Vidyasagar University

Midnapore 721102, WB

Curriculum for B.Sc Honours in Physiology
[Choice Based Credit System]

2022

Semester-I

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	C1T: i. Cell Biology and Structural Units of Human Systems ii. Tissue Organization and of Human Body iii. Biophysical and Biochemical Principles	Core Course-1		4	0	0	6	75
	C1P: Histology: i. Staining and examination of fresh tissues ii. Identification of stained permanent slides	Core Course1 [Practical]		0	0	4		
C2	C2T: i. Chemistry of Bio-molecules ii. Enzymology	Core Course-2		4	0	0	6	75
	C2P: Biochemistry: i. Qualitative identification ii. Determination of strength of acid and alkali iii. Quantitative analysis	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
Total							20	275

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline]: Chemistry/Microbiology/Zoology/Botany/Nutrition

C1 (Theory)

Cell Biology and Structural Units of Human Systems:

Electron microscopic structure and functions of the organelles of eukaryotic cells: Structure of plasma membrane - Bio-chemical components, their arrangement, membrane asymmetry and fluidity; Functions; Fluid mosaic model. Membrane transport: active and carrier mediated transport; Mechanism of exocytosis and endocytosis. Artificial membrane: liposome and its functions. Endoplasmic reticulum: EM structure and functions of smooth and rough ER. Microsomes: basic functional aspects. Golgi complex: structure, and functions. Lysosomes and its functions. EM structure and functions of nucleus. Peroxisomes and its function. Mitochondria: EM structure and its functions. Ribosomes – cytoribosomes and mitoribosomes; their structure and functions. Cytoskeleton: structure and its role in stabilization of cell shape. Microtubules and their role in cellular movements and secretions. Events of Cell cycle; Cell differentiation; Gap junction, Tight junction (structure and functions); Cell adhesion molecule (brief).

Tissue Organization of Human Body:

Structure, classification, distribution and functions of different tissues. Organization of different organs and systems of the human body.

Biophysical and Biochemical Principles:

Law of mass action, orders of reactions, properties of water. Significance and physiological application of the following phenomena: diffusion, osmosis, dialysis, surface tension, viscosity, adsorption, absorption. Colloids: properties and significances, sol and gel, lyophilic and lyophobic sol, electrokinetic properties; Isoelectric pH and isoelectric precipitation. Gibbs-Donnan membrane equilibrium and its biological importance. Acids and bases as proton donors and acceptors. Conjugate acid-base pairs; pH: definition, explanation, determination and significance; Buffers: definition, types; functions of buffers. Role of kidney, erythrocyte and lungs for maintaining body pH. Indicators and its applications. First and second laws of thermodynamis, closed and open system, living body as a thermodynamic system, entropy, enthalpy, maintenance of physiological steady state. Gibbs concept of free energy.

C1 (Practical)

Histology

Staining and Examination of fresh tissues: Study of compound microscope. Squamous, columnar epithelium (methylene blue), corneal cell space (silver nitrate), adipose tissue (Sudan III or IV), Specimens should be taken strictly from Goat / Rat.

Study and Identification of supplied paraffin sections of mammalian tissues (Eosin and Hematoxylin stain).

Trachea, lung, spleen, lymph gland, tongue, esophagus, stomach, duodenum, ileum, jejunum, large intestine, liver, kidney, salivary glands, pancreas, adrenal gland, thyroid gland, testis, ovary, uterus, spinal cord, cerebral cortex, cerebellum, skin, artery, vein.

C2 (Theory)

Chemistry of Bio-molecules:

Carbohydrates: Definition and classification.

Monosaccharides - Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures - Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) - Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides: Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance.

Disaccharides - Maltose, Lactose and Sucrose: Occurrence, Structure, bio-chemical properties and Physiological importance.

Polysaccharides - Starch, Glycogen, Dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids, Lectins, Blood group polysaccharides.

Lipids: Definition and classification. Fatty acids: Classification, systemic nomenclature and structure. Mono, Di- and Triglycerides. Properties of Fat and Fatty acids -Hydrolysis, Saponification, Saponification number, Iodine number. Rancidity - Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester - their structure and physiological importance. Lipoproteins - Structure, classification and physiological importance.

Amino acids and Proteins:

Amino acids: Classification, Structure, Nomenclature and Optical properties. Protonic equilibrium of amino acids - amphoteric nature, Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

Peptides and Proteins: Structure and properties of peptide bonds - Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure - Primary, Secondary (α-helix and β- pleated sheet), Tertiary and Quarternary. Forces stabilizing the structures (Covalent bonds, Ionic and hydrogen bonds, Van-derWaals forces and hydrophobic interactions). Denaturation and Renaturation reactions.

Purine and Pyrimidine: Structure, nomenclature and tautomerism.

Nucleic acids: Nucleosides and Nucleotides - structure. Polynucleotides. DNA double helix - Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA - Structure and types. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half $C_o t$ value.

Enzymology – Definition, chemical nature, classification and nomenclature. Mechanism of enzyme action - active site, specificity and enzyme-substrate complex formation. Enzyme kinetics: Hyperbolic kinetics and linear transformation (Lineweaver-Burk Plot). Michaelis - Menten constant. Effect of temperature, pH and metal ions on enzyme activity. Allosteric enzyme- Definition, properties, and types; Sigmoid kinetics. Regulation of enzyme activity - Allosteric modulation; Feedback and feed forward regulations; Covalent modification; Inhibition: Reversible- competitive, noncompetitive and uncompetitive inhibition; Irreversible inhibition. Coenzyme and prosthetic groups; Activation of pro enzymes. Isoenzymes. Rate limiting enzymes. Ribozymes, Abzymes, Enzymes in clinical diagnosis (amylase, acid and alkaline phosphatase, SGOT, SGPT, LDH and CPK).

C2 (Practical)

Biochemistry

i) **Qualitative analysis of biochemical molecules:**

Carbohydrates- Glucose, fructose, maltose/ lactose, sucrose, starch, dextrin.

Proteins – Albumin, gelatin, peptone;

Others - glycerol, cholesterol, bile salts and pigments, acetone, HCI, lactic acid, urea, uric acid blood.

Quantitative analysis:

a. Determination of strength of NaOH, HCl and H_2SO_4 by titration against oxalic acid.

b. Preparation of buffer (pH 6-8)

c. Quantitative estimation of chloride by Mohr's method, amino nitrogen by formoltitration method.

d. TLC: Chromatography: Identification of amino acid.

GENERIC ELECTIVE

GE-1 & 3 [Interdisciplinary/Generic Elective (GE) for Other Departments]

GE-1T/3T: Physiology (Theory) **Credits: 04**

Introduction to physiology and basic biophysical principles

Study of importance of physiology. Scope of physiology in improvement of health. Distribution, characteristics and functions of different tissues.

Physiological importance of the following processes: diffusion, osmosis, dialysis, ul1rafil1ration, surface tension. Brief idea about pH, buffer and maintenance of pH in the body. Brief idea about colloids. Enzyme- definition, classification, factors affecting enzyme action. Concept of co-enzyme, isoenzyme.

Biomolecules

Carbohydrate- Classification of monosaccharides, oligosaccharides (Lactose, Maltose and Sucrose), and polysaccharides, Pyranose and Furanose structure of monosaccharides, isomer of aldopentose and ketopentose. Reducing sugar and non-reducing sugar.

Protein- Classification of amino acids, peptide band, disulphide bond, configuration of protein.

Lipid- Definition, saturated and unsaturated fatty acids, essential fatty acids.

Digestive System and metabolism

Different parts and functions of gastrointestinal (GI) tract. Digestive glands and their functions. Composition and functions of digestive juice including bile. Movements of the stomach & small intestine.

Digestion and absorption of carbohydrates, lipids, proteins

Glycolysis, TCA cycle. Fatty acid oxidation,

Amino acid pool-Fate &. functions of amino acids in the body. Deamination, transamination.

Blood and Cardiovascular System

Blood - composition, functions. Plasma Proteins: origin, functions, separation. Plasmapheresis: Formed elements of blood - their formation, functions, fate. Hemoglobin: types of compounds & derivatives. Blood volume: determination (dye & radio isotope methods), Blood coagulation: mechanism, factors affecting, anticoagulation. Blood groups. Blood transfusion & incompatible transfusion. .

Heart: Properties of cardiac muscle,origin & propagation of cardiac impulse, Events of cardiac cycle, Heart rate, Heart Sound, Heart rate control, Cardiac output: basic concept, factors affecting, ECG - normal waves, different intervals. Myocardial Infarction. Atherosclerosis, thrombosis, hypertension, heart block.

Respiratory System

Functions of the respiratory passages and organs. Role of respiratory muscles in respiration. Significance of anatomical and physiological dead space, lung volumes and capacities. Exchange of respiratory gases between lung and vessels, and between tissues. Transport of O_2 and CO2 in vessels. Hypoxia, apnea, hypercapnia, cyanosis, emphysema, cystic fibrosis. Mountain sickness, acclimatization.

Paper: GE-1P/3P: Physiology (Practical) **Credits: 02**

Qualitative analysis of carbohydrate-glucose, fructose, sucrose and starch, Proteins- albumin, gelatin, acetone, bile salts, glycerol, HCl and lactic acid.

Examination & staining of fresh tissue: squamous, skeletal muscle fibre by Methylene blue stain.

Histological slide identification- lung, liver, pancreas, stomach, small intestine, large intestine, tongue.artery, vein,

Preparation of blood film, Identification of RBC, WBC. Preparation of haemin crystals. Estimation of hemoglobin

Semester-II

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	C3T: i. Nerve-Muscle Physiology ii. Blood and Body Fluids	Core Course-3		4	0	0	6	75
	C3P: Hematology	Core Course-3 [Practical]		0	0	4		
C4	C4T: i. Cardio-Vascular Physiology and Circulation ii. Respiratory System	Core Course-4		4	0	0	6	75
	C4P: Clinical Physiology CC4 (PR): 1. Measurement of respiratory rate, HR, BP 2. Pneumograph Determination of vital capacity	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AECC	Environmental Studies	AECC					4	100
Total							22	325

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/Generic Elective (GE) from other Department

[Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline]: Chemistry/Microbiology/Zoology/Botany/Nutrition

C3 (Theory)

Nerve-Muscle Physiology:

Histological structures of striated, smooth and cardiac muscles. Properties of muscles: Excitability and contractility, all or none law, summation of stimuli and contractions, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Muscle proteins and Sarcotubular system of Human Skeletal and Cardiac Muscle. Mechanism of skeletal muscle contraction and relaxation. Isometric and isotonic contractions. Red and white muscles. Fast and slow twitch muscle fibers. Muscle length, Tension and Velocity relationships of skeletal muscle. Muscle groups: antagonists and agonists. Mechanical, chemical, thermal and electrical changes in striated muscle during contraction and relaxation. Motor unit and motor point. EM structure of Neuromuscular junctions, Neuro-Muscular transmission of impulse, end-plate potential. Electromyography. Single and multi-unit smooth muscle and mechanism of smooth muscle contraction and relaxation. Factors affecting smooth muscle contraction. The resting membrane potential and its origin. The Action Potential - components and its ionic basis. Compound action potentials. Concept of Chronaxie and Rheobase. Saltatory conduction. Myelinated and Unmyelinated nerve fibers and process of Myelinogenesis. Propagation of nerve impulse in different types of nerve fibers. Conduction velocity of nerve impulse in relation to myelination and diameter of nerve fibers. Properties of nerve fibers: Excitability, Conductivity, All-or-none law, Accommodation, Adaptation, Summation, Refractory period, Indefatigability. Synapses: Types and EM, Structure-Function. Mechanism of synaptic transmission of the impulse, Synaptic Potentials (EPSP, IPSP) and neurotransmitters. Injury to peripheral nerves- Degeneration and regeneration of peripheral nerve fibers: Changes in the nerve cell body, reaction of degeneration and mechanism of regeneration.

Blood and Body Fluids:

Basic idea of intracellular and extracellular compartments of body fluid. Composition and function of Blood. Plasma proteins: Classification, normal value, origin and functions, Plasmapheresis. Erythrocytes: Morphology, fate and functions; Steps of erythropoiesis, role of different factors on erythropoiesis. Hemoglobin: chemistry, biosynthesis, functions, catabolism; derivatives like oxyhemoglobin, methemoglobin, carboxyhemoglobin and hemin. Abnormal hemoglobin: thalassemia, sickle cell anemia. Normal value and clinical significane of ESR, TC, DC, PCV, MCH, MCHC, MCV. Anemia: megaloblastic and microcytic, pernicious, aplastic, hypo-chromic. Polycythemia. Blood groups: ABO system; Rh-antigens, blood transfusion and its hazards. Blood group incompatibility- erythroblastosis fetalis. Leucocytes: Morphology, classification, life cycles, functions. Significance of Arneth count, Schilling index, reticulocyte count. Platelet- Morphology, life cycles, functions. Significance of platelet count. Haemostasis Coagulation factors, mechanism of blood coagulation:, disorders of coagulation; anticoagulants (natural and artificial) and their mode of action, coagulation time, bleeding time, prothrombin time, hemolysis. Blood volume: Normal values, determination by dye method and isotope method and factors influencing blood volume. Regulation of blood volume.

C3 (Practical)

Hematology and histology

Preparation of hemin crystal. Determination of coagulation time by capillary method. Bleeding time (Dukemethod), Blood grouping, Rh typing. Preparation and staining of human blood film (Leishman);Identification and measurement of WBC. Differential count of WBC, Arneth count, total count

of RBC and WBC. Staining of reticulocyte. Estimation of hemoglobin (visual method) and cyanmethaemoglobin method. Determination of hematocrit value, calculation of red blood cell indices (MCV, MCH and MCHC). Study of bone marrow for identification of megakaryocytes.

Study of node of Ranvier (silver nitrate), voluntary and involuntary muscle (methylene blue).

C4 (Theory)

Cardio-Vascular Physiology and Circulation:

Basic properties of cardiac muscle: rhythmicity, refractory period, all or none law, and stair case phenomenon. Transmembrane potential, pacemaker potential and electrophysiology of cardiac tissue. Specialized junctional tissue of the heart and origin and propagation of cardiac impulse. Understanding of cardiac muscle as mechanical, electrical and functional syncytium. Heart block and basic idea about artificial pacemaker. Electrocardiography- Origin and significance of different components of normal ECG; Different types of ECG leads; Einthoven triangle. Cardiac valves: Location and functions. Heart rate and its regulation. Cardiac cycle: Different phases and pressure changes in cardiac chambers. Frank – Starling's law of heart. Heart sounds: Their origin and significance. Cardiac output: Definition, normal values and factors regulating it, Determination by Fick method, dye dilution method and isotope method. Nerve supply of the heart and its role in the regulation of the function of the heart. Blood pressure: Definition, normal values and factors regulating it, systolic, diastolic, mean arterial and pulse pressure. Measurement of blood pressure by sphygmomanometer - principle, method. Central pulse and peripheral pulse and their patterns. Venous pulse, Regulation of blood pressure: Innervations of blood vessels and vasomotor control, vasomotor reflex; role of baroreceptors and chemoreceptors, neural and humoral control. Role of renin-angiotensin system. Vasopressin or ADH in BP regulation. Anatomical organization, peculiarities and significance of coronary, pulmonary, cerebral, cutaneous, hepatic and renal circulation.

Respiratory System:

Basic concepts about respiratory tract, histology of lungs, respiratory muscles and their innervations. Mechanism of respiration and the role of different respiratory and accessory muscles. Compliance, elasticity and elastic recoil of the lung. Role of lung surfactants. Intra-thoracic and intra-pleural pressures. Tidal volume, inspiratory and expiratory reserve volumes, residual volume, vital capacity, functional residual capacity, maximum breathing capacity. Partial pressures and percentage of respiratory gases in inspired, expired, alveolar airs and in blood. Respiratory gases and their exchange between the lung alveoli and blood and between the blood and the tissues. Transport of O_2 and CO_2 in blood. O_2 dissociation curve, CO_2 dissociation curve and factors affecting. Modern concept of regulation of respiration: Role of respiratory centers, central and peripheral chemoreceptors. Respiratory failure, artificial respiration and its different techniques (mouth to mouth, tank respirator method). Hypoxia, asphyxia, dyspnea, asthma, cardiac and bronchial emphysema, cyanosis, dysbarism, Lung function tests. Brief idea on non respiratory functions of lung: coughing and sneezing, immune system defence and biosynthetic functions.

C4 (Practical)

Measurement of respiratory rate, HR, BP
Pneumograph, Peak flow meter, pulse oxymeter
Determination of vital capacity. Measurement of different waves of ECG,

GENERIC ELECTIVE

GE-2/4 [Interdisciplinary/Generic Elective (GE) for other Departments]

GE2T/4T: Physiology (Theory) **Credits: 04**

Nerve - Muscle Physiology and Nervous system (NS)

Different types of muscles and their characteristics. Red and white muscle. Mechanism of skeletal muscle contraction. Isotonic and isometric contraction. Single unit and multi unit smooth muscle amd their importance.

Structure & classification of nerves. Origin & propagation of nerve impulse. Synapse: structure, mechanism of synaptic transmission. Motor unit, motor point. Neuromuscular junction: structure, mechanism of impulse transmission.

A brief outline of the organization and functions of nervous system. Reflex action: definition, reflex arc. A brief idea about the structure and function of cerebral cortex. A brief description about the organization and functions of autonomic nervous system (sympathetic and parasympathetic). Basic concept of CSF.

Endocrinology and Reproductive Physiology

a) Concept of autocrine and paracrine glands.

b) Pituitary gland and its hormones. General physiological functions of GH, ACTH, TSH, LH, FSH. Acromegally, gigantism. Functions of Posterior pituitary hormones.

c) Physiological functions of thyroid hormones. Cretinism and myxoedema. Goitre.

d) Pancreatic islets of Langerhans. Physiological functions of insulin and glucagon. Diabetes mellitus.

e) Adrenal cortex- Aldosterone and its functions. Glucocorticoids and its functions. Adrenal medulla- Catacholamines and their role in catabolism and cardio-respiratory system (outlines only).

Primary and Secondary sex organs and sex characters**.** Puberty- A brief idea. Testis: histology, spennatogenesis, Testicular hormones and their functions. Ovary: Histology, Menstrual cycles – different phases & hormonal control. Ovarian hormones and their functions. Fertilization process in

mammals (basic concept).

Excretory Physiology

Nephrons –Structure, types and function. Mechanism of formation of urine. Normal & abnormal constituents of urine. Non excretory functions of kidney. Juxtaglomerular apparatus- structure and function. Diabetes insipidus. Skin*:* Structure and functions; composition of sweat.

Community Health & Nutrition

a) Basic idea about community health, malnutrition (Marasmus and Kwashiorkor), over and under nutrition.

b) Significance of Dietary fibers. Balanced diet.

Paper: GE-2P/4P: Physiology (Practical) Credit: 02

Study and identification of histological slides - Spinal cord, cerebrum, cerebellum, thyroid gland, adrenal gland, pancreas, testes, ovary, kidney.

Abnormal constituents of urine - glucose, protein, bile salts, acetone.

Measurement of pulse rate and blood pressure. Determination of PFI of an individual by Harvard step test. Measurement of some common anthropometric parameters - stature, head breadth, head circumference, chest circumference, MUAC, Calf circumference. Waist-hip ratio, BMI.

Semester-III

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C5	C5T: i. Digestive System ii. Metabolism of Bio-molecules	Core Course-5		4	0	0	6	75
	C5P: Analytical biochemistry i. Determination of free and total acidity. Estimation of blood glucose, phosphate, cholesterol. Plasma protein	Core Course-5 [Practical]		0	0	4		
C6	C6T: i. Nervous System ii. Skin and Body Temperature Regulation	Core Course-6		4	0	0	6	75
	C6P: Experimental Physiology on Toad	Core Course-6 [Practical]		0	0	4		
C7	C7T:i. Sensory Physiology ii. Work Physiology, Sports Physiology and Ergonomics	Core Course - 7		4	0	0	6	75
	C7P: Human Experiment and Anthropometric Measurements	Core Course-7 [Practical]		0	0	4		
GE-3	GE-3	GE					4/5	75
	GE-3	GE					2/1	
SEC-1	i. Nutrition and Dietetics, Diet Survey **OR** Epidemiological Data Analysis (Only Theory)	Skill Enhancement Course-1		1	1	0	2	50
Total							26	350

L=Lecture, T=Tutorial, P=Practical SEC = Skill Enhancement Course,

Interdisciplinary/Generic Elective (GE) from other Department [Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline]: Chemistry/Microbiology/Zoology/Botany/Nutrition

Modalities of selection of Generic Electives (GE): A student shall have to choose 04 Generic Elective (GE1 to GE4) strictly from 02 subjects / disciplines of choice taking exactly 02 courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

C5 (Theory)

Digestive System:

Histology and functions of digestive organs - tongue, pharynx, esophagus, stomach, small intestine, large intestine, pancreas, liver, gall bladder and salivary glands. Nerve supply to the alimentary system. Mechanism, functions and regulation of mastication, deglutition, movement of the alimentary canal. Composition, functions, mechanism of secretion and control of saliva, gastric juice, pancreatic juice, bile and intestinal juice. Mechanism and control of gastric HCl secretion. Functions of gall bladder and large intestine. Mechanism and importance of Enterohepatic circulation of bile. Brief idea about gall stones, achlorhydria, hyperchlorhydria, peptic ulcer, Pavlov's pouch, defecation reflex, vomiting reflex.

Metabolism of Bio-molecules

Digestion and absorption of carbohydrates, lipid, proteins and nucleoproteins.

Carbohydrate Metabolism and regulation: Glycolysis, TCA cycle, Gluconeogenesis, Cori cycle, Glucose-Alanine cycle. Pentose Phosphate Pathway, Glycogenesis and Glycogenolysis. Regulatory mechanism of carbohydrate metabolic pathways. Inborn errors of metabolism of glycogen, galactose. Biological Oxidation: Concept of substrate-level phosphorylation and oxidative phosphorylation, Redox Potential and redox couple. Mitochondrial Electron Transport Chain and its components. Mechanism of electron transport and ATP synthesis. Oxidative Phosphorylation, Inhibitors and uncouplers.

Lipid Mechanism: β-oxidation of saturated fatty acids (Palmitic acids), ω and α oxidation. Biosynthesis of saturated fatty acid (C16). Formation and sphingomyelin. Brief concept of cholesterol biosynthesis and its physiological significance. Role of lipoproteins in transport and storage of lipids.

Amino Acids Metabolism: Glucogenic and ketogenic amino acids and amino acid pool. Non protein nitrogen. Trans-amination, oxidative and non-oxidative deaminations. Ammoniotelic, ureotelic and uricotelic organisms. Synthesis of specialized products from amino acids (viz., catecholamines, creatine phosphate, histamine, serotonin and melatonin, melanin, gamma-aminobutyrate, and glutathione). Inborn errors of metabolism of tryptophan, phenylalanine and tyrosine. One carbon metabolism, labile methyl group and transmethylation. Synthesis of Urea and Nitric oxide.

Purine & Pyrimidine Metabolism: Purines and Pyrimidines: Biosynthesis - de novo and salvage pathways. Catabolism (Regulation of the above-mentioned biochemical pathways/cycle not required).

Mineral metabolism: Sodium, potassium, chloride, calcium and phosphorus metabolism. Trace elements (iron, iodine, fluorine, selenium) - their functions and deficiencies.

C5 (Practical)

Analytical biochemistry

a) Estimation of free and total acidity in supplied gastric juice.

b) Estimation of lactose and calcium from milk.

d) Estimation of free amino acids by ninhydrin method and total protein by quantitative biurette reagent method from pulses.

e) Determination of acid value and iodine number of fat.

f) Estimation of Vit-C from lemon juice.

g) Identification of food adulterants: starch from milk, dalda from butter, saw dust and coloring agents from spices, saccharine in sugar.

C6 (Theory)

The Nervous System:

Organization: A brief outline of the organization and basic functions of the nervous system – central and peripheral. Structural organization of the different parts of brain and spinal cord. Receptors: Definition, Structure, Classification, Mode of action. Role of blockers and stimulators (Drugs included in pharmacology). Reflex action: Definition, classification, properties. Structure and functions of the spinal cord with special reference to functional changes after hemi section and complete section of spinal cord, Brown Sequard syndrome. Ascending and descending tract: Origin, courses, termination and functions. Lower motor neuron and upper motor neuron. Structure and function of vestibular apparatus. Postural reflexes, Muscle spindle, muscle tone and its regulation. Decerebrate and decorticate rigidity. Structure, connections and functions of cerebellum. Nuclei, connections and functions of thalamus and hypothalamus. Basal ganglia: structure, connections and functions. Cerebral cortex: histological structure, connections and functions. Physiological basis of different types of sleep, changes in EEG. Higher functions of nervous system: memory, conditioning and learning. Physiology of pain. CSF: formation, circulation and functions. Autonomic nervous system: Organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous system; Nicotinic and muscarinic acetyl choline receptors, alpha and beta adreno-receptors and their agonists and antagonists. Central control of autonomic nervous system for regulation of internal body homeostasis.

ii) Skin and Body Temperature Regulation: Histological structure of skin. Organization of sweat gland. Composition and functions of sweat. Regulation of sweat secretion. Insensible and sensible perspiration. Composition and functions of sebum. Triple response. Normal body temperature. Channels of heat loss and heat gain process of heat production and heat loss. Regulation of body temperature: higher centers and mechanism of regulation. Hypothermia and hyperthermia. Physiological basis of fever.

C6 (Practical)

Experimental Physiology:

Skeletal Muscle: Study and use of kymograph, induction coils, key and tuning fork in Gastrocnemius sciatic preparation. Kymographic recording of isotonic muscle twitch. Effects of temperature, summation and load (after-load) on muscle contraction.

Heart: Kymographic recording of heart beat of toad. Preparation of amphibian Ringer solution. Kymographic recording of perfused heart beat of toad. Demonstrations: Study of the effects of acetylcholine and excess calcium ion on perfused heart.

C7 (Theory)

Sensory Physiology:

Classification of general and special senses and their receptors. Muller's law of specific nerve energies. Weber-Fechner law. Mechanism of transduction of stimuli from sensory receptors. Adaptation of receptors-phasic and tonic adaptations.

General Sense: Classification, distribution, function and neural pathway of touch, pressure, pain, thermal and kinesthetic sensation.

Olfaction and Gustation: Structure and functions of the receptor organs, nerve pathways, centers. Physiology of taste and smell. Olfactometer.

Audition: Sound waves, decibel, structure and functional significance of auditory apparatus – external, middle and internal ears. Structure of Organ of Corti. Mechanism of hearing and its modern theories. Discrimination of sound frequency and loudness. Auditory pathway and centers.

Vision: Anatomy and structures of the eyeball. The structures of lens. Errors of refraction and their corrections. Contact Lens. Pupillary reflexes, light reflex, near response. Argyll Robertson pupil. Histological details of retina. Photopic and Scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual Pathway and effects of lesion. Color visions and its modem concept. Color blindness. Electroretinogram. Visual field, Perimetry. Visual acuity and its measurement. Factors affecting Visual Acuity. Binocular vision and depth perception.

Work Physiology, Sports Physiology and Ergonomics:

Physical work-definition and units of measurements. Concepts and classification of physiological work-static, dynamic, positive, negative and isokinetic work. Difference between work and sports. Energetics of work - source of energy- aerobic and anaerobic metabolism. Cardiovascular and respiratory responses during graded work. Aerobic and anaerobic capacity. Maximal aerobic power, factors affecting and methods of measurement. Concept of excess post-exercise oxygen consumption. Concept of fatigue. Tests for physical work capacity - Measurement with bicycle ergometer, tread mill and Harvard step test. Basic concepts of Sports Psychology, Role of sports in emotion and social factors. Elementary idea of ergogenic aids. Physical training - general principles and different methods. Nutrition in sports - nutrients and calorie requirements for different kinds of sports. Anthropometry – common instruments for anthropometric measurements. Application of anthropometry in nutrition and ergonomics. Basic concepts of ergonomics and its application in industry to increase individual and group productivity. Work-rest cycle. Industrial safety, Occupational hazards – Physical Bio-chemical hazards. Occupational diseases - Silicosis, Asbestosis, Farmer's lung.

C7 (Practical)

Human experiments & Anthropometric measurements:

Measurement of arterial blood pressure at rest, after exercise and at different postural conditions by Sphygmomanometer. Harvard step test and determination of physical fitness. Measurement of breathing rate before and after exercise. Determination of VO_2 max by Queen's College method. Study of effect of graded exercise (by Bicycle ergometer/Treadmill) on heart rate. Pneumographic effects of talking, laughing, coughing, exercise, hyperventilation and breath holding. Spirometric measurement of vital capacity. Determination of hand and foot reaction time.

Anthropometric parameters: Weight, stature, eye height, shoulder height, elbow height, bi-acromion breadth, head breadth, head circumference and neck circumference. Mid upper arm circumference, chest circumference, waist circumference, hip circumference, waist hip ratio, BMI, BSA.

Study of visual acuity, perimetry, color blindness, deafness, knee jerk, planter reflex.

SEC I

Nutrition and Dietetics (Theory)

Basic concept: Nutrition, Nutrients, Nutraceutical, Cosmeceutical, Nutrigenomics. Nutritional Evaluation of Carbohydrates: Glycemic Index (GI), Classification of dietary fibers with potential of health benefit, Resistance starch. Nutritional Evaluation of Proteins: Essential and Non essential amino acids, Protein Efficiency ratio (PER), nitrogen balance, Net protein utilization (NPU), Biological value of protein, protein spares, Nutritive value of major food groups (basic concepts). Vitamins: Water soluble vitamins (Vit-B complex, Vit-C, Folic acid) and fat soluble vitamins (Vit-A, D, E and K): source, brief chemistry, dietary requirements, functions, deficiency, hyper-vitaminosis, and antioxidant. Energy in Human Nutrition: Basic concept of energy and units, calorific and physiological fuel value, respiratory quotient (RQ), Total energy expenditure (TEE), Basal metabolic rates (BMR) and Resting energy expenditure (REE), Specific dynamic action (SDA), physical activity ratio (PAR), Determination of BMR by Benedict Roth apparatus. Factors affecting BMR. Adult consumption unit (ACU). Formulation of balance diet chart for college students, pregnant and lactating mothers and athletes.

Practical

Diet Survey: Nutritional assessment as per ICMR specification (Steps- Introduction, Diet History, Methodology, Dietary Survey, Clinical Examinations, Remarks, Recommendation and Conclusion). Report should be handwritten. Each student has to prepare and submit the report preferably on his/her own family.

OR

Epidemiological Data Analysis (Theory)

Epidemiology: a. Principle of Epidemiology and Epidemiological methods: Terms used in describing disease transmission and control. Morbidity and mortality indicators. Measurements of epidemiological indicators, Epidemiology study designs. Concept of association, causation and bias. Screening for diseases. b. Epidemiology of communicable diseases: Extent of problem, Diagnosis- clinical and laboratory, Treatment and control, Health Programmes. Respiratory infections: measles, rubella, mumps, influenza, diphtheria, whooping cough, tuberculosis. Intestinal infections: poliomyelitis, viral hepatitis, cholera, typhoid, food poisoning, acute diarrheal diseases. Arthropod-borne infections: dengue, malaria, filariasis, leishmaniasis. Zoonosis: rabies, surface infections: leprosy, HIV/AIDS c. Epidemiology of chronic non-communicable disease and conditions: Coronary heart disease, cancer, diabetes, hypertension, blindness.

Epidemiological Data, epidemiologic methods and survey: Components of epidemiology: Frequency, distribution and determinants of disease. Epidemiological approach and measurements - vital statistics (rates, ratios and proportions), measurements of health indicators. Epidemiologic methods and survey: Data collection: observational (descriptive and analytical) and experimental studies. Epidemiology study designs - case control and cohort studies (prospective and retrospective), techniques of sampling and matching, sources of bias. Data Organization & Presentation, Statistical Modeling and analysis using 'R' on NCRP data and survey conducted by the students: Basic principles of 'R' software for tabulation and graphical

representations, measures of central tendency, dispersion and skewness. Statistical modeling and analysis using 'R' on NCRP data and survey conducted by the students: Correlation analysis (scatter diagrams and Karl Pearsons coefficient of determination, standard and probable errors) and regression analysis. Inferential statistics: sampling distributions and standard error null and alternate hypothesis, basic concept and illustrations of type I and type II errors, concept of confidence interval estimation, large sample tests for single mean and difference of means, single proportion and difference of proportions, students t-distribution (test for single mean, difference of means and paired t-test), chi-square distribution, F-distribution, one-way and two-way ANOVA, non parametric analysis (sign and rank tests), p-value.

GENERIC ELECTIVE

GE-1 & 3 [Interdisciplinary/Generic Elective (GE) for other Department]

GE-1T/3T: Physiology (Theory) **Credits: 04**

Introduction to physiology and basic biophysical principles

Study of importance of physiology. Scope of physiology in improvement of health. Distribution, characteristics and functions of different tissues.

Physiological importance of the following processes: diffusion, osmosis, dialysis, ul1rafil1ration, surface tension. Brief idea about pH, buffer and maintenance of pH in the body. Brief idea about colloids. Enzyme- definition, classification, factors affecting enzyme action. Concept of co-enzyme, isoenzyme.

Biomolecules

Carbohydrate- Classification of monosaccharides, oligosaccharides (Lactose, Maltose and Sucrose), and polysaccharides, Pyranose and Furanose structure of monosaccharides, isomer of aldopentose and ketopentose. Reducing sugar and non-reducing sugar.

Protein- Classification of amino acids, peptide band, disulphide bond, configuration of protein.

Lipid- Definition, saturated and unsaturated fatty acids, essential fatty acids.

Digestive System and metabolism

Different parts and functions of gastrointestinal (GI) tract. Digestive glands and their functions. Composition and functions of digestive juice including bile. Movements of the stomach & small intestine.

Digestion and absorption of carbohydrates, lipids, proteins

Glycolysis, TCA cycle. Fatty acid oxidation,

Amino acid pool-Fate &. functions of amino acids in the body. Deamination, transamination.

Blood and Cardiovascular System

Blood - composition, functions. Plasma Proteins: origin, functions, separation. Plasmapheresis: Formed elements of blood - their formation, functions, fate. Hemoglobin: types of compounds & derivatives. Blood volume: determination (dye & radio isotope methods), Blood coagulation: mechanism, factors affecting, anticoagulation. Blood groups. Blood transfusion & incompatible transfusion.

Heart: Properties of cardiac muscle, origin & propagation of cardiac impulse, Events of cardiac cycle, Heart rate, Heart Sound, Heart rate control, Cardiac output: basic concept, factors affecting, ECG - normal waves, different intervals. Myocardial Infarction. Atherosclerosis, thrombosis, hypertension, heart block.

Respiratory System

Functions of the respiratory passages and organs. Role of respiratory muscles in respiration. Significance of anatomical and physiological dead space, lung volumes and capacities. Exchange of respiratory gases between lung and vessels, and between tissues. Transport of O_2 and CO2 in vessels. Hypoxia, apnea, hypercapnia, cyanosis,emphysema, cystic fibrosis. Mountain sickness, acclimatization.

Paper: GE-1P/3P: Physiology (Practical) **Credit: 02**

Qualitative analysis of carbohydrate-glucose, fructose, sucrose and starch, Proteins- albumin, gelatin, acetone, bile salts, glycerol, HCl and lactic acid.

Examination & staining of fresh tissue: squamous, skeletal muscle fibre by Methylene blue stain.

Histological slide identification- lung, liver, pancreas, stomach, small intestine, large intestine, tongue.artery, vein,

Preparation of blood film, Identification of RBC, WBC. Preparation of haemin crystals. Estimation of hemoglobin

Semester-IV

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C8	C8T: i. Microbiology ii. Immunology	Core Course-8		4	0	0	6	75
	C8P: Microbiology	Core Course-8 [Practical]		0	0	4		
C9	C9T:i. Pharmacological Physiology ii. Environmental Physiology	Core Course-9		4	0	0	6	75
	C9P: Environmental Physiology Educational Excursion	Core Course-9 [Practical]		0	0	4		
C10	C10T: i. Genetics and Molecular Biology ii. Applied Biotechnology	Core Course - 10		4	0	0	6	75
	C10P: Genetics & Biotechnology	Core Course-10 [Practical]		0	0	4		
GE-4	GE-4	GE					4/5	75
	GE-4	GE					2/1	
SEC-2	Histochemistry and Histopathology (only theory) **OR** Medical Microbiology and Immunology (only theory)	Skill Enhancement Course-2		1	1	0	2	50
Total							26	350

L=Lecture, T=Tutorial, P=Practical SEC = Skill Enhancement Course,

Interdisciplinary/Generic Elective (GE) from other Department [Four papers are to be taken and each paper will be of 6 credits]:

[Papers are to be taken from any of the following discipline]: Chemistry/Microbiology/Zoology/Botany/Nutrition

Modalities of selection of Generic Electives (GE): A student shall have to choose 04 Generic Elective (GE1 to GE4) strictly from 02 subjects / disciplines of choice taking exactly 02 courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

C8 (Theory)

Microbiology:

Organization of prokaryotic cell. Classification of bacteria based on morphology, staining characteristics, biochemical tests and 16S rRNA test for identification. Nutritional requirements of bacteria, nutritional types, culture media. Sterilization - types, principles and importance. Pasteurization and its application. Concept of pure culture and different methods of pure culture technique. Bacterial growth curve and physical conditions for growth, Bacterial metabolism: fermentation (ethanol, lactic acid, acetic acid), glyoxylate cycle and Entner-Doudoroff pathway, pathway. Bacterial genetics: elementary idea of transformation, conjugation and transduction. Control of bacterial growth: concept of antiseptics, disinfectants, antibiotics, probiotics and prebiotics. Elementary idea of bacteriostatic, bactericidal and bacteriolytic agents. Food microbiology – Brief ideas about food spoilage (fish, meat, milk, vegetables) and its prevention. Industrial Microbiology: Elementary knowledge for production of fermented products like alcohol, and milk products (cheese, dahi). Elementary knowledge of fungus, algae, protozoa, and virus.

Immunology:

Overview of Immune System - properties of immune system; types of immunity: innate immunity, acquired immunity, active and passive immunity. First and second line defence. Immuno-competent Cells- Structure and functions of Neutrophil, B-lymphocytes, Tlymphocytes (helper, cytotoxic and suppressor), Natural killer cells, monocytesmacrophages. Primary and secondary lymphoid organs. Antigen-Antibody: Properties of immunogen, antigens and haptens. Classification, structure and functions of immunoglobqlins (IgG, IgM, IgA, IgD, IgE). Antigen antibody interaction, their physiological effects and clinical applications. Major Histocompatibility Complex: Elementary ideas about Human leucocyte antigens. Self, Non-self. Antigen processing and presentation with MHC (Class I and II). Elementary idea of B-Cell and T-cell receptors. Humoral immunity: Primary and secondary immune responses. Mechanisms of humoral immunity- Cooperation of T cells B cells and macrophages for the production of specific antibody. Role of cytokines in humoral immunity. Cytokines basic concept. Complements: Classification, components, activation of pathways (classical, alternative and lectin) and functions. Cell mediated immunity: Generation and activation CTLs; Effector molecules and mechanism of cytolytic effects. Innate immunity: Mechanical barrier against pathogenic organism, Physiological barrier-antibacterial and antifungal substances in external body secretions, bactericidal action of HCl. Chemotaxis, mechanism of phagocytosis. Inflammation: mechanism and effects Hypersensitivity reactions: Mechanism of different types of hypersensitivity reactions and their physiological effects. Autoimmunity: Immunological features of autoimmune diseases. Acquired Immunodeficiency: AIDS, Immunization: Concept about immunization, Immunizing agent- vaccine, antisera, DNA vaccine, edible vaccine. Immunization schedules - National and WHO. Hazards of immunization. Immunological techniques - Principle of Immunoassay, ELISA, RIA and immunoelectrophoresis.

C8 (Practical)

Microbiology: Sterilization, Culture preparation and isolation of bacteria. Biochemical characterization of microorganisms (Biochemical tests – Catalase test, Oxidase test, Fermentation of sugar- Glucose, Lactose, Hydrolysis of Starch). Negative staining. Gram staining, Acid-fast staining. Water potability by MPN method.

Identification of stained slide related to immunology: thymus, bone marrow, spleen, lymph node, Peyer's patches in small intestine, different types of WBC

ELISA: (demonstration),

C9 (Theory)

Pharmacological Physiology: The importance of pharmacology in the study of physiological processes. Drugs, Agonist, Antagonist. Pharmacokinetics- absorption, distribution, excretion and bioavailability of drugs. Pharmacodynamics-Drug biotransformation and mechanism of drug action (elementary idea). The dose effect relationship and the characteristics of dose response curve. Assessment of drug toxicity - LD50 and ED50. Mechanism of action of phenoxybenzamine, phentolamine and propranolol. Drugs affecting catecholamine and cholinergic neuro-transmission –reserpine, physostigmine. Neuromuscular blocking agents-tubocurarine, nicotine. Sedative- hypnotics: Barbiturates- actions on organ systems and mechanism of action. Narcotic analgesics: Pharmacological properties and mechanism of action. Antihistamine: Pharmacological properties. Diuretics.

Environmental Physiology: Environment- Its physiological aspects. Effects of exposure to hot and cold environment. Acclimatization to hot and cold environment. Heat disorders and their preventive measures. Effects of hypobaric and hyperbaric environment. Mountain sickness. Acclimatization to high altitudes. Preventive measures against hypobaric and hyperbaric effects. Physiological effects and preventive measures against G force, noise, vibration and radiation. Types of pollutants (primary, secondary and tertiary), sources, mechanism of action and effects of metabolic pollutants, neurotoxin, mutagen, carcinogen, teratogens. Heavy metal toxicity (Pb, Hg, Cd, As). Air and water pollutions - sources, effects and control. Brief idea about biotransformation, bioaccumulation, biomagnification and health hazards of pesticides. Elementary idea about xenobioticsand their effects. Oxidative stress and reactive Oxygen Species formation. Role of catalase, superoxide dismutase, glutathione peroxidase and glutathione reductase in combating oxidative stress.

C9 (Practical)

Environmental Physiology:

i) Measurement of environmental temperature - dry bulb and wet bulb, relative humidity.

ii) Determination of O_2, CO_2, BOD. Determination of total alkalinity, Ca, and chlorine in water by titration method,

iii) Measurement of noise by sound level meter.

iv) Determination of light intensity (at library, laboratory &class room) by lux meter.

v) Demonstration: effect of acetyl choline before and after application of atropine in perfused heart of toad.

Educational Excursion:

A report is to be submitted on the basis of a visit to a Medical college / University / Research Institute. Report should be prepared with proper justification and illustrations.

C10 (Theory)

Genetics, Molecular Biology and Biotechnology:

Chromosome structure: Concept of nucleosome, molecular organization, chromosomal proteins, the different levels of chromatin organization. Double helical structure and Watson Crick model of DNA. Basic concept of DNA replication: Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Brief idea of DNA damage and repair. Structure of different RNA molecules and mechanism of transcription of RNA (prokaryotic). Elementary idea of gene, genetic code, Wobble hypothesis and mechanism of translation (prokaryotic). Elementary idea about regulation of gene expression - operon concept, lac operon. Chromosomal aberration and gene mutations (agents and types). Idea about human genome project. Concept of oncogenes, tumour suppressor genes and properties of cancer cells.

Biotechnology: Elementary idea of genetic engineering: concept of cloning and its significance, isolation of DNA fragment to be cloned, restriction enzymes, vectors, ligation of DNA to the vector, introduction of recombinant DNA into host cell, screening for recombinant cell. Applications of recombinant DNA technology and gene therapy, Basic concepts of Southern, Northern, Western blot techniques Fermentation technology. Fermentation: types (submerged and solid state), bioreactors and downstream processing (elementary idea). Production of human insulin, vaccines (hepatitis). Production, application and utility of monoclonal antibodies. Concept of single cell proteins, biofuels, biopesticides, biosensors and biochips. Concept of genetically modified organisms, Bio-safety and Intellectual property rights. Elementary idea about bio-informatics, genomics and proteomics.

C10 (Practical)

i) Estimation of DNA, RNA and total protein by DPA, Orcinol and Lowry method

ii) Chromosome Staining and Karyotyping

iii) Determination of optimum pH, temperature of enzyme (amylase through 3, 5 dinitrosalicylate reagent).

iv) Isolation and quantification of DNA and prlotein, Gel electrophoresis of DNA and protein (demonstration).

SEC II

Histochemistry and Histopathology (Theory)

Introduction of histopathology: cellular physiology and Pathology. Histological laboratory organization, care & maintenance of equipments used in histopathology laboratory. Fixation and fixatives : Types and mechanism Microtome, its type. Staining theory: Stains and dyes, dye types. mordant, accelerators. silver impregnations. Haematoxylin and Eosin staining, Mounting and mounting media, Tissue processing and its steps. Decalcification. Embedding media - types and properties. Cryotomy, cryostat, impregnation techniques, frozen sections and staining for emergency diagnosis

Histochemistry: General consideration, limitation to histochemistry. PAS reactions, Sudan Black, Perchloric acid/ Naphthoquinone reaction (PAN). Histochemistry of Nucleic acids, proteins and enzymes

– basic concept, process, and quantitation of enzyme activity. Types and applications of antibody as histological reagents. Exfoliative cytology – advantage and disadvantage.

Practical:

1. Glass wares and equipment used in histopathology laboratory.
2. To prepare graded alcohol.
3. Preparation and section cutting of paraffin embedded tissue.
4. H&E staining of tissue sections,
5. Preparation and staining of bone marrow smear,
6. PAP staining techniques.
7. Staining carbohydrates with PAS reaction.

OR

Medical Microbiology and Immunology (Theory)

Fundamental Concepts: a) History of microbiology, Discovery of microorganisms, Contributions of Louis Pasteur and Robert Koch in Medical Microbiology. b) Molecular methods of assessing microbial phylogeny molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny. c) Microbial growth, growth factors, culture media - types of media. Pure Cultures, Growth curves and generation time, Control of microbial growth, general concept of effect of environmental factors on growth of microbes. Normal microflora of the human body and host pathogen interaction : Normal microflora of the human body, importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection. Bacterial Cells - fine structure and function : Size, shape and arrangement of bacterial cells. Cell membrane, cytoplasmic matrix, inclusion bodies (eg. magnetosomes), nucleoid, ultrastructure of Gram +ve and Gram –ve bacterial cell wall, Pili, Capsule, Flagella and motility. Microbial Genetics. Principles of Diseases and Epidemiology: Relationship between normal microbiota and host, Opportunistic microorganisms. Development and spread of infectious diseases: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types.

Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples and their identification characteristics.

Bacterial Diseases (with reference to etiology, clinical symptoms, virulence factors involved, detection and prevention): Respiratory tract infections, Diphtheria and tuberculosis, Gastrointestinal tract infections, staphylococcal food poisoning and E. coli gastroenteritis, Urinary tract infections: gonorrhea and syphilis.

Viruses, viroids, prions: General characteristics of viruses, structure, isolation, cultivation and identification of viruses, viral multiplication, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, clinical virology with reference to HIV virus and hepatitis virus (Life cycle and clinical symptoms), viroids and prions.

Medical Mycology (with reference to life cycle and clinical symptoms) : General and detailed life cycle of Aspergillus and Candida albicans in relation to human diseases caused by them.

Parasitology (with reference to life cycle and clinical symptoms): Classification of medically important parasites. Common protozoan disease: Malaria, Infections caused by *Taenia solium*/Taeniasaginata, *Fasciola hepatica* and *Ascaris lumbricoides*.

Antimicrobial chemotherapy and emerging antimicrobial resistance: Spectrum of antimicrobial activity, action of antimicrobial drugs, anti-mycobacterial antibiotics, inhibitors of protein synthesis and nucleic acid synthesis, inhibition of cell wall synthesis, inhibitor of cell membrane function, inhibitor of metabolism. Antifungal agents: mechanism of actions of Amphotericin B, Griseofulvin , Antiviral agents :Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Anti - protozoan drugs; effectiveness of chemotherapeutic agents. Antimicrobial resistance – concepts.

Overview of Immune System - properties of immune system; types of immunity: innate immunity, acquired immunity, active and passive immunity. First and second line defence. Antigens and Antibodies: Characteristics of an antigen (foreignness, molecular size and heterogeneity); haptens; epitopes (T & B cell epitopes), Adjuvants : Structure, Types and Functions of antibodies.

Generation of Immune Response: Primary and secondary immune response; Generation of humoral immune response (Plasma and Memory cells); Generation of cell mediated immune response. Cytokines. Complements.

Immunological Disorders and Tumor Immunity & Immunological Techniques: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies – acquired immune deficiency. Animal models (Nude and SCID mice). Transplantation immunity. Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.

GENERIC ELECTIVE

GE-2 & 4 [Interdisciplinary/Generic Elective (GE) for other Departments]

GE2T/4T: Physiology (Theory) Credits: 04

Nerve-Muscle Physiology and Nervous system (NS)

Different types of muscles and their characteristics. Red and white muscle. Mechanism of skeletal muscle contraction. Isotonic and isometric contraction. Single unit and multi unit smooth muscle amd their importance.

Structure & classification of nerves. Origin & propagation of nerve impulse. Synapse: structure, mechanism of synaptic transmission. Motor unit, motor point. Neuromuscular junction: structure, mechanism of impulse transmission.

A brief outline of the organization and functions of nervous system. Reflex action: definition, reflex arc. A brief idea about the structure and function of cerebral cortex. A brief description about the organization and functions of autonomic nervous system (sympathetic and parasympathetic). Basic concept of CSF.

Endocrinology and Reproductive Physiology

Concept of autocrine and paracrine glands.

Pituitary gland and its hormones. General physiological functions of GH, ACTH, TSH, LH, FSH. Acromegally, gigantism. Functions of Posterior pituitary hormones.

Physiological functions of thyroid hormones. Cretinism and myxoedema. Goitre.

Pancreatic islets of Langerhans. Physiological functions of insulin and glucagon. Diabetes mellitus.

Adrenal cortex- Aldosterone and its functions. Glucocorticoids and its functions. Adrenal medulla- Catacholamines and their role in catabolism and cardio-respiratory system (outlines only).

Primary and Secondary sex organs and sex characters**.** Puberty- A brief idea. Testis: histology, spermatogenesis, testicular hormones and their functions. Ovary: Histology, Menstrual cycles – different phases & hormonal control. Ovarian hormones and their functions. Fertilization process in mammals (basic concept).

Excretory Physiology

Nephrons –Structure, types and function. Mechanism of formation of urine. Normal & abnormal constituents of urine. Non excretory functions of kidney. Juxtaglomerular apparatus- structure and function. Diabetes insipidus. Skin*:* Structure and functions; composition of sweat.

Community Health & Nutrition

Basic idea about community health, malnutrition (Marasmus and Kwashiorkor), over and under nutrition. Significance of Dietary fibers. Balanced diet.

Paper: GE-2P/4P: Physiology (Practical) **Credit: 02**

Study and identification of histological slides - Spinal cord, cerebrum, cerebellum, thyroid gland, adrenal gland, pancreas, testes, ovary, kidney.

Abnormal constituents of urine - glucose, protein, bile salts, acetone.

Measurement of pulse rate and blood pressure. Determination of PFI of an individual by Harvard step test. Measurement of some common anthropometric parameters - stature, head breadth, head circumference, chest circumference, MUAC, Calf circumference. Waist to Hip Ratio, BMI.

Semester-V

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C11	C11T: i. The Endocrine System and Chronobiology	Core Course-11		4	0	0	6	75
	C11P: Experimental Physiology(Dales)	Core Course-11 [Practical]		0	0	4		
C12	C12T:i. Renal Physiology Bioinstrumentation y ii. Techniques in Studying Physiolog	Core Course-12		4	0	0	6	75
	C12P: Identification normal and abnormal constituents of urine Blood Biochemistry	Core Course-12 [Practical]		0	0	4		
DSE-1	Clinical Hematology **OR** Medical Biochemistry	Discipline Specific Electives -1		4	0	0	6	75
				0	0	4		
DSE-2	Social Physiology and Community Health Field Survey **OR** Occupational Health	Discipline Specific Electives -2		4	0	0	6	75
				0	0	4		
Total							24	300

L= Lecture, T= Tutorial, P = Practical, CC - Core Course, TBD - To be decided, DSE: Discipline Specific Elective

C11 (Theory)

Endocrine System and Chronobiology:

Concept & Definition of endocrine systems, glands and hormones. Experimental and clinical methods of study of endocrine glands. General classification of hormones on chemical basis. Concepts of hormone receptors and cell signalling. Mechanisms and Modern Concept of hormone actions: G-protein, Cyclic AMP, cyclic GMP, IP3-DAG, Ca^{2+}, Tyrosine Kinase, JAK-STAT pathway and nuclear receptor mediated action. Hypothalamo-hypophysial axis: Feedback regulation, Hypothalamus as a neuroendocrine organ, Releasing Factors, Tropic hormones of hypothalamus. Vascular and neural connections between the hypothalamus and the pituitary, role of median eminence. Histological structures, functions, and regulation of anterior, middle and posterior lobes of pituitary. Chemistry, modes of action and functions of growth

hormone, TSH, ACTH, FSH, LH, Prolactin, MSH, Vasopressin and Oxytocin. Cushing's disease, gigantism, acromegaly, dwarfism, diabetes insipidus. Thyroid Gland: Electron microscopic structure of thyroid gland. Thyroid hormone: Chemistry, Biosynthesis, Storage and Transport. Functions of T4 (Thyroxin) and T3 (Triiodothyronine). Regulation of Thyroid hormone secretion. Cretinism. Myxedema, Grave's disease. Hashimoto's disease, iodine deficiency goiter. Parathyroid Gland: Histological Structure, Parathyroid hormone: Role in calcium metabolism. Relation of parathyroid hormone with bone formation and bone resorption, Role of Vitamin D3 in calcium homeostasis. Calcitonin: its source, functions and regulation. Adrenal Cortex: histological structure, functions and regulation of secretion. Cushing's syndrome, Addison's disease, Hyperaldosteronism. Adrenal Medulla: Histological structure, functions and regulation, Pheochromocytoma. Pancreas: Histological structure of pancreatic islets. Regulation, modes of action and functions of insulin and glucagon, Type-l and Type-II diabetes mellitus. Gastrointestinal hormones (Gastrin, Secretin, Cholecystokinin, VIP and GIP)- Physiological functions. Endocrine Role of the Pineal. ANF and its functions.

Chronobiology: Different types of physiological rhythms- ultradian, circadian, infradian. Different zeitgebers and their relation with circadian rhythm. Biorhythms of LH, FSH, Prolactin, Estrogen, Progesterone, ACTH GH, Cortisol. Light dark cycle and regulation of pineal hormone. Neural basis of biological clock and the role of suprachiasrnatic nuclei. Brief idea of jet-lag.

C11 (Practical)

Identification of pituitary, adrenal, thyroid gland, pancreas, testis, ovary.

Experimental Physiology:

Kymographic recording of normal movements of rat's intestine in Dale's apparatus. Effects of anoxia, acetylcholine and adrenaline on normal intestinal movements.

C12 (Theory)

Renal Physiology:

Gross structure of kidney. Microanatomy (including electron microscopy) of a nephron and structural differences between cortical and Juxtamedullary nephrons. Juxtaglomerular apparatus. Mechanism of urine formation: Concept of ultrafiltration, glomerular filtration rate, reabsorption by passive and active tubular transport. Concept of counter current system, countercurrent multiplier, exchanger and mechanism of concentrated urine formation. Non-excretory functions of kidney. Normal and abnormal constituents of urine and their clinical significance. Concept of renal threshold. Renal function tests (inulin, urea clearance tests). Renal stone formation. Dialysis and artificial kidney. Innervations of urinary bladder and micturition, micturition reflexes and its regulation by higher centers.

Techniques in Studying Physiology:

Basic principle and use of light, phase contrast, electron microscopy, atomic force microscopy and fluorescence microscopy. Spectrophotometer. Principle of chromatography, ion exchange, gel filtration, GLC, TLC and immune-affinity chromatography. Electrophoresis: SDS-PAGE and agarose gel. Cell fractionation: Homogenization and ultrasonication, Ultracentrifugation and differential centrifugation for separation of cell fractions. Radio activity - use of radio isotopes in physiological studies. Principle and uses of biomedical instruments - USG, X-ray,

C12 (Practical)

Blood Biochemistry:

Determination of normal and abnormal constituents of urine.

Photo-colorimetric estimation of blood constituents:

i) Blood glucose by Nelson-Somogyi method

ii) Blood inorganic phosphate by Fiske - Subbarow method

iii) Serum total protein by Biuret method and determination albumin globulin ratio.

v) Serum billirubin by Diazo method.

vi) Serum urea by DAM method.

vii) Blood cholesterol by $FeCl_3$ method

viii) Estimation of acid and alkaline phosphatase, SGOT & SGPT of supplied blood (Kit/Manual).

DSE I

Clinical Hematology (Theory)

Anemia and its classification. Laboratory investigation and management of anemia. Iron deficiency anemia, megaloblastic anemia, pernicious anemia- pathogenesis and laboratory investigation. Reticulocytes. Aplastic anemia- laboratory diagnosis. Bone marrow examination. Aspiration techniques. Hemoglobin - abnormal hemoglobin. Hemolytic anemia and its laboratory investigation. Haemoglobinopathies. Hemoglobin electrophoresis. Sickle cell anemia , Thalassemialaboratory diagnosis. Blast cell. Causes and significances of leucocytosis, leucopenia, neutrophilia, eosinophilia, basophilia, monocytosis, lymphocytosis, neutropenia, lymphopenia. Toxic granulation. Leukemia and its classification. HIV on blood cell parameters. LE cells and its significances. Blood parasites. Hemostasis and Coagulation: Platelet development. Qualitative and quantitative disorders of platelets. Secondary hemostasis. Hemophilia, Willebrand diseases. Disorder of fibrinogen. Fibrinolysis. Bleeding and coagulation disorders. Blood groups: Immunological basis of identification of ABO and RH blood groups. Biochemical basis of ABO system and Bombay phenotyping. Others blood groups :Kell, Kidd, Duffy, etc. Blood transfusion. Blood banking. Definition determination and significance of TC, DC ,ESR, Arnth count, PCV, MCV, MHC, MCHC. bleeding time, clotting time, prothrombin time.

DSE 1 (Practical)

1. General blood picture

2. Differential leucocyte count

3. Determination of haemoglobin by various methods.

4. Determination of total RBC count and WBC count.

5. Determination of PCV

6. Determination of red cell indices

7. Determination of ESR.

8. Determination of reticulocyte count.

9. Staining of bone marrow

10. Determination of blood groups.

12. Determination of total platelet count.

13. Demonstration of thrombin time.(Demonstration)

14. Perform Heinz bodies (Demonstration)

15. Demonstration of leukemic slides (Demonstration).

16. Determine fibrinogen conc.(Demonstration)

17. Demonstrate malarial parasite (Demonstration)

OR

Medical Biochemistry (Theory)

Basic Concepts and scope. Clinical Biochemistry - Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

Evaluation of biochemical changes in diseases: Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile. Pathophysiological significances of glucose, serum protein, albumin, urea, creatinine, uric acids, ketone bodies.

Enzymes: Distribution and diagnostic significance- Properties of enzymes used in diagnosis of metabolic disorders, clinical significance of diagnostically important enzymes: creatine kinase, lactate dehydrogenase, alanine and aspartate aminotransferases, amylase, acid and alkaline phosphatase, beta glucoronidase, with a detailed account of the biochemical

reactionscatalysed by these enzymes and of their clinical assays; kinetic assay and end point assay for the enzymes. A detailed account on isoenzymes, their tissue distribution and clinical significance.

Hormones: Classification with reference to their biochemical nature, mechanism of action (one example from each class of hormones), Function. Pathophysiology of disorders associated with hormones. Biochemical diagnosis of hormonal disorders.

Structural complexities and diseases associated with carbohydrates and lipids: Carbohydrates: Sugars as information molecules; detailed account on Lectins: their role in physiological functions and their potential as drug targets in various infectious diseases. Dietary fibers. Assessment of glucose metabolism in blood: Clinical significance of variations in blood glucose. Diabetes mellitus. Glycosylated Hb Lipid profile: Types of Lipoproteins (chylomicrons, VLDL, LDL, HDL); disorders associated with lipoprotein

metabolism (hypercholesterolemia, atherosclerosis). Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein. Lipid profile in health and diseases. Metabolism of ketone bodies in diabetic patients. Prostaglandins- classification, biosynthesis, role of COX-1, COX-2, NSAIDS in synthesis; functions Steroids-Cholesterol- biosynthesis and regulation, inhibitors of cholesterol biosynthesis (Statins-structure and mechanism of action).

Vitamins: Definition, classification, requirement and recommended allowances, and dietary precursors; diseases due to deficiency of water-soluble and fat-soluble vitamins: the symptoms and the clinical significance. Assay of vitamin.

An overview of integrative metabolism: Local and global regulation in tissue specific metabolism, interplay of insulin and glucagon integration of various metabolic pathways of proteins, lipids, carbohydrates and nucleic acids, obesity- role of Leptin, Ghrelin and other hormones in regulation of body mass, electron transport chain and inhibitors, oxidative phosphorylation, role of uncouplers and ionophores.

Organ Function Tests: a. Liver function tests: Structure of the liver, liver function tests, causes of different liver diseases, liver function tests in the diagnosis of liver diseases. Pathophysiological significance of bilirubin. b. Renal function tests and urine analysis: Composition of urine. Use of urine strip / dipstick method for urine analysis. Basic ideas on different types of test for renal diseses. c. Tests for cardiovascular diseases: Involvement of enzymes in diagnostics of heart disease: aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Practical:

A. Collection of blood and storage. Preparation of serum and plasma from whole blood and storage.

B. Quantitative determination of the following from the whole blood/plasma/serum:

1. Estimation of blood glucose by glucose oxidase-peroxides method.

2. Estimation of blood glucose by Nelson – Somogyi method.

3. Estimation of blood inorganic phosphates by Fiske - Subbaraow method.

4. Estimation of serum total protein by Biurate methods and determination of albumin globulin ratio.

5. Estimation of HDL/LDL and Triglycerides.

6. Estimation of bilirubin (direct and indirect).

7. Quantitative determination of serum creatinine, uric acid and urea.

8. Determination of serum amylase by iodometric method.

9. Estimation of creatine kinase.

10. Estimation of SGOT, SGPT, Acid & Alkaline Phosphatase.

Demonstration: 1. Estimation of Lactate dehydrogenase, beta glucoronidase.

2. SDS-PAGE for serum Protein.

DSE II

Social Physiology and Community Health (Theory)

Basic Concept: Demography, Society and Community. Factors affecting Community Health, Direct and Indirect Nutritional Assessment of Human Individual and Community (Steps- Diet History, Nutritional Anthropometry, Dietary Survey, Clinical Examinations, Biochemical and Radiological assessment, Mortality rates, and Morbidity rates). Nutritional Problem in Community: Malnutrition, Undernutrition, Kwashiorkor, Marasmus, Marasmic Rickets, Osteomalacia, Xeropthalmia, Beri Beri, Pellagra, Nutritional Anemia, Dental Caries, Endemic Goiter. Nutritional Deficiencies in pregnancy and remedial measures. Dietary Management for coronary heart disease, Diabetes mellitus. Diets of Renal Disorders, Obesity and Cancer. Causes, pathogenesis and Preventions of Some Communicable Diseases: cholera, measles, pox, tuberculosis, malaria, HIV and poliomyelitis. Composition, functions and uses of ORS. National Nutrition Related Health Programmes: Vit. A Prophylaxis Programme, Anemia Prophylaxis Programme, ICDS, Mid-Day Meal Programme. Human Breast milk Composition, its requirement and benefits. Colostrum.

Practical

Field study Report: Performed in a group and maximum 6 students will be in a group. (Field survey report should be prepared on community health).

OR

Occupational Health (Theory)

Occupational health: Concept. The occupational medical history, workers compensations, disability prevention and management. Occupational health risk. Occupational Injury: Musculoskeletal injury, peripheral nervous injury, eye injuries, facial injuries, hearing loss, injury caused by physical hazards, Ergonomics and the prevention of occupational injuries. Occupational exposures: Metals, chemicals, solvents, gasses & airborne toxicants, pesticides. Occupational illness: Brief idea on : Clinical toxicology & immunology, cardiovascular toxicology, liver, renal &neurotoxicology. Occupational hematology, infection, skin disorders & lung disease. Reproductive toxicology. Occupational Diseases: Human diseases associated with occupational exposure. Brief idea on pneumoconiosis, asbestosis, silicosis, farmer's lung and work-related musculoskeletal disorders. Program management: Occupational stress, substances abuse & employee assistance programs. Occupational safety, industrial hygiene, biological monitoring. Prevention of accidents. Concept of industrial safety.

Practical:

1. Measurement of working heart rate by ten beats methods.

2. Determination cardiac cost of specific work.

3. Measurement of blood pressure before and after different grades of exercise.

4. Measurement of some common anthropometric parameters. Calculation of BSA and BMI from anthropometric data.

5. Measurement of WBGT indices.

6. Measurement of noise level by noise level meter.

7. Assessment of illumination.

8. Determination of strength by hand grip dynamometer.

Semester-VI

Sl. no.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C13	C13T: i. Reproductive Physiology ii. Embryology	Core Course-13		4	0	0	6	75
	C13P: Histology: i. Staining and identification of supplied paraffin sections	Core Course13 [Practical]		0	0	4		
C14	C14T: i. Bio-Statistics and Concept of Computer ii. Bioinformatics	Core Course-14		4	0	0	6	75
	C14P: Biostatistics& Computer Application	Core Course-14[Practical]		0	0	4		
DSE-3	Yoga and Stress Physiology **OR** Cognitive Science	Discipline Specific Electives-3		4	0	0	6	75
				0	0	4		
DSE-4	Research methodology and Design **OR** Pathophysiological Basis of Diseases	Discipline Specific Electives-4		4	0	0	6	75
	Project Work/Review Work			0	0	4		
Total							24	300

L= Lecture, T= Tutorial, P = Practical, CC - Core Course, TBD - To be decided, DSE: Discipline Specific Elective.

C13T (Theory)

Reproductive Physiology:

Primary and secondary sex organs: Physiology and anatomy, secondary sex characters. Puberty and its control. Testis: Histological structure of testis, seminiferous tubules and interstitial cells of Leydig. Chemical nature and functions of testosterone. Spermatogenesis, Spermiogenesis and hormonal control of testicular function. Prostate and seminal vesicle. Ovary: Histological structure of ovary, Graafian follicle and Corpus luteum, chemical nature and functions of Estrogen and Progesterone. Hormonal control of ovarian functions. Menstrual cycles and its hormonal control. Formation, Maturation of Ovum. Physiological Mechanism of Ovulation. Basic concepts of ovarian cysts. Estrous cycle. Pregnancy: Transport of ovum and sperm in female reproductive tract. Fertilization. Uterine implantation of fertilized ovum. Formation, structure, functions and fate of placenta. Placental hormones. Changes during pregnancy and their hormonal control. Pregnancy tests (immunological). Parturition, Ectopic pregnancy. Lactation and Mammary Gland: Anatomical and Histological structure of mammary gland. Phases of mammary development and their hormonal control. Hormonal control of lactation and milk ejection reflex.

Embryology

Cleavage, Embryogenesis, morula, blastula, gastrula and blastocyst. Formation of trilaminar germ disc. Development of Alimentary system, Heart and Urogenital system. Fetal circulation and its changes after birth. Basic concept of stem cell biology.

C13 (Practical)

Histology

i) Tissue preparation, section cutting, staining and submission of five histological slides duly signed by teacher.

Liver, kidney, esophagus, duodenum, lungs, spleen, ovary, testis, adrenal, pancreas, spinal cord, cerebellum, cerebrum.

Pregnancy test, sperm count, estrus cycle

C14 (Theory)

Biostatistics and Concept of Computer:

Definition and classification of statistics. Definition of population, parameter and sample. Sampling methods. Frequency distribution & frequency polygon, histogram, bar-diagram, pie diagram. Mean, median, mode and the methods of their computation, merits, demerits and applications. Variance, standard deviation, standard error of mean and their computation. Normal probability distribution. Students t-distribution. Skewness, Kurtosis, Null-hypothesis, errors of inference, level of significance, two tail and one tail ‘t’ test for significance of difference between sample means. Chi-square test. Linear correlation: product moment correlation coefficient, Spearman’s p (rho).

Computer: Basic concepts of software, hardware and types of computers. Computer packages: concept of MS Word, Excel, power point. Concepts of networking and web site, computer virus.

Bioinformatics:

Introduction to bioinformatics - Definition, important contributions, task, application, challenge and opportunities. Computer Fundamentals. Role of Super computer in biology. Historical background. Scope of bioinformatics – Genomics, Proteomics and Computer aided Drug Design (Structure based and ligand based approaches). Biological databases and data retrieval: Information Network. Database, Tools and uses. Introduction to biological databases – primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL), Protein databases (PIR, Swiss- Port). Bioinformatic tools- FASTA, BLAST.

C14 (Practical)

Computer application: Operation of MS Word and Excel: Preparation of body text and table by using MS word, Graphical representation of data in pie, bar and line diagram using Microsoft Excel, presentation of study material by using power point.

Biostatistics: Computation of mean, median, mode, standard deviation, standard error of the mean with physiological data like body temperature, height, weight, heart rate, respiratory rate, blood pressure of human subjects. Student's t test and chi-square test for significance of difference between means. Spearman's rank difference correlation coefficient. Chi-square test.

DSE III

Yoga and Stress Physiology (Theory)

Stress physiology & its management: Defining stress response in different environmental conditions. Stress related health hazards: cardiovascular disease, diabetes, and cancer. Effect of stress-inducing and anti-stress agents on the activities of catalase, peroxidases, superoxide dismutase. Cardio-respiratory responses during high altitude acclimatization.
Perspective of Yoga: Different types of yoga with their physiological importance. Role of yoga in cognitive functions, immunological response, cell signaling.

Practical:

1. Determination of VO_2 max by Queen's college test.
2. ECG recording and interpretation.
3. Determination of percentage of body fat and desired body weight
4. Determination foot and hand reaction time
5. Measurement of dark adaptation time
6. Two point discrimination

Performances of Asanas: Dhanurasana, Bhadrasana, Bhujangasana, Dhanurasana, Gomukhasana, Halasana, Muktasana, Padmasana, Ushtrasana.

Pranayamas: Anuloma-Viloma, Surya bhedana, Bhastrika, Kapalabhati

OR

Cognitive Science (Theory)

Anatomy of brain and spinal cord Gross anatomy of cerebrum, cerebellum, brain stem and spinal cord. Cranial and spinal nerves. Autonomic nervous system - sympathetic and parasympathetic nervous system. Neurogenesis in developing brain.

Methods of neuroscience EEG, Event-related potential, CAT, MRI, fMRI, PET, Magnetoencephalography, Optical recording.

Memory and Emotion Different types of memory. Neural organization of memory. Cellular and molecular basis of memory. Cortical and subcortical contribution to emotion: Fight or Flight response, Reward and motivation, Regulation of emotion, communicating emotion,

Language and speech Neural basis of speech, Speech disorders. Neural organization of language, language processing. Hemispheric specialization in language and other functions. Split brain. Neural basis of attention and social cognition

Developmental disorders Cognitive development theory,- Piaget's and Kohlberg moral reasoning theory, mental retardation, degree of mental retardation, causes of mental retardation, down syndrome, dyslexia, Attention deficit hyperactivity disorder, autism

Cognitive disorders Cognitive changes with aging. Cognitive disorders: Alzheimer's disease, Frontotemporal dementia, Creutzfeldt Jakob disease, Vascular dementia, Schizophrenia, Depression, Anxiety disorders.

Practical:

1. Primacy and recency in short term memory in human subjects

2. Cognitive assessment by colored matrices test in children

3. Test to assess the duration of short-term memory

4. Psychometric tests for children- Developmental Assessment Scale for Indian Infants (DASII), Wechsler Preschool and Primary Scales of Intelligence (WPPSI), Children Apperception Test (CAT).

5. Animal study: Food retrieval in maze study

DSE IV

Research Methodology and Design (Theory)

Foundation of Research: Meaning, Objectives, Motivation of research. Research Methods vs. Methodology, Types of Research: Analytical vs. Descriptive, Quantitative vs. Qualitative, Basic vs. applied. Planning of Research design and experiment, - Need for research design: Features of good design, important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample design, working a proposal - Review of literature. Research hypothesis sampling and data collection. Ethics in research - Code of ethics and research, Ethics and research process, Importance of ethics in research, bio-safety. Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement.

Practical:

A Research project /review work on physiology/ or related health topics to be submitted based on any above tools and techniques. Formulation of the Project: meaning of scientific research and its methods, designing a project, types of project design, methods, tools and techniques, tabulation and interpretation.

OR

Pathophysiological Basis of Diseases (Theory)

Introduction - History of pathology, Basic definitions and common terms used in pathology, Survival mechanism and disease, microscopic and cellular pathology, scope and techniques used.

Cell Injury and responses of cells: Cellular Adaptations and Cell Death - An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing

Role of inflammation in disease (with suitable examples) - Basic concepts with suitable examples of general features of acute and chronic inflammation: vascular changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, granulomatous inflammation. Unit-IV: Role of tissue repair healing and fibrosis (with suitable examples) - Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis

Common Hemodynamic Disorders in diseases (with suitable examples) - An overview of edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples

Nutritional diseases - Protein energy malnutrition, deficiency diseases of vitamins, minerals, nutritional excess and imbalances. Roles and effects of metals.

Cancer - Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes, DNA repair genes and cancer stem cells.

Infectious diseases epidemiology- Modes of infections with suitable examples. Overview of cause, extent, prevention, treatment and control of the diseases: Respiratory infections, Intestinal infections, Arthropod-borne infections, Zoonosis and Surface infections

Practical:

A Research project /review work on physiology/ or related health topics to be submitted based on any above tools and techniques. Formulation of the Project: meaning of scientific research and its methods, designing a project, types of project design, methods, tools and techniques, tabulation and interpretation.

RECOMMENDED BOOKS FOR PHYSIOLOGY (HONOURS) COURSE

(The latest edition available should be used for all books)

TEXT BOOKS:

1. Text book of Medical Physiology, by A.C. Guyton, John E. Hall, Eleventh edition. Elsevier Saunders.

2. Vander et al's Human Physiology: The Mechanisms of Body Function; 9th Edition Eric P. Widmaier, Hershel Raff, Kevin T. Strang The Mc Graw-Hill Companies.

3. Human Physiology, From Cells to Systems Lauralee Sherwood, Brooks/Cole.

4. Best & Taylor's Physiological Basis of Medical Practice, edited by B.R Brobeck. The William and Wilkins Co.

5. Ganong's Review of Medical Physiology, by Kim E. Barrett et al., Lange Medical Book.

6. Harper's Review of Biochemistry by R K. Murry and others. Lange Medical Book, Prentice-Hall International.

7. Lehninger Principles of Biochemistry, by, D. L. Nelson and M. M. Cox, CBS Publishers Inc.

8. Text book of Biochemistry, by E.S. West, W.R. Todd, H.S. Mason, J.T. Van Bruggen, The Macmillan Company.

9. Biochemistry, by D. Das: Academic Publishers.

10. Biophysics and Biophysical Chemistry, by D .Das, Academic Publishers.

11. Samson Wright's Applied Physiology, edited by C.A. Keele. E. Neil & N. Toets. Oxford University Press.

12. Physiology, by R.M. Berne & M.N. Levy, B.M. Koeppen, B. A. Stanton, Mosby Co.

13. Basic Histology, by L.C. Jungquire, J. Carneiro& J.A Long; Appleton & Lange.

14. Neuroscience Third Edition Edited By D. Purves, G. J. Augustine, D. Fitzpatrick, W. C. Hall, A S.I. Lamantia, J.O. Mcnamara, S. M Williams, Publishers Sinauer Associates, Inc.

15. Histology - A Text and Atlas, by M.H.Ross&E.J.Reith, The Williams and Wilkins Company.

16. Bailey's Text Book of Histology, revised by W.M. Copenhaver; The Williams and Wilkins Company.

17. Human Physiology, by R.F. Schmidt & G. Thews, Springer-Verlag.

18. Core Text Book ofNeuro-Anatomy, by M.B. Carpenter; The Williams and Wilkins Company.

19. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.

20. The Human Nervous System by M.L.Barr& I.A. Kierman, Harper & Row.

21. Essential Immunology, by I.M. Roitt, Blackwell Scientific Publications.

22. Cellular & Molecular Biology, by E. D. P. De Robertis& E. M. F. De Robertis, Lea &Febiger.

23. Principles of Genetics, Sixth edition, D. Peter Snustad, Michael J. Simmons John Wiley & Sons, Inc.

24. Molecular Biology of the Gene, by J.D. Watson. H.H. Nancy & others; Pearson education.

25. Molecular Biology of the Cell, by B. Alberts and others, Garland.

26. Human Physiology, by Rhoades & Pflanzer, Brooks/Cole.

27. Carleton's Histological Techniques, by R.A.B. Drury & E.A. Wallignton, Oxford University Press.

28. Medical physiology W. F. Boron and E. I. Boulpsep, Elsevier Saunders.

29. Handbook of Experimental Physiology and Biochemistry, by P. V. Chadha; Jaypee Brothers Medical Publishers.

30. Kuby Immunology, by R.A. Goldsby. T.J. Kindt and B.A. Osbome. W H. Freeman and Co.

31. Neurobiology. by G.M. Shepherd, Oxford University Press.

32. Biochemistry, by L. Stryer, WH. Freeman and Co.

33. Molecular Cell Biology, by H. Lodish, D. Baltimore & others, Scientific American Book.

34. Genetics: Analysis of Genes and Genomes, by D.L. Hartl and E. W Jones. Jones &Boolen Publishers.

35. Note Books on Practical Biochemistry, Experimental Physiology and Histology. (published by the Physiological Society of India, Kolkata).

36. Willam's Text Book of Endocrinology by J.D. Wilson and D.W. Foster W.B. Saunders of Co.

37. The Kidney-An outline of Normal and Abnormal Functions by H.E. Dewardeper. ELBS

38. Essential Food and Nutrition. by M. Swaminathan. The Bangalore Printing & Publishing Co. Ltd.

39. Medical Embryology by J. Langman, .Williams & Wilkins.

40. Circadian Rhythms and the Human by D.S. Minors and 1M. Wat~rhouse, Wright, PSG.

41. Clinical Gynecologic Endocrinology and Infertility by L, Speroff, R. H. Glass, N. G. Kase, MacMillan.

42. Text book of Medical Physiology by G. K. Pal, P. Pal, Ahuja Pub. House.

43. Essential Medical Physiology Edited by L R. Johnson, Academic Press:

44. Human Anatomy and Physiology by E. Marieb, Pearson Education.

45. Fundamentals of Biochemistry by Jain and Jain, S. Chand and Com.

46. Biochemistry by U. Satyanarayan, Boks and Allied.

47. Lippincott's Illustrated Reviews: Biochemistry by P. C. Champe et al., Lippincott Williams & Wilkins.

48. Biochemistry by PankajaNaik, Jaypee Brothers.

49. Physiology by J. Bullck et al Lippincott Williams & Wilkins.

50. Text book of Biochemistry by T. M.Devlin, John Wiley Pub.

51. Fundamentals of Biochemistry by Voet, Voet, and Pratt, John Wiley Pub.

52. Cellular and Molecular Immunology A.K. Abbas and A.H. Lichtman, Elsevier Saunders.

53. Under Standing Immunology by Peter Wood, Pearson Education.

54. Text Book of Biochemistry and Physiology by G. P. Talwar and LM. Stivastava, Prentice Hall of India.

55. Chronobiology Edited by J.C. Dunlap, J.J. Loros, P.J. deCoursey, Sinauer Associates Inc. Pub.

56. Text Book of Physiology by G. H. Bell, J. N. Daviclcon and H. Scarborougl, ELBS.

57. Physiology of Respiration by J.H. Comroe, Year Book Medical Publishers.

58. Text Book of Physiology. Vols. I & II by H. D. Patton. A. F. Fuchs, B. Hille. A. M. Scher and R. Sleiner, W B. Saunders Co.

59. Concise Medical Physiology by S.K. Chaudhury, New Central Book Agency.

60. Medical Physiology by A.B.S. Mahapatra, Current Books International.

61. Endocrinology, Vols. I, II and III by La. DeGroot. W.B. Saunders Co.

62. Essentials of Human Embryology by AK. Das Current Books International.

63. Human Embryology by I.B. Singh, MacMillan India Ltd.

64. The Circadian System of Man by R.A Wever, springer- verlag.

65. The Clocks That Time Us by M. C. Moore - Ede and others, Harvard University Press.

66. The Physiological Clock: Circadian Rhythms and Biological Chronometry by E. Bunning, Springer Verlag.

67. Theory and Practice of Histological Techniques by J. D. Bancroft &A Stevens, Churchill Living stone.

68. Practical Biochemistry in Medicine by Srinivas Rao, Academic Publishers.

69. The Physiology of Reproduction, Vots, I & II, by E. Knobil and J.D. Neil, Raven Press.

70. Introduction to Biotechnology by W.J. Thieman and M.A. Palladino, Pearson Education.

71. Microbiology by G. J Tortora, B. R. Funke, C. I. Case, Pearson Education.

72. A Text Book of Basic and Applied Microbiology, K.R. Aneja, P. Jain, R. Aneja New Age Inc. Pub.

73. Brock Biology of Microorganism by M. T. Madigan et al., Prentice Hall Inc.

74. Microbiology by J.L. Slonczewski and J.W. Foster, W.W. Norton.

75. Fundamentals of Biochemistry by A.C. Deb, New Central Book Agency.

76. Biotechnology by R.C. Dubey; S. Chand Pub. 77. Essentials of Molecular Biology by V. Malathi, Pearson Education.

78. Biostatistics by P. Mariappan, Pearson Education.

79. Genetics and Genomics by Waseem Ahmad (Faridi), Pearson Education.

80. Text Book of Preventive and Social Medicine, M. C. Gupta and B. K. Mahajan, Jaypee Brothers.

81. Microbial Physiology, A G. Moat, J. W. Foster, M. P. Spector, John Wiley Pub.

82. Essentials of Medical Pharmacology by K. D. Trip:lthi, Jaypee Brothers.

83. Environmental Pollution by S. S. Purohit and A. K. AgrawaLAgrobios India.

84. Genera and Applied Toxicology, B. BallanTye, T. Marrs, P. Turner, Macmillan Pub.

85. Environmental Toxicants Edited by M Lippmann, John Wiley Pub.

86. Basic and Clinical Endocrinology Edited by F. S. Greenspan and D. G. Gardner, Lange Medical Book.

87. A Text Book Biophysics by R. N. Roy, New Central Book Agency.

88. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw-Hill Pub.

89. Cell Biology by C. B. Power, Himalaya Publishing House.

90. Neuroscience, M. F. Bear, B. w. Connors, M. A Paradiso, Lippincott Williams & Wilkins.

91. Genetics by L. H. Hartwell et al., McGraw-Hill Pub.

92. Cell and Molecular Biology by G. Karp, John Wiley Pub.

93. Fundamentals of Biostatistics by V. B. Rastogi, Ane Books.

94. Exercise Physiology by S. K.. Powers, E. T. Howley, McGraw-Hill Pub.

95. The Physiological Basis of Physical Education and Athletics by E.L Fox and D.K. Mathews. Saunders College Publishing.

96. Statistics in Biology and Psychology by D. Das, Academic Publishers.

97. Pesticides by P.K.. Gupta, Interpret.

98. Environmental Chemistry by A.K. De, New Age Inc.

99. Exercise Physiology - Energy, Nutrition and Human Performance by W.D. McArdle. F. Katch and Y.L. Katch. Williams and Wilkins.

100. Essentials of Exercise Physiology by L.G. Shaver, Surjeet Publications.

101. Text Book of Environmental Physiology by C. Edger Folic Jr., Lea and Febiger.

102. The Pharmacological Basis of Therapeutics by LS. Goodman and A. Gihnan. Macmillan Publishing Co.

103. Quintessence of Medical Pharmacology. S.K. Chaudhuri. New Central Book Agency.

104. Pharmacology in Medicine by S.N. Praclhan. R.P. Maickel and S.N. Dutta. S.P. Press International Inc.

105. Microbiology by M.I. Pelczer& Others; Tata McGraw Hill Publishing Co. Ltd.

106. Biomedical Instrumentation & Measurements, by L. Cromwell, Fj. Weibell& E.A. Pfeiffer; Prentice Hall of India Pvt. Ltd.

107. Molecular Biology and Biotechnology by R.A. Meyers, VCH publishers

108. Recombinant DNA and Biotechnology by H. Kreuzer and A. Massey, ASM press.

109. Park's Text Book of Preventive and Social Medicine by K. Park, BanarsidasBhanot Publishers.

110. Text Book of Work Physiology by P.O. Astrand and K. Rodahl. McGraw-Hill Book Co.

111. Human Factors in Engineering and Design by E.O. McConnick and M. Saunders. Tata McGraw-Hill.

112. Energy Work and Leisure by J.Y.G.A. Durinand, R. Passmore. Heinemann Educational Books.

113. Sports Physiology by E.L. Fox. Saunders College Publishing. Holt-Saunders.

114. The Principles and Practice on-Tuman Physiology by O. G. Edholm and others Academic Press.

115. Pharmacology by M. Das, Books and Allied (P) Ltd:

116. Basic and Clinical Pharmacology by E.G. Katzung, Appleton and Lange Pub.

117. An Introduction to Biological Rhythms by John D. Palmer, Academic Press.

118. Medical Statistics by B.K. Mahajan. Jaypee Brothers, Medical Publishers Pvt. Ltd.

119. Statistical Methods by G. W. Snedeeor and W.G. Cochnin, Oxford &ffiH Publishing Co Pvt. Ltd.

120. A text Book of Practical Physiology, C. L. Ghai, Jaypee Brothers.

121. Modern Human Physiology, B. K. Chakraborty, H. N. Ghosh, and S. N. Sahana, The New Book Stall.

122. Medical Physiology. A. K. Das, Books and Allied (P) Ltd.

123. The elements of Immunology, F. H. Khan, Pearson Education.

124. The world of The Cell, Becker, Pearson Education.

125. Physiology of Sports and Exercise, 1.H. Wilmore, D. L. Costill, W. L. Kenney, Pub. Human Kinetics.

126. Crash Course of Physiology, Shahid and Nunhuck, Mosby Pub.

127. Introduction to Clinical Nutrition by V. Sardesai, CRC Press.

128. Endocrinology by Hadley, Pearson Education.

129. Introduction to Biochemistry and Metabolism by Anandhi, Pearson Education.

130. Modern Experimental Biochemistry by Boyer, Pearson Education.

131. Cell Organization and Function by Shakir Ali, Pearson Education.

132. Fundamentals of Immunology by Sumitha Pearson Education.

133. IPR, Biosafety and Bioethics, Goel and Parashar, Pearson Education.

134. Practical Physiological Chemistry by P.B. Hawk, B.L. Oser, W.H. Summerson, McGraw-Hill Publishing Co.

135. Basic Concept in Immunology, A. Hati, S. Roy, B. Saha, K. Bharati, Allied Book Agency, Kolkata.

136. Nutritive Value of Indian Foods, by C. Gopalan and other, NIN, Hydreabad.

137. Text book of Microbiology, by R. Anantanarayan and C. K. JoyramPaniker, Oriennt Longman.

138. Food Microbiology by W.C Frazier and D.C. Westhoff. Tata McGraw Hill Publisher.

139. Text book of Preventive and Social Medicine by M.C. Gupta and B.K. Mahajan, Jaypee Bothers.

140. Recombinant DNA by J.D. Watson, M. Gilman, J. Witkowski and M. Zoller, Scientific American Books.

141. Biotechnology by S. S. Purohit; Agrobios , India.

142. Lippincott's Illustrated Review of Physiology, by R. R. Preston; Lippincott Williams and Wilkins.

143. Computer in Biology by Prof P.C. Dhara. Academic Publication, Kolkata.

144. Vander's Human Physiology by E.P. Widmaier et al., McGraw Hill Publication.