UNIVERSITY OF CALCUTTA
PHYSIOLOGY (HONS.) SYLLABUS FOR CBCS

CORE COURSES(CC)

1. Cellular Basis of Physiology ,Genetics & Enzymes

2. Biophysical Principles and Chemistry of Biomolecules
3. Cell Signalling & Nerve-muscle Physiology

4. Nervous System
5. Blood and Body Fluids
6. Cardiovascular System
7. Respiratory System
8. Digestion and Metabolism
9. Molecular Biology
10. Nutrition and Dietetics
11. Special Senses
12. Endocrinology
13. Reproductive Physiology& Developmental Biology
14. Excretory Physiology

DISTRIBUTION OF CORE COURSES(CC) IN SEMESTERS

Semester 1
CC--1. Cellular Basis of Physiology ,Genetics & Enzymes
CC--2. Biophysical Principles and Chemistry of Biomolecules

Semester 2
CC--3. Cell Signalling & Nerve-muscle Physiology
CC--4. Nervous System

Semester 3
CC--5. Blood and Body Fluids
CC--6. Cardiovascular System
CC--7. Respiratory System

Semester 4
CC--8. Digestion and Metabolism
CC--9. Molecular Biology
CC--10. Nutrition and Dietetics Public Health

Semester 5
CC--11. Special Senses

CC--12. Endocrinology

Semester 6
CC--13. Reproductive Physiology & Developmental Biology **CC--14**. Excretory Physiology

GENERIC ELECTIVE (GE)

GE- 1 is equivalent to CC-1 of one general subject in Semester 1

GE- 2 is equivalent to CC-2 of one general subject in Semester 2

GE- 3 is equivalent to CC-3 of one general subject in Semester 3

GE- 4 is equivalent to CC-4 of one general subject in Semester 4

Discipline Specific Electives (DSE)

DSE –-A (ONE course in Semester 5 & ONE course in Semester 6)
1. Biostatistics
2. Microbiology & Immunology
3. Ergonomics
4. Community and Public Health

DSE - B (ONE course in Semester 5 & ONE course in Semester 6) 1. Chronobiology and Stress Physiology
2. Advanced Molecular Biology and Nanotechnology
3. Toxicology and Pharmacology
4. Work, Exercise and Sports Physiology

Ability Enhancement Compulsory Courses(AECC)

AECC- 1: Communicative English or any other Modern Indian Language in Semester 1

AECC-2: Environmental Studies in Semester 2

Skill Enhancement Course (SEC)

SEC -- A (ONE course in Semester 3)
1. Hematological Techniques
2. Clinical Biochemistry

SEC -- B (ONE course in Semester 4)
1.. Detection of Food Additives /Adulterants and Xenoboiotics
2. Bio-Medical Technology and Bioinformatics

SEMESTERS	CORE COURSE CC1-14
Semester 1 2 COURSES	CC--1. Cellular Basis of Physiology ,Genetics & Enzymes
	CC--2. Biophysical Principles and Chemistry of Biomolecules
Semester 2 2 COURSES	CC--3. Cell Signalling & Nerve-muscle Physiology
	CC--4. Nervous System
Semester 3 4 COURSES	CC--5. Blood and Body Fluids
	CC--6. Cardiovascular System
	CC--7. Respiratory System
	SEC -A : COMPULSORY ELECTIVE ONE AMONG 2 COURSES SEC-A1/A2(ONE course in Semester3)
Semester 4 4 COURSES	CC--8. Digestion and Metabolism
	CC--9. Molecular Biology
	CC--10. Nutrition and Dietetics Public Health
	SEC -B : COMPULSORY ELECTIVE ONE AMONG 2 COURSES SECB1/B2 (ONE course in Semester4)
Semester 5 4 COURSES	CC--11. Special Senses
	CC--12. Endocrinology
	DSEA : COMPULSORY ELECTIVE ONE AMONG 4 COURSES [mentioned below]
	DSEB : COMPULSORY ELECTIVE ONE AMONG 4 COURSES [mentioned below]

Semester 6 4 COURSES	**CC--13. Reproductive Physiology & Developmental Biology**	
	CC--14. Excretory Physiology	
	DSEA : COMPULSORY ELECTIVE ONE AMONG 4 COURSES [mentioned below]	
	DSEB : COMPULSORY ELECTIVE ONE AMONG 4 COURSES [mentioned below]	
Discipline Specific Electives (DSE) ***[Among 8 courses offered any student has to take 4 courses in 2 separate semesters]***	**DSE-A [4 COURSES]** ***(ONE course in Semester 5 & ONE course in Semester 6)***	**1. Biostatistics**
		2. Microbiology & Immunology
		3. Ergonomics
		4. Community and Public Health
	DSE-B [4 COURSES] ***(ONE course in Semester 5 & ONE course in Semester 6)***	**1. Chronobiology and Stress Physiology**
		2. Advanced Molecular Biology and Nanotechnology
		3. Toxicology and Pharmacology
		4. Work, Exercise and Sports Physiology
Skill Enhancement Course (SEC) ***[Among 4 courses offered any student has to take 2 courses in 2 separate semesters]***	**SEC-A [2 COURSES]** ***(One course in Semester 3)***	**1. Hematological Techniques**
		2. Clinical Biochemistry
	SEC-B [2 COURSES] ***(One course in Semester 4)***	**1.Detection of Food Additives /Adulterants and Xenobiotics**
		2. Bioinformatics

Detailed syllabus of Courses in each Semester

Semester I

CC1TH.

Cellular Basis of Physiology

Cell Structure and function--Electron microscopic structure and functions of Nucleus, endoplasmic reticulum, ribosomes, Golgi bodies, mitochondria, lysosomes, peroxisomes ,cytoskeletal elements, centrosomes and plasma membrane . .

Cellular transport—Passive and active transport. Ion channels, ionophores.

Intercellular communication--- Basic idea of tight junctions, gap junctions, adherens junctions, desmosomes and cell adhesion molecules.Extracellular matrix components.

Genetics

Chromosome Structure-- Morphology. Chromosomal DNA packaging-nucleosomes and higher level of organisation of chromatin. Euchromatin and heterochromatin..Human genome and its characteristics. Mitochondrial DNA. Epistasis, Penetrance, Expressivity, Pleiotropism. Karyotyping.

Cell cycle – Events and regulatory role of cyclin. Cell division- Mitosis & Meiosis phases and significance. Crossing-over, Linkage.

Enzymes

Classification-EC nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors and prosthetic group. Mechanism of enzymes. Concept of initial rate, maximum velocity and steady-statekinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics-- Lineweaver Burk plot. Significance of Km and Vmax. Factors influencing enzyme-catalyzed reactions : substrate concentration, enzyme concentration, pH, temperature. Competitive, noncompetitive and uncompetitive inhibitions. Regulation of enzyme activities--covalent modifications, allosteric modifications: K- and M- series. Feed-back inhibition. Rate limiting enzymes. Isozymes, Ribozymes and Abzymes. (4)

CC1P.

1. Study of various stages of meiosis from grasshopper testis
2. Cell viability study by Trypan blue staining
3. Osmotic fragility test of goat blood R.B.C
4. Staining of adipose tissue using Sudan III or IV. **(2)**

CC2TH.

Biophysical Principles

- **Diffusion :**Its characteristics, factors influencing and physiological

applications.

- **Osmosis:** Osmotic pressure – laws, determination – freezing point depression method and physiological applications.
- **Surface tension & viscosity:**-- Physiological applications.
- **pH& Buffer**- Henderson Hasselbach- equation (quantitative problems). Determination of pH.
- **Colloids :**Classification, properties – optical, electrical, electrokinetic. Physiological importance of colloids.
- **Gibbs-Donnan membrane equilibrium**.
- **Thermodynamics :**Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.

Instruments

Principles of construction, uses and advantages and disadvantages : Compound microscope, Phase contrast microscope, Fluorescence microscope, Polarizing microscope, Confocal microscopy, Transmission and Scanning electron microscope. Photoelectric colorimeter, Spectrophotometer and pH meter.

- **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 : Structure, Occurrence and Physiological importance.
Polysaccharides – Starch, Glycogen, Dextrin,Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids.
- **Lipids :**Definition and classification. Fatty acids - Classification, systemic nomenclature and structure. Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids Hydrolysis, Saponification number, Iodine number, Acetyl number, Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester ---- their structure and physiological importance. Lipoproteins - Structure and classification.
- **Amino acids :**Classification, Structure, Nomenclature and Optical properties. Protonicequilibria of amino acids – 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. Denaturation and Renaturation.

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 Cot value. **(4)**

CC2P.

1. Qualitative tests for the identification of physiologically important substances: Hydrochloric acid, Lactic Acid, Uric Acid, Albumin, Gelatin, Peptone, Starch, Dextrin, Glucose, Fructose, Lactose, Sucrose, Urea, Acetone, Glycerol and Bile salts 2. Preparation Of Buffer and pH measurement. . **(2)**

Semester II

CC3TH.

Cell Signalling :

Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP3, DAG, Protein kinases, Ca^{2+},CO,NO. Signal transduction pathways: Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD.

Nerve :

Structure, classification and functions of neurons and neuroglias. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. Current of injury. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Properties of nerve fibers : excitability, conductivity, all or none law, accommodation, adaptation, summation, refractory period, indefatigability. Chronaxie, rheobase and utilization time. Synapses : types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters, cotransmitters, neuromodulators. The neuromuscular junction : structure, transmission, end-plate potential, MEPP, post-tetanic potentiation. Motor unit. Motor point. Injury to peripheral nerves – degeneration and regeneration in nerve fiber, changes in the nerve cell body, transneuronal degeneration, changes in receptors and motor end-plates, denervation hypersensitivity. Thermal changes of nerve during activity. Nerve growth factors.

Muscle:

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle. Muscle groups : antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation : Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions – muscle length,

tension and velocity relationships. Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography. (4)

CC3P.

1. Staining of isolated nerve fiber by silver nitrate method.
2. Staining of skeletal & cardiac muscle by methylene blue.
3. Staining of collagen in tissue sections. **(2)**

CC4TH.

The Nervous System

- Structural organization of different parts of brain and spinal cord.

Reflex action – definition, reflex arc, classification and properties.

- **Autonomic nervous system :**organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous systems.
- **CSF:** Formation, circulation and functions. Blood-CSF and Blood-Brain barrier.
- **Ascending and descending tracts :**origin, courses, termination and functions.
- **Functions of the spinal cord** with special reference to functional changes following hemisection and complete section of spinal cord. Pain production, perception and regulation. Referred pain.
- **Muscle spindle and golgi tendon organ:** their structure, innervations and functions, postural reflexes. Decorticate, decerebrate rigidity and spinal animal. **Brain:** Structure, nerve connections and functions of brainstem, cerebellum, reticular formation, hypothalamus, thalamus, basal nuclei and cerebral cortex- Speech and aphasia. Structure and functions of vestibular apparatus.
- **Limbic system:** Structure, connections and functions.

Physiology of sleep, learning, memory, and emotion.
Cerebral circulation & stroke.
Principles,uses, advantages and disadvantages of CT scan, MRI and PETscan .

Molecular neurobiology : General concept of ionotropic and metabotropic receptors. Structure, sub-types and functions of nicotinic and muscarinic acetylcholine receptors, adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors. (4)

CC4P.

1. Basic concepts of brain imaging. Identification of different structures of human brain using CT scan and MRI images.

2.Study and use of Kymograph, induction coil, key, Gastrocnemius-sciatic nerve preparation and kymographic recording of isotonic muscle twitch, effects of two successive stimuli and load (afterload) on muscle twitch. (2)

Semester III

CC5TH.

Physiology of Blood and Body Fluids

Bone marrow: Formed elements of blood–origin, formation, functions and fate.

Plasma proteins Origin and functions.

Erythropoiesis Role of erythropoietin and leucopoiesis.

Haemoglobin : Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia. **Blood volume :**Regulation and determination by dye and radioisotope methods.

Hemostasis : Factors, mechanism, anticoagulants, procoagulants. Disorders of hemostasis- Hemophilia, Thrombosis and Embolism.

Blood group :ABO and Rh systems (Chemical nature of relevant biomolecules). Erythroblastosis foetalis. Blood transfusion and its hazards.

Lymph and tissue fluids : Formation, circulation, functions and fate.

Lymphatic organs : Histological structures and functions of lymph gland and spleen. Splenomegaly causes and effects.

Circulatory disorder : Oedema**. (4)**

CC5P.

1.Haematological experiments : Preparation and staining of blood film with Leishman's stain. Identification of blood cells. Total count of W.B.C and R.B.C .Differential count of W.B.C. Haemoglobin estimation by Sahli's hemoglobinometer. Preparation of haemin crystals.

Preparation and staining of bone marrow. Measurement of diameter of megakaryocytes. Reticulocyte staining. **(2)**

CC6TH

Cardiovascular System

Anatomy of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Heart Block.
Cardiac cycle : Pressure and volume changes. Heart sounds. Murmurs.
Cardiac output : Measurement by application of Fick's principle & factors affecting.
Starling's law of heart.
Electrocardiography: The normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram and the mean electrical axis of heart. The His bundle electrogram.
Principles of Echocardiography.
Cardiac Arrhythmias &. Myocardial Infarctions.
The pulse: Arterial and venous.
Hemodynamics of blood flow.
Cardiac and vasomotor centers, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes. Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels.
Atherosclerosis.Coronary Circulation.
Blood pressure: Its measurement and factors affecting. Cardiovascular adjustment after haemorrhage. **(4)**

CC6P.

1.Cardiovascular Physiology Experiments : Determination of Blood pressure by Auscultatory Method. Determination of mean pressure, pulse pressure and pulse rate. Preparation of Amphibian Ringer Solution. Interpretation of Kymographic recording of the movements of perfused heart of toad and the effects of acetylcholine and adrenaline on the contraction of heart.ECG. (2)

CC7TH.

Respiratory System

Anatomy and histology of the lung and airways.
Mechanics of breathing : Role of respiratory muscles, glottis.
Compliance of lungs and chest wall, pressure-volume relationships, alveolar surface tension and surfactant, work of breathing.
Spirometry: Lung volumes and capacities. Dead space.
Pulmonary Circulation : Ventilation- perfusion ratio.
Transport of gases in body : Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting.
Carbon dioxide dissociation curve. Regulation of respiration -- neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors. **Disorders of Breathing :**Hypoxia : Types& effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema. Non-respiratory functions of lung. **(4)**

CC7P.

1.**Respiratory Human Experiments:** Pneumographic recording of effects of hyperventilation, breath-holding and talking. Lung function tests using Spirometry(Digital) and analysis of the results . (2)

Semester IV

CC8TH.

Digestion

Anatomy and histology of alimentary canal.
Digestive glands – histological structures of salivary glands, pancreas, liver. Deglutition. Movements of alimentary canal and their regulations. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Enterohepatic circulation. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Defecation. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gallstones.

Metabolism

Redox potential. Mitochondrial Electron Transport Chain. Oxidative phosphorylation- inhibitors and uncouplers.

Carbohydrate : Glycolysis, R-L cycle. TCA cycle, Gluconeogenesis - Cori cycle, Anaplerotic reactions and Amphibolic nature of TCA cycle. Pentose phosphate pathway. Glycogenesis and Glycogenolysis.

Lipid: β-oxidation and biosynthesis of saturated and monounsaturated fatty acids. Biosynthesis of lecithin. Biosythesis of Cholesterol. Ketone body metabolism.
Hormonal regulation of the above mentioned biochemical pathways not required.

Amino acids: Amino acids - Amino acid pool. Deamination, transamination, amination and decarboxylation. Synthesis of Urea and Nitric oxide. Glucogenic andketogenic amino acids. Metabolism of glycine, methionine, tryptophan and phenylalanine.

Purines and Pyrimidines– Biosynthesis :*de novo* and salvage pathways. Catabolism.
*Regulation of the above mentioned biochemical pathways/cycle not required.***(4)**

CC8P.

1.**Dale's Experiment :**Kymographic recording of normal movements of rat's intestine using Dale's apparatus and effects of acetylcholine and adrenaline on normal intestinal movements of rats..

2.**Biochemical estimations:**

Quantitative estimation of amino nitrogen by Sorensen's formol titration method

(percentage as well as total quantity to be done). **(2)**

CC9TH.

Molecular Biology

- DNA replication—Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Transcription ---RNA Polymerase and other regulatory mechanism in prokaryotes.Genetic code – properties and wobble hypothesis. Translation – codon-anticodon interaction and mechanism in prokaryotes. Regulation of gene expression : operon concept – the lac operon. Gene mutation – agents and types. DNA repairing processes. Concept of oncogenes and properties of cancer cells. Recombinant DNA technology in brief and its applications – gene therapy, transgenic animal.

Methodologies : Chromatography: Principles and uses of : TLC, Gel filtration, Affinity chromatography,ion-exchange chromatography. Electrophoresis: Principles and method, uses of Agarose gel electrophoresis, SDS – PAGE. Ultracentrifugation: moving boundary and density gradient ultracentrifugation. Radioactivity – Classification and properties. Their use – radiolabelling of biomolecules and its detection by autoradiography. Principles of RIA, ELISA. Western, Northern and Southern blotting techniques. Polymerase chain reaction-basic concept. (4)

CC9P.

Biochemical estimations:

1.Colorimetric methods—

i) Estimation of serum protein by Lowry method and serum albumin by Bromocresol green dye method and calculation of A/G ratio. ii) Estimation of blood glucose by Folin–Wu method .(iii) Estimation of serum urea by DAM method.

2.Thin layer chromatography. **(2)**

CC10TH.

Nutrition and dietetics

- **Vitamins:** Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Dietary sources, daily requirements, biochemical functions, deficiency symptoms, hypervitaminosis, antivitamins.
- **Minerals:** Sources, biological functions of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride.
- **SDA, RQ and BMR :**Factors affecting. Determination of BMR.
- Fuel Values of Food. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Balanced diet and principles of formulation of balanced diets for adult man, adult woman,lactating woman and pregnant women.. Nitrogen balance.Protein sparers. Supplementary value of proteins.Biological value of proteins.Net protein utilization.Protein efficiency ratio.Dietary fibers. **(4)**

CC10P.

Nutrition and Dietetics :

1.Composition and nutritional value of common foodstuff.
2.Diet survey report of a family as per ICMR specification. 3.Qualitative analysis of milk, potato, flour, rice, pulses. **(2)**

Semester V

CC11TH:

Special Senses

Characteristics of special senses, Sensory Coding -- Weber-Fechner law, Steven's power law.

Vision: Structure of eyeball. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Mechanism of accommodation. Errors of refraction and their corrections. Formation and Circulation of Aqueous Humour. Cataract and Glaucoma. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Positive and negative after- images. Contrast phenomenon. Light and dark adaptation. Colour vision—Trichromatic, Single and Double Opponent mechanism. Colour blindness. Visual field-- perimetry. Visual acuity – measurement, mechanism and factors affecting. Critical fusion frequency Ferry-Porter law.

Hearing : Structure and functional significance of auditory apparatus. Organ of Corti. Auditory pathways and centers. Mechanism of hearing – Excitation of Hair Cells, Conversion of Sound Waves into Action Potentials in the Auditory Nerve. Mechanism of discrimination of sound frequencies and intensities. Localization of sound source. Deafness.

Olfaction and Gustation: Structure and functions of the receptor organs, nerve pathways, Centers. Signal Transduction of olfactory and gustatory stimuli. Olfactory and Gustatory Coding. Abnormalities of olfactory and taste sensation. **(4)**

CC11P.

1. Determination of Visual Acuity by Snellen's Chart
2. Determination of Colour Blindness by Ishihara Chart.
3. Determination of Deafness by Tuning Fork Tests.
4.Study and identification of stained sections of different mammalian tissues and organs: Cardiac muscle, Skeletal muscle, Smooth muscle, Trachea ,Lung, Hyaline cartilage, Artery, Vein, Cerebellum, Cerebral cortex, Spinal cord,
5.Silver nitrate preparation of corneal cell space. **(2)**

CC12TH.

Endocrinology

Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary -- histological structure of the gland. Chemical nature, molecular mechanism of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland.

Pineal gland – Histological structure. Chemical nature, biosynthesis, molecular mechanism of action, functions and regulation of secretion of melatonin.

Thyroid and Parathyroid -- Histological structure of the glands. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands.

Adrenal cortex and medulla -- Histological structure of the gland. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Biosynthesis of catecholamines. Hypo- and hyperactive states of the gland.

Heart as an endocrine organ.

Pancreatic islets -- Histological structure. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus. **Gastro-intestinal hormones** -- Chemical nature, molecular mechanism olfaction, functions and regulation of secretion of the hormones. **(4)**

CC12P.

1. Study of Effects of Oxytocin and Adrenaline on uterine contractions of albino rat.
2.Study and identification of stained sections of different mammalian tissues and organs: Parotid gland, Submaxillary gland, Sublingual gland ,Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine and Liver. **(2)**

Semester VI

CC13TH.

Reproductive Physiology

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Physiology of puberty. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and postmenopausal changes. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control.

Developmental Biology

Stem cell : Characteristics and applications.Totipotency,Differentiation. **Ultra structure :**Sperm and Ovum. **Fertilization,Blastulation,Implantation, Gastrulation**(Concept of induction, determination and differentiation).
Organogenesis : Development of Heart, urinary system and genital system.

Fetal Circulation. (4)

CC13P.

1. Study and identification of stained sections of different mammalian tissues and organs: Kidney, Ureter, Skin, Uterus, Testis, Ovary, Thyroid gland, Pancreas, Spleen, Lymph gland.
2. Pregnancy Test by immunological method using kit.
3.Silver nitrate preparation of urinary bladder for study of cell spaces. **(2)**

CC14TH.

Excretory System, Environmental Pollutants and Human Health

Kidney : Anatomy of kidney. Histology of nephron. Renal circulation – peculiarities and autoregulation. Formation of urine – glomerular function and tubular functions. Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and micturition.

Constituents of urine. Abnormal constituents of urine, and pathophysiological significance. Renal dialysis. Non-excretory functions of kidney.

Skin and Body Temperature Regulation : Structure and functions of skin. Cutaneous circulation. Sweat glands –structure and composition of sweat. Mechanism of sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms – its physical and physiological processes, roles of neural and hormonal processes. Pyrexia, hyperthermia and hypothermia.

Environmental Pollutants and Human Health : Sources and effects of Chlorinated hydrocarbons, Organophosphorus, Organocarbamates, Lead, Arsenic, Fluorine, Aluminium, Ionizing and non-ionizing radiations. **(4)**

CC14P.

1.Identification of normal and abnormal constituents of urine.
2**.** Staining and identification of histological sections of liver, adrenal gland, thyroid gland, ovary, testes, and kidney. **(2)**

Suggested Readings

1. Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
2. Best & Taylor's Physiological Basis of Medical Practice, O.P.Tandon & Y.Tripathi, Lippincott Williams & Wilkins
3. Ganong's Review of Medical Physiology. Barrett *et.al*, McGraw Hill Lange
4. Harper's Illustrated Biochemistry, V.W. Rodwell and others, Lange
5. Lehninger's Principles of Biochemistry. By D.L. Nelson and M. M. Cox, Worth Publishers Inc. 6. Textbook of Medical Physiology, D.Venkatesh & H.H.Sudhakar, Wolters Kluwer 7. Text Book of Biochemistry, by E.S. West. W.R. Todd. H.S. Mason. J.T. Van Bruggen. The Macmillan Company.
8. Biochemistry, D.Das, Academic Publishers.

9. Biophysics and Biophysical Chemistry, D.Das. Academic Publishers.
10. Samson Wright's Applied Physiology, C.A. Keele. E Neil & N. Toels. Oxford University Press.
11. Physiology, R.M. Berne & M.N. Levy, C.V. Mosby Co.
12. Basic Histology, L.C. Junqueira & J Carneiro, McGraw- Hill .
13. diFiore's Atlas of Histology, V.P. Eroschenko, Wolters-Kluwer
14. The Cell – A Molecular Approach, G.M. Cooper & R.E.Hausman, ASM Press SINAUER.
15. Cell Biology, G.Karp, John Wiley & Sons, Inc.
16. Core Text Book of Neuro-Anatomy, by M.B. Carpenter; the Williams and Wilkins Company.
17. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.
18. The Human Nervous System. By M.L. Barr & J.A. Kierman, Harper & Row.
19. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co.
20. Cell & Molecular Biology, EDP De Robertis & EMF De Robertis; Lea & Febiger 21. Molecular Biology of the Gene, by J.D. Watson, H.H. Nancy & others; BenjaminCummings. 22. Molecular Biology of the Cell, B. Alberts and others, Garland.
23. Textbook of Medical Physiology, Indu Khurana, Elsevier
24. Textbook of Medical Biochemistry, R.Chawla *et.al* , Wolters-Kluwer
25. Biochemistry, J.M.Berg, J.L. Tymoczko & L. Stryer, W.H. Freeman
26. William's Text Book of Endocrinology Larsen *et. al* An Imprint of Elsevier.
27. Endocrinology, Mac E. Hadley, Pearson Education.
28. Vander's Human Physiology, E.P. Widmaier *et al*., McGraw-Hill, Higher Education.
29. Concise Medical Physiology by S.K. Chaudhuri, New Central Book Agency.
30. Medical Physiology by A.B. Mahapatra, Current Books International.
31. Endocrinology. Vols.I , II and III by L.O. DeGroot. W.B. Saunders Co.
32. Langman's Medical Embryology by J.W. Sadler, Lippincott Williams and Wilkins.
33. Essentials of Human Embryology by A.K. Datta. Current Books International. 34. Human Embryology by I. Singh & G.P.Pal, McMillan.
35. Human Physiology An Integrated Approach by D.U. Silverthorn,Pearson.

Discipline Specific Electives (DSE)

Group A

1. Biostatistics
2. Microbiology & Immunology
3. Ergonomics
4. Community and Public Health

Group B

1. Work, Exercise and Sports Physiology
2. Advanced Molecular Biology & Nanotechnology
3. Chronobiology and Stress Physiology
4. Toxicology and Pharmacology

Semester V Semester VI

Group – A 1 & 2 (Anyone) Group – A 3 & 4 (Anyone) Group – B 1 & 2 (Anyone) Group – B 3 & 4 (Anyone)

Group A

1. Biostatistics (DSE A1TH)

Scope of statistics – utility and misuse. Principles of statistical analysis of biological data.

Basic concepts – variable. Population and Sampling -- parameter, statistic. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram.

Different classes of statistics- mean median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score.

Degrees of freedom. Probability. Normal distribution. Student's tdistribution. Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference.

Distribution-free test - Chi-square test.

Linear correlation and linear regression.

One way ANOVA **(4)**

DSE A1P

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means. Determination of correlation coefficient (r) and computation of linear regression equation.

Statistical analysis and graphical representation of biological data with computer using One way Anova . **(2)**

Suggested Readings

1. Statistics in Biology and Psychology by D.Das and A.Das Academic Publishers.
2. An Introduction to Biostatistics, N. Gurumani, M.J.P. Publishers, Chennai. 3.
Biostatistical Analysis by J.H Zar, Pearson.
4. Statistical Methods in Biology, Norman T.J.Bailey, Cambridge University Press.

2. Microbiology & Immunology (DSE A2TH)

Classification of microorganisms. Techniques employed for the identification of microorganisms -- microscopic and biochemical methods.

Control of microbial growth : Physical and Chemical methods used in sterilization, disinfection and pasteurization.

Bacteriology : Bacterial classification based on staining techniques (Gram stain and Acid-fast stain) and morphological aspect.

Bacterial structure :cell-wall, LPS layer, pili, flagella, chromosome, plasmid, spores and cysts.

Culture of bacteria : Nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement) ; bacterial growth curve : different phases and their significance ; quantitative estimation of bacterial growth ; continuous growth culture and its utility.

Food microbiology : Beneficial and harmful microorganisms in food, causative organisms of food-borne infections- mode of transmission and methods of prevention.

Bacterial metabolism: Fermentation, Glyoxalate cycle and Entner Doudoroff pathway.

Bacterial genetics : Transformation, conjugation and transduction. **Treatment of bacterial infection :**

Chemotherapeutic agents.

antibiotics- definition, bactericidal and bacteriostatic and their mechanism of action. **Virology :**Viral structure – virion, prion and bacteriophages ; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – lytic and lysogenic cycle. **Overview of innate and acquired immunity :** Elements of acquired immunity: Characteristics of immune response, cells and organs involved in immune response.

Immunogens and antigens : Requirements of immunogenicity, epitopes recognized by B- & T- cells, haptens, adjuvants, cross-reactivity. Antibody structure, classification and functions.

Kinetics of antibody responses : Primary & secondary. Antigen - antibody interactions - Primary interaction : association constant, affinity & avidity. Secondary interaction : precipitation & agglutination. B-cell receptor. **MHC molecules :**structure of class I and II molecules, brief idea of peptide binding by MHC molecules, cellular distribution.

Antigen processing and presentation: T-cell receptor. T-cell maturation and differentiation - thymic selection in brief. B-cell activation &differentiation : thymus dependent and independent antibodies, T-B co-operation, the carrier effect.

Cytokines : Produced by TH1 & TH2 cells, regulating specific immune response only.

Complement : Activation components – classical, alternative and lectin. Biological consequence of complement activation. Cell-mediated effector responses : CTLS, NK cells, K cells.

Brief idea of autoimmunity, cancer immunotherapy and AIDS. Hypersensitivity reactions and their types

Vaccination : Passive and active immunization, types and uses of vaccine. **Toxins and toxoids.**

Hybridoma technology (4)

DSE A2P

1. Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.
2. Determination of human blood group using immunological method. 3. Quantitation of antigen or antibody by precipitin test.
4. Isolation and staining of splenocytes.
5. Lactophenol cotton blue staining of yeast cells. (2) Suggested readings:

1. Microbiology, Pelczar Tata McGrawhill.
2. General Microbiology By Stanier *et.al*, Prentice Hall.

3. Microbiology An Introduction, G.J Tortora, Pearson.
4. Prescott's Microbiology, J. Willey *et.al*., McGraw-Hill
5. Kuby Immunology by T.J Kindt et.al, W.H Freeman.
6. Cellular and Molecular Immunology, A.K. Abbas *et.al,* Elsevier.

3. Ergonomics (DSE A3TH)

Introduction to Ergonomics

A brief history of ergonomics
Multidisciplinary approach to Ergonomics
Definition and scope of Ergonomics
Role of ergonomics in health safety and productivity

Human machine interaction

Introduction to man machine interaction and interfaces
Fundamentals of human computer interaction
Fundamental idea of display and control

Anthropometric considerations in Ergonomics

Definition of anthropometry
Common terminologies used in anthropometry
Different body dimensions measured in anthropometry
Basic Concepts of reach, clearance, posture, range of motion.
Concept of percentile and its calculation and use of percentile values in anthropometry

The work place

Workplace components. Work place stressors and work place risk factors

Environmental Ergonomics

Ergonomic consideration of thermal environment
Ergonomic consideration of visual environment
Ergonomic consideration of environmental noise

Workplace and workplace design

Anthropometric principles in workplace design
Design principles for sitting and standing work

Ergonomic principles of load handling

Fundamentals of manual material handling
Different categories of movement in manual load handling
Ergonomic principles of safe load handling

Musculoskeletal Disorders

Basic idea about the role of skeletal system in movement, categories of joints, role of muscles, soft tissues and bones in movement
Risk factors for musculoskeletal disorders
Different types of musculoskeletal disorders
Evaluation of musculoskeletal disorders by questionnaire technique
Basic concept of OWAS method of work posture analysis.

Ergonomic intervention

Ergonomic principles of reducing work place stressors and improving work efficiency

DSE A3P

1. Determination of heat stress by WBGT indices
2. Assessment of llumination
3. Basic anthropometric measurements
4. Determination of range of motion by goniometer and strength by hand grip dynamometer
5. Assessment of prevalence of musculoskeletal disorder by questionnaire method

Suggested Readings

1. Fitting the task to the man: A textbook of Occupational Ergonomics. KHE Kroemer and E Grandjean. Taylor and Francis.
2. Engineering Physiology: Bases of Human factors / Ergonomics, KHE Kroemer and HB Kroemer. Van Reinhold.
3. Bodyspace: Anthropometry, Ergonomics and Design. S.Phesant, Taylor and Francis 4. Human Factors in Engineering. EJ McCormick and H Saunders. 5th Edition. McGraw-Hill . 5. Ergonomics Man in His working Environment. Murrell K. 3rd Ed. Springer.
6. Introduction to Ergonomics,R.S. Bridger, Routledge : Taylor & Francis group

4. **Community and Public Health (DSE A 4TH)**

Basic idea about community,public health issues.

Malnutrition in a community, over nutrition and possible remedial measures. Diet management of obese, diabetic, hypertensive individuals and athletes. Iron and iodine deficiency.

Population problem – principles and methods of family planning,. Problem of infertility and Assisted Reproductive Technologies. PCM -- Marasmus, Kwashiorkor, Marasmic Kwashiorkor, endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Principles and social importance of

immunization against diseases. Etiology, epidemiology and prevention -- Communicable diseases : Cholera, Malaria, Swine flu, Japanese Encephalitis, Rabies, Dengue, Hepatitis and AIDS; Non-communicable diseases – Hypertension and Obesity.

DSE A4P

1. Calculation of Body Surface Area (using nomogram), Body Mass Index and Ponderal Index from anthropometric measurements.

2. A report (hand-written) on the basis of field survey from ONE of the followings:
a) Physiological parameters of human (at least three parameters).
b) Anthropometric measurements on human (at least three parameters).
c) Epidemiological studies on human.

Suggested Readings

1. Park's Textbook of Preventive and Social Medicine, K.Park, M/s. Banarasidas Bhanot, 2015. 2. Communicable Disease Control Handbook, Jeremy Hawker *et.al*, Blackwell Publishing

Group B

1. Work,Exercise and Sports Physiology (DSE B1TH)

🌧Introduction to work physiology

Definitions in work and exercise Physiology,

Fundamental concepts of work; work characteristics, work cycle and work

pauses Different categories of work

Different approaches to describe work and work load.

Physiological basis of work

Physiology of muscle action

Physical work load; Static and dynamic work

Physiological responses to static and dynamic work

Relationship between oxygen consumption and heart rate

Effect of heat stress on physiological responses to work load

Work load assessment

Physiological assessment of work load, work load classification, cardiovascular and respiratory indices for evaluating work load. acceptable work load.

Work Organization

Fundamental concept of work organization
Principles of reducing stress from physical work load

Exercise and Physical fitness

Exercise, physical activity and physical fitness. Benefits of exercise Components of fitness and their evaluation

Physical Working Capacity

Concept of maximal physical working capacity VO2 max,and its estimation by different methods. Factors affecting VO2max. Step test, bicycle ergometry and treadmill exercise for assessment of Physical working capacity.

Bioenergetics

Work power and energy, sources of energy. Aerobic and anaerobic capacity, EPOC, lactate threshold and lactate tolerance and their limitations. Determination of energy cost by direct and indirect methods

Athletic performance based on aerobic capacity and O_2 debt

Training Principles

Training principles, different training methods. Training principles for different sports

activities. Over training and detraining and their physiological effects. Ergogenic aids.

Body composition

Determination of Physical growth status. Methodologies for body composition analysis. (2)

DSE B1P

1.Determination of BMI, BSA, PI, waist hip ratio, body fat percentage and body type
2.Determination of V_{O2}max by Queen's College Test and physical fitness by modified Harvard step test
3.Determination of agility, flexibility and anaerobic power by shuttle run, sit and reach and vertical jump test
4.Recording of heart rate and blood pressure during static and dynamic work, determination of workload from heart rate and cardiac indices and classification of work load. (2) Suggested Readings

1. Exercise Physiology: Theory and Application to Fitness and Performance. S.K. Powers and E.T. Howley. 10th edition. McGraw Hill publishers.
2. Exercise Physiology: Nutrition, Energy, and Human Performance. W.D. McArdle, F.I. Katch and V.L. Katch. 7th edition. Lippincott,Williams & Wilkins publishers.
3. Physiology of Sport and Exercise. J. H. Wilmore, D. L. Costill, W. Larry Kenney. Human Kinetics 4. Textbook of Work Physiology: Physiological Bases of Exercise. Per- Olof Åstrand, Kaare Rodahl, Hans A. Dahl, Sigmund B. Strømme . Human Kinetics
5. Fox's Physiological Basis for Exercise and Sport by M. L.Foss. S. J. Keteyian, E. L. Fox , William C Brown Pub
6. The Physiology of Work, K. Rodahl, Taylor & Francis,
7.Essentials of Exercise Physiology, V.L. Katch, W.D. McArdle, F.I. Katch, Wolters Kluwer

2. Advanced Molecular Biology (DSE B2TH)

Repetitive DNA, interrupted genes, gene families, transposons.
Control of gene expression – attenuation and antitermination, Operon - trp, arabinose, DNA methylation, (DCM, DAM). Post-transcriptional modifications, cap, poly A tail splicing, RNA editing. Role of chromatin in gene expression and gene silencing. Cell-cell communication and quorum sensing in bacteria.
Molecular basis of apoptosis in brief.
Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods. Molecular markers in genome analysis. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as Micro array based techniques . RFLP, RAPD and AFLP techniques.Gene Knockout.Point mutations and deletions. Methods for detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.Genomic medicine. Genetic counselling. Outline of ChIP technique. .
. Fundamentals of nanoscience :The nanoscale dimension and paradigm.Definition of a Nano system,Example- bone minerals and silk. Engineered Nanostructures—Carbon nanotubes, Gold & Silver nanoparticles. Bionanomaterials – Self-assembly in bionanostructures, e.g., virus self-assembly. Nanomotors- Ribosomes and mammalian myosin. Applications of Nanomaterials in Biology-- Biochemical sensor, Labelling and

cellular imaging, Cancer treatment and Regenerative Medicine. (4)

DSE B2P

1. SDS-PAGE of proteins. 2. Isolation of DNA from animal cells.
3.Estimation of RNA by Orcinol method . (2)

Suggested Readings

1. Harper's Illustrated Biochemistry 30th edition. Lange.
2. Biotechnology: Lessons from Nature. D.S. Goodsell, Wiley India , 2012.
3. Nanobiotechnology: Concepts, Applications and Perspectives, Niemeyer and Mirkin, Wiley India , 2013.
4. Molecular Cell Biology,Berk,Kaiser,Lodish *et.al,* WH Freeman.

3.**Chronobiology and Stress Physiology (DSE B3TH)**

Different types of physiological rhythms – ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock.
Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin.
Neural basis of biological clock and role of suprachiasmatic nuclei.
Sleep-wakefulness cycle.
Body temperature rhythm.
Time keeping genes.
Jet-lag and shift work.
Stress : Physical and Emotional Stressors. General Adaptation Syndrome.
Role of Hypothalamic-Pituitary-Adrenal Axis and Sympathoadrenal Medullary Axes in coping stress.
Effects of chronic stress: Immunological, Cardiovascular Disease, Emotional.
Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson disease. Preventive measures for hypobaric and hyperbaric effects.

Oxidative stress-Formation of Reactive Oxygen Species and the role of Catalase, Superoxide Dismutase, Glutathione. Peroxidase and Glutathione Reductase in combating oxidative stress – role of vitamins. (4)

DSE3P

1.Project work on assessment of individual differences in human circadian rhythms (chronotype in human population) by questionnaire method among school children and college students.

2.Assessment of environmental heat load.

3.Assessment of noise level using noise level meter.

4.Determination of diurnal and /or circalunar rhythm of body temperature of college going students. **(2)**

Suggested Readings

1. Chronobiology – The Biological Timekeeping, J.C. Dunlap, Sinauer Associates
2. The Rhythm of Life, M. Kelly, The New York Times Bestseller
3. Biological Rhythms, Vinod Kumar, Narosa Publishers
4 Behavioural Endocrinology, R.J. Nelson,Sinauer Associates
5. Physiology of Stress, Hans Selye, Jones and Bartlett Publishers

4.Toxicology and Pharmacology (DSE B4TH)

Toxins and Toxicology Factors Affecting toxicity.
LD_{50}, LOD_{50}, ED_{50}, NOEL, LOEL
Concepts of Biomagnification and Bioconcentration
The importance of pharmacology in the study of physiological processes. Definition of drug, agonist and antagonist. Drug delivery Drug reactivity. Pharmacokinetics : Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Permeation, Elimination,Clearance,Halflife.
Pharmacodynamics:dose-responsecurves.Beneficial versus toxic effects of drugs. Drug biotransformation. Bioavailability. Drug accumulation. Therapeutic index. Anaesthetics : types and mechanism of action of general anaesthetics. Sedatives - hypnotics: benzodiazepine, zolpidem. Diuretics - Carbonic anhydrase inhibitor, loop diuretic, potassium sparing and osmotic diuretics. Neuromuscular blockers :Tubocurarine and succinyl choline. Organ system effects and mechanism of action of adrenoceptor agonists and antagonists:
Adrenergic stimulants : Amphetamine and ephedrine. α- adrenergic stimulants – Methaxomine and clonidine. β- adrenergic stimulants – Metaproterenol and salbutamol.
Adrenergic antagonists :Labetelol. α- adrenergic blockers – Phenoxybenzamine andphentolamine. β- adrenergic blockers – Propranolol and atenolol.
Antianginaldrugs :Nitroglycerine and calcium-channel blocker – Nifedipine and verapamil. (4)

DSE B4P
Kymographic recording of the effects of atropine and propranonol on the perfused heart of toad. (2)

Suggested Readings
1.Goodman and Gilman"s The Pharmacological basis of Therapeutics, McGraw-Hill. 2.Basic and Clinical Pharmacology by E.G Katzung .Appleton sand Lange.
3.Textbook of Pharmacology by Seth and Seth Elsevier.

Skill Enhancement Course (SEC)

SEC-A (One course in Semester 3)

1. Hematological Techniques
2. Clinical Biochemistry

SEC-B (One course in Semester 4)

1.Detection of Food Additives /Adulterants and Xenobiotics
2. Bioinformatics

SEC-A

1. **Haematological techniques**

Blood groups - ABO and Rh. Immunological basis of identification of ABO and Rh blood groups. Biochemical basis of ABO system and Bombay phenotype .Blood transfusion - precaution and hazards. Concept of Blood Bank. Erythropoietin and thrombopoietin. Abnormal haemoglobins. thalassaemia and sickle-cell anaemia. Glycemic index , Glycated haemoglobin, C peptide C-reactive protein, Ghrehlin and Leptin in health and diseases. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV,MHC, MCHC, bleeding time,clotting time and prothrombin time. Anaemia - types (definition and causes).Leucocytosis, leucopenia and leukaemia.Purpura. (2)

Suggested Readings:

1. Wintrobe"s- Clinical Haematology By J. P. Greer et.al., Wolters Kluwers
2. William's Haematology By E. Deutler et. Al., McGrawhill

3. Clinical Biochemistry

Pathophysiological significance of the following blood constituents: glucose, serum protein, albumin, urea, creatinine, uric acid, bilirubin and ketone bodies. Lipid and thyroid profile in health and disease. Pathophysiological significance of the following serum enzymes and proteins: Lactate dehydrogenase, Creatine kinase, Amylase, Acid and Alkaline phosphatases, β-glucurodinase, Alanine and Aspartate Transaminases, Lipase, γ-glutamyl transpeptidase, Regan Isoenzyme, Cardiac Troponins. (2)

Suggested Readings:

1.Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill.

2.Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde, Jaypee.

3. Biochemistry, D. Das, Academic Publishers.

SEC-B

1.Detection of Food Additives /Adulterants and Xenobiotics

Definition ,examples and health hazards of food additives/adulterants. Tests for identifying Food Adulterants in food samples and their pathophysiological effects: Metanil yellow, Rhodamin B, Saccharin, Monosodium glutamate, Aluminium foil, Chicory, Bisphenol A and Bisphenol S, Margarine, Lead, Arsenic, Mercury, Polychlorinated Biphenyls, Dioxin and Urea.
Concept of Xenobiotics- Types, sources and fate. Types of reactions in detoxification and their mechanisms- oxidation, reduction, hydrolysis and conjugation. (2)

Suggested Readings:

1.Harper's Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill

2.Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

2.Bioinformatics

Introduction to Bioinformatics, Bioinformatic databases- PubMed, PDB, Gen Bank, NCBI. Bioinformatic tools- FASTA, BLAST. Applications of bioinformatics- Analysis and interpretation of sequence data, homology searches, sequence alignments and pattern searching, analysis and interpretation of genome data- gene prediction, full gene comparison. Introduction to computational biology- prediction of 3-D protein structure, identification of unknown protein, drug design and application in medical sciences.(2)

Suggested Readings:

1. Bioinformatics -Principles and Applications By Z. Ghosh and B. Mallick., Springer.

2. Bioinformatics-Databases, Tools and Algorithms By O. Bosu and S. K. Thukral., Oxford Higher Education.
3. Introduction to Bioinformatics By Attwood et. Al., Pearson. 4.
Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill.

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University of Calcutta

PHYSIOLOGY (GENERAL) SYLLABUS FOR CBCS

CORE COURSES(CC) / GENERIC ELECTIVE (GEN)

Semester 1

CC-1 / GEN 1

Cellular Basis of Physiology and Genetics

Biophysical Principles, Enzymes and Chemistry of Bio-molecules Digestion, Absorption & Metabolism

Semester 2

CC-2 / GEN2

Blood and Body Fluids

Cardiovascular System

Respiratory System

Semester 3

CC-3 / GEN 3

Nerve-muscle Physiology

Nervous System

Special Senses

Semester 4

CC-4 / GEN 4

Endocrinology

Reproductive Function

Excretory Physiology

Discipline Specific Electives (DSE)

DSE –-A (ONE course in Semester 5)

1. Biostatistics
2. Haematology

DSE - B (ONE course in Semester 6)

1. Work, Exercise and Sports Physiology
2. Human Nutrition and Dietetics

Ability Enhancement Compulsory Courses(AECC)

AECC- 1: Communicative English or any other Modern Indian Language in

Semester 1 **AECC-2:** Environmental Studies in Semester 2

Skill Enhancement Course (SEC)

SEC -- A (ONE course in Semester 3)

1 Microbiology & Immunology
2. Clinical Biochemistry

SEC -- B (ONE course in Semester 4)

1. Detection of Food Additives /Adulterants and Xenoboiotics
2. Communty health and formulation of diet charts.

Outline of Courses and Credits in Each Semester

Semester I

Core Courses (CC).Theoretical (TH)

CC1TH / GEN 1 TH

Cellular Basis of Physiology

Structure and functions of plasma membrane, nucleus and different cell organelles – Endoplasmic reticulum, Golgi bodies,Mitochondria, Lysosome and Peroxisome.

Biophysical Principles, Enzymes and Chemistry of Bio-molecules

Physiological importance of the following physical processes: Diffusion , Osmosis and Surface tension. pH and Buffers – Significance in human body and maintenance of pH in the blood. Colloids - Classification and physiological importance.

Enzymes: Classification, factors affecting enzyme action. Concept of coenzymes and isozymes.

Carbohydrates **:** Definition and classification.
Monosaccharides – Classification, structure, physiological importance.
Disaccharides **—**Maltose, Lactose and Sucrose: Structure, occurrence and physiological importance.
Polysaccharides **—**Starch, Glycogen, Dextrin, Cellulose.
Lipids : Definition and classification. Fatty acids Classification. — Definition and importance of, Saponification number and,
Iodine number.. Phospholipids, Cholesterol &
its ester **—**physiological importance.
Amino acids, Peptides and Proteins**:** Classification and structure. Structure of peptide bonds.

Nucleic acids:Structure of DNA and RNA.

Digestion & Metabolism

Structure in relation to functions of alimentary canal and digestive glands. Composition, functions and regulation of secretion of digestive juices including bile. Digestion and absorption of carbohydrate, protein and lipid. Movements of the stomach and small intestine.
Glycolysis, TCA cycle, Importance of Glycogenesis, Glycogenolysis and. Gluconeogenesis. Beta oxidation of saturated fatty acid. Importance of Ketone bodies . Deamination & Transamination. Formation of urea . (4)

CC1P / GEN 1P:

Examination and staining of fresh tissues : Squamous, Ciliated and Columnar Epithelium by Methylene Blue stain.
Qualitative tests for identification of : Glucose, Fructose, Lactose, Sucrose, Starch, Dextrin, Lactic acid, Hydrochloric acid , Albumin, Acetone, Glycerol and Bile Salts.
Quantitative estimation of amino nitrogen by Sorensen's formol titration method (percentage to be done) (2) **.**

Semester II

CC2TH / GEN 2TH-

Blood and Body Fluids

Blood: composition and functions. Plasma proteins: origin and functions. Blood cells-- their morphology and functions. Erythropoiesis. Hemoglobin : different types of compounds and derivatives. Coagulation of blood: mechanism, procoagulants, anticoagulants.. Lymph and tissue fluids: composition, formation, and functions.

Cardiovascular System

Anatomy and histology of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Cardiac cycle : Events. Heart sounds. Heart rate. Cardiac output: Determination by following Fick principle, factors affecting. Pulse - arterial and venous. Blood pressure and factors controlling. Baro- and chemoreceptors. Vasomotor reflexes. Peculiarities of regional circulations: coronary and cerebral.

Respiratory System

Anatomy and histology of the respiratory passage and organs.Role of respiratory muscles in breathing. Lung volumes and capacities. Exchange of respiratory gases between lung and blood and between blood and tissues. Transport of oxygen and carbon dioxide in blood. Regulation of respiration - neural and chemical. Hypoxia. (4)

CC2P GEN 2P:

Preparation and staining of human blood film with Leishman's stain and identification of different types of blood cells.
Preparation of hemin crystals.
Demonstration- kymographic recording of the unperfused heart of toad and effects of warm and cold saline.
Measurement of systolic and diastolic pressure by sphygmomanometer and determination of pulse and mean pressure.
Measurement of peak expiratory flow rate.
Pneumographic recording of normal respiratory movements and effects of hyperventilation and breath-holding. (2)

Semester III

CC3TH / GEN 3TH

Nerve-muscle Physiology

Structure of neurons. Origin and propagation of nerve impulse. Velocity of impulse in different types of nerve fiber. Properties of nerve fibers: all or none law, rheobase and chronaxie, refractory period. indefatiguability. Synapses: structure, mechanism of synaptic transmission. Motor unit. Myoneural junction: structure, mechanism of impulse transmission. Degeneration and regeneration in nerve fibers.

Different types of muscle and their structure. Red and white muscle. Muscular contraction: structural, mechanical and chemical changes in skeletal muscle during contraction and relaxation. Isotonic and isometric contractions. Properties of muscle: all or none law, beneficial effect, summation, refractory period, tetanus, fatigue.

Nervous System

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system, central and peripheral nervous system. Ascending tracts carrying touch, kinaesthetic,temperature and pain sensations. Descending tracts: pyramidal tract and brief outline of the extra-pyramidal tracts. Reflex action -

definition, reflex arc, classification, properties. Functions of the spinal cord. Outline of functions of brain stem.
A brief idea of the structure, connections and functions of cerebellum. Different nuclei and functions of thalamus and hypothalamus. Cerebral cortex: histological structure and localization of functions. CSF : composition, formation, circulation and functions. A brief description of the organization of the autonomic (sympathetic and parasympathetic) nervous system. Functions of sympathetic and parasympathetic nervous system. A brief idea of speech, aphasia, conditioning, learning and memory.

Special Senses

Olfaction and Gustation: Structure of sensory organ, neural pathway of olfactory and gustatory sensation. Mechanism of olfactory and gustatory sensation. Olfactory and gustatory adaptation. After-taste.

Audition: Structure of ear, auditory pathway, mechanism of hearing.

Vision: Structure of the eye. Histology of retina. Visual pathway. Light reflex. Chemical changes in retina on exposure to light. Accommodation - mechanism. Errors of refraction. Light and dark adaptation. Elementary idea of colour vision and colour blindness. (4)

CC3P / GEN 3P:

Silver Nitrate preparation of nodes of Ranvier.
Silver nitrate preparation of corneal cell space.
Examination and staining of skeletal and cardiac muscles by Methylene Blue stain.
Demonstration : Use of kymograph, induction coil and mercury key. Recording of simple muscle curve with sciatic-gastrocnemius muscle preparation of toad.
Determination of visual acuity by Snellen's chart / Landolt's C chart. Determination of colour blindness by Ishihara chart.
Exploration of conductive and perceptive deafness by tuning fork method. (2)

Semester IV

CC4TH / GEN 4TH

Endocrinology

Hormones - classification. Elementary idea of mechanism of hormone action.

Hypothalamus: Basic concept of neurohormone.
Hypothalamo-hypophyseal tract and portal system.
Pituitary: Histological structure, hormones, functions. Hypo and hyper active states of pituitary gland.
Thyroid: Histological structure. Functions of thyroid hormones (T_4T_3).
Thyrocalcitonin. Hypo and hyper-active states of thyroid.
Parathyroid: Histological structure, functions of parathyroid hormone. Tetany.
Adrenal Cortex: Histological structure and functions of different hormones. Hypo and

hyper-active states of adrenal cortex.

Adrenal Medulla: Histological structure and functions of medullary hormones. The relation of adrenal medulla with the sympathetic nervous system.
Pancreas: Histology of islets of Langerhans. Origin and functions of pancreatic hormones. Diabetes mellitus.
Brief idea of the origin and functions of renin-angiotensin, prostaglandins. erythropoietin and melatonin. Elementary idea of gastrointestinal hormone.

Reproductive Physiology

Primary and accessory sex organs and secondary sex characters. Testis: histology, spermatogenesis, testicular hormones and their functions. Ovary: histology, oogenesis, ovarian hormones and their functions.
Menstrual cycle and its hormonal control.
Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

Excretory Physiology

Structure and function relationship of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Physiology of micturition. Renal regulation of acid-base balance. Non-excretory functions of kidney.

Structure and functions of skin. Insensible and sensible perspiration Regulation of body temperature —physical and physiological processes involved in it. Physiology of sweat secretion and its regulation. (4)

CC4P / GEN 4P:

Study and Identification of Stained Sections of Different Mammalian Tissues and Organs: Esophagus, Stomach, Small Intestine, Large Intestine, Liver, Lung,Trachea, Spinal cord, Cerebral cortex, Cerebellum, Thyroid Gland, Adrenal Gland, Pancreas, Spleen,Testes, Ovary, Kidney, Artery and Vein.
Identification of :
Normal constituents of urine : Chloride, Sulphate, Phosphate, Creatinine and Urea; Abnormal constituents of urine: Glucose, Protein, Acetone, Bile pigment and Bile Salt. (2)

Suggested Readings

1. *Human Physiology Vol. 1* & 2, C. C. Chatterjee, Medical Allied Agency.
2. *Sharirbigyan (Bengali) Vol. I* & 2, J. Debnath, Sridhar Prakashani.
3. *Principles of Physiology,* D.Pramanik, Academic Publishers, Kolkata.
4. *Concise Medical Physiology,S.* K. Chaudhuri, New Central Book Agency.
5. *Biochemistry,* D. Das, Academic Publishers.
6. *Paripak, Bipak* 0 *Pusti,* D. Das, Paschim Banga Rajya Pustak Parshad.
7. *Snatok Sharirbidya*, A. Bandopadhyay, Calcutta Book House.
8. diFiore's Atlas of Histology, V.P. Eroschenko, Wolters-Kluwer
9. *Essentials of Exercise Physiology,* L.G. Shaver, Surjeet Publications.
10. *Text Book of Medical Physiology,* A.C.Guyton, W.B. Saunders Co.
11. Textbook of Medical Physiology, D.Venkatesh & H.H.Sudhakar, Wolters Kluwer

12. Textbook of Medical Physiology, Indu Khurana, Elsevier

15. *Medical Physiology,* A.B. Singha Mahapatra, Current Books International.
16. *Essentials of Medical Physiology:* K. Sembulingam and P. Sembulingam, Jaypee Brothers Medical Publishers Pvt. Ltd. 19. *Nutritive Value of Indian Foods* by C. Gopalan and other, NIN, Hyderabad.
20. *Practical Physiology*, by M.K. Manna, Sritara Prakashani, Kolkata

Discipline Specific Electives

DSE: GROUP-A

Biological Statistics (DSE A1TH)

Basic concepts– Variable, population, parameter, sample, statistic. Classification of data – qualitative and quantitative, continuous and discontinuous. Presentation of data–frequency distribution, bar diagram, pie diagram, frequency polygon and histogram.
Mean, median, mode, standard deviation and standard error of ungrouped data. Concept of probability, Null and Alternate Hypotheses, Characteristics and uses of Normal and t-distributions. (4)

DSE A1P

Computation of mean, median, mode, standard deviation and standard error of the mean using physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in bar diagram, pie diagram frequency polygon and histogram. (2)

Suggested Readings
1. Statistics in Biology and Psychology by D.Das and A.Das Academic Publishers.
2. Essentials of Biostatistics, I.Saha and B.Paul, Academic Publishers.

Haematology (DSE A2TH):

Blood groups - ABO and Rh. Immunological basis of identification of ABO and Rh blood groups. Biochemical basis of ABO system and Bombay phenotype.Blood transfusion - precaution and hazards. Concept of blood bank.
Erythropoietin and thrombopoietin .Foetal haemoglobin.Abnormal haemoglobins - thalassaemia and sickle-cell anaemia. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV, MHC, MCHC, bleeding time, clotting time and prothrombin time. Anaemia - types (definition and causes). Leucocytosis, Leucopenia and Leukaemia. Purpura. Disorders of coagulation. (4)

DSE A2P:

DC of WBC, Estimation of haemoglobin , Blood group determination, Bleeding time and Clotting time. (2)

Suggested Readings
1. Medical Physiology A.B.S. Mahapatra, Current Books International.
2. Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

DSE: GROUP - B

Work & Exercise Physiology and Ergonomics (DSE B1TH) Concept of physical work and physiological work. Classification of work loads. Energetics of muscular work. Measurement of energy cost. Cardiovascular and respiratory responses to graded exercise.Maximal oxygen consumption and post-exercise oxygen consumption – definition, factors affecting, measurement and significance. Muscle fatigue and recovery. Physical fitness and its assessment by modified Harvard Step Test.
Ergonomics. Importance of ergonomics in occupational health and well being. Definition of anthropometry. Different body dimensions measured in anthropometry and their significance. (4)

DSE B1P

Measurement of resting and working heart rate using thirty beats and ten beats methods respectively.
Measurement of blood pressure before and after exercise.
Determination of Physical Fitness Index by modified Harvard Step Test.
Measurement of some common anthropometric parameters- stature, weight, eye height (standing), shoulder height, sitting height, knee height (sitting), arm reach from wall, mid-arm circumference, waist circumference, hip circumference, neck circumference,head circumference, chest circumference.
Calculation of BSA and BMI from anthropometric data. (2)

Suggested Readings
1. Essentials of Exercise Physiology, V.L. Katch, W.D. McArdle, F.I. Katch, Wolters Kluwer 2. Exercise Physiology and Ergonomics An Introduction, A.Goswami, Academic Publishers.

Human nutrition and dietetics (DSE B2TH):

Basic constituents of food and their nutritional significance. Vitamins-Classification, functions, deficiency symptoms and daily requirements. Hypervitaminosis. Mineral metabolism – Ca, P, Fe. BMR: definition, factors affecting. Respiratory quotient: definition, factors affecting and significance. Biological value of proteins. Essential and non-essential amino acids. Nitrogen balance. SDA : definition and importance. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Dietary fibres. Principles of diet survey. Composition and nutritional value of common food stuffs. (4)

DSE B2P:

Diet survey report (hand-written) of a family (as per ICMR specification): Each student has to submit a report on his/her own family. (2)

Suggested Readings
1. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co. 2. Biochemistry, U. Satyanarayan, NCBA

Ability Enhancement Compulsory Courses (AECC)

English / MIL Communication (AECC 1TH):
Environmental Science (AECC 2TH)

Skill Enhancement Course (SEC)

SEC A

Microbiology & Immunology (SECA1)

Viruses - DNA virus and RNA virus. Viroids and Prions. Bacteriophages. Bacteria-structure and morphological classification. Gram positive and Gram negative and acid-fast bacteria. Pathogenic and non-pathogenic bacteria - definition with a few examples. Physical and chemical methods used in disinfection,sterilization and pasteurization. Nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement). Bacterial growth curve. Elementary idea of bacteriostatic and bacteriocidal agents.

Beneficial and harmful microorganisms in food.
Elementary knowledge of innate and acquired immunity. Humoral and cell mediated immunity. Toxins and toxoids.Vaccination – Passive and active immunisation, types and uses of vaccine.
Immunological basis of allergy and inflammation. (2)

Suggested readings:
1. Microbiology, Pelczar Tata McGrawhill.
2. Prescott's Microbiology, J. Willey *et.al*., McGraw-Hill

Clinical Biochemistry (SEC A2)

Pathophysiological significance of the following blood constituents: glucose, serum protein, albumin, urea, creatinine, uric acid, bilirubin and ketone bodies. Lipid profile in health and diseases. Pathophysiological significance of the following serum enzymes and isozymes: Lactate dehydrogenase, Creatine kinase, Amylase, Acid and Alkaline phosphatases, β-glucurodinase SGPT and SGOT. (2)

SEC B

Detection of Food Additives / Adulterants & Xenobiotics (SEC B1):

Definition of food adulterants/ additive. Tests for identifying food adulterants-- Metanil yellow, Rhodamin B, Saccharin, Monosodium glutamate, Aluminium foil , Dioxin, Chicory and Bisphenol.

Concept of Xenobiotics- Types, sources and fate. Types of reactions in detoxification and their mechanisms- oxidation,reduction, hydrolysis and conjugation. (2)

Suggested Readings:

1. Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill
2. Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

Community and Public Health (SEC B2)

Basic idea about community, public health issues.

Malnutrition in a community, over nutrition and possible remedial measures. Diet management of obese, diabetic.

Basic idea of PCM and their prevention.

PCM -- Marasmus, kwashiorkor. Endemic goiter, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Etiology, epidemiology and prevention of: Communicable diseases : Malaria, Dengue, Hepatitis and AIDS; Non-communicable diseases – Hypertension and Obesity.

Population problem – principles and methods of family planning, and Assisted Reproductive Technologies.

Principles of formulation of diet chart of growing children, pregnant & lactating women and diabetic patients. (2)

Suggested Reading

1. Park’s Textbook of Preventive and Social Medicine, K.Park, M/s. Banarasidas Bhanot, 2015.