

HUMAN PHYSIOLOGY INCLUDING BIOPHYSICS

1. PHYSIOLOGY

1.1. GOAL

The broad goal of the teaching of undergraduate students in Physiology aims at providing the student comprehensive knowledge of the normal functions of the organ systems of the body to facilitate an understanding of the physiological basis of health and disease.

1.2. OBJECTIVES

1.2.1. Knowledge

At the end of the course the student will be able to

1. Explain the normal functioning of all the organ systems and their interactions for well-coordinated total body function.
2. Assess the relative contribution of each organ system to the maintenance of the milieu interior.
3. Elucidate the physiological aspects of normal growth and development.
4. Describe the physiological response and adaptations to environmental stresses.
5. List the physiological principles underlying pathogenesis and treatment of disease.

1.2.2. Skills

At the end of the course the student shall be able

1. Conduct experiments designed for study of physiological phenomena;
2. Interpret experimental / investigative data;
3. Distinguish between normal and abnormal data derived as a result of tests which he / she has performed and observed in the laboratory.

1.2.3. Integration

At the end of the integrated teaching the student shall acquire an integrated knowledge of organ structure and function and its regulatory mechanisms.

2. BIOPHYSICS

2.1. DEPARTMENT GOAL AND OBJECTIVES

The broad goal of teaching Biophysics to undergraduate students is that they should understand basic physical principles involved in the functioning of body organs in normal and diseased conditions.

2.1.1. The total amount of time for teaching Biophysics is 5 hours which includes Three hours Didactic lectures, One hour Tutorial / group discussion and One hour Practical

2.2. TOPIC DISTRIBUTION

2.2.1. Didactic lectures

This lectures which covers Physical principles of transport across cell membranes and across capillary wall, Bio-potentials and Physical principles governing flow of blood in heart and blood vessels. Also physical principles governing flow of air in air passages.

2.2.2. Tutorial / group discussion

The same topics covered in didactic lectures mentioned as clause 2.2.1.

2.2.3. Practicals

Demonstration of Bio-potential on oscilloscope, Electroencephalogram (E.E.G.), Electromyogram (E.M.G.), Electrocardiogram (E.C.G.) and Ultrasound (U.S.G.)

3. SYLLABUS 3.1. Theory

3.1.1. General Physiology (6 Hours)

Introduction - Cell Function: Morphology of cell components & Functions, Inter cellular connections - Body Fluids: compartment muscle contraction; Types of skeletal muscle fibres changes induced by training; Types of smooth muscle; Structure and function; Properties; Innervation, Differences between skeletal, smooth & cardiac muscle - Nerve: Neurons and Neuroglia; Nerve fibre; Excitation and conduction; Ionic basis; Measurements of Electrical Events; Classification of Nerve fibres

3.1.3. BLOOD (16 Hours)

Introduction - Composition, Function, Volume & Measurements of Blood and Plasma; Functional characterization of plasma proteins Oncotic Pressure - R.B.C.; Morphology, Function, Erythropoiesis, Anemia, Reticulocytes, Haemoglobin; W.B.C.; Morphology, Function, Leucopoiesis, Immune Mechanism - Platelets; Morphology, Function, Formation - Blood types; A B O system, Rh system, Blood transfusion - Haemostasis, Anticoagulants - Lymph, Reticulo Endothelial system

3.1.4. Digestion (12 Hours)

Introduction - Salivary Digestion, Deglutition - Digestion in stomach, Movements, Vomiting, applied aspects - Pancreatic juice - Bile, Liver and gall bladder - Succus Entericus - Motility of small intestine - Digestion and absorption of various food stuffs; Carbohydrate, Protein and fat, mineral and vitamin absorption - Large Intestine; Secretion and Motility; Dietary Fibre; Defaecation - Gastro - intestinal Hormones.

3.1.5. Excretion (10 Hours)

Introduction - Functional Anatomy of Excretory system, Nephron in detail - Renal Circulation, Auto regulation, Renal function Tests - Glomerular Filtration, Tubular function, Water excretion, counter current mechanism - Acidification of urine & Bicarbonate Excretion Regulation of Na⁺, K⁺, Cl⁻, H⁺ Ions - Innervation and function of bladder; Micturition; Filling and emptying; diuretics, Applied aspects, Dialysis - Structure and functions of Skin.

3.1.8. Endocrine Glands (16 Hours)

1. Introduction: Hormonal regulation; Receptors; Second messengers

2. Pituitary gland

Introduction - Physiological Anatomy of Pituitary gland - Anterior - Pituitary Hormones, Growth Hormone - Physiology of Growth, clinical correlates - TSH, ACTH, LH, FSH, PL Hormones and Functions - Intermediate Lobe - Proopiomelanocortin - Products - Posterior Pituitary Hormones : Synthesis, Secretion, actions

3. Hypothalamus

Hormones - Functional anatomy - Interrelationship between Hypothalamus, Anterior & Posterior Pituitary and target organs - Clinical correlation - Hypo & Hypersecretion

4. Thyroid gland

Physiological Anatomy, Formation, Secretion, Transport and Metabolism of T₃ & T₄ - Effects of Thyroid Hormone & Regulation of its secretion - Hypo & Hypersecretion - Clinical Correlation Calcitonin.

5. Parathyroid Glands

Ca. & Phosphorus Metabolism - Bone Physiology - Vit. D & Calcitriol - Physiological Anatomy, Secretions, Transport and Functions of Para hormone, calcitonin - Effect of other hormones and hormonal agents on calcium homeostasis - Hypo & Hyper secretion - clinical correlation

6. Pancreas

Introduction - Islet structure - Biosynthesis and secretion of insulin - Fate, effects, mechanism of action of insulin - clinical correlation - HYPO & Hyper secretion - Diabetes Mellitus - Regulation of Insulin secretion - Glucagon, other islet cell hormones and their effects

7. Adrenal Glands

Introduction - Adrenal Medulla - Morphology - Biosynthesis functions and regulation of adrenal medullary hormones, Pheochromocytoma - Adrenal cortex - Structure - Biosynthesis of Adrenal cortical hormones - Transport, Metabolism and Excretion of adrenal Cortical Hormones - Effects of Adrenal Androgens and Oestrogens - Glucocorticoids - Physiological effects - Regulation of secretion - Mineralocorticoids - Regulation of Aldosterone secretion - Role played by it in the regulation of salt balance - Adrenocortical hypo & hyperfunction in humans

7.1. Minor endocrine glands: Kidney, Pineal body, Thymus, Atrium of heart

7.2. Local hormones - bradykinin, substance P, Prostaglandin, Histamine, Serotonin, etc.

3.1.9. Reproduction (15 Hours)

1. Introduction (3 Hours)

Sex differentiation and chromosomal sex in brief-factors influencing differentiation of genitalia, puberty

1.1. Male Gonads and genitalia structure - Gametogenesis - Erection, Emission and Ejaculation - Semen composition Endocrine function of Testis - Biosynthesis, secretion and actions of hormones control of Testicular function - Abnormalities.

2. Female gonads and genitalia (8 Hours)

Ovarian function - menstrual cycle; Hypothalamus, Pituitary, Ovary, Uterus, Vagina cyclic changes - Biosynthesis, secretion and actions of oestrogens and progesterone

3. F.P & Contraceptives (4 Hours)

Fertilization and conception - Contraception - corpus luteum of pregnancy - Chorion and Placenta - hormones - Pregnancy tests - Physiology of Pregnancy - Labour - Lactation - Feto placental unit.

3.1.10. Respiration (12 Hours)

Introduction: Functional Anatomy of Respiratory system - Mechanism of Respiration, Diffusion and Transport of Gases - Regulation of Respiration, Neural and chemical - Pulmonary Circulation -

Respiratory adjustments in Health and Diseases: Hypoxia; types, Oxygen therapy, periodic breathing, Respiratory abnormalities Asphyxia, Dysbarism, Cyanosis, Effect of Exercise, high altitude Phys.; Mountain sickness; Space Physiology - Artificial Respiration; Respiratory changes during exercises

3.1.11. Cardio Vascular System (25 Hours)

Introduction: Structure and Properties of Cardiac muscle; Action potential - Origin and spread of cardiac impulse. Sinus arrhythmia - E.C.G.: 12 Leads; Tracing in Lead II, correlation with action potential and cardiac cycle - Cardiac cycle: mechanical events; JVP and radial arterial pulse tracing - Cardiac output: Measurement; factors affecting - Heart rate & Regulation - Haemodynamics: Pressure at different segments of vasculature - Arterial Blood Pressure; systolic pressure, diastolic pressure, pulse pressure, Mean arterial pressure; normal values, methods for evaluating blood pressure; Factors for maintenance and regulation; Hypertension; Nervous and humoral regulation of Blood Pressure - Starling forces; Formation and reabsorption of tissue fluid, Patho Physiology of shock - Regional circulation; Pulmonary, cerebral, coronary, splanchnic, cutaneous & foetal circulations - Cardio Vascular changes during exercise

3.1.12. Special Senses (10 Hours)

Introduction - Vision: Functional Anatomy; Aqueous humor; Glaucoma, Image forming mechanism; Refractory error; Layers of Retina; Photoreceptors; Photochemistry of vision; Light and Dark adaptation; Electrical responses, Electro Retinogram; Visual Pathway, Lesions; colour vision; Movements; Visual acuity field of vision visual reflexes - Hearing: Functional Anatomy; Middle ear function; Cochlea Auditory pathway; Hearing defects; Tests for hearing, Audiogram - Smell: Receptor Organ and Pathway Physiology of olfaction; Abnormalities - Taste: Receptor organ and Pathway Physiology of Taste; Abnormalities

3.1.13. Central Nervous System (30 Hours)

1. General Neurophysiology

Neuron: Structure, types; Neuroglia; Nerve Degeneration, Regeneration; Denervation hypersensitivity - Sensory Receptors: Classification and Function, Electrical and Ionic events in receptors; Receptor potential - Synapse and junctional transmission: Properties, Neurotransmitters-synaptic plasticity and learning - Reflexes: Introduction; Mono and Poly synaptic reflexes properties - Spinal cord: Groups of cells; Transverse section; Anterior Nerve root, Posterior Nerve root; Ascending tracts: Posterior column & Anterolateral systems, Spinocerebellar tracts - Pain: types; Pathways; Referred Pain; Pain inhibiting pathways - Descending tracts: Pyramidal and extra pyramidal tracts; complete section and hemi section of spinal cord

2. Special Neurophysiology

Cerebral cortex: layers, lobes, methods of study, function of each lobe - Thalamus: Thalamic nuclei, connections, functions, thalamic syndrome - Basal Ganglia: Nuclei, Connections, circuits, functions, Lesions of Basal Ganglia; Clinical correlates - Hypothalamus: Nuclei, connections, functions; Lesions; Experimental and clinical syndromes - Reticular formation: Ascending and Descending Pathways, ARAS & EEG - Sleep: Theories; Physiological Changes during sleep; REM & NREM Sleep; Disorders of sleep - Cerebellum: lobes; cortex, circuitry; Deep Nuclei, connections, functions cerebellar syndrome; cerebellar function tests - Vestibular Apparatus: Semicircular canal, otolith organs, Mechanism of equilibrium - Maintenance of posture, tone, equilibrium: Muscle spindle types, Postural reflexes - Autonomic Nervous system: Organization, division with examples of

autonomic reflexes, chemical transmission - Limbic system: Parts, circuits, functions - Higher functions: Mechanism of speech; mechanism of learning; mechanism of memory, types; conditioned reflexes - C.S.F. formation, circulation, absorption, function, lumbar puncture

3.2. Practical Physiology

3.2.1. List of Experiments

Erythrocyte Count - Leucocyte Count - Leucocyte Differential Count - Eosinophil Count - Clinical Examination of Cardio vascular system - Clinical Examination of Respiratory system - Clinical Examination of Sensory Nervous system - Clinical Examination of Motor Nervous system - Effect of posture / exercise on Pulse and Blood pressure.

3.2.2. Minor Experiments

Estimation of Hb. - Packed cell volume - Erythrocyte sedimentation rate - Blood groups - Rh factor, ABO system. - Osmotic fragility of blood - Specific Gravity of blood - Bleeding time & Clotting time - Respiratory efficiency test (Spirometer / Peak flow meter) - Recording of Respiratory movements with stethograph - Clinical Examination of any one or more cranial nerves - Clinical Examination of superficial reflexes - Clinical Examination of deep reflexes - Cerebellar Function Tests.

3.2.3. Charts

Discussion of Comments: Problem Oriented - Discussion of Calculation.