotechnology

Isolation of microorganism, microbial metabolic products- primary and secondary metabolites, genetic improvement of strains. production of Organic solvents – alcohol, organic acids – citric acid and lactic acid, antibiotics – penicillin and streptomycin, vitamins – riboflavin and ascorbic acid. Single cell protein

UNIT 3- Medical Biotechnology

DNA in disease diagnosis : DNA probes, DNA in diagnosis of infectious diseases, genetic diseases, Pharmaceutical products of DNA technology : Human protein replacement, therapeutic agents for human diseases. Recombinant vaccines : subunit vaccines, DNA vaccines, attenuated recombinant vaccines, plants as edible subunit vaccines

UNIT 4- Plant and Animal Biotechnology

Plant cell and tissue culture: cell culture media, cell culture techniques , protoplast culture, protoplast fusion. Methods of gene transfer in plants: Agrobacterium mediated transformation. Animal cell culture : fundamentals and applications Culture media for animal cells, cultured cells – Biology and characterization, primary culture and cell lines, cell viability and cytotoxicity, cell transformation and cell cloning.

UNIT 5- Environmental Biotechnology

Environmental pollution : Types of pollution, pollution monitoring, biotechnological methods for management of pollution. Biodegradation : xenobiotic compounds. Bioremediation : Types of bioremediation, genetic engineering for efficient bioremediation, bioremediation of contaminated soil and waste land. Microbial mining.

Text Books

1. Satyanarayana,U. Biotechnology, Uppala Author - Publisher Interlinks, First Edition, 2005.
2. Singh,B.D. Biotechnology – expanding horizons, Kalyani Publishers, First Edition, 2004.

Reference Books

1. Cruger,W. and Cruger, A. Biotechnology – A text book of Industrial Microbiology, Panima Publishing Corporation, Second Edition, 2000.
2. Casida, L.E. Industrial Microbiology, Willey Eastern Ltd. Mumbai, First Edition, 1991.
3. Stanbury, P. and Whitaker, A. Principles of Fermentation technology, Pergamon Press, 1984.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD

Credit :4

Code-RR4PBCEL5

Hours / week :6

Medium : English

SEMESTER – IV

(For the students admitted from 2015 onwards)

ELECTIVE 5 - BIOSTATISTICS & RESEARCH METHODOLOGY

Unit I

Definition of Biostatistics , Data, sample, variable. Collection of data – Organization of statistical investigation, Planning of statistical investigation, Primary and secondary data,. Methods of data collection, Sampling – Methods of sampling, Advantages and disadvantages of sampling.

Unit II

Classification of data – Types of classification, Methods of classification, Frequency distribution, Types and illustration, Diagrammatic presentation of data- Line diagram, Bar diagram, Pie diagram, Pictogram. Graphical presentation of data- Line graph, histogram, Frequency polygon, Frequency curve, Ogive curve.

Unit III

Measures of central tendency –Definition of Average, Arithmetic mean- Direct method and short cut method for continuous series, Discrete series, Median – Definition, Calculation of median for individual series, Discrete series, Continuous series, Difference between mean and median, Mode- Definition, Calculation of mode for individual series, Continuous series, Discrete series.

Unit V

Measures of dispersion – Definition of dispersion, Properties and classification of dispersion. Standard Deviation – Definition, Calculation of Standard deviation for individual series, Discrete series, Continuous series, Merits and demerits of S.D., Definition – Variance, Standard error, Coefficient of variation.

Correlation analysis –Definition, Uses, causation of correlation, Degree of correlation, Types of correlation-, Methods of studying correlation. Karl Pearson's correlation for individual

series, continuous series and discrete series. Analysis of variance- one way ANOVA and Two way ANOVA.

Unit V

Principles and method of research designs –experimental and non experimental design, sectional, prospective and retrospective studies. Time scheduling – lab and field facilities, Research duration, choice of research topic, methodology procedure. Preparing, writing and documentation of research reports. Role of computers in biological research and practice.

Reference Books

1. Biostatistics analysis, zar, J.H, Prentice Hall, New Jersey (1984).
2. Statistical methods for biologists, Palanichamy. S and Manoharan. M (1990).
3. Statistical methods by S.P Gupta. S.Chand&Co., (2011)
4. Biostatistics – A foundation for analysis in health science, Daniel(2006)
5. Research Methodology – Methods and Techniques by C.R. Kothari(2007)
6. Research methods for biological science by Gurumani. N, MJP pub., (2007)
7. Research methods in biological science – Dr. S.Palanichamy, M. Shanmugavelu
8. Biochemical calculation and biostatistics – Dr E. Padmini.

Question Paper Pattern

Maximum marks -75
Exam duration – 3 hours

Part A- (10x2=20) Answer all questions (two questions from each unit)

Part B- (5 X5 =25) Answer all questions (either or type – two questions from each unit)

Part C (3 x 10=30 Answer any three questions (one question from each unit)

Signature of the HOD