अखिल भारतीय आयुर्विज्ञान संस्थान, नागपुर

ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NAGPUR

DEPARTMENT OF PHYSIOLOGY

"Educate and Explore with Empathy"

PG Curriculum

for

M. D. Physiology

Mission Statement

To Promote the health and wellbeing of community through evidence based educational programs, innovative research and integrated health services.

"Educate and Explore with Empathy"

Table of Content

Prepared by

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1. Goal:

The goal of training MD Physiology students is to develop and inculcate self directed learning for a life time by self-motivation; to acquire necessary knowledge of functions of various body systems, to facilitate understanding of the physiological basis of health and disease; to develop relevant skills and appropriate attitude to impart education and to carry out research in Physiology and interdisciplinary fields and serve as competent Applied Physiologist so as to render appropriate advice/service to the clinician.

2. Programme outcomes:

At the end of the Physiology Programme, the MD student should:

S.No.	*Description of Outcome*
PO 2.1	Be able to Describe the functions of each organ system along with the regulation of their functions and the individual and integrated contribution of the systems in maintenance of homeostasis.
PO 2.2	Be able to Describe the body responses and adaptations and correlate the regulatory mechanisms under different environmental conditions, during exercise and physical training.
PO 2.3	Be able to Describe the process of normal growth & development and the mechanisms of aging.
PO 2.4	Understand and elucidate the physiological principles underlying the pathogenesis of diseases and their management.
PO 2.5	Perform and interpret basic laboratory tests/ procedures to study blood parameters and Human physiological phenomena
PO 2.6	Assess relevant clinical cases and interpret the findings.
PO 2.7	Record and describe the finding of electrophysiological and other clinical investigations and interpret the results.
PO 2.8	Participate in, and contribute to, National Health Programs and community welfare by all means in the purview of the subject.
PO 2.9	Follow a healthy lifestyle, so as to set an example for proving the worth of scientifically understanding the importance of healthy diet, adequate sleep, regular exercise and practices for holistic growth.
PO 2.10	Work with team spirit and for overall growth of the fraternity.
PO 2.11	Be scientifically inquisitive, develop quest for search and research and be a lifelong learner.

3. **Duration of programme**: Three years
4. **Eligibility**: MBBS
5. **Selection**: Entrance Examination

6. Syllabus:

6a. Theory:

6a. (i). Paper wise distribution:

Physiology Paper I	Physiology Paper II
1. General physiology 2. Blood 3. Immunity 4. Research Methodology and biostatistics 5. History of Physiology 6. Comparative Physiology 7. Genetics 8. Medical Education, Bioethics and communications skills	1. Renal physiology 2. Autonomic Nervous System 3. Gastrointestinal system 4. Physiology of Nutrition and Metabolism 5. Endocrine physiology 6. Reproductive Physiology

Physiology Paper III	Physiology Paper IV
1. Cardiovascular physiology 2. Respiratory physiology 3. Environmental physiology 4. Exercise physiology 5. Nerve and Muscle Physiology	1. Central Nervous system 2. Special senses 3. Yoga & Meditation 4. Clinical & Applied Physiology 5. Recent advances

6a. (ii). Detailed theory Syllabus:

Physiology Paper I			
Sr. No.	**Systems**	**Programme content**	**Related Clinical procedure or investigation to be observed/ learnt**
1	**General physiology**	• Functional Organization of human body • Cell and cell organelles; • Intercellular junctions; Cytoskeleton; Molecular Motors, Cytoskeleton related diseases.; • Cell cycle and cell division; Basis of Cancerous growth; • Cell membrane and transport mechanisms across cell membrane; Patch clamp technique, bio-electrical potentials, • Homeostasis: Milieu interieur, Control Systems • Body fluid Compartments: Normal volumes; Basic regulatory mechanisms of their homeostasis in terms of composition and volume; Measurement of body water; basic concepts of electrolyte imbalances; Physiological basis of therapeutic uses of	

		various replacement fluids • Genes and Genetic control of protein synthesis • Growth and Development including aging; • Programmed cell death.	
2	**Blood**	• Blood: Composition & Functions of blood; Plasma proteins: Types, concentration, functions; Plasmapheresis, role of liver in plasma protein synDissertation; • Haemopoesis: Bone marrow and General concepts of haemopoesis, Bone marrow structure and cellular elements; indication and basics of Bone marrow transplantation.; Stem cell and stem cell banking;; • Erythrocytes: Morphology, functions, normal count, Erythropoiesis: Sites, stages, regulation, reticulocyte, RBC membrane and related disorders. • Haemoglobin (Hb): Synthesis, Types, Functions, Normal values, Physiological variations, HbA1C, Catabolism of Hb, bilirubin metabolism, Hemolytic Jaundice. • Physiological basis of Anaemia; Nutritional anaemia, Polycythemia, Sickle cell anemia and other hemoglobinopathies, Thalassaemia • Leukocytes: Classification of WBCs, • Normal count & differential WBC counts, physiological variations, Morphology, functions of WBCs; Leucopoesis: stages, regulation; Monocyte – macrophage system; functions of spleen; Lymph node histology and function; basic aspects of Leukemia • Blood groups: Landsteiner's law, Blood group systems, ABO system: A & B antigen, relation to transfusion, major & minor cross matching: Rh System: Rh system antigens, Rh incompatibility & blood transfusion, Erythroblastosis fetalis; Blood transfusion: Indications, transfusion reactions. • Concepts of blood banking & changes during storage of blood; Clotting disorders; • Platelets: Formation, Structure, Normal count & variations, functions; Thromboaesthenia; Thrombocytopenic purpura; • Haemostasis: Basic mechanisms of Haemostasis • Blood coagulation: Platelet plug formation, Clotting factors in plasma, Intrinsic & Extrinsic pathways of blood coagulation; Role of calcium in coagulation; Role of vitamin K; & clot retraction; • Anticlotting and Fibrinolytic system	

		mechanism in the body; Anticoagulants: commonly used in vitro & in vivo & their mechanism of actions; Tests of Blood coagulation: bleeding time, clotting time, PTT, APTT, INR value; Disseminated intravascular coagulation (DIC),	
3	**Immunity**	• Innate & Acquired immunity & their mechanisms, T lymphocytes & Cell mediated Immunity; B Lymphocytes, Concept of antigen & antibody, humoral immunity, Antigen-antibody reactions, Primary & secondary response, basis of vaccination. • Recognition of Self antigen and processing of lymphocytes • Autoimmune disease concept; HLA and HLA matching in organ/ tissue transplant • Immunodeficiency	
4	**Genetics**	Genetic code, its expression, Regulation of gene expression, Cell cycle and its regulation Operon system	
5	**Research Methodology and Biostatistics**	• **Conceptualizing a research study-** Introduction to health research (What is research, justification for undertaking a research study, types of research), Formulating research question, hypothesis and objectives, Literature review • **Epidemiological considerations in designing a research study** Measures of disease frequency, Descriptive study designs (Case reports/series, Ecological study, Cross-sectional study), Analytical study designs (Cohort, Case-control), Experimental study designs (RCT, Quasi-exp), Validity of epidemiological studies, Qualitative research methods: An overview • **Bio-statistical considerations in designing a research study** Measurement of study variables (Types of data, Descriptive statistics), Sampling methods, Calculating sample size and power • **Planning a research study** Selection of study population (inclusion/exclusion criteria), Study plan and project management, Designing data collection tools, Principles of data collection, Data management, Overview of data analysis, • **Ethical issues in conducting a research study-**Ethical framework for health research, Conducting clinical trials • **Writing a research protocol-**Preparing a concept paper for research projects, Elements	

		of a protocol for research studies, Publication ethics	
6	**History of Physiology**	• Scientists Contribution made to the field of physiology (Indian / Foreign) • Noble Prize for Physiology/Medicine	
7	**Comparative Physiology**	• Comparative Physiology of Cardiovascular system, Central nervous system, Respiratory system, Reproductive system, Excretory system, Vision and Hearing	
8	**Medical Education, Bioethics and communication skills**	• Teaching and Learning- Theories and principles, types of learning, Principles of Skill learning, Learning Approaches, mode of teaching, Teaching and Learning Methods • Assessment & Evaluation- concept, type, level, characteristics of assessment instrument, roadmap to students assessment, • Curriculum designing – Six step Approach • Communication skills	

Physiology Paper II			
S. No.	**Systems**	**Programme content**	**Related Clinical procedure or investigation to be observed/ learnt**
1	**Renal Physiology**	• Structure, Functional organization and Functions of the kidneys; Details of Functional unit-The Nephron; Juxtaglomerular apparatus; Innervations of kidneys • Renal Blood flow; Concept of Clearance. • Steps of urine formation in detail: Glomerular filtration and its control; Tubular Secretion; and Tubular Reabsorption; Mechanisms of Urine concentration and dilution; Countercurrent multiplier and exchanger mechanisms; Transport maximum of substances, T_{max} of Glucose • Regulation of Extracellular fluid Volume • Regulation of Extracellular Fluid osmolarity • Role of Kidney in maintenance of acid base balance- acidification of urine Metabolic acidosis, Metabolic alkalosis; Anion gap in acid base disorders • Micturition: mechanism; micturition reflex; Cystometrogram; Micturition disorders • Diuretics: Mechanism and site of action • Kidney Function tests (KFT): normal and abnormal constituents • Kidney stones; Pathophysiology of	• Cystometrography • Dialysis • Urine analysis for protein, urea and glucose

		Nephrotic Syndrome, Acute and chronic Renal failure; • Principles of Artificial kidney and Dialysis; Renal transplant	
2	**Autonomic Nervous system**	• Functional Organization and functional anatomy of Autonomic nervous system • Effects of Sympathetic stimulation on various organs and systems • Effects of Parasympathetic stimulation on various organs and systems • Sympathetic and Parasympathetic neurotransmitters Adrenergic receptors and Cholinergic receptors • Central control of autonomic output • Drugs acting on Autonomic nervous system and physiological basis of their clinical use • Autonomic dysfunctions • Autonomic function test • Heart rate variability	• Autonomic function test • Heart rate variability
3	**Gastrointestinal System**	• General introduction & organizational plan of GI system, Relevant histology, Innervations and splanchnic circulation; GI Smooth muscle: syncytium, Electric activity and control of contraction • Gastrointestinal hormones • Salivary secretion: Salivary Glands; mechanism of secretion, composition, functions and regulation of salivary secretion. • Mastication and deglutition: Phases of deglutition, mechanism & control • Oesophageal histological feature, secretion and peristalsis; Lower oesophageal sphincter; Achalasia cardia, Reflux esophagitis (GERD), hiatus hernia • Gastric secretion: Functional anatomy and histology and functions of stomach; Composition of gastric juice; • Mechanism of secretion of gastric acid and proton pump; phases of gastric secretion; regulation of gastric secretion; Protection of stomach from acid-pepsin mixture- Gastric mucosal barrier; Peptic ulcer; Zollinger Ellison Syndrome; experiments to study regulation of gastric juice secretion; • Gastric Motility: Electrical activity of stomach, Filling and emptying of Stomach, Regulation of and factors	GI Manometry

		promoting & inhibiting Gastric emptying; Barium meal studies • Pancreatic secretion: microscopic structure of pancreas; composition, mechanism of secretion function and Regulation Pancreatic juice • Hepatobiliary system: Microscopic structure and functions of liver, composition and formation of bile, Enterohepatic circulation of bile salts, control of secretion, concentration &storage of bile in gall bladder; hepatic and post hepatic Jaundice; Liver cirrhosis; Effects of hepatectomy; Liver transplant; Gall stones; Liver function Tests • Small Intestine: Duodenum, jejunum and ileum; microscopic details of Villi and Crypts; Intestinal secretion: Composition & mechanism of secretion of small intestinal juice, regulation of secretion; Motility of small intestine and their control: Mixing and Propulsive movements; vomiting; Paralytic ileus, diarrhoea, intestinal obstruction, irritable bowel syndrome; • Colon: Parts, Microscopic features, Secretions; Motility of large intestine: Mixing & mass movements, defecation reflex' and its control; Hirschprung's disease; constipation • Gut immune system • Gut flora, Dietary fibers	
4	**Physiology of Nutrition and Metabolism**	• Digestion & absorption of Carbohydrate, Proteins and Fats; Absorption of water, electrolytes and vitamins; Oral rehydration solution • Recommended dietary allowances • Balanced diet, Diet for infants, children, pregnant and lactating mothers, and the elderly • Energy metabolism • Obesity and starvation • Basic concepts of Bariatric surgery	
5	**Endocrine system**	• General consideration of hormones; Mechanism of action of Hormones; • Endocrine functions of Hypothalamus – Mechanism of hormone action; function, regulation and disorders • Anterior pituitary hormones: Functions, Hypothalamic and feedback regulation; Growth hormone: function, regulation	Radioimmunoassays; ELISA

		and disorders • Posterior pituitary hormones: Antidiuretic hormone and Oxytocin: functions, regulation and disorders • Thyroid hormone: synthesis, Secretion, Functions, regulation, Disorders- Goitre, Hypothyroidism, Hyperthyroidism. • Adrenal cortex and medulla: Mineralocorticoids, Glucocorticoids, Sex Steroids and Adrenaline hormone: Synthesis, Secretion, Functions, Regulation, Disorders • Pancreatic hormones: Insulin and Glucagon- secretion, functions, regulation, disorders; Pathophysiology of Diabetes mellitus • Parathyroid hormone: Synthesis, Functions, Regulation, Disorders; Vitamin D and Calcitonin • Pineal Gland and endocrine function of other organs viz - heart, kidneys, Adipose tissue • Radioimmunoassays; ELISA; • Stress	
6	**Reproductive system**	**Male Reproductive System** • Sex chromosomes, sex determination, sex differentiation and abnormalities of sexual differentiation • Puberty: Changes in males & females and its control; Disorders related to puberty -precocious & delayed puberty; • Functional anatomy of Male reproductive system • Spermatogenesis- Stages & regulation; Blood-testis barrier; Structure of Spermatozoa • Semen: Composition; Prostate gland and its secretions • Testicular hormonal Functions: Testosterone- Actions, Regulation and mechanism of action; and Control of testicular function • Abnormalities of testicular and Prostate function • Male infertility;; Semen analysis, Sperm Function Tests **Female Reproductive System** • Functional anatomy of female reproductive system; Oogenesis • Menstrual cycle: Cyclical changes in ovary, uterus, cervix, vagina and breast	• Semen Analysis • Sperm Function Tests • Test of ovulation • Test of infertility

		during menstrual cycle; hormonal regulation of the menstrual cycle by ovarian hormones and Gonadotropins; Ovulation; Indicators of Ovulation; anovulatory cycles; Corpus luteum; Abnormalities of Menstrual cycle • Ovarian hormones: Estrogen and Progestrone-Functions, Mechanism of action and regulation of secretion of estrogen; Abnormalities of secretion • Menopause • Contraception: Principles and methods of contraception in male and female. • Female infertility **Pregnancy and Lactation** Fertilization and implantation of Ovum • Placenta and its functions • Physiological changes during pregnancy and hormonal control of pregnancy • Parturition: Mechanics and Control; labor pains • Lactation: Development of breast; Control of milk secretion and milk ejection; Composition of milk; effect of lactation on menstrual cycle **Fetal and Neonatal Physiology** • Fetal circulation • Adjustments after birth • Physiology of Growth and development of the fetus and neonate; Development of genitals & gonads • Congenital anomalies related to cardiovascular system; Problem of prematurity	

Physiology Paper III			
S. No.	**Systems**	**Programme content**	**Related Clinical procedure or investigation to be observed/ learnt**
1	**Respiratory Physiology**	• Introduction to the Respiratory System; Functional anatomy of respiratory system. • Pulmonary Ventilation: Mechanics of Inspiration and Expiration, Intrapleural pressure; Lung volumes and Capacities, Measurement of FRC and residual volume ; Alveolar Ventilation; Dead Space; Physical principles governing air	• PFT -Spirometry , -Body Plethysmography, -Diffusing capacity for carbon monoxide (DLCO) -Blood Gas analysis • Ventilator

		flow in respiratory passages, Lung compliance, Surfactant, Hyaline membrane disease; Pathophysiology of obstructive and restrictive disorders; Pulmonary circulation and its special features; Blood flow through pulmonary capillaries; Ventilation-Perfusion Ratio; Pulmonary edema, Pleural effusion; Pulmonary Hypertension, Cor Pulmonale. • Diffusion of gases: Principles of diffusion, Respiratory membrane; Factors affecting diffusion and related disorders; Composition of air in respiratory passage • Transport of oxygen; Oxygen Haemoglobin dissociation curve, Bohr's effect • Transport of carbon dioxide, Haldane's effect, Chloride Shift • Regulation of respiration- Neural and Chemical control; Respiratory acidosis and alkalosis; Periodic breathing, • Hypoxia; Principles of oxygen therapy • Cyanosis; Dyspnea • Pulmonary function tests • Artificial respiration; Positive pressure respiration • Respiratory adjustments to Muscular Exercise and training	
2	**Cardiovascular Physiology**	• Introduction to cardiovascular system, its functions & importance. • General organization: Structure of heart, pericardium, myocardium, endocardium, Nerve supply • Cardiac Muscle: Structure, Histology, Functional syncytium, Intercalated discs, Details of cell junctions, E-C Coupling, Action potential of cardiac muscle; Cardiac Ion channel • Properties of cardiac muscle: autorhythmicity, excitability, conductivity, contractility, all or none law, long refractory period. • Heart as a pump, Frank Starling's Law, Metabolism and energetics • Excitatory and Conducting Tissue: Sinoatrial Node, Atrioventricular node, Bundle of His and its branches and Purkinje fibers, Pacemaker potential, Generation & conduction of cardiac impulse.	• Electrocardiography • Echocardiography • Angiography • Angioplasty

		• Electrocardiography (ECG): Definition, Arrangement of ECG leads, Normal ECG waves, segments & intervals and their significance • Cardiac Cycle: Systole, Diastole, Pressure & Volume changes, Heart Sounds, Correlation of pressure changes, volume changes, ECG, Heart sounds in cardiac cycle. • Heart rate & its regulation. • Haemodynamic Principle of Blood Circulation related to blood flow and vascular resistance • Blood pressure: Definition, Normal values, measurement, determinants, Regulation of BP- Neural & Long term, Pathophysiology aspects of Hypertension • Microcirculation: Structure, exchange across capillaries, Starling's forces, Regulation of blood flow in the tissues • Lymphatic system: Functional anatomy, its function, formation and composition of lymph, lymph flow & factors affectingit. Physiological basis of Edema • Cardiac output: Definition, Normal values, physiological variations, Determinants of Cardiac output, Regulation of Cardiac Output- Homometric and Heterometric, factors affecting cardiac output, Measurement of Cardiac Output. • Venous Return: Factor affecting VR • Coronary circulation: Coronary arteries and venous drainage of heart, special features of coronary blood flow. Applied physiological aspects of Coronary circulation- ischemic heart disease including atherosclerosis, Angina pectoris, Myocardial infarction. • Regional circulation: Functional anatomy, special features, regulation and factors affecting- cerebral, cutaneous, skeletal muscle circulations • Circulatory shock – causes, stages & compensatory mechanisms, effects on body, physiological basis of treatment in brief. • Heart Failure: Causes, Compensated and Congestive cardiac Failure, Physiological basis of treatment.	

		• Adaptation Cardiovascular system to muscular training and Aerobic exercise • Important & receptors in cardiovascular system: Their Physiological, pharmacological & clinical significance • Heart blocks, Arrhythmias, Mean Electric Axis deviation, ECG changes in ischaemia and infarctions. • Murmurs & their clinical significance. • Congenital heart diseases • Echocardiography • Heart transplant in general • History of cardiovascular physiology • Comparative physiology	
3	**Environmental Physiology**	• **Regulation of Body temperature** in hot and Cold environment: • Normal body temperature • Balance between heat gain & heat loss • Role of Skin in regulation of body temperature; cutaneous circulation; sweating mechanism • Role of Hypothalamus in regulation of body temperature, Fever , Hypothermia • **Hypobaric Condition**: Acute and chronic Acclimatization to High altitude, Mountain sickness • **Hyperbaric conditions**: Deep sea diving and other condition; Effect of high partial pressures of different gases; Decompression sickness or Caissons disease, SCUBA diving • **Space Physiology:** Effects of acceleratory forces and Microgravity; Basic knowledge about physiological variation and adjustments of space travel • Aviation physiology • **Environmental Pollution**: Noise pollution, Radiation hazards; Smoke pollution	
4	**Exercise and sports physiology**	• Muscle response to athletic training; Fast and Slow twitch fibers, Fuel utilized; Muscle hypertrophy • Cardiovascular response to muscular training and Aerobic exercise • Respiratory adjustments to Muscular Exercise and training; Vo2 max, EPOC (Excessive Post Exercise Oxygen Consumption)-Oxygen debt; Lactate Threshold	• Treadmill Testing • CPET • Exercise Prescription as Lifestyle modification

		• Doping in Sports • Benefits of Regular exercise	
5 a	**Nerve**	• Neuron; Myelination; Classification of nerve fibers; • Resting Membrane Potential: generation & maintenance, Measurement of RMP; • Action potential: Phases, ionic basis of depolarization & Repolarisation, Generation & propagation of AP, Properties of AP; Saltatory conduction • Patch clamp technique, voltage clamp Methods, Chronaxie and factors affecting it; Rheobase; • Nerve conduction studies	Nerve conduction studies
5 b	**Muscle**	• Gross and Electron microscopic structure of skeletal muscle; Sarcomere; Muscle proteins: contractile, regulatory, structural & enzymatic; Sarcoplasmic reticulum and T-tubular system; • Molecular basis of skeletal muscle contraction: sliding filament theory, power stroke; role of calcium • Muscle relaxation • Neuromuscular Junction: Physiologic anatomy, Transmission of impulse, Myasthenia gravis. • Excitation – contraction coupling. • Energetics: fuel used by skeletal; White/ Fast and Red/Slow muscle fibers; Rigor mortis • Properties of skeletal muscle: excitability, refractory period (absolute, relative), conductivity, contractility • Types of muscle contraction: Isometric and isotonic; Free load and afterload • Strength of muscle contraction: Length Tension relationship; Motor unit recruitment • Muscle response to athletic training; Muscle hypertrophy • Muscular Dystrophy; • Neuromuscular blockade • Electromyography (EMG) • **Smooth muscle**: Structure, Types, Distribution, Molecular mechanism of contraction, Properties, Regulation, and disorders	Electromyography

Physiology Paper IV			
S. No.	**Systems**	**Programme content**	**Related Clinical procedure or investigation to be observed/ learnt**
1	**Central Nervous system**	• Organization of the central nervous system. • Neuron and Neuroglia • Synapses: Synaptic transmission and properties, Neurotransmitters, Receptors of Neurotransmitters Glutamate and GABA; Synaptic plasticity; role of neurotransmitters in Psychosis and Depression • Spinal cord: organization & Functions • **Somatosensory Systems**: – Sensory Receptors: Classification, mechanism of action, Sensory modalities; sensory coding; – Ascending/Sensory Tracts, Sensory modalities; Somatosensory Cortex; Effect of their lesions; Phantom limb, Cortical plasticity – Physiology of Pain: Pain Pathways; Internal analgesia system; Referred pain; Visceral pain • **Thalamus:** Nuclei, their functions and connections; Thalamic syndrome • **Motor System**: – Reflexes; Muscle spindles, Stretch reflex; Golgi tendon organs; Spinal cord and other reflexes; – Role of Spinal cord, Brain stem, Motor cortex, Descending/ Motor tracts and their functions in control of motor Movements – Control of Posture and Equilibrium and muscle tone – Basal Ganglia: Components, Connections and function; Parkinson's disease; Huntington's disease – Cerebellum: Physiological anatomy and Cerebellar Circuitry; Connections and functions of cerebellar lobes; effect of their lesions. • **Spinal cord injury**: Complete transection and Brown Sequard Syndrome; Concepts of Upper and Lower motor neuron lesions • Experimental sections and Clinical lesions in brain stem and sub-cortical	Electroencephalography

		levels; Decorticate and decerebrate rigidity • **Higher & other functions** – Cortical Association Areas, Categorical and Representational Cortex, Language and its disorders; – Memory and Learning, Conditioned Learning, pathophysiologic basis of Alzheimer's disease. – Electroencephalography: waves and their significance; Epilepsy – Reticular Arousal System: Components, Wakefulness, Sleep – Hypothalamic nuclei & their Functions – Limbic system: Components and its functions; Motivation and behaviour; Kluver-Bucy Syndrome • **Cerebral circulation &Cerebrospinal fluid**: Details of cerebral blood flow; CSF Formation, Circulation and functions, Blood brain barrier; Stroke Hydrocephlus • Basic knowledge of Thought generation; Coma; Brain death	
2	**Special Sense**	**Vision** • Functional anatomy of the eye; Aqueous Humour; Intraocular tension; Glaucoma • Principles of optics; visual optics; Refractory media and image formation; Errors of refraction; Visual acuity; Depth Perception • Structure and functions of retina; Macular degeneration, Retinitis pigmentosa; Electroretinogram • Photoreceptors (Rod and cone) and their pigments; Vitamin A and night Blindness; Photochemistry of vision; Electrical responses in rods and cones; Dark adaptation; Light Adaptation; • Colour vision: Its theories; Retinal and neural mechanisms of colour perception; Colour blindness • Visual pathways; Field of vision; and effect of lesion at various levels of visual pathway; Electrophysiology of vision, and colour vison; Lateral inhibition; Processing of visual information at different components of visual pathway; • Visual cortex: structure; Detailed function; fusion of visual image of the	• Visual Evoked Potentials • Tests of hearing • Brainstem Auditory Evoked Potentials • Audiometry

		two eyes; Critical fusion frequency; Visual Evoked Potential (VEP) • Accommodation reflex and the Near response; Light reflex; Abnormal pupillary reflexes • Eye movements and their control **Hearing** • Functional anatomy of external, middle and inner ear(Cochlea and Organ of Corti) • Physics of Sound waves, their pitch and loudness; Sound transmission • Functions of external, middle and Cochlea • Perception of intensity, frequency and direction of sound • Generation of electrical potentials in cochlea and genesis of action potentials in Cochlear nerve fibres. • Auditory pathways • Role of auditory cortex in hearing. • Types of deafness; Tests for hearing • Audiometry • Cochlear transplant, Speech therapy; Autism **Taste** • Taste buds • Receptors and pathways for taste • Basic taste modalities and receptor stimulation • Taste threshold and intensity discrimination • Abnormalities of taste sensation **Smell** • Olfactory Membrane • Receptors and pathways for smell • Cortical and limbic areas associated with smell • Physiology of olfaction. • Abnormalities of olfaction. **Equilibrium** • Vestibular Apparatus- Semicircular canals, Utricle and saccule: Structure and functions • Central Connections and their integrated role in maintenance of equilibrium, Lesions of Vestibular System	
3	**Physiology of yoga and meditation**	• Introduction to yoga • Basic knowledge of yogic practices	Lifestyle Modification

4	**Clinical & Applied Physiology**	Physiological basis of various clinical investigation tests • Lung function tests and interpretation of results. • Diffusion capacity o Carbon monoxide • Autonomic function testing and Heart Rate variability • Cardiopulmonary exercise traning • Semen analysis and sperm function test • Electroencephalography(EEG) and sleep studies • Electrocardiography (ECG) • Electromyography (EMG) • Electro Oculography (EOG) • Electronystamography (ENG) • Nerve conduction study (NCV) • Visual evoked potential (VEP) • Brainstem auditory evoked potential (BAEP) • Somato- sensory evoked potential (SEP) • Motor evoked potential (MEP) • Any other newer technology	

6b. Practical:
List of Practicals:

6b (i) Section I Hematology:

	Topic
1	Study of Compound Microscope
2	Determination of hemoglobin concentration of blood
3	Determination of total red blood cell count
4	Determination of total leucocyte count
5	Preparation and examination of peripheral blood smear and determination of differential leukocyte count
6	Determination of ABO and Rh blood groups
7	Determination of bleeding time and clotting time
8	Determination of platelet count
9	Determination of Reticulocytes count
10	Determination of Eosinophil count
11	Demonstration of Bone marrow smear
12	Demonstration of osmotic fragility of erythrocytes and specific gravity of blood
13	Demonstration of erythrocyte sedimentation rate

14	Demonstration of packed cell volume
15	Calculation of the blood indices values

6b (ii)Section II Clinical Examination:

	Topic
1	Clinical Examination and history taking
2	Clinical examination of the cardiovascular system
3	Clinical examination of the respiratory system.
4	Clinical examination of the abdomen
5	Clinical Examination of Higher functions
6	Clinical Examination of the Motor system
7	Clinical Examination of sensory system
8	Clinical Examination of Cranial nerves
9	Testing of visual acuity and color vision
10	Perimetry : Mapping the field of vision
11	Tests of hearing
12	Record and interpret normal ECG.
13	Demonstration of Autonomic Function Tests
14	Determination of Ovulation time by Basal body temperature chart, Pregnancy diagnostic test - Immunological Test
15	Semen analysis: Sperm count and motility, Sperm function Tests

6b (iii)Section III-Human Experiments:

	Topic
1	Study of phenomenon of human fatigue by Mosso's Ergograph and Hand Grip Dynamometer
2	Study of Stethography
3	Study of Spirometry - Effect of posture on Vital capacity
4	Study of fitness test by Harvard Step test
5	Demonstration of Basic Life Support
6	Perform and interpret Autonomic function tests
7	Perform and interpret Sleep Studies
8	Perform and interpret Pure Tone Audiometry
9	Cardio pulmonary exercise training (CPET)
10	Perform Reaction time (VRT & ART)

11	Perform and interpret Gastrointestinal Manometry
12	Perform and interpret Neuroelectrodiagnostic techniques: a. Nerve conduction study b. Electromyography (EMG) c. Visual evoked potential (VEP) d. Brainstem auditory evoked potential (BAEP) e. Somato- sensory evoked potential (SEP) f. Motor evoked potential (MEP) g. Eletroencephalography (EEG) h. Electrooculography (EOG) i. Electronystagmography (ENG)

6b (iv)Section IV Amphibian Experiments:

	Topic
1	Introduction to animal experiments
2	Study of instruments and circuits
3	Amphibian nerve-muscle experiments
	1. To study of excitable and contractile properties of a nerve muscle preparation 2. To study Simple muscle curve (SMC) 3. To study effect of temperature, 4. To study the effect of subthreshold, threshold and suprathreshold stimuli on isotonic contraction 5. To study the effect of two or more successive stimuli and genesis of tetanus 6. To study isometric contraction and length tension relationship 7. Estimation of the work performed by skeletal muscle in vitro under after loaded and free loaded conditions 8. Study of neuromuscular transmission in an amphibian nerve muscle preparation under 9. Determination of strength duration curve in frog's nerve and muscle 10. Determination of conduction velocity 11. To study the phenomenon of Fatigue, 12. To study the genesis of tetanus
4	Amphibian Cardiac experiments
	1. To study the Normal cardiogram, 2. To study the Effect of temperature, 3. To Study the properties of cardiac muscle, 4. To study the Effect of Stannius ligature, 5. To study the All or none Law and summation, 6. To Study the staircase phenomenon, 7. To study the Extra systole and compensatory pause, 8. To study the Effect of stimulation of Vagus and WCL, 9. To study the Effect of drugs and ions on normal cardiogram 10. Study of the factors controlling inotropic and chronotropic functions in isolated perfused frog's heart

6b (v) Section IV Mammalian Experiment:

	Topic
1)	**Rabbit experiments**
a)	Study of heart & intestine
2)	**Dog experiments**
a)	Effect of Vagus stimulation (intact and cut on Blood pressure and respiration)
b)	Effect of hemorrhage on BP
c)	Effect of Drugs on BP- Adrenalin, Acetylcholine.
3)	**Other experiments**
a)	Recording of smooth muscle activities & effects of various factors

7. Teaching learning Activities:

The teaching learning activities would consist of:

- Participating in preparing and conducting undergraduate classes under supervision.
- Microteaching sessions.
- Journal clubs moderated by teachers.
- Seminars, symposia, panel discussion of suitable topics moderated by teachers.
- Small group discussion.
- Dissertation work presentation.
- Attend & participate in CME, conferences, workshops & share knowledge & experiences with others.
- Rotation in various Clinical Departments to gain the knowledge of various techniques used to study the functions of various systems.

8. Teaching Programme:

To achieve the above objectives in three years, following structured programme will be implemented in six semesters:

Semester I:

1. Orientation to the Department.
2. Enroll for 6 month "Basic Course in Biomedical Research" conducted by National Programme on Technology Enhanced Learning (NPTEL).
3. Selection of topic for Dissertation under the guidance of allotted guide.
4. Writing and submission of the Dissertation synopsis to Research committee and Institutional Ethical committee.
5. Participate in preparing and conducting undergraduate classes.

Semester II:

1. Participate in Basic Course of Medical Education Training.
2. Participate in preparing and conducting undergraduate classes.
3. Dissertation work – Review of Literature, Data Collection.
4. Rotations to Clinical physiology Laboratories.
5. Attend National/ State Conference (Oral/Poster Presentation).

Semester III:

1. Participate in bioethics and communication skill training.
2. Participate in preparing and conducting undergraduate classes.
3. Seminar presentation.
4. Journal club.

5. Dissertation work- Data collection.
6. Rotation to Clinical Physiology Laboratories.

Semester IV:

1. Participate in preparing and conducting undergraduate classes.
2. Seminars.
3. Journal clubs.
4. Dissertation work- Data collection and Dissertation writing.
5. Rotation to Clinical Physiology Laboratories.
6. Clinical Rotation to other Departments. (4 weeks)
7. Paper presentation in National Conference.

Semester V:

1. Participate in preparing and conducting undergraduate classes.
2. Seminars.
3. Journal club.
4. Submission of Dissertation.
5. Rotation to Clinical Physiology Laboratories.
6. Clinical Rotations to other Departments. (4 Weeks)
7. Paper publication in peered reviewed journal.

Semester VI:

1. Participate in preparing and conducting undergraduate classes.
2. Seminars.
3. Journal clubs.
4. Rotation to Clinical Physiology Laboratories.

9. Teaching schedule:

The teaching schedule is as follows:

Sr. No	Activity	Frequency
1	**Seminar**	**Once a week**
2	**Journal Club**	**Once a week**
3	**Tutorial / Discussion/ Microteaching**	**Once a week**
4	**PG Practical**	**Once a week**
5	**Dissertation work presentation**	**Six monthly**

In addition to the above students will attend all MBBS classes.

10. Rotation in Clinical physiology Laboratory

Cyclic two weeks rotations in each Clinical physiology Laboratory will be from II Semester till VI Semester viz

- Pulmonary Function Tests Laboratory.
- Autonomic Function tests Laboratory.
- Andrology Laboratory.
- Electrophysiology Laboratory.
- Cognitive Neurophysiology Laboratory.
- GI Laboratory.

11. Rotations in other Departments:

The postgraduate student will rotate through following allied clinical departments

Sr. No	Departments		Duration of Rotation (2-5 PM)
1	**Biochemistry**	Lectures on Metabolism of Carbohydrate Protein and Lipids, Acid base balance – 8 hrs Learn the methodology of all clinical Biochemical tests and interpretation of data. Blood Gas Analysis.	As per Biochemistry Schedule 3 days
2	**Pathology and Transfusion Medicine**	Transfusion Reactions - Lecture -2 hrs. All Blood investigations & interpretations. Collection, storage, transfusion of Blood. Blood grouping and cross matching.	As per Pathology Schedule 3 days
3	**General Medicine**	1) Clinical Examination of a patient. Learning the pathophysiology of common medical problems. 2) Interpretation of Data- a) X-rays. b) ECG. c) Laboratory Investigations.	1 week
4	**Pulmonary Medicine**	1)Lung function tests and interpretation of results. 2) Spirometry - procedure & Interpretation. 3) Bronchoscopy.	1week
5	**Cardiology**	1) Learn methodology of Cardiac Monitoring, Echocardiography, Doppler, Cardiac Catheterization, Resuscitation technique. 2) Interpretation of E.C.G. and other records.	1 week
6	**Neurology**	1) Clinical Examination of patient. 2) Principles of EEG, EMG. 3)Interpretation of EEG, EMG, and other investigative Data. 4) Nerve conduction study.	1 week
7	**Endocrinology**	1) Clinical Examination of patients. 2) Discussion and treatment guidelines. 3) Radio Immuno Assay techniques.	4 days
8	**Nephrology**	1) Urodynamic study. 2) Stenting. 3) Intravenous Urogram (IVU). 4) Dialysis.	4 days
9	**Anaesthesia**	1) Basic Life Support. 2) Ventilator.	4 days
10	**Obstetrics**	1) Tests for infertility. 2)Assisted Reproduction Techniques.	1 week
Total duration			8 weeks

12) Gantt chart for M. D. physiology activities:

PG Activities		Semesters					
PG activity	**Particulars**	**I**	**II**	**III**	**IV**	**V**	**VI**
Academic	UG classes (Preparation and conduction)						
	Seminar presentation						
	Journal club presentation						
Dissertation	Selection of topic for thesis						
	Submission of Dissertation synopsis						
	Review of literature, data collection						
	Data collection						
	Data collection & Dissertation writing						
	Submission of Dissertation						
Clinical posting	Rotation in clinical physiology lab						
	Clinical rotation in other dept (4 weeks)						
	Clinical rotation in other dept (4 weeks)						
Research	Enroll for 6 month 'Basic Course in Biomedical Research'						
MET	Basic course of MET (participate)						
Conference	Attend National/ State conference (oral/poster presentation)						
	Paper presentation in National conference						
Paper publication	Publication of paper in peer reviewed journal						

13. Dissertation:

13.1 Every candidate shall carry out work on an assigned research protocol under the guidance of a recognized Postgraduate teacher; the protocol shall be written and submitted in the form of a Dissertation.

13.2 Every candidate shall submit Dissertation plan in form of synopsis to the Academic section within the given time frame.

Process to be completed within six months of admission to MS / MD program:

Activity	July admission	January admission
Selection of topic in consultation with PG Guide	September / October	March / April
Approval by Department PG Committee		
Institute Scientific Committee approval	November / December	May / June
Institute Ethics Committee approval		
Final approval letter by Academics Section	31st December	30th June

13.3 Dissertation shall be submitted to the Academic section six months before the commencement of theory examination i.e. by 31st December for June Examination and by 30th June for Dec examination.

13.4 The student will (i) identify a relevant research question; (ii) conduct a critical review of literature; (iii) formulate a hypothesis; (iv) determine the most suitable study design; (v) state the objectives of the study; (vi) prepare a study protocol; (vii) undertake a study according to the protocol; (viii) analyze and interpret research data, and draw conclusions; (ix) write a research paper for Presentation / Publication.

14. Assessments

14.1 Continuous assessments:

a) **Six Monthly Progress Reports**: For daily and regular assessment of the resident's work.

Timing for Six Monthly Progress Reports Submisson is as follows:

Report	July Session		January session	
	Period	To be submitted	Period	To be submitted
First	July to December	7th January	January to June	7th July
Second	January to June	7th July	July to December	7th January
Third	July to December	7th January	January to June	7th July
Fourth	January to June	7th July	July to December	7th January
Fifth	July to December	7th January	January to June	7th July
Sixth	January to June	10th June	July to December	10th December

* **Note**: The first five reports will be taken into consideration to decide the eligibility of the student to appear for the Professional Examination.

b) **Dissertation:** It will be assessed separately before the summative assessment.

c) **Logbooks:** The performance of the Postgraduate student during the training period should be monitored throughout the course and duly recorded in the log books as evidence of the ability and daily work of the student.

14.2. Formative Assessment:

14.2. a) Timeline:

	At the end of I year	At the end of II year	At the end of III year
Formative Assessment	1st Internal Assessment Examination	2nd Internal Assessment Examination	Pre professional Examination
Format of Examination	• One theory paper • Practical examination	• One theory paper • Practical examination	• Four theory papers • Practical examination including theory viva

14.2. b) Formative Assessment Examination Pattern & Marks distribution:

1st Internal Assessment examination	*Theory Examination 100 marks (3 hours)*			*Practical Examination 100 marks*	
	Question Type	**Marks**	**No. of Q.**	**Total Marks**	**Sections**	**Marks**
	LAQ	15	2	30	Hematology and Human Physiology Practicals	50
	SN	10	5	50	Clinical case	50
	BAQ	5	4	20		
	Total			***100***	***Total***	***100***

2nd Internal Assessment examination	*Theory Examination 100 marks (3 hours)*				*Practical Examination 100 marks*	
	Question Type	**Marks**	**No. of Q.**	**Total Marks**	**Sections**	**Marks**
	LAQ	15	2	30	Recording and interpretation of Electrophysiological parameters	50
	SN	10	5	50	Clinical Case	50
	BAQ	5	4	20		
	Total			***100***	***Total***	***100***

Pre Professional Examination	*Theory Examination 80 marks each (3 hours)*			*Practical Examination (220 marks+100 Marks Viva)*	
	Paper I	100 marks	*Day 1*	Day 1	200 marks
	Paper II	100 marks	*Day 2*		
	Paper III	100 marks	*Day 3*	Day 2	200 Marks
	Paper IV	100 marks	*Day 4*		
	Total	**400 Marks**		**Total**	**400 Marks**

*Theory paper pattern will be same as 1st and 2nd Internal Examinations.

Practical Pattern for Pre- Professional Examination is as follows:

Pre Professional Practical Examination					
Practical *Examination*		Headings	No. of questions	Each Q. Marks	Total Marks
Day 1	OSPE 1	Stations (Other department postings).	**6**	**5**	**30**
	OSPE 2	Cased based Haematology practical.	**1**	**50**	**50**
	OSCE 3	Clinical case presentation.	**1**	**80**	**80**
	OSPE 4	Clinical Physiology practicals.	**1**	**80**	**80**
	OSPE 5	Viva on Amphibian & Mammalian Experiments.	**4**	**10**	**40**
		Total			**280**
Day 2		Microteaching /Pedagogy.			**20**
		Grand viva including the following components: ➢ Thesis (PPT presentation). ➢ Discussion of physiology theory. ➢ Teaching methodologies. ➢ Contribution of scientists ➢ Journals (Indian/Foreign). ➢ Recent research advances.			**100**
		Total			**120**
Grand total					**400**

14. 2. c). Eligibility to appear in Professional Examination:

S. No	Parameters	Criteria
1	Research Methodology Examination conducted at end of Induction Programme	Pass
2	Internal Assessment marks	≥50% marks separately in theory and practicals
3	Dissertation	Accepted
4	MD Programme attendance	≥80% in each year
5	Poster and Paper presentation in Conference	1 poster and 1 paper presentation
6	Peer reviewed Indexed Publication	One (Accepted /published/ Sent for publication)
7	Six Monthly Progress Report	At least 4 out of 6 satisfactory Progress Reports

14.3. Summative Assessment:

14.3. a) Timeline:

	At the end of I year	At the end of II year	At the end of III year
Summative Assessment	---------N/A---------	---------N/A---------	Professional Examination
Format of Examination	---------N/A---------	---------N/A---------	• Four theory papers • Practical examination including theory viva

14.3.b) Pattern of Professional Examination:

Professional Examination	*Theory Examination Four Papers (3 hours)*		*Practical Examination (Practical + Viva)*	
	Paper	**Marks**		Marks
	Paper I	400	Practical	300
	Paper II	400		
	Paper III	400	Grand Viva including Thesis Viva	100
	Paper IV	400		
	Total	**400**	**Total**	**400**

*Theory paper pattern and practical pattern will be same as Pre- Professional examination.

14.3.c). Criteria for Passing in MD Physiology Programme:

Professional Examination		Theory	Passing Percentage	Aggregate Percentage for passing
	Theory examination	**Paper I**	40%	50 % aggregate of all four papers.
		Paper II	40%	
		Paper III	40%	
		Paper IV	40%	
	Practical examination		50%	50%

14. 4. Gantt Chart for Assessment in MD Physiology programme:

Assessment		***Semesters***					
Type	Tool / Mode	I	II	III	IV	V	VI
Continuous	Progress report (six monthly)						
	Dissertation						
	Logbook						
Formative	First Internal Assessment						
	Second Internal Assessment						
	Pre-professional examination						
Summative	Professional examination						

15. Recommended Books and Journals:

15. a. Textbooks:

- Guyton and Hall Textbook of Medical Physiology - Hall John E
- Ganong's Review of Medical Physiology- Barrett Kim E, Barman SM
- Berne and Levy Physiology- Koeppen Bruce M, Stanton Bruce
- Physiological basis of medical practice- Best and Taylor
- Comprehensive Textbook of Medical Physiology- G K PAL
- Textbook of Practical Physiology by Dr G K Pal and Dr Pravati Pal
- Hutchison's Clinical Methods: An integrated approach to Clinical Practice
- Textbook of Practical Physiology: by Dr Ranade
- Vander's Human Physiology: The mechanism of body function- Eric P. Widmaier, Hershel Raff, Kevin T. Strang
- Medical Physiology: A cellular and molecular approach- Boron Walter F, B Emile
- Keel, Samson and Wright's Applied Physiology.
- Understanding physiology, Dr. RL Bijlani

15. b. Reference book:

- **Blood:**
  - Wiliams Haematology by Kenneth Kaushansky
  - Wintrobe's Clinical Hematology by John P. Greer
- **Nerve Muscle:**
  - Cellular Physiology of Nerve and Muscle by Gary G. Matthews
  - Essential of exercise physiology by William D. McArdle. Frank I Katch
- **Cardiovascular Physiology:**
  - Levick's Introduction to cardiovascular Physiology
  - Mosby physiology monograph series-Cardiovascular Physiology
  - The ECG made easy by John Hampton
- **Respiratory Physiology:**
  - Respiratory physiology, the essentials by Au John B West
  - Pulmonary Physiology and Pathophysiology: An Integrated, Case-Based Approach by Au John B West
  - J.E. Cotes- Respiratory Physiology
- **Endocrine Physiology:**
  - Williams Textbook of Endocrinology
- **Gastrointestinal System:**
  - Yamada's Textbook of Gastroenterology

- **Renal Physiology:**
  - Vander's renal physiology
- **Central Nervous System:**
  - Principles of neural science by Eric Kandel
  - Clinical Neuroanatomy by Richard S. Snell
  - Neurophysiology : A Conceptual Approach by Roger Carpenter
  - Clinical neurophysiology by Jun Kimura
- **Clinical Examination:**
  - Macleod's Clinical Examination
  - Bates' Guide to Physical Examination and History Taking
- **Clinical Neurophysiology:**
  - Mishra uk, Kalita J- Clinical neurophysiology
  - Niedermeyer's EEG – Basic principles, Clinical application, and related fields
- **Experimental Physiology**
  - D.T. Harris – Experimental Physiology
- **Medical Education:**
  - Basics In Medical Education by Zubair Amin
  - Principles Of Medical Education by Tejinder Singh
- **Research Methodology:**
  - Research methodology methods and techniques by C R Kothari
- **Miscellaneous:**
  - Harrison's Principles of Internal medicine
  - Davidson's Principles and Practice of Medicine, International Edition
  - Harpers Illustrated Biochemistry

15. c. Journals Recommended:

- American Journal of Applied Physiology.
- Annual Review of Physiology.
- Advances in Physiological education and Recent advances in Physiology
- Journal of Physiology (British pub.)
- Indian Journal of Physiologists and Pharmacologists
- Journal of Experimental Physiology
- Indian Journal of Medical Research
- Acta Physiologica Scandivinavia
- Indian J of Chest diseases and allied sciences.
- J sports physiology.
- Fundament of Exercise testing: WHO publications.
- Brain
- Nature
- Lancet
- News in Physiological Sciences
- Physiological Reviews.
- The New England Journal of Medicine.

15. d. Periodicals:

- Annual Review of Physiology.
- Annual Review of Neuroscience.
- Annual Review of Biochemistry.