

POST-GRADUATE CURRICULUM FOR PHYSIOLOGY: M.D. PHYSIOLOGY

1. GOAL:

The purpose of this programme is to standardize Physiology teaching at post-graduate level so that it will benefit in achieving a competent physiologist, capable of conducting independent research for the advancement of medical sciences , and a good medical teacher in Physiology.

Thus, the training in MD Physiology should be distinct from that in M.Sc. or Ph.D. (Physiology), where the approach to the subject is primarily experimental.

Duration of course: Three years

Eligibility: After completion of MBBS

Selection: Entrance Exam (Delhi PG exam, All India PG Exam.)

2. SPECIFIC LEARNING OBJECTIVES:

Learning should encompass the following domains: Cognitive, Psychomotor and Affective.

A candidate upon successfully qualifying in the MD (Physiology) examinations should be able to:

- Understand and deal with all aspects of general and systemic physiology.
- Conduct relevant clinical/experimental research as would have significant bearing on human health and patient care.
- Critically evaluate published journal literature.
- Acquire skills in conducting collaborative research in the field of Physiology and allied sciences.
- Function as an effective member of a teaching or research team.
- Effectively teach undergraduate medical, paramedical and all other basic science students, the basic physiological mechanisms of the human body, with reference to their implications in the pathogenesis (pathophysiological processes) of diseases affecting the various organ systems and the physiological basis of their management.
- Select and use appropriate teaching techniques and resources.
- Be able to demonstrate to the students how the knowledge of physiology can effectively be used in a variety of clinical settings to solve diagnostic and therapeutic problems.
- Effectively use the library facilities including computer, CD ROM and internet research.
- Interact with the allied departments by rendering services in advanced laboratory investigations and giving relevant opinion.
- Participate and present scientific material in various workshops/seminars etc. in Physiology as well as allied departments.
- Uphold the prestige of the discipline amongst the fraternity of doctors.

3. TRAINING PROGRAMME:

Knowledge:

- Postgraduate students should be trained according to the syllabus provided in the Course Content given below.
- The postgraduate curriculum should include the entire undergraduate curriculum in detail with recent advances in each topic.
- Postgraduates should attend all undergraduate lectures, practicals, tutorials and give undergraduate exams.
- Active learning should form the mainstay of postgraduate training.
- The training programme should consist of lectures (atleast 20 per year, taken by faculty), practicals, seminars, symposia, journal clubs and group discussions.
- Maintenance of practical file should be compulsory. Based on the available facilities, departments can prepare a list of post-graduate experiments pertaining to basic and applied physiology.
- Research methodology and biostatistics must be made a part of the curriculum. There should be regular classes in Biostatistics at least in the first year of postgraduate course. It is recommended that rather than a continuous block of classes these classes should be spread out over a period of 6 to 9 months so that the students are continuously in touch with the concepts rather than just being taught at one time.
- Postgraduates should be regularly assessed during their 3 years of MD.
- A log book should be maintained by the postgraduate students and it should be evaluated at the time of final examination.

Scientific research:

- They should also be trained in Physiology research methodologies which will include conduction of a research project with submission of thesis and presentation of data

Teaching:

- The postgraduate students should be able to teach Physiology to undergraduate students. Each college should have a Medical Education Unit (MEU) to train the postgraduates in the teaching-learning methodologies, to help generate teaching resource material for undergraduates and to evolve problem solving modules.

Integration:

- Multi disciplinary seminars with active participation of postgraduates of Pre, Para and Clinical subjects should be incorporated in the academic calendar.
- The postgraduate students should at least be posted in the departments of Biochemistry, Pathology, Medicine, Gynaecology & Obstetrics and Pediatrics, on rotation basis, for a particular period of time. Clinical case presentations should be introduced and the students should be able to explain the physiological basis of various signs and symptoms together with the biochemical and pathological derangements pertaining to various organ systems of the case.
- The postgraduate students should regularly attend the ward rounds of various clinical departments and select cases of interest for discussion with the Physiology faculty.
- They should render special investigative services in their respective area of specialization.

4. COURSE CONTENT:

I. Knowledge:

a. General and Cellular Physiology

- Cell as the living unit of the body
- The internal environment
- Homeostasis
- Control system
- Organization of a cell
- Transport across cell membranes
- Functional systems in the cells
- Genetic code, its expression, and regulation of gene expression
- Cell cycle and its regulation

b. Hematology

- Erythrocytes
 - Erythropoiesis
 - Structure and function of RBCs
 - Formation of hemoglobin
 - Destruction and fate of RBCs
 - Anemias
 - Polycythemias

- Leucocytes
 - General characteristics
 - Genesis and life span of WBCs
 - Classification and functions of each type of WBC
 - Leucopenia
 - Leukemias
- Blood Groups
 - Classification
 - Antigenicity
 - Agglutination
 - Blood typing
 - Principles of transfusion medicine
- Hemostasis
 - Platelets
 - Components of hemostasis
 - Mechanism of coagulation
 - Coagulation tests
 - Anticoagulants
- Immunity
 - Innate immunity
 - Acquired immunity
 - Allergy, hypersensitivity and immunodeficiency

c. Renal Physiology and Fluid balance

- Body fluid compartments
- Water balance: regulation of fluid balance
- Urine formation
- Regulation of extracellular sodium and osmolarity
- Renal mechanisms for the control of blood volume, blood pressure and ionic composition
- Regulation of acid-base balance
- Micturition
- Diuretics
- Renal failure and Kidney function tests

d. Cardio-vascular Physiology

- Properties of cardiac muscle
- Cardiac cycle
- Heart as a pump

- Cardiac output
- Nutrition and metabolism of heart
- Specialized tissues of the heart
- Generation and conduction of cardiac impulse
- Control of excitation and conduction
- Electrocardiogram
- Arrhythmias
- Principles of hemodynamics
- Neurohumoral regulation of cardiovascular function
- Microcirculation and lymphatic system
- Regional circulations
- Cardiac failure
- Circulatory shock
- Exercise physiology

e. Respiratory Physiology

- Functional anatomy of respiratory system
- Pulmonary ventilation
- Alveolar ventilation
- Mechanics of respiration
- Pulmonary circulation
- Pleural fluid
- Lung edema
- Principles of gas exchange
- Oxygen and carbon-dioxide transport
- Regulation of respiration
- Hypoxia
- Oxygen therapy and toxicity
- Artificial respiration

f. Environmental Physiology

- Physiology of hot environment
- Physiology of cold environment
- High altitude
- Aviation physiology
- Space physiology
- Deep sea diving and hyperbaric conditions

- g. Nerve and Muscle Physiology
 - Resting membrane potential
 - Action potential
 - Classification of nerve fibres
 - Nerve conduction
 - Degeneration and regeneration in nerves
 - Functional anatomy of skeletal muscle
 - Neuro-muscular transmission and blockers
 - Excitation-contraction coupling
 - Mechanisms of muscle contraction
 - Smooth muscle

- h. Neural Physiology: General, Sensory and Motor
 - General design of nervous system
 - Interneuronal communication
 - Classification of somatic senses
 - Sensory receptors
 - Sensory transduction
 - Information processing
 - Dorsal column and medial lemniscal system
 - Thalamus
 - Somatosensory cortex
 - Somatosensory association areas
 - Pain
 - Organization of spinal cord for motor function
 - Cerebellum
 - Basal ganglia
 - Maintenance of posture and equilibrium
 - Motor cortex

- i. Physiology of Special Senses
 - Optics of vision
 - Receptors and neural functions of retina
 - Colour vision
 - Perimetry
 - Visual pathways
 - Cortical visual function
 - Functions of external and middle ear
 - Cochlea
 - Semicircular canals
 - Auditory pathways
 - Cortical auditory function

- Deafness and hearing aids
 - Primary taste sensations
 - Taste buds
 - Transduction and transmission of taste signals
 - Perception of taste
 - Peripheral olfactory mechanisms
 - Olfactory pathways
 - Olfactory perception
- j. Limbic System and Higher Nervous System
- Autonomic nervous system
 - Limbic system and hypothalamus
 - EEG
 - Sleep
 - Emotions and behavior
 - Learning and memory
 - Yoga and meditation
- k. Physiology of Nutrition and Metabolism
- Carbohydrates
 - Fats
 - Proteins
 - Minerals
 - Vitamins
 - Dietary fibre
 - Recommended dietary allowances
 - Balanced diet
 - Diet for infants, children, pregnant and lactating mothers, and the elderly
 - Energy metabolism
 - Obesity and starvation
- l. Gastro-intestinal Physiology
- General principles of GI function
 - Mastication and swallowing
 - Esophageal motility
 - Salivary secretion
 - Gastric mucosal barrier
 - Pancreatic and biliary secretion
 - Gastrointestinal motility
 - Digestion and absorption
 - Functions of colon

- Pathophysiology of peptic ulcer and diarrheal disease
- Liver functions

m. Endocrine and Reproduction Physiology

- Classification of hormones
- Mechanism of hormone action
- Measurement of hormones in blood
- Endocrine function of the hypothalamus
- Pituitary
- Thyroid
- Adrenals
- Endocrine pancreas
- Pathophysiology of diabetes
- Parathyroid, calcitonin, Vit D and calcium metabolism
- Pineal gland
- Testosterone and male sex hormones
- Spermatogenesis
- Hyper and hypogonadism
- Menstrual cycle
- Female sex hormones
- Pregnancy and lactation
- Functions of placenta
- Parturition
- Foetal and neonatal physiology
- Physiology of growth

II. Practical skills

A) Hematology experiments:

- Estimation of hemoglobin
- Determination of total erythrocyte (RBC) count.
- Determination of RBC Indices (Blood standards)
- Determination of total leucocytes (WBC) count : TLC
- Preparation of a peripheral blood smear and determination of differential leukocyte count: DLC.
- Determination of Arneht count.
- Determination of bleeding time (BT) and clotting time (CT).
- Determination of blood groups (A,B,O and Rh system)
- Determination of specific gravity of blood.
- Determination of erythrocyte sedimentation rate (ESR) and packed cell volume (PCV).

- Determination of osmotic fragility of red blood cells.
- Determination of platelet count.
- Determination of reticulocyte count.
- Determination of absolute eosinophil count.
- Study of haemopoietic cells present in the bone marrow.

B) Animal experiments:

i) Amphibian (frog) experiments.

- Effect of temperature on simple muscle twitch
- Effect of two successive stimuli (of same strength)
- Effect of increasing strength of stimuli.
- Effect of increasing frequency of stimuli (genesis of tetanus)
- Effect of free load and after load.
- Effect of repeated stimuli (study of phenomenon of fatigue).
- Determination of conduction velocity of sciatic nerve and effect of variables on it.
- Heart experiments:
 - o properties of cardiac muscle
 - o regulation of heart - effect of vagus nerve and WCL stimulation
 - o effect of variables.

ii) Mammalian experiments (dog/rabbit)

- General management of mammalian experiments.
- Perfusion of isolated mammalian heart and to study the effect of drugs and ions.
- Recordings of isolated intestine - movement & tone and to study the effect of drugs and ions.
- Other experiments on intact animal.

C) Human Physiology

a. Clinical Physiology

- Elementary principles of clinical examination
- General physical examination.
- General principles of inspection / palpation / percussion / auscultation

b. Nerve Muscle Physiology

- Ergography and hand grip spring dynamography – study of phenomenon of human fatigue.
- Recording of electromyography (EMG)

c. **Cardiovascular system (CVS)**

- Clinical examination of CVS
- Examination of arterial and venous pulses.
- Measurements of arterial blood pressure.
- Recording of 12 lead electrocardiography (ECG) and its interpretation.

d. **Respiratory system**

- Clinical examination of respiratory system
- Stethography – study of respiratory movements and effect of various factors.
- Assessment of ventilatory functions – vitalography
- Spirometry – study of lung volumes and capacities.
- Measurement of BMR.
- Cardio pulmonary cerebral resuscitation and artificial respiration.

e. **Abdominal system:**

- Clinical examination of abdomen.

f. **Reproductive system**

- Determination of ovulation time by basal body temperature chart, cervical smear and vaginal smear examination
- Semen analysis: sperm count and motility

g. **Nervous system including special senses.**

- Clinical examination of the nervous system and its physiological basis
- Examination of higher mental functions.
- Examination of cranial nerves.
- Examination of sensory system
- Examination of motor system including reflexes
- Clinical examination of special senses:
 - (i) Smell and taste
 - (ii) Tests of hearing
 - (iii) Ophthalmology:
 - (a) Clinical examination of the eye and pupillary reflex
 - (b) Visual acuity
 - (c) Perimetry –mapping out of visual field and blind spot
 - (d) Accommodation
 - (e) Fundoscopy
 - (f) Colour vision and colour blindness
- Reaction time (visual and auditory) and reflex time
- Electroencephalography (EEG)
- Autonomic function tests (AFT)

- Neuroelectro diagnostic techniques:
 - (i) Nerve conduction study
 - (ii) Visual evoked potential (VEP)
 - (iii) Brainstem auditory evoked potential (BAEP)
 - (iv) Somato- sensory evoked potential (SEP)
 - (v) Motor evoked potential (MEP)

h. **Others:** Tests for physical fitness: Cardio-respiratory responses to steady state exercise using Harvard step test, bicycle ergometry and treadmill test; determination of VO_2 max.

III. Skills

In the departments the following **laboratories should be developed** and the department should be involved in active research in one or more well- defined fields.

Clinical Neurophysiology Laboratory

1. Electroencephalography
2. Evoked potential recording
3. Electromyography
4. Nerve conduction studies
5. Autonomic nervous system (ANS) testing.

Cardio-respiratory laboratory

1. Electrocardiography and Holter
2. Pulse plethysmograph
3. GSR recorder
4. Blood-gas analyzer
5. Computerized multifunctional spirometer with graphic display and measurement of lung volumes and capacities
6. Equipment for measuring pulmonary diffusion capacity and FRC
7. Measurement of Basal metabolic rate (BMR)

Exercise Physiology Laboratory

1. Bicycle ergometer
2. Two step test exerciser
3. Treadmill

Metabolic/Endocrinology/Reproductive Bio-medicine laboratory

This laboratory will perform various tests pertaining to Gastrointestinal, renal, metabolic, endocrinal and reproductive bio-medicine.

1. Spectrophotometer
2. pH meter
3. ELISA reader/washer
4. Luminometer
5. Semi-autoanalyzer

Additional facilities in the department:

The department / college should be equipped with general facilities like internet access and a library well stocked with books and journals, especially those related to its field of research.

5. EVALUATION:

a) Internal (Formative) Assessment:

Postgraduates should be assessed regularly by conduction of theory and practical exams, seminar presentations, micro-teaching and viva-voce sessions. The internal assessment (100 marks for theory and 100 marks for practicals) should be added to the University assessment.

b) University (Summative) Assessment

The postgraduate examination should be in 4 parts:

- Thesis, to be submitted by each candidate at least 6 months before the date of commencement of the theory examinations.
- Theory examinations
- Practical examinations
- Viva-voce

Theory papers:

There should be 4 theory papers:

- each of 3 hours duration
- each containing a minimum of 3 questions
- comprising of structured long questions and short structured questions, designed to evaluate the understanding of the subject by the student.

Paper I General Physiology including History of Physiology.

- Physiology of cell; various cellular mechanisms. Genetic control mechanisms.
- Various principles of physics and physical chemistry involved in physiological phenomenon, e.g. haemodynamics, bio-electrical potentials, body fluids, methods of measurements.
- Interaction of human body in ambient environment including high altitude and deep sea.
- Sports physiology.
- Yoga and meditation.
- History of physiology

Paper II Systemic Physiology A (systems concerned with transport, nutrition & energy and including comparative physiology)

- Blood and immunity
- Cardiovascular system.
- Respiratory system.
- Gastro intestinal tract (GIT) and dietary requirements.
- Excretion, pH, water and electrolyte balance.
- Comparative physiology.

Paper III Systemic Physiology B (systems concerned with procreation, regulation and neural control).

- Reproduction and family planning/foetal and neonatal physiology.
- Nerve-muscle physiology including muscle mechanics.
- Endocrine physiology.
- Nervous system (Central, peripheral and autonomic)
- Special senses.

Paper IV Applied Physiology including recent advances

- Pathophysiology pertaining to systemic physiology
- Physiological basis of various evaluation tests
- Biostatistics, Biophysics, Biochemistry; Micro anatomy
- Recent advances
- Growth and development including ageing

Practicals including Viva-voce:

Should be spread over 2 days and include the following components:

1. Spotting.
2. Problem solving exercises pertaining to clinical physiology.
3. Performing and reporting two special laboratory investigations.
4. Two animal experiments (one long and one short) illustrating mechanisms, physiological concepts and their application to humans.
5. Two human experiments (one long and one short), dealing with clinical physiology as would have significant bearing on human health and patient care.
6. Micro-teaching session for assessing communication skills.
7. **Viva-voce** should include the following components:
 - o Text discussion of general and systemic physiology
 - o Teaching methodologies
 - o Thesis
 - o Contribution of scientists to Physiology (Foreign / Indian).
 - o Recent research advances.

Marking:

I. Theory

1. Four theory papers each of 03 hours duration (100 marks, each with minimum of 3 questions)	400
2. Internal Assessment	100

	Total marks Theory 500

II. Practicals including viva-voce

1. Spotting	2x10=20
2. Problem solving	10x2=20
3. Two special investigations	15x2=30
4. Two long experiments (one animal and one human)	60x2=120
5. Two short experiments (one animal and one human)	30x2=60
6. Micro- teaching session	50
7. Viva- voce	100
8. Internal assessment	100

	Total marks Practical 500

Note:

1. Minimum of 50% marks in theory and 50% in practicals including viva-voce are required to declare a student pass in the subject.
2. A candidate obtaining $\geq 80\%$ marks separately in theory and practicals including viva-voce will be declared to have passed the subject with honors.

RECOMMENDED BOOKS

RECOMMENDED READING

1. Keel, Samson and Wright's Applied Physiology.
2. Best and Taylor – Physiological Basis for Medical Practice.
3. AC Guyton – Text book of medical physiology.
4. WF Ganong – Review of medical physiology
5. Text books of Physiology Vol I & II Dr. A.K. Jain.
6. Manual of practical physiology, Dr. AK Jain.
7. Understanding physiology, Dr. RL Bijlani
8. Cambell – clinical physiology.
9. Vernon – B Mount Castle, Medical Physiology Vol. I & II.
10. William's Text book of endocrinology.
11. Harper's Biochemistry.
12. Mogou- Hand book of Neuro Physiology
13. JE Cotes – Respiratory Physiology
14. DT Harris – Experimental Physiology
15. Wintrobe's – Clinical Haematology
16. Brown – Cell Signalling, Biology and medicine of signal transudation.
17. Berne and Levy Medical Physiology.
18. Harrison 's Principles of Internal Medicine

JOURNALS

1. American Journal of Applied Physiology.
2. Annual Review of Physiology.
3. Advances in Physiological education and Recent advances in Physiology.
4. Journal of Physiology (British pub.)
5. Indian Journal of Physiologists and Pharmacologists.
6. Journal of Exeperimental Physiology.
7. Indian Journal of Medical Research.
8. Acta Physiologica Scandivinia.
9. Indian J of Chest diseases and allied sciences.
10. J sports physiology.
11. Fundament of Exercise testing: WHO publications.
12. Brain
13. Nature
14. Lancet
15. Annals of Neurology
16. Physiological Reviews
17. News in Physiological Sciences