

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT.**F.Y. M.B.B.S.****HUMAN PHYSIOLOGY****I) 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 diseases.

II) EDUCATIONAL OBJECTIVES:

- 1) At the end of the course, the student will be able to: describe the normal functions of all the organ systems, their regulatory mechanisms and interactions of the various systems for well-coordinated total body function.
- 2) Understand the relative contribution of each organ system in the maintenance of the milieu interior (homeostasis).
- 3) Explain the physiological aspects of normal growth and development.
Analyse the physiological responses and adaptation to environmental stresses.
- 4) Comprehend the physiological principles underlying pathogenesis and treatment of disease.
- 5) Correlate knowledge of physiology of human reproductive system in relation to National Family Welfare Program.

III) SKILL :

At the end of the course the student shall be able to :

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

IV) INTEGRATION :

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

V) COURSE CONTENT :

Theory

List of topics.

A) GENERAL PHYSIOLOGY. (5 hours)

Must know.

- Introduction to Physiology
- Branches of Physiology

- Functional organization of human body.
- External and internal environment
- Homeostasis, Biofeedback mechanisms

Cell Physiology:

- Transport across cell membrane.

B) HEMATOLOGY : (15 hours)

Must know

- Composition of blood
- Functions of blood
- Plasma proteins: Types, concentration, functions.
- Erythrocytes: Morphology, functions, normal count physiological variations in normal count & anaemia, polycythemia.
- Haemopoiesis: general concepts
- Erythropoiesis: stages, Sites, regulation, reticulocyte & its clinical significance.
- Haemoglobin: Functions, normal values, physiological variations.
- Fate of erythrocytes: life span, Catabolism of Hb, bilirubin metabolism, jaundice.
- Physiological basis of anaemia, nutritional anaemia.
- Polycythemia: Primary & secondary.
- Leukocytes: differences between R.B.C. & W.B.C., types of W.B.C.s normal count & differential W.B.C. count, physiological variations, properties, functions of W.B.C.s,, Granulopoiesis – stages, regulation, Lymphopoiesis. Pathological variations in total & differential W.B.C. count.
- Immunity: definition, concept of antigen & antibody, types of immunity-Innate & Acquired, & their mechanism, cell mediated & humeral immunity, B lymphocytes, T lymphocytes & their types. Primary & secondary response, basis of vaccination.
- Blood groups: Landsteiner's law, ABO System – type A & B antigen, ABO system & inheritance, relation to transfusion, cross matching major & minor. Rh System – inheritance, Rh incompatibility & blood transfusion, Erythroblastosis foetalis.

- Blood transfusion: indications, storage of blood & changes during storage, transfusion reactions.
- Monocyte - macrophage system: Classification, functions, functions of spleen.
- Hemostasis: definition, basic mechanisms of Hemostasis,
- Platelets: structure, normal count & variations, functions, role in platelet plug formation, Hemostasis & clot retraction.
- Blood coagulation: Coagulation factors in plasma, basic mechanism of blood clotting, intrinsic & extrinsic pathways & difference between two pathways, role of calcium in coagulation, role of vitamin K, fate of clot.
Anticoagulants – commonly used & their mechanism of actions, blood coagulation tests – bleeding time, clotting time.
Haemophilia.
- Body fluid compartments: role of water in body & its distributions, different body fluid compartments & composition of their fluid.
- Blood volume: normal value, physiological & pathological variations, blood volume regulation in detail (To be taken at end of lectures on C.V.S, kidney and endocrines)

Desirable to know

- Physical properties of blood.
- Plasma proteins: Plasmapheresis, role of liver in plasma protein synthesis, relationship of diet & plasma protein synthesis.
- R.B.C.: advantages of biconcave shape.
- Bone marrow structure and cellular elements.
- Common Haemoglobinopathies (Hbs, Hbc, Thalassaemia)
- Method of determination of life span of R.B.Cs.
- Types of jaundice.
- Polycythemia – effects on haemodynamics,.
- Immunity: Antibody structure & types, antigen – antibody reactions.
- Blood group: M. N. system, other blood groups.
- Thrombocytosis, thrombocytopenia purpura.
- Anticoagulants: used in vitro & in vivo.
- Other blood coagulation tests.
- Classification of haemorrhagic diseases, D.I.C.
- Measurement of: total body water, blood volume, plasma volume, I.C.F. volume.

Nice to know

- Blood component therapy.
- Effects of splenectomy.
- Plasmin system.

C) NERVE (5 hours)**Must know:**

- Distinctive histological features relevant to functions of nerve fibers.
- Classification of nerve fibers: based on structure, diameter, functions and only for sensory nerves.
- R.M.P. definition, production & maintenance, method of measurement, significance.
- Action potential: definition,
Phases – depolarization, repolarisation, ionic basis of depolarization & repolarisation.
Production & propagation of A.P.,
Properties of A.P., significance.
- Properties of nerve fibers.
- Strength duration curve: chronaxie and factors affecting it.
- Factors affecting conduction in a nerve.

Desirable to know:

- Experimental techniques to study the mechanism of production of R.M.P. & A.P.: patch clamp, voltage clamp
- Methods of recording of A.P.

D) MUSCLE (7 hours)**Must know.**

- Classification of muscles,
- Structure of skeletal muscle:
Electronmicroscopic structure, muscle proteins – contractile, regulatory, structural & enzymatic.
Sarcoplasmic tubular system: concept of sarcoplasmic triads & their functions.
- Neuromuscular transmission: Physiologic anatomy, events, N-M blocking & its clinical significance, applied aspect – myasthenia gravis.
- Excitation – contraction coupling.

- Molecular basis of skeletal muscle contraction: sliding filament theory, power stroke
 - cross bridge cycle, role of calcium.
- Energetics: fuel used by skeletal, muscle at rest & in exercise, metabolic pathways involved to yield A.T.P.,
Oxygen debt: definition, types (lactic, alactic), incurring of debt, repaying the debt, significance.
- Properties of skeletal muscle: excitability, refractory period (absolute, relative), conductivity, contractility – types (isometric, isotonic), effects of summations (multiple motor unit summation, frequency summation & tetanizability), all or none law, extensibility & elasticity, fatiguability.
- Factors affecting development of tension in the muscle:
 - a) number of motor units contracting- type of muscle, number of muscle fibers in each unit activated, supraspinal influences.
 - b) length – tension relationship
 - c) frequency of stimuli, duration of stimulation
 - d) load
 - e) type of contraction
 - f) chemical composition of muscle fibers and ions.
- E.M.G. (in brief)
- Skeletal muscle circulation.
- Smooth muscle: structure, distribution, types molecular mechanism of contraction, properties, regulation, and disorders.

Desirable to know

- Heat liberated during various phases of contraction, Fenn effect.
- Recording of muscle activity.

Nice to know

- E.M.G. details.

E) RESPIRATORY PHYSIOLOGY (15 hours)

Must know:

- Physiologic anatomy
- Functions of respiratory system, non respiratory functions of lung
- Mechanics of respiration:

Ventilation :

Inspiratory & expiratory muscles, intrapleural pressure, lung & thoracic compliance, factors affecting compliance, work of breathing, surface tension forces & role of surfactant, airway resistance, elastic resistance.

- Lung volumes and capacities. Measurement, physiological & significance (tidal volume, vital capacity, forced vital capacity – details)
- Pulmonary ventilation, alveolar ventilation, alveolar dead space, - applied aspect, Maximum breathing capacity & breathing reserve.

Diffusion of Gases :

- Exchange of respiratory gases at alveolar – capillary membrane, factors affecting diffusion.

Gas Transport :

- Transport of oxygen, role of Haemoglobin, oxygen dissociation curve & factors affecting it.
- Transport of carbon dioxide

Control of Breathing :

Neural control – higher centers, reflexes.

Chemical control – central & peripheral chemoreceptors role of CO_2 , O_2 , H^+

Pulmonary Circulation

- Characteristics
- Ventilation perfusion ratio
- Respiratory adjustment in exercise.
- Hypoxia: types & high altitude hypoxia.
- Artificial respiration:
- Pulmonary function tests - principles

Desirable to know.

- Method of determination of dead space, residual volume, functional residual capacity.
- Oxygen therapy: indications, hazards of hyperbaric oxygen & use.

Nice to know

- Concept of P_{50}
- Positive pressure breathing.

F) CARDIOVASCULAR PHYSIOLOGY (20 hours)

Must know:

- Introduction, functions & importance of the system.
- General organization.

- Structure of heart, pericardium, myocardium, endocardium, nerve supply, Histology, details of cell junctions, syncytium, contractile & conducting fibers.
- Properties of cardiac muscle: excitability, conductivity, contractility, autorhythmicity, all or none law, long refractory period.
- Junctional tissues of heart, pacemaker potential, action potential of cardiac muscle.
- Generation & conduction of cardiac impulse.
- ECG: lead arrangement, normal waves & their significance with reference to lead II
- Cardiac cycle: pressure – volume changes, heart sounds & their clinical significance, correlation of pressure, volume, ECG, heart sounds in cardiac cycle.
- Heart rate & its regulation.
- Haemodynamics - def., blood flow, resistance
- Cardiac output: normal values, physiological variations, factors affecting cardiac output – details, regulation, measurement – principles.
- Blood pressure:
Normal levels, measurement, determinants, short term & long term regulation - details.
- Capillary circulation, tissue fluid formation.
- Lymphatic system: Anatomy & structure, formation of lymph, composition of lymph, functions of lymphatic system, lymph flow & factors affecting it.
- Regional circulation: Physiologic anatomy, factors affecting, special features: coronary, cerebral, skin, portal
- Adaptation of cardiopulmonary system to various grades of exercise.
- Hemorrhagic shock – stages & compensatory mechanisms, effects on body, physiological basis of treatment in brief.

Desirable to know:

- Ion channel & receptors (physiological, pharmacological & clinical significance)
- E.C.G. – electrical axis of heart, heart blocks, arrhythmias, ischaemia, infarctions.
- Heart sounds: murmurs & their clinical significance.

Nice to know

- Experimental methods of studying cardiovascular physiology,
- Patho physiology of oedema

G) RENAL PHYSIOLOGY(10 hours)**Must know:**

- General introduction, structure & functions of kidney.

- Renal circulation: special features from functional point of view.
- Concept of clearance: to study renal physiology, for :
 - a) GFR – Inulin, Creatinine, basic principle of radioisotope method.
 - b) renal blood flow – PAH
 - c) concentration & dilution of urine – free water.
- Formation of urine:
 - 1) Glomerular stage – GFR (definition, dynamics, factors affecting & measurement))
 - 2) Tubular stage – Reabsorption & secretion.
 - a) Sodium, potassium, glucose : details
 - b) Handling of water – concentration & dilution of urine.
 - c) Secretion of H^+
 - 3) Role of kidney in acid – base balance.
- Physiology of micturition: basic reflex & control, cystometrogram.
- Artificial kidney: basic principles of dialysis.

Desirable to know:

- Experimental studies for renal functions.

Nice to know

- Disorders of micturition.

H) BODY TEMPERATURE REGULATION: (2 hours)**Must know:**

- Homeothermia – Balance between heat gain & heat loss.
- Regulation of body temperature,

Desirable to know:

- Hyperthermia, Hypothermia.

I) ALIMENTARY SYSTEM: (12 hours)**Must know:**

- General introduction & organizational plan, innervations and blood supply.

Salivary secretion :

- General principles & basic mechanisms of secretion composition ,and functions of saliva, mechanism & regulation of salivary secretion.

Mastication and deglutition:

- Three phases of deglutition- physiologic anatomy, mechanism & control

Gastric secretion:

- Functional anatomy, histology, functions of stomach, composition of gastric juice, cellular mechanism of gastric secretion of acid, pepsin, intrinsic factor, other enzymes, phases of gastric secretion, regulation of gastric secretion.
- Gastric Motility:
Electrical activity of stomach, pylorus, emptying of the stomach-pyloric pump, regulation & factors promoting & inhibiting emptying.

Pancreatic secretion:

- Structure, composition & mechanism of secretion of electrolytes & enzymes, regulation of secretion.
- Liver & gall bladder:
Microscopic structure, functions of liver, composition of bile, cellular mechanism of bile formation, enterohepatic circulation of bile salts, control of secretion, concentration & storage of bile in gall bladder. filling & evacuation of gall bladder functions of gall bladder

Intestinal secretion:

- Structure, innervations.
- Composition & mechanism of secretion of small intestinal juice, regulation of secretion.
- Secretion of large intestine: mucous, water, electrolyte.
- Motility of small intestine:
Structure & innervation electrical activity of smooth muscle, resting membrane potential, slow waves, spike potentials, rhythmic segmenting contractions, peristalsis, control – neural & hormonal, functions of ileocecal valve.
- Motility of large intestine:
- Structure & innervation, 'mixing & mass movements, defecation reflex' and its control
- G.I. hormones: in brief.

Digestion & absorption:

Digestion & absorption of - carbohydrate,

- Proteins
- Fats

absorption of water, electrolytes and vitamins.

Desirable to know:

- Gastric mucosal barrier, experiments to study regulation of gastric juice secretion, disorders of secretion, peptic ulcer., inhibitors of gastric secretion
- Effects of vagotomy, abnormal gastric motility vomiting.
- Barium meal studies, endoscopy, biopsy.
- Pathophysiology of small intestinal motility, paralytic ileus, diarrhea, obstruction.
- Pathophysiology of colonic motility, irritable bowel syndrome, drugs, constipation.
- Pancreatic function tests.
- Gall stone, effects of removal of gall bladder

Nice to know

- disturbances of esophageal motility, spasm, achalasia, hiatus hernia.
- Methods for study of intestinal absorption.
- Effects of hepatectomy.

J) NUTRITION: (2 hours)**Must know:**

- concept of balanced diet
- factors affecting caloric requirements
- requirements of various nutrients, sources, daily needs.
- nutrition under special conditions – pregnancy, lactation, growing child.

K) ENDOCRINE SYSTEM (10 hours)**Must know:**

- Introduction
- Endocrine functions of Hypothalamus – releasing hormones, Mechanism of hormone action
- Anterior pituitary hormones:
functions, regulation, disorders.
posterior pituitary hormones, ADH, Oxytocin. functions, regulation, disorders.

Thyroid:

hormone: synthesis, fate, functions, regulation, disorders.

- Parathyroid:

hormone: synthesis, functions, regulation, disorders – tetany.

- Adrenal cortex: and medulla.

hormone: secretion, functions, regulation, disorders

- Pancreatic hormones:
secretion, functions, regulation, disorders.

Desirable to know:

- Radioimmuno assays.

Nice to know

- Experimental studies.

L) REPRODUCTIVE PHYSIOLOGY: (8 hours)

Must know:

- Sex chromosomes, sex determination, sex differentiation
- Functional anatomy of reproductive system.
- Puberty: changes in males & females and its control.
- Spermatogenesis: stages & regulation
Semen analysis.
- Testosterone: actions & regulation.
- Male sexual act.
- Menstrual cycle & ovarian cycle:
Phases & hormonal regulation.
- Menopause.
- Ovulation: indicators & importance
- Fertilization, implantation of ovum.
- Functions of placenta
- Physiology of pregnancy;
- Maternal changes during pregnancy
- Parturition: in brief – stages and mechanism.
- Lactation: initiation & maintenance and control.
advantages of breast-feeding.
- Contraception: to be taken as integrated topic.

Desirable to know:

- Sex chromosomes: Barr bodies.
- Development of genitals & gonads

Nice to know

- Precocious & delayed puberty.

M) SPECIAL SENSES (8 hours)**Must know:****- Eye:**

Functional anatomy of eye, optics, microscopic structure of retina with retinal circuits, image formation,

Photochemistry of vision (photopic & scotopic vision, dark & light adaptation),

Pupillary reflexes, Accommodation reaction, Errors of refraction and their correction,

Colour vision – physiological & neural basis, accepted theory of colour vision, classifications, basis of colour blindness and tests of colour blindness, significance.

Visual pathway – processing of information at different levels in visual pathway, organisation of visual cortex. Effects of lesion at different levels in visual pathway,

Movements of eyeballs: functions & control.

- Ear:

Physics of sound, decibel system,

Functions of external ear,

Functional anatomy of middle ear, functions of middle ear in detail, assessment of functions of middle ear, Functional anatomy of cochlea, functions of inner ear, place principle, theories of hearing.

- Audiometry,

Auditory pathway & important features, auditory cortex (role in hearing & speech development)

- Taste:

Functional anatomy of taste buds, different taste modalities, pathway, factors affecting taste sensation,

- Smell:

Functional anatomy of receptors, primary olfactory sensations, pathway, factors affecting smell sensation,

Desirable to know:**- Resolution of images,****- Electrophysiology of internal ear: cochlear micro phonics.****Nice to know****- Electrophysiology of retina.****- Theories of hearing.**

N) CENTRAL NERVOUS SYSTEM: (50 hours)**Must know**

- Outline of nervous system.

1) General nervous system:

Synapse: definition, physiological anatomy, sequence of events of synaptic transmission, properties, (state the property & its significance), significance of synaptic transmission, applied aspect.

Neurotransmitters – in brief.

Receptors: definition, classification (basis of each classification with example), properties (state each property with underlying mechanism & significance), significance (homeostasis, conscious awareness of environment, tone posture, protection).

Sensations: different modalities, classification with examples and significance

- sensation of touch, pain proprioception : details of each

Reflexes: definition, classification (basis of classification with example), reflex arc & its components, properties (state each property with basis & importance)

Stretch reflex – definition, muscle spindle (details with innervation, role of gamma motor neurons) role of supra spinal control – in brief, functions of stretch reflex (regulation of muscle tone) inverse stretch reflex.

Polysynaptic reflexes: withdrawal reflex.

2) Tracts:

Ascending & descending tracts: details of each tracts – (situation & extent in spinal cord, origin, course & termination, collaterals, somatotopic arrangement, functions, applied aspect, tests)

Ascending tracts: Basic plan of somato sensory pathway for conscious Sensation, pathway from head, face region.

Descending tracts: pyramidal tracts – details., extra pyramidal tracts, differences between UMN & LMN lesions.

3) Sections at various levels in CNS :**a) Spinal transection – spinal animal.**

Complete – 3 stages – spinal shock, stage of recovery, stage of reflex failure – details of each stage.

Incomplete. Transection

Hemisection

- b) Low midbrain section – decerebrate animal : Decerebrate rigidity. (Classical & ischaemic with mechanisms, characteristics features, physiological significance)
- c) High midbrain section – High decerebrate animal.
- d) Thalamic or Decorticate animal.

4) Posture - & Equilibrium.

Definition, classification of postural reflexes.

(Details of each reflex and its function.)

regulation of posture (integrating centers at various levels of CNS)

vestibular apparatus : Physiologic anatomy, mode of function of utricle & saccule and semicircular canals, vestibulo ocular & vestibulo spinal reflexes.

5) Thalamus :

Functional classification of Thalamic nuclei, with connections of different nuclear groups, functions of thalamus, thalamic syndrome.

6) Hypothalamus :

Functional classification of different hypothalamic nuclei, connections in brief, functions in details.

7) Limbic system :

Parts of limbic system, connections in brief, functions.

8) Reticular formation :

Introduction, anatomy in brief, functional divisions.

(A) Ascending reticular activating system – details with connections & role in sleep wakeful cycle, applied aspect.

(B) Descending reticular system – role in regulation of muscle tone by pontine & medullary regions.

(C) Visceral centres.

9) E. E. G. :

Definition, different waves, characteristics & functional significance of each wave, physiological variation, clinical application in brief.

10) Sleep & Wakefulness :

Concept of alertness & wakefulness with their physiological basis,

Definition of sleep, stages of sleep correlated with EEG, sleep cycle – types of sleep, salient features of NREM & REM sleep, physiological effects of sleep on different systems of the body, Neurophysiological mechanisms of sleep, functions of sleep.

11) Cerebellum :

Introduction, functional classification, intracortical circuit, deep cerebellar nuclei, connections of different lobes, functions of cerebellum, cerebellar function tests, effects of lesion in brief.

12) Basal Ganglia :

Introduction, classification of nuclei, connections, intracortical circuits, functions, lesions - Parkinsonism.

13) Cerebral Cortex :

Gross anatomy & divisions, concept of Brodmann's mapping with diagram, Parietal lobe – anatomical & functional divisions, details of each functional part as regards connections, topographic organisation, functions.

Frontal lobe – excitomotor Cortex – anatomical & functional parts, details of each part as regards connections, topographic organisation, functions.

Prefrontal Cortex – different areas, connections in brief, functions, effects of lobectomy.

14) speech –

Afferent and efferent mechanisms and role of cortical centers in speech, concept of cerebral dominance, development of speech, vocalization.

15) Memory :

Definition, stages, types, physiological basis, factors affecting, applied – amnesias in brief.

16) Learning :

Definition, types with examples, stages, factors influencing, role of motivation (positive & negative reinforcement, reward & punishment), physiological basis – role of different parts of CNS, structural, biochemical changes.

17) Conditioned reflexes :

Definition, difference between unconditioned & conditioned reflexes, development of conditioned reflexes, properties, significance.

18) Autonomic nervous system :

Organization and functions of Parasympathetic & Sympathetic and their control.

19) CSF :

Introduction, composition, normal CSF pressure, formation & circulation, functions, applied aspect – brief, blood brain barrier, blood CSF barrier.