

SYLLABUS FOR
4-Years Bachelor's Degree Programme
(Major/ Honours / Honours with Research)

PHYSIOLOGY

2023



WEST BENGAL STATE UNIVERSITY

Course and Curriculum with effect from 2023-2024

Name of Programme: 4-Years B.Sc. (Honours / Honours with Research) Courses in Physiology

Programme Specific Objectives:

The main objective of the course is to know the systematic, extensive and coherent knowledge and understanding of human body as a whole. The applications and links to disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of Physiology.

Outcome of the Programme

At the end of the curriculum of Physiology course, the student would able to

- understand the all physiological systems of human body like cardiovascular system, respiratory system, nervous system, endocrine and reproductive system, reticuloendothelial system excretory system, immune system and musculoskeletal system;
- understand how these separate systems interact to yield integrated physiological response to challenges such as high altitude, stress and exercise;
- explain the mechanisms in maintaining homeostasis, molecular mechanism of cell signalling, aging, cancer and other pathological disorders;
- perform and analyse the biophysical, biochemical and histological experiments;
- formulate the diet chart for adult, child, lactating and pregnant mother;
- enhance their skills regarding different techniques and analysis of samples;
- perform data analysis and interpretation of observed result of field work and research work.

Physiology Honours

SEM	MAJOR (DSC) with Course Code 5 credits each	SEC For Major 3 credits each
1	DS 1 – Fundamentals of Anatomy and Physiology (PHYDSC101T, PHYDSC101P)	SEC 1 - Haematological techniques PHYHSE101M/PHYGSE301M/PHYGSE401M/ PHYGSE501M/PHYGSE601M
2	DS 2 - Biophysical principles & Enzymes (PHYDSC202T, PHYDSC202P)	SEC 2 - Biomedical Instruments and Computer Applications in Physiology (PHYHSE202M/PHYGSE302M/PHYGSE402M/ PHYGSE502M/ PHYGSE602M)
3	DS 3 –Chemistry of Biomolecules (PHYDSC303T, PHYDSC303P)	
4	DS 4 - Circulating body fluids & Cardiovascular system PHYDSC404T, PHYDSC404P, DS 5 – Respiration& Sports Physiology (PHYDSC405T, PHYDSC405P) DS 6 - Gastrointestinal Physiology (PHYDSC406T, PHYDSC406P), DS 7 - Energy Balance metabolism and nutrition (PHYDSC407T, PHYDSC407P)	
5	DS 8 - Physiology of Environment & Altered Environment (PHYDSC508T, PHYDSC508P), DS 9 – Nerve Muscle Skeletal Physiology (PHYDSC509T, PHYDSC509P), DS 10 - Nervous system (PHYDSC510T, PHYDSC510P), DS 11 - Special Senses (PHYDSC511T, PHYDSC511P)	
6	DS 12 - Excretory Physiology (PHYDSC612T, PHYDSC612P), DS 13 - Endocrinology & Reproductive Physiology (PHYDSC613T, PHYDSC613P), DS 14 - Microbiology & Immunology (PHYDSC614T, PHYDSC614P) DS 15 - Ergonomics (PHYDSC615T, PHYDSC615P)	
7	DS 16 - Developmental Biology and Embryology (PHYDSC716T, PHYDSC716P) DS 17 - Biostatistics (PHYDSC717T, PHYDSC717P)	
8	DS 18 Molecular biology & Genetics (PHYDSC818T, PHYDSC818P) DS 19 - Pharmacology & Toxicology (PHYDSC819T, PHYDSC819P) DS 20 - Community Health & Epidemiology (PHYDSC820T, PHYDSC820P) DS 21 - Review work (PHYDSC821P)	

Physiology Honours (With Research)

SEM	MAJOR (DSC) with Course Code 5 credits each	SEC For Major 3 credits each
1	DS 1 – Fundamentals of Anatomy and Physiology (PHYDSC101T, PHYDSC101P)	SEC 1 - Haematological techniques PHYHSE101M/PHYGSE301M/PHYGSE401M/ PHYGSE501M/PHYGSE601M
2	DS 2 - Biophysical principles & Enzymes (PHYDSC202T, PHYDSC202P)	SEC 2 - Biomedical Instruments and Computer Applications in Physiology (PHYHSE202M/PHYGSE302M/PHYGSE402M/PHYGSE502M/ PHYGSE602M)
3	DS 3 –Chemistry of Biomolecules (PHYDSC303T, PHYDSC303P)	
4	DS 4 - Circulating body fluids & Cardiovascular system (PHYDSC404T, PHYDSC404P) DS 5 – Respiration& Sports Physiology (PHYDSC405T, PHYDSC405P) DS 6 - Gastrointestinal Physiology (PHYDSC406T, PHYDSC406P), DS 7 - Energy Balance metabolism and nutrition (PHYDSC407T, PHYDSC407P)	
5	DS 8 - Physiology of Environment & Altered Environment (PHYDSC508T, PHYDSC508P), DS 9 – Nerve Muscle Skeletal Physiology (PHYDSC509T, PHYDSC509P), DS 10 - Nervous system (PHYDSC510T, PHYDSC510P), DS 11 - Special senses (PHYDSC511T, PHYDSC511P)	
6	DS 12 - Excretory Physiology (PHYDSC612T, PHYDSC612P), DS 13 - Endocrinology & Reproductive Physiology (PHYDSC613T, PHYDSC613P), DS 14 - Microbiology & Immunology (PHYDSC614T, PHYDSC614P) DS 15 - Ergonomics (PHYDSC615T, PHYDSC615P)	
7	DS 16 Developmental Biology and Embryology (PHYDSC716T, PHYDSC716P) DS 17 - Biostatistics (PHYDSC717T, PHYDSC717P)	
8	DS 18 Molecular biology & Genetics (PHYDSC818T, PHYDSC818P) DS 19 Research Work (PHYRES801M) (15 Credits)	

Basic Structural Framework of Syllabus

21 Discipline Specific courses (DSC)/Major: DSC 1 TO 21: Theory and Practical, 5 Credit each
 3 Skill Enhancement Courses (SEC): SEC 1 to 3, 3 Credit each

Course Code	Subject of Course	Distribution of Credit		Total Credit
		TH	PR	
	Semester I			
PHYDSC101T	Fundamentals of Anatomy and Physiology	03	00	03
PHYDSC101P	Cellular Physiology lab	00	02	02
	Total	03	02	05
	Semester II			
PHYDSC202T	Theory: Biophysical Principles & Enzymes	03	00	03
PHYDSC202P	Biophysical Principles & Enzymes lab	00	02	02
	Total	03	02	05
	Semester III			
PHYDSC303T	Chemistry of Biomolecules	03	00	03
PHYDSC303P	Chemistry of Biomolecules Lab	00	02	02
	Total	03	02	05

Course Code	Subject of Course	Distribution of Credit		Total Credit
		TH	PR	
	Semester IV			
PHYDSC404T	Theory: Circulating Body Fluids & Cardiovascular System.	03	00	03
PHYDSC404P	Circulating Body Fluids & Cardiovascular Lab	00	02	02
	Total	03	02	05
PHYDSC405T	Theory: Respiration and Sports Physiology	03	00	03
PHYDSC405P	Respiration and Sports Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC406T	Theory: Gastrointestinal Physiology	03	00	03
PHYDSC406P	Gastrointestinal Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC407T	Theory: Energy Balance, Metabolism and Nutrition	03	00	03
PHYDSC407P	Energy Balance, Metabolism and Nutrition Lab	00	02	02
	Total	03	00	05

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Course Code	Subject of Course	Distribution of Credit		Total Credit
	Semester V	TH	PR	
PHYDSC508T	Theory: Physiology of Environment & Altered Environment	03	00	03
PHYDSC508P	Environmental Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC509T	Theory: Nerve Muscle Skeletal Physiology	03	00	03
PHYDSC509P	Nerve Muscle Skeletal Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC510T	Theory: Nervous System.	03	00	03
PHYDSC510P	Nervous System Lab	00	02	02
	Total	03	02	05
PHYDSC511T	Theory: Special Senses.	03	00	03
PHYDSC5111P	Special Senses Lab	00	02	02
	Total	03	02	05

Course Code	Subject of Course	Distribution of Credit		Total Credit
	Semester VI	TH	PR	
PHYDSC612T	Theory: Excretory Physiology	03	00	03
PHYDSC612P	Excretory Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC613T	Theory: Endocrinology and Reproductive Physiology	03	00	03
PHYDSC613P	Endocrinology and Reproductive Physiology Lab	00	02	02
	Total	03	02	05
PHYDSC614T	Theory: Microbiology and Immunology	03	00	03
PHYDSC614P	Microbiology and Immunology Lab	00	02	02
	Total	03	02	05
PHYDSC615T	Theory: Ergonomics	03	00	03
PHYDSC615P	Ergonomics Lab	00	02	02
	Total	03	00	05

	Semester VII	TH	PR	
PHYDSC716T	Developmental Biology and Embryology	03	00	03
PHYDSC716P	Developmental Biology and Embryology Lab	00	02	02
	Total	03	02	05
PHYDSC717T	Biostatistics	03	00	03
PHYDSC717P	Biostatistics Lab	00	02	02
	Total	03	02	05

Course Code	Subject of Course	Distribution of Credit		Total Credit
	Semester VIII	TH	PR	
PHYDSC818T	Theory: Molecular biology & Genetics	03	00	03
PHYDSC818P	Molecular biology & Genetics Lab	00	02	02
	Total	03	02	05
PHYDSC819T	Theory: Pharmacology & Toxicology	03	00	03
PHYDSC819P	Pharmacology & Toxicology Lab	00	02	02
	Total	03	02	05
PHYDSC820T	Theory: Community Health & Epidemiology	03	00	03
PHYDSC820P	Epidemiology Lab	00	02	02
	Total	03	02	05
PHYDSC821P	Review Work	00	05	05
	Total	00	05	05

Honours with Research

Course Code	Subject of Course	Distribution of Credit		Total Credit
	Semester VIII	TH	PR	
PHYDSC818T	Theory: Molecular biology & Genetics	03	00	03
PHYDSC818P	Molecular biology & Genetics Lab	00	02	02
	Total	03	02	05
PHYRES801M	Research Work	00	15	15
	Total	00	15	15

Discipline Specific courses (DSC)

SEMESTER – I

Total Credit – 05 (Theory-03, Practical - 02)

Theory, Paper Code: PHYDSC101T (Credit: 03)

Fundamentals of Anatomy and Physiology

Anatomical directional terms, planes and positions of human body. Anatomy of Heart, Lungs, Skin and Kidney.

Histological structure, classification, distribution of different tissues (Epithelial, Connective, Muscular and Nervous tissues) and functions.

Functional morphology of cell: Structure of plasma membrane - Bio-chemical components, their arrangement, membrane asymmetry and fluidity, transmembrane proteins and hydrophathy plot. Membrane lipids, membrane dynamics, fluidity of bilayer, lipid rafts, Fluid Mosaic Model. Experimental evidences of the fluid mosaic structure of Plasma Membrane.

Endoplasmic reticulum: EM structure of smooth and rough ER and functions. Microsomes: basic functional aspects. Golgi complex: structure, its storage and processing functions (Molecular basis). Lysosomes and its functions. EM structure and functions of nucleus. Peroxisomes and its function. Mitochondria: EM structure and its functions. EM structure of nucleus-structure of nuclear membrane and nucleolus. Ribosomes – structure and functions. Microtubules and their role in cellular movements and secretions. Cytoskeleton: Microtubule, Intermediate filaments and Microfilament. Intercellular Junctions: Cell adhesion molecules (CAMs)-Types, Mechanism of Adhesions, Intercellular connections: Tight junctions, Desmosomes and Gap junctions (structure and functions).

Transport Through Cell Membrane: Passive Transport-Simple diffusion (Protein Channels- aquaporins; Gated Channels-Voltage gated, Ligand gated Channels & mechano-gated channels) and Facilitated diffusion -Mechanism, Types of Carrier Protein system (Uniport, Symport and Antiport); Active Transport-Types of active transport (Primary- Na^+ - K^+ -pump and Secondary); Ionophores. Artificial membrane: liposome and its functions, erythrocyte ghost.

Cell cycle – events and regulatory role of cyclins and CDK, Role of proto-oncogenes (focus on Ras gene) and tumour. Cell Division: Phases and Significance of Mitosis & Meiosis. Cell death: Necrosis, Autophagy, Apoptosis - Molecular mechanism of extrinsic and intrinsic pathway, analysis of apoptosis in cells.

Cell signaling: G-proteins, G-protein coupled receptors. Calcium, IP3 & DAG, cAMP, cGMP as second messengers. JAK-STAT pathway. RAS pathway. MAP kinase pathway. PI3 kinase pathway.

Practical, Paper Code: PHYDSC101P (Credit: 02)
Fundamentals of Anatomy and Physiology Lab

1. Demonstration of different organs and systems of human body through different models and chart.
2. Identifications of different bones and joints of human skeleton system through different models and chart.
3. Principle, use and functions of compound microscope.
4. Fresh tissue experiments: Suitable staining and examination of fresh tissues- Squamous and columnar epithelium (methylene blue) and adipose (Sudan III or IV). Specimens should be taken strictly from mammals.
5. Histology: Study and Identification of Stained Sections of Different Mammalian Tissues: Cardiac muscle, Skeletal muscle, Smooth muscle, Bone, Cartilage, Trachea, Lungs, Spleen, Lymph gland, Tongue, Salivary glands -Parotid, Sublingual, Submandibular, Esophagus, Stomach, Duodenum, Ileum, Jejunum, Large Intestine, Liver, Kidney, Ureter, Pancreas, Adrenal gland, Thyroid gland, Testes, Ovary, Spinal Cord, Cerebral cortex, Cerebellum, Skin, Artery, Vein.

SEMESTER – II

Total Credit – 05 (Theory-03, Practical - 02)

Theory, Paper Code: PHYDSC202T (Credit: 03)

Biophysical Principles & Enzymes

Diffusion, Viscosity, Surface tension- Definition, Factors influencing and biological applications. Osmosis: Definition, Osmotic pressure- laws, determination – freezing point depression method and biological applications. pH, Determination of pH –Basic concept of indicators, principle of pH meter- hydrogen electrode and glass electrode. Biological significance of pH. Buffers in pH regulation, Henderson Hasselbach –equation (quantitative problems). Colloids: Classification, properties – optical, electrical, electrokinetic. Biological importance of colloids. Ultrafiltration, Ultracentrifugation. Definition and physiological importance of Dialysis, adsorption, 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

Classification- IUBMB nomenclature, Concept of apoenzyme, holoenzyme, cofactors, coenzyme, and prosthetic group. Mechanism of enzyme action: Activation energy, Enzyme-substrate complex, Transition state and Products. Models of enzyme-substrate interactions. Specificity of enzymes. Catalytic Mechanisms. Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics-- Lineweaver-Burk plot. Significance of K_m and V_{max} . Factors influencing enzyme-catalyzed reactions: substrate concentration, enzyme concentration, pH, temperature. Competitive, non-competitive and uncompetitive inhibitions. Regulation of enzyme activities -- covalent modifications, allosteric modifications – Sigmoid kinetics and Hill equation: K- and M-series, Model of Allosteric modulation, Feed-back inhibition. Rate-limiting enzymes. Isozymes, Ribozymes and Abzymes.

Practical, Paper Code: PHYDSC202P (Credit: 02; Marks: 30)

Biophysical Principles & Enzymes Lab

- a) Preparation of 1M and 0.5 M Phosphate Buffer Solution (PBS).
- b) Preparation of 1N and N/10 NaOH solution.
- c) Measurement of pH of given buffer solution/biological sample.
- d) Determination of Alanine Aminotranferase (ALT) activity from tissue sample.
- e) Determination of Aspartate Aminotranferase (AST) activity from tissue sample.
- f) Determination of Alkaline phosphatase (ALP) activity from tissue sample.
- g) Preparation of Sucrose gradient.
- h) Salivary amylase activity on starch at body temperature (37.5°C), above 40°C and in presence of HCl (Demonstration)

SEMESTER – III

Total Credit – 05 (Theory-03, Practical - 02)

Theory, Paper Code: PHYDSC303T (Credit: 03)

Chemistry of Biomolecules

Chemistry of 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 & proteoglycan.

Chemistry of proteins:

Amino acids: Structure, Classification and Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

Proteins: Different levels of protein structure – Primary and secondary (α -helix and β -pleated sheet) structure. Structure and properties of peptide bonds. Phi and Psi angles. Tertiary and Quaternary structure. Forces stabilizing the structures. Denaturation and Renaturation.

Chemistry of lipids:

Definition and classification. Fatty acids - Classification, systemic nomenclature and structure. Triacylglycerols. Properties of Fat and Fatty acids: Hydrolysis, Saponification, Saponification number, Iodine number, Acetylation, Acetyl number, Hydrogenation, Rancidity. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester - their structure and physiological importance. Lipoproteins - Structure and classification.

Chemistry of nucleotides and nucleic acids:

Nucleotide structure. Nucleic acid structure. Polynucleotides. DNA double helix - Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. Supercoiled DNA. RNA - types. Clover-leaf and L-shaped structure of tRNA. Denaturation and Renaturation. Hyperchromicity,

Practical, Paper Code: PHYDSC303P (Credit: 02)

Chemistry of Biomolecules Lab

Qualitative tests for the identification of physiologically important substances:

Carbohydrates: glucose, fructose, lactose, sucrose, maltose, starch, dextrin.

Protein: albumin, gelatin, peptone.

Lipid: glycerol, acetone, cholesterol.

Others: hydrochloric acid, lactic acid, uric acid, urea, bile salts.

SEMESTER – IV

No. of Discipline Specific courses (DSC): 4 Courses (Viz. PHYDSC404, PHYDSC405, PHYDSC406, PHYDSC407)

Total Credit in Each course – 05 (Theory-03, Practical - 02)

PHYDSC404: Circulating Body Fluids & Cardiovascular System

Theory, Paper Code: PHYDSC404T (Credit: 03)

Circulating Body Fluids

Blood: Composition and Function. **Bone marrow:** Types and Functions. **Plasma proteins:** normal values, origin, classification, separation by salting out and electrophoresis, Plasmapheresis. **Red blood cells:** Introduction, fate. **Erythropoiesis:** Mechanism, factors controlling. **Hemoglobin:** Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia. Polycythemia, ESR. TC, DC, PCV, MCH, MCHC, MCV. Different types of anaemia. Fetus hemoglobin. Glycosylated hemoglobin.

White blood cells: Introduction, classification, Leukopoiesis, Arneeth count, Functions of WBC. **Platelets:** Histology, functions, purpura.

Blood Coagulation: Definition, clotting factors, mechanism, intravascular clotting, factors hastening coagulation, anticoagulants, procoagulants. Bleeding time, Clotting time, Prothrombin time, Disorders of hemostasis -Hemophilia.

Blood volume – normal values, regulation and determination by dye and radioisotope methods., Thrombosis and Embolism.

Blood group: ABO groups, Rh factors. Erythroblastosis foetalis. Blood transfusion and its hazards

Lymph: Composition, formation, circulation, functions. Structure & functions of lymph gland. **Spleen:** Structure, functions.

Cardiovascular System

Anatomical Organization of cardiovascular System. Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids. Properties of cardiac muscle. Special Junctional tissues of heart. Origin and propagation of cardiac impulse. Stannius ligature. **The Cardiac cycle**-definition, time, events pressure and volume changes. Heart sounds. Murmurs. Heart Rate. **Cardiac output** – measurement by application of Fick's principle and dye dilution method, factors affecting. **Starling's** law of heart. **Electrocardiography** – the normal electrocardiogram, electrocardiographic leads, Interpretation of ECG, Einthoven's triangle, Wenckebach phenomenon, Myocardial Infarctions, Vectorial analysis, the vectorcardiogram,

the mean electrical axis of heart. Cardiac Arrhythmias. Artificial pacemaker. Angiography and angioplasty. Ventricular Hypertrophy

Blood pressure definition and factors affecting, Determination methods. Venous pressure. **Cardiovascular Control:** Innervation of blood vessels & heart, Medullary control of cardiac functions. Nervous regulation of blood pressure. Baroreceptors and chemoreceptors: peripheral and central. cardiac and vasomotor reflexes.

Regional Circulation: Cerebral Circulation, Anatomic Considerations, Cerebral Blood Flow, Regulation of Cerebral Circulation, Coronary Circulation, Hepatic Circulation, Pulmonary Circulation, Splanchnic Circulation, Circulation through Skeletal muscle, Cutaneous Circulation.

Practical, Paper Code: PHYDSC404P (Credit: 02) Circulating Body Fluids & Cardiovascular System Lab

- i) Preparation & staining of blood film with Leishman's stain
- ii) Identification of blood cells
- iii) Total Count of RBC using improved Neubauer's Chamber
- iv) Haemoglobin estimation
- v) Preparation of hemin crystal.
- vi) Preparation and staining of bone marrow smear
- vii) Determination of Bleeding, clotting time & prothrombin time.
- viii) Kymographic recording of normal movement of perfused heart of toad.
- ix) Study of the effects of changes in perfusion fluid pressure, changes in temperature, excess calcium & potassium, acetylcholine and adrenaline.
- x) Measurement of Blood Pressure, pulse pressure, mean pressure and study of blood pressure with the changes of postures (Standing, Supine, Sitting).
- xi) Study of pulse rate as an effect of breath-holding

**PHYDSC405: Respiration and Sports Physiology
Theory, Paper Code: PHYDSC405T (Credit: 03)**

Respiration

Anatomy and histology of the lung and airways. Mechanics of Respiration: Muscles of respiration, Movement of thoracic cage, respiratory pressures, pressure-volume relationships, Compliance of lungs. Work of breathing. Lung volumes and capacity. Alveolar surface tension and surfactant. Ventilation: Pulmonary & alveolar ventilation, Dead space and ventilation perfusion ratio. Spirometry. Transport of oxygen and carbon dioxide 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, pulmonary receptors. Apnea, Hyperventilation, Hypoxia – types, effects. Hyper & hypo-capnia,

Asphyxia, Dyspnea, Cyanosis, Periodic breathing, Asthma, Pulmonary edema, Emphysema. Artificial respiration. COPD, Concept of non-respiratory functions of lung. Lung function tests.

Sports Physiology

Human energy transfer during exercise: Immediate energy, Short-term energy, Long-term energy, Oxygen deficit, Maximum oxygen uptake, Energy transfer in fast & slow twitch muscle fibers, Oxygen debt, Concept of excess post exercise oxygen consumption (EPOC), physiological fatigue and recovery.

Cardio-respiratory responses during different grades of exercise.

Physical Training – Principles, Warm up and Cool down, Adaptive changes in cardiovascular and respiratory system. Adaptive changes in muscles. Overtraining and detraining. Training methods for endurance, strength and speed in sports activities.

Nutritional & Pharmacologic aids in sports: Phosphate loading, Anti-Cortisol producing compounds, Creatine, Chromium, Ginseng & Ephedrine, Amino acid supplements, Coenzyme Q-10.

Doping: concept, mechanism of doping and its adverse effects. Blood doping.

Methods to assess body size & composition: Bioelectrical Impedance analyses (BIA), Body mass index (BMI).

Sports Injuries: Meaning, Definition and Types; Management of Sprain, Strain, Wound, Fracture and Dislocation.

Practical, Paper Code: PHYDSC405P (Credit: 02)

Respiration and Sports Physiology Lab

- a) Measurement of peak expiratory flow rate.
- b) Measurement of oxygen saturation by Pulse Oximeter before and after exercise.
- c) Blood pressure measurement before & after exercise
- d) Determination of physical fitness index (PFI) by Harvard step test and recording of recovery Heart rate after exercise
- e) Determination of VO_2 max by queen college step test.
- f) Measurement of body fat percentage by skinfold caliper.
- g) Determination of endurance time by hand grip dynamometer
- h) Pneumographic recording of effect of talking, laughing, coughing, breath holding and hyperventilation

PHYDSC406: Gastrointestinal Physiology

Theory, Paper Code: PHYDSC406T (Credit: 03)

Anatomy and histology of alimentary canal. Digestive glands – histological structures of salivary glands, pancreas, liver. Nerve supply of the alimentary system. Mastication. Deglutition. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Mechanism of gastric HCl secretion. Pavlov pouch, sham feeding,

Heidenhain's pouch. Synthesis of Bile acids. Enterohepatic circulation of bile. Functions of Gall bladder, Defecation. Feces. Gastrointestinal hormones: Chemistry & functions of gastrin, cholecystokinin, secretin, GIP, VIP, motilin, somatostatin, enteroglucagon.

Movements of alimentary canal and their regulations. GALT. Basic concepts of Peptic Ulcer, gastric ulcer, Jaundice and Gall-stones, Pancreatitis, Achlorhydria. Hyperchlorhydria. Liver function tests.

Digestion of carbohydrates, proteins, lipids and nucleic acids. Absorption of carbohydrates, proteins, lipids, water, electrolytes and vitamins. Gastrointestinal(Splanchnic) Circulation. Inborn errors: Lactose intolerance and Hartnup disease.

Practical, Paper Code: PHYDSC406P (Credit: 02)

Gastrointestinal Physiology Lab

- a) H& E Staining of esophagus, stomach, small intestine, large intestine and liver.
- b) Test of emulsification of bile from biological sample.
- c) GOD POD method for Blood glucose estimation.
- d) Experiment of protein digestion by pepsin
- e) **Dale's experiment:** Kymographic recording of normal movements of intestine.
- f) Effects of hypoxia/ acetylcholine/ adrenaline on normal movements of intestine.

PHYDSC407: Energy Balance, Metabolism and Nutrition

Theory, Paper Code: PHYDSC407T (Credit: 03)

General plan of metabolism. Energy transfer. Biological oxidation – Redox Potential, Mitochondrial Electron Transport Chain and its components, redox loop mechanism, substrate-level phosphorylation. Oxidative Phosphorylation – Inhibitors and uncouplers.

Metabolism of Carbohydrate - Glycogenesis and Glycogenolysis, Glycolysis, Rapoport-Luebering cycle, TCA cycle, Gluconeogenesis - Cori cycle, Glucose-Alanine cycle. Anaplerotic reactions and Amphibolic role of TCA cycle. Pentose Phosphate Pathway. Metabolism of hexoses other than glucose. Regulation of glycogenesis, glycolysis and TCA cycle.

Metabolism of Protein: Amino acid pool. Nitrogen balance, Deamination, transamination, transdeamination and decarboxylation. Oxidative amination. Ammonia toxicity. Urea Synthesis: reactions, energy expenditure, significance. Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine.

Metabolism of nucleic acids: Purines and Pyrimidines – Biosynthesis: *de novo* and salvage pathways. Catabolism Purines and Pyrimidines.

Metabolism of Lipid: Beta-oxidation – activation of fatty acids, carnitine shuttle, reactions, energetics. Ketogenesis – formation & significance. Oxidation of unsaturated fatty acids. Alpha & Omega oxidation. Synthesis of saturated fatty acid – fatty acid synthase, reactions, energetics. Fatty liver. Cholesterol metabolism. Biosynthesis of Lecithin and Cephalin Metabolism of Adipose Tissue. Role of lipoproteins in transport and storage of lipids

Vitamins: Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Chemistry, dietary sources, daily requirements, biochemical roles and functions, deficiency symptoms, hypervitaminosis, antivitamins. Antioxidants. Minerals: Sources, biological functions,

metabolism and regulation of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride.

Basal metabolic rate -factors, determination by Benedict-Roth apparatus. Respiratory quotient, Specific dynamic action. Adult consumption unit, Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance, essential amino acids, biological value of proteins. Supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins. Dietary fibres. Physiology of starvation and obesity

Practical, Paper Code: PHYDSC407P (Credit: 02)

Energy Balance, Metabolism and Nutrition Lab

- a) Quantitative estimation of glucose and sucrose by Benedict's method
- b) Quantitative estimation of amino nitrogen [Sorensen's formol titration method (percentage as well as total quantity to be done)].
- c) Estimation of lactose from milk by Benedict's method.
- d) Diet survey report (hand-written) of a family (as per ICMR specification): Each student has to submit a report on his/her own family

SEMESTER – V

No. of Discipline Specific courses (DSC): 4 Courses (Viz. PHYDSC508, PHYDSC509, PHYDSC510, PHYDSC511)

Total Credit in Each course – 05 (Theory-03, Practical - 02)

PHYDSC508: Environmental Physiology

Theory, Paper Code: PHYDSC508T (Credit: 03)

Environment- Its physiological aspects. Effects of exposure to hot and cold environments. Acclimatization to hot and cold environments. 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. G force, ionizing and non-ionizing radiations - physiological effects and preventive measures.

Types of pollutants (primary, secondary, and tertiary), sources, mechanism of action, and effects of metabolic pollutants, brief idea of war gas, neurotoxin, mutagen, carcinogen, teratogens. Heavy metal toxicity (Pb, Hg, Cd, As).

Air Pollution: definition, sources, air pollutants, effects of air pollution on human health, the concept of the ozone hole, greenhouse effects, and global warming.

Water Pollution: definition, types, health hazards, water pollutants, biochemical oxygen demand (BOD), thermal pollution, concept of safe drinking water standards. Arsenic Pollution: sources, sources of arsenic in groundwater, drinking water standard for arsenic (WHO, USEPA), health effects of chronic arsenic poisoning. Sound Pollution: definition, concept of noise, source of sound pollution, effects of sound pollution on human health, noise index (noise standards).

Geography and the human response to altitude, Genetics and high altitude, Altitude acclimatization and deterioration, Control of breathing at high altitude, Limiting factors at extreme altitude, High altitude populations, Acute mountain sickness, Hyperbaric and Hypobaric Pressure Chamber, High altitude cerebral edema, High altitude pulmonary edema, Chronic mountain sickness and high altitude pulmonary hypertension, Pre-existing medical conditions at altitude, Extremes of age at altitude: children and the elderly, Physiology and medical aspects of heat and cold environment, Decompression sickness- cause & treatment, caisson disease, motion sickness, scuba diving, Motion Sickness in Space: Prevention and Treatment, weightlessness, effect of gravity on human system, Radiation Hazards on physiological system.

Practical, Paper Code: PHYDSC508P (Credit: 02)

Environmental Physiology Lab

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

ii) Determination of dissolved oxygen in the supplied water samples

- iii) Measurement of noise by the Sound level meter.
- iv) Determination of light intensity (at library, laboratory & classroom) by lux meter.

PHYDSC509: Nerve Muscle Skeletal Physiology
Theory, Paper Code: PHYDSC509T (Credit: 03)

Nerve Physiology

Structure, classification, and functions of neurons and neuroglia. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. The 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, co-transmitters, 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 the nerve during activity. Nerve growth factors.

Musculo-Skeletal Physiology

Microscopic and electron microscopic structure of skeletal, smooth, and cardiac muscles. The sarcomeric 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, the genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility, and elasticity. Optimal load is the optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation. Sliding filament theory of **A F Huxley and H E Huxley**. Excitation-contraction coupling. Dihydropyridine receptors and 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.

Practical, Paper Code: PHYDSC509P (Credit: 02)

Nerve Muscle Skeletal Physiology Lab

- a) Suitable staining and examination fresh muscle Tissues-Skeletal and Cardiac (methylene blue).
- b) H & E Staining and identification Tissues: Cardiac muscle, Skeletal muscle, Smooth muscle, Spinal cord, Cerebellum and Cerebrum.
- c) Gastrocnemius-sciatic preparation and kymographic recording of isotonic muscle twitch.
- d) Effect of temperature on muscle twitch.
- e) Effect of two successive stimuli on muscle twitch.
- f) Effect of load (after-load) on muscle twitch. Calculation of work done by the muscle.

g) Determination of nerve conduction velocity by kymographic recording of simple twitches.

h) Silver nitrate preparation of sciatic nerve for nodes of Ranvier.

i) Ergographic recording of muscular fatigue by Moss's ergograph

PHYDSC510: Nervous System

Theory, Paper Code: PHYDSC510T (Credit: 03)

Anatomy of Central and Peripheral Nervous System. Structural organization of the different parts of the 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 hemisection and complete section of the spinal cord, Brown Sequard syndrome. CSF: formation, circulation, and functions. Blood-CSF and Blood-Brain barrier. Ascending and descending tracts: 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 the cerebellum. Nuclei, connections, and functions of thalamus and hypothalamus. Basal ganglia: structure, connections and functions. Cerebral cortex: histological structure, connections, and functions. Organization of the limbic system and its functions. Emotion. Origin and components of EEG. Physiological basis of different types of sleep. Sleep-wakefulness cycle. Higher functions of the nervous system: memory, conditioning, and learning. Speech and aphasia. Physiology of pain. CSF: formation, circulation, and functions. Autonomic nervous system: Organization, outflow, ganglia, centers, and functions. Chemical transmission in the autonomic nervous system; Nicotinic and muscarinic acetylcholine receptors, alpha and beta adreno-receptors and their agonists and antagonists. glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine, and histamine receptors. Central control of the autonomic nervous system for regulation of internal body homeostasis.

Practical, Paper Code: PHYDSC510P (Credit: 02)

Nervous System Lab

a) Experiments on superficial (plantar) and deep (knee-jerk) reflex

b) Measurement of grip strength

c) Reaction time by stick drop test.

d) Short-term memory test (shape, picture word).

e) Two-point discrimination test.

f) Clinical examination of cranial nerves

PHYDSC511: Special Senses

Theory, Paper Code: PHYDSC511T (Credit: 03)

Classification of general and special senses. Receptors as biological transducers. 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.

Chemical Senses: Olfaction and Gustation: Structure and functions of the receptor organs, nerve pathways, and centers. Properties of olfactory and gustatory sensation and their transduction & coding. Electro-olfactogram. Abnormalities of olfactory and taste sensation.

Sense of Hearing: Sound waves, decibel, structure, and functional significance of auditory apparatus – external, middle, and internal ears. Structure of organ of Corti. Auditory transduction. Auditory pathways and centers. Mechanism of hearing and its modern theories. Discrimination of sound frequency and loudness. Localization of sound source. Auditory pathways and centers. Auditory defects.

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

Practical, Paper Code: PHYDSC511P (Credit: 02)

Special Senses Lab

- a) Determination of visual acuity by Snellen's chart / Landolt's C chart.
- b) Determination of color blindness by Ishihara chart.
- c) Near point and near response.
- d) Tuning Fork test of hearing
- e) Test for accommodation reaction

SEMESTER – VI

No. of Discipline Specific courses (DSC): 4 Courses (Viz. PHYDSC612, PHYDSC613, PHYDSC614, PHYDSC615)

Total Credit in Each course – 05 (Theory-03, Practical – 02)

PHYDSC612: Excretory Physiology

Theory, Paper Code: PHYDSC612T (Credit: 03) 60 Hours

Functional Anatomy of kidney. Histology of nephron and structural differences between cortical and juxtamedullary nephron. Renal circulation – peculiarities and autoregulation. Justaglomerular apparatus. Mechanism of formation of urine – concept of ultrafiltration. Glomerular filtration: Composition, Factors controlling, Measurement. Passive and active tubular transport. Concentration of Urine-Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of body fluid. Disturbances of volume and concentration of body fluid.

Renal regulation of acid-base balance, acidification of urine. Concept of renal threshold. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and Structure & innervation of urinary bladder urethra. Physiology of Micturition: Filling & emptying of bladder. Cystometrogram. Micturition reflexes. Abnormalities of micturition. Renal dialysis. Diuretics. Composition of urine. Abnormal constituents of urine, their detection and significance. Non-excretory functions of kidney. Renal Disorders: Acute and Chronic failure. Renal stone formation.

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.

Practical, Paper Code: PHYDSC612P (Credit: 02)

Excretory Physiology Lab

a) Identification of normal constituents of urine – chloride, sulphate, phosphate, creatinine and urea. Identification of abnormal constituents of urine - glucose, protein, acetone blood and bile salts

b) Determination of serum creatinine by Jaffe's method.

c) Determination of serum urea by DAM method.

PHYDSC613: Endocrinology and Reproduction

Theory, Paper Code: PHYDSC613T (Credit: 03)

Endocrinology

Definition of endocrine glands and hormone. Classification of hormones on chemical basis. Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary -- histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland. Pineal gland – histological structure. Chemical nature, biosynthesis, mode of actions, functions and regulation of secretion of melatonin. Thyroid and parathyroid -- histological structure of the glands. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands. Physiology of bone.

Adrenal cortex and medulla -- histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Biosynthesis and catabolism of catecholamines. Hypo- and hyperactive states of the gland. Heart as an endocrine organ. Prostaglandins and Kinins.

Pancreatic islets -- histological structure. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus. Biological rhythms, Placental Hormones: Chemistry and functions of hormones.

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. Body temperature rhythm. Neural basis of biological clock and role of suprachiasmatic nuclei. Sleep-wakefulness cycle. Time keeping genes.

Reproduction

Chromosomal sex: Sex chromosomes, sex chromatin. Chromosomal abnormalities. Primary & secondary sex characters. **Puberty:** Introduction, control of onset of puberty, precocious & delayed puberty. **Male reproductive system:** Structure of testis. Structure of sperm, Composition of semen, Endocrine functions of testes. Blood-testis barrier.

Spermatogenesis: Stages, factors controlling (including hormonal control).

Female Reproductive Physiology: Menarche. Histology of ovary. Oogenesis: Process & hormonal control. Corpus luteum: Formation & functions. **Menstrual cycle:** Introduction, phases, uterine & ovarian changes, Hormonal regulation. Anovulatory cycle. **Ovulation:** Mechanism, phases & hormonal control. Abnormalities of Menstrual cycle. Menopause.

Development of mammary gland, lactation and Hormonal control.

Corpus luteum: Formation & functions. **Placenta:** Formation & functions.

Pregnancy: Response of mother's body to pregnancy, Hormonal control.

Parturition: Mechanics, stages and factors controlling.

Estrous cycle: Stages. Difference between estrous and menstrual cycle.

Physiological concept of a planned family.

Course II: Practical, Paper Code: PHYDSC613P (Credit: 02)

Endocrinology & Reproduction Lab

- a) Kymographic recording of normal uterine contraction of Rat.
- b) Kymographic recording of the effect of oxytocin on uterine contraction of Rat.
- c) Kymographic recording of the effect of adrenaline on uterine contraction of Rat.
- d) Staining and identification of Testis, uterus and ovary.
- e) Study of estrous cycle.

PHYDSC614: Microbiology and Immunology

Theory, Paper Code: PHYDSC614T (Credit: 03)

Microbiology

Brief history of infectious diseases, developments preceding the germ theory, the germ theory of disease. Classification of microorganisms: fungi, algae, bacteria, virus, protozoa. Control of microbial growth: Physical and Chemical methods used in sterilization, disinfection, and pasteurization.

Bacteriology: Bacterial classification based on staining techniques (Gram 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.

Bacterial metabolism: fermentation, glyoxalate cycle, and Entner-Doudoroff Pathway. Bacterial genetics: molecular mechanism of transformation, conjugation and transduction and how these pathways differ in Gram positive and Gram negative bacteria.

Virology: Viral structure – virion, prion, and bacteriophages; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – molecular mechanism of lytic and lysogenic cycles. Peculiarities of RNA viruses (example of HIV and SARS CoV2 is to be read thoroughly).

Chemotherapeutic Agents: Characteristics of chemotherapeutic agents, synthetic agents, antibiotics: bactericidal and bacteriostatic and their mechanism of action, antifungal agents, antiviral agents, microbial resistance, treatment and complications.

Immunology

Historical background of immunology, elements of immunity – innate, acquired; interrelation between innate and adaptive immunity; organization of lymphoid organs, immunogens and antigens: requirements of immunogenicity, epitopes recognized by B- & T-cells, haptens, adjuvants.

Humoral immunity - Immunoglobulin structure, classes of immunoglobulin: IgA, IgG, IgD, IgM, Ig, biological properties of immunoglobulin; triggering of the immune response, humoral immunity, adaptive immunity; Antigen-antibody reactions, Kinetics of antibody responses: primary & secondary. Antigen-antibody interactions – Primary interaction: association constant, affinity & avidity. Secondary interaction: precipitation & agglutination. titre, Ouchterlony double diffusion (ODD), single radial immune diffusion (SRID), Sandwich and competitive ELISA, immunofluorescence, Hybridoma technology.

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 & amplification; differentiation: thymus-dependent and independent antibodies, T-B co-operation, the carrier effect. Cytokines: produced by TH1 & TH2 cells, regulating specific immune responses only.

Complement: Activation components – classical, alternative, and lectin pathways. Biological consequence of complement activation.

Cell-mediated effector responses: CTLs, NK cells, K cells. Immune responses in allergy. A brief idea of autoimmunity and AIDS. Vaccination: Passive and active immunization, types and uses of vaccine. Toxins and toxoids. Basic concepts of tissue grafting. Cancer biology basics.

Practical, Paper Code: PHYDSC614P (Credit: 02)

Microbiology and Immunology Lab

- a) Cleaning of glassware and sterilization, Preparation of media, and cultivation of bacteria.
- b) Gram staining of bacteria and identification of Gram positive and Gram negative bacteria
- c) Characterization of bacteria: acid-fast stain
- d) Study of bacterial growth --generation time-synchronous and asynchronous growth (only demonstration)
- e) Assay of antibiotic—MIC (only demonstration)
- f) Determination of Total count of WBC
- g) Identification of macrophages and neutrophils.
- h) Agglutination techniques Hands-on: Blood grouping and Rh factor.
- i) Isolation and culture of peritoneal cells from experimental animal (only demonstration)
- j) Isolation of lymphocytes and macrophages using ficoll density gradient centrifugation (only demonstration)

PHYDSC615: Ergonomics

Theory, Paper Code: PHYDSC615T (Credit: 03)

Brief history and components of ergonomics: Brief history of the development of Ergonomics. Role of the subject in community development, definition of Ergonomics, role of the subject in industry and agriculture; characteristics of man-machine-environment system, fitting the man to the task and fitting the task to the man, human factor application in system design. Man-machine interaction: Interaction of man and machine through control and display; different types of controls and displays- visual, auditory and tactile, control –movement stereotype, Compatibility – types, relationship with control and display design, coding of controls, design of symbols and labels. Failure of system accident.

Management of systems: work, time and motion study; Ergonomics & safety. Application of Ergonomics for development of safety; Analysis of accident: Unsafe conditions; Occupation Health and safety norms; Anthropometry: static, dynamic, Newtonian anthropometry; Application of Anthropometry in design.

Practical, Paper Code: PHYDSC615P (Credit: 02)

Ergonomics Lab

a) Evaluation of occupational stress: development of Nordic questionnaire. quantitative evaluation technique, pain mapping

b) Measurement of different heat stress indices: WBGT, ET, CET, P4SR; measurement of relative humidity

c) Anthropometrics measurements- static and dynamic, anthropometric measurements for different design consideration- design of seat, work station, consumer products, personal protective equipment's, hand tools, etc

d) Biochemical study of work posture, joint angle study, determination of spinal curvature, analysis of posture by video graphic method – OWAS, REBA, RULA, OCRA etc

SEMESTER – VII

PHYDSC716: Developmental Biology and Embryology

Theory, Paper Code: PHYDSC716T (Credit: 03)

Developmental Biology

Introduction to Developmental Biology. Principles of Development in Biology. Anatomical Approach to Development. Gametogenesis: Spermatogenesis & Oogenesis. Ultrastructure: sperm and ovum in mammals. Egg Membranes. Gametes Interaction during fertilization. The Determination of germ cells in different groups of animals

Embryology

Fertilization: in vitro fertilization. In Sea-urchin and mammals Cleavage: Cleavage plane, types, role of yolk in cleavage; cleavage process in mammals. Morula. Blastula formation: formation of trilaminar disc. Development of embryonic disc. Placenta. Formation of tissues—epithelial, mesenchyme, bone, and muscles. Development of the alimentary canal, Cardiovascular system, urinary system, and genital system. Placental & Fetal Circulation.

Practical, Paper Code: PHYDSC716P (Credit: 02)

- a) H & E staining of ovarian tissue sections and identification of Graafian follicle, Corpus Luteum, and demonstration of preserved mammalian embryo
- b) Staining and identification of testis
- c) Staining of discrete stages of gametogenesis

PHYDSC717T – Biostatistics

Theory, Paper Code: PHYDSC717T (Credit: 03)

Definition and classification of statistics, Importance of statistical analysis in biological data management. Basic concepts – variable, parameter, statistics. Sampling schemes –types of sampling, Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram.

Measures of central tendencies - mean, median, mode, Measures of dispersion, Range, Mean deviation, variance, standard deviation, Quartile deviation.

Sampling error, Sampling distribution, standard error of the mean. Standard scores. Degrees of freedom. Probability. Normal distribution. Probability distribution, Best fitting normal distribution, Skewness, Kurtosis, Student's t distribution, Binomial distribution, Poisson distribution, Null hypothesis, Level of significance, Error of inference, one – tail and two – tail tests, Test of significance - t-test, Chi-square test, F/z test, Linear Correlation, Regression, Analysis of variance: definitions, formula and applications. One and two way methods of ANOVA

Basics of computers - basic commands - file creation, copying, moving & deleting in Windows. Computer packages: Statistical software available on the web and their use.

PHYDSC717P - Biostatistics Lab - a) 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.

b) Graphical representation of data in frequency polygon and histogram.

c) Student's 't' test for significance of difference between means.

d) Operation Microsoft word, Microsoft excel, Microsoft Power Point and internet.

e) Preparation of graph of experimental data using MS Excel and other software.

f) Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software

SEMESTER – VIII

PHYDSC818: Genetics and Molecular Biology

Theory, Paper Code: PHYDSC818T (Credit: 03)

Genetics

Basic principles of Mendelian genetics - monohybrid and dihybrid, test and backcrosses, Bacterial genetics-transformation, transduction, conjugation (mention of F+ /F-, Hfr strain, function of pilus). Extension of Mendelism - Epistasis and its different types present in plants and animals. Penetrance, expressivity, pleiotropism. Crossing over and Gene mapping. Numerical and Structural variations in chromosome - basic concepts of aneuploids and polyploids. Human Cytogenetics - human karyotype, banding technique, use of human cytogenetics in medical science, inborn errors of metabolism, aneuploidy in humans. Sex determination and sex linkage.

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: lac operon. Definition of mutation, Point mutation (Transitions, transversions, Missense mutation, Nonsense mutation, silent mutation, Frame shift mutation), Spontaneous mutation and Induced mutation, Mutagen – physical (Ionizing radiation, UV radiation), chemical (Base analogs, Nitrous acid, Acridine dyes, Alkylating agents), Ames's test. DNA repair processes. Cloning strategies: Construction of recombinant DNA: Joining of cohesive ends and blunt ends, c-DNA synthesis and cloning. Transformation of *E. coli* host by Calcium chloride method and electroporation. Gene therapy, transgenic animal. Polymerase chain reaction (PCR) - basic concepts, RT-PCR, Real-Time PCR and their applications. Concept of oncogenes and properties of cancer cells. Methods used in Molecular Cloning: Agarose gel electrophoresis of DNA, Southern, Northern and Western blotting. Idea about the human genome project. Protein sequencing – Initial phase to Edman method. Protein sequencing by Mass Spectrometry (MALDI-TOFF). DNA sequencing – initial development to automated sequencing. Reverse sequencing. Sequence Alignment.

Practical, Paper Code: PHYDSC818P (Credit: 02)

- a) Determination of R_f value and separation of amino acids by TLC chromatography.
- b) Determination of R_f value and separation of amino acids by paper chromatography.
- c) Estimate the amount of Protein present in the given sample by Bradford's method.
- d) Separate Protein by SDS PAGE.
- e) Quantitative estimation of DNA by diphenylamine reaction using colorimeter.
- f) Determination of Purity of DNA using UV-Visible spectrophotometer (A₂₆₀/A₂₈₀ measurement)
- g) Quantitative estimation of RNA by orcinol method using colorimeter

- h) DNA isolation (plasmid & chromosomal) (only demonstration).
- i) Separate DNA by Agarose gel electrophoresis.
- j) Construct the pedigree for the given data /analyse the given pedigree

PHYDSC819: Pharmacology and Toxicology

Theory- PHYDSC819T (Credit: 03)

The importance of pharmacology in the study of physiological processes. Definition of Drugs, Agonist, Antagonist. Drug delivery Drug reactivity

Pharmacokinetics- Drug-receptor interaction, Desensitization of receptors, absorption, distribution, excretion Permeation, Elimination, Clearance, Half-life of drugs.

Pharmacodynamics- Drug biotransformation and mechanism of drug action (elementary idea). The dose-effect relationship and the characteristics of the dose-response curve. Assessment of drug toxicity - LD50 and ED50.

Drugs affecting acetylcholine receptors

(i) Acetylcholine receptor agonists - mechanism of different drugs, Direct-acting acetylcholine receptor agonists – pilocarpine. Indirect-acting acetylcholine receptor agonists - physostigmine. Irreversible choline esterase inhibitors - role of organophosphates.

(ii) Acetylcholine receptor antagonists - Muscarinic receptor antagonists – mechanism and action of atropine and tiotropium.

Nicotinic receptor antagonists - mechanism and action of tubocurarine, Drugs affecting adrenoceptors, Basic concepts of catecholamines.

Adrenoceptor agonists, Direct-acting adrenoceptor agonists - mechanism and action of isoproterenol. In-direct acting adrenoceptor agonists - mechanism and action of amphetamines.

Adrenoceptors antagonists, Mechanism and action of phentolamine and Propranolol.

Sedative- hypnotics: Barbiturates- actions on organ systems and mechanism of action.

Narcotic analgesics: Pharmacological properties and mechanism of action.

Antihistamine: Pharmacological properties. Diuretics: Effects on renal functions and mechanism of action of benzothiadiazides.

History of Toxicology. Classification and ramifications in toxicology. Toxicants: Exposure, exposure characterization. Routes of exposure: Organism environment interaction.

Animal and plant toxins. Absorption and distribution of toxicants. Human health risk assessment. Hazard identification: Risk assessment, Risk prediction and management

Drug discovery and development: Models and bioassay: Methods in toxicity testing, dose-response characterization. Threshold limitations: Hormesis, lower dose extrapolation. Animal to human extrapolation: Flow chart, "Case by Case" basis in non-clinical development and its influences in safety assessment, usefulness and limitations

Practical, Paper Code: PHYDSC819P (Credit: 02)

- i) The effect of diuretics on the urine output in rats
- ii) In-silico molecular docking (protein-ligand docking).

PHYDSC820T: Community Health & Epidemiology (Credit: 03)

Community health: Basic ideas, categories & importance.

Community health education: Basic idea, objectives, & strategies.

Definition, aim and concept of epidemiology. Uses of epidemiology.

Basic measurement of epidemiology: Tools of measurement.

Mortality, morbidity, incidence, prevalence. Mortality rates & ratios: Crude death rate, specific death rate, case fatality rate, proportional mortality rate, survival rate, standardized rate.

Epidemiologic methods: Cross-sectional, case-control & cohort studies.

Basic ideas of Infectious disease epidemiology.

Dynamics of disease transmission: Mode of transmission, Susceptible host, Host defences, Immunizing agents, Disease prevention & control.

Disinfection: Definition, types & agents.

Epidemiology of communicable diseases: Etiology, pathogenesis, prevention and control of malaria, cholera, tuberculosis, diarrhoea, viral hepatitis, measles, dengue, rabies, AIDS, plague.

Non-communicable diseases viz., Pneumoconiosis, silicosis, asbestosis, coronary heart disease, hypertension, diabetes mellitus, cancers, stroke.

PHYDSC820P- Epidemiology Lab (Credit: 02)

Anthropometry: Standing height, weight, circumferences of head, mid-upper arm (MUAC), waist, hip, thigh, calf, Skinfold thickness measurements: Biceps, triceps, subscapula, suprailiac.

Calculation of body density and percentage of body fat from skinfold thickness (Siri formula for adults and Slaughter formula for boys & girls). Calculation of fat mass, fat free mass and fat free mass index.

Calculation of Body Mass Index (BMI), Ponderal index (PI), Waist-hip ratio (WHR).

Use of growth charts of height, weight, MUAC, skinfold thickness in terms of Z-score, percentile values. Calculation of growth velocity.

Biochemical estimation of serum albumin, serum iron, total iron binding capacity (TIBC), serum ferritin, serum transferrin, transferrin saturation.

Measurement of cardiovascular autonomic neuropathy.

PHYRES801M – Research Work (Credit: 15)

Students undertaking research need to submit a dissertation of the work which will include Review of Literature, Aims and Objectives, Study Design followed by Results and Discussion.

Skill Enhancement Courses in Physiology

**Course Code: PHYHSE101M / PHYGSE301M / PHYGSE401M / PHYGSE501M / PHYGSE601M
(Credits: 3)**

SEC 1 - Hematological techniques

Preparation of blood smear and identification of blood cells. Preparation of haemin crystal. Bleeding time, clotting time. Measurement of hemoglobin in blood. Preparation of serum, Blood group determination. Identification of megakaryocyte from bone marrow.

**Course Code: PHYHSE202M / PHYGSE302M / PHYGSE402M / PHYGSE502M / PHYGSE602M
(Credits: 3)**

SEC 2- Biomedical Instruments and Computer Application in Physiology

Basic principles and analysis by using the following instruments: Sphygmomanometer, Pulse Oximeter, pH- meter, Colorimeter, Peak flow meter, Spirometer, Centrifuge, Microtome, Spectrophotometer, ECG & Autoclave.

Physiological Data sorting & analysis using spreadsheet: Mean, SD, SE computation and Bar diagram, Pie diagram, Line diagram preparation using computer, Manuscript preparation using Word, Physiological data presentation using Power point. Retrieving and documentation of a topic using PubMed and uses of ethics in preparation of documentation- use of Plagiarism Checker.

MDC Courses in Physiology

Details of Courses:

MDC1: Community Health Education

3 Credits

Community health: Basic ideas, categories & importance.

Community health education: Basic idea, objectives, & strategies.

Concept of health & diseases: Definition, determinants of health. Concept of diseases: Pathogenesis, risk factors, concept of control.

Epidemiology: Definition, Aims, Basic measurements.

Brief idea about Communicable & non-communicable diseases.

First hand management in burn & fracture.

Brief idea about Vaccination programme.

MDC2: Management of Non-Communicable Diseases

3 Credits

Non-communicable diseases: Definition & basic ideas.

Screening for common non-communicable disease: Methods & Equipment required for screening.

Risk factors for non-communicable diseases.

Health promotion: In school, families & communities.

Management of non-communicable diseases: Role of ASHA & ANM, Role of physical activity - Yoga & Meditation, By controlling Tobacco & Alcohol.

Common non-communicable diseases: Definition, consequences, risk factors, screening, diagnosis & management for Hypertension, Overweight & Obesity, Diabetes Mellitus, Cardiovascular disease (Heart attack & stroke), Common cancers (Oral cancer).

MDC3: Physiological & Nutritional Therapeutics

3 Credits

Therapeutic nutrition: Introduction & Basic ideas.

Therapeutic adaptation of normal diet. Progressive diets: clear fluid, full fluid, soft & regular.

Balanced diet & food groups. Basic idea about meal planning. Recommended Dietary Allowances (RDA).

Principle of therapeutic diet, Therapeutic adaptation of normal diet, Water purification, Food sanitation & hygiene.

Concept of malnutrition. Importance of dietary fibers,

Etiology, clinical features, diagnosis & nutritional management of food allergy & food intolerance. Diet in Constipation, Diarrhea, Diabetes, Renal failure, Cancer.

Reference Books

- 1) Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
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- 4) Murray, R.K. Granner, D.K., Mayers, P.A. and Rodwell, V.W. Harper's Illustrated Biochemistry, XXVIII Edition, Lange Medical Books/ McGraw Hill
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- 6) Widmaier, E.P, Raff, H.and Strang, K.T. Vander's Human Physiology, XI Edition, McGraw Hill