CURRICULUM OF HUMAN PHYSIOLOGY INCLUDING BIO-PHYSICS FOR UNDERGRADUATE MEDICAL STUDENTS

I. PHYSIOLOGY

A. GOAL

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

B. OBJECTIVES

(a) Knowledge

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

1) Understand and explain the normal functioning of all the organ systems and their interactions for well coordinated total body function.
2) Assess the relative contribution of each organ system to the maintenance of the milieu interior.
3) Explain various regulatory mechanisms and their integration.
4) Elucidate the physiological aspects of normal growth and development.
5) Describe the physiological response and adaptations to environment stresses and during disease process.
6) List the physiological principles underlying, pathogenesis and treatment of disease.
7) Understand reproductive physiology as relevant to National Family Welfare Programme.

(Course content: see Appendix 1)

(b) Skills

At the end of the course the learner shall be able to perform and interpret following skills:

1) Conduct experiments designed for study of physiological phenomena.
2) Interpret experimental / investigative data to assess health status.
3) Distinguish between normal and abnormal data derived as a result of tests which he/she has performed and observed in the laboratory.
4) Understand basic laboratory investigations relevant for a rural set up.
5) Acquire a concept of professionalism.
6) Learn to approach the patient with humanity and compassion.

(List of Experiments/Investigation: see Appendix II)

(c) Teaching methodologies to be employed:

- Didactic lectures
- Practicals :Hematology experiments, Human experiments including Clinical examination, Demonstration of frog and mammalian experiments, Demonstration of some human experiments
- Tutorials
- Student seminars
- Graphs and charts to be made in the departments to teach different principles of physiology, as well as pathophysiology, and to provide problem-solving exercises.

(d) Integration

Efforts are to be made to encourage integrated teaching between medical subjects. At the end of this teaching the student shall acquire an integrated knowledge of organ structure, function, its regulatory mechanisms, its pathophysiology and principles of management.

II. BIOPHYSICS

(a) GOAL AND OBJECTIVES:

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

Total time of teaching Biophysics	=	5 hours
Out of which:		
Didactic lectures	=	3 hours
Tutorial/group discussion	=	1 hour
Practical	=	1 hour

(b) TOPIC DISTRIBUTION:

(1) Lectures

1) Physical principles of transport across cell membranes and across capillary wall.
2) The membrane potentials; Gibbs – Donnan membrane equilibrium; Resting membrane potential; Action potential.
3) Biopotentials.
4) Physical principles governing flow of blood in heart and blood vessels.
5) Work done during breathing.
6) Physical principles governing flow of air in air passages.

(2) Tutorial/group discussion: on the topic covered in didactic lectures.

(3) Practicals – Demonstration of:

(i) Electroencephalogram (E.E.G.)
(ii) Electromyogram (E.M.G.)
(iii) Electrocardiogram (E.C.G.)

RECOMMENDED EVALUATION SCHEME FOR PHYSIOLOGY AND BIOPHYSICS

(A) TIME OF EVALUATION

Formative assessment:

There should be regular formative assessment and the day-to-day performance of the student should be given greater importance.

1. It should be based on the evaluation of the student's assignments, preparation for seminars, assessment tutorials etc.
2. Regular periodical tests and viva should be conducted through out the course for e.g. at the end of each system / unit.
3. Formative examination to be held at the end of 1st and 2nd semesters e.g. Terminal examination and Sent-up examination.

Summative assessment:

University (Professional) examination:

Theory, viva and practical, to be held at the end of 2nd semester.

(B) PATTERN OF THEORY PAPERS

There should be two theory papers.
Each paper shall be of 03 hours duration and of 50 marks.

PART 1

Q 1.Structured long question (with distribution of marks)	8 marks
Q 2. Draw labeled diagram/flow chart/table to illustrate (4 questions)	2x4=8 marks

PART II

Q 3. Structured long question (with distribution of marks)	8 marks
Q 4. What happens and why? (4 questions)	2x4=8 marks

PART III

Q 5. Write short notes on following (3 questions)	3x3=9 marks
Q 6. Write physiological/clinical significance of the following (3 questions)	3x3=9 marks

Marking

Theory	50x2	=	100 marks
Oral	10x2	=	20 marks
Internal Assessment		=	20 marks
		Total =	140 marks

(C) PRACTICALS

1. Spotting/OSPE	05 marks
2. Problem solving exercise	05 marks
3. Graph and charts (including those pertaining to Amphibian nerve muscle and heart experiments)	05 marks
4. Human Experiment	05 marks
5. Haematology	10 marks
6. Clinical Exercise	10 marks
Internal Assessment (including practical record book)	20 marks
Total	60 marks

Note:

1. Pass percentage - Minimum of 50% marks in theory including oral and internal assessment and 50% in practicals including internal assessment shall be required to declare a candidate pass in the subject.

2. A candidate obtaining ≥75% marks in theory plus practicals shall be declared to have passed the subjects with Honors.

RECOMMENDED READING

(A) TEXT BOOKS

1. Textbook of Medical Physiology by A.C. Guyton.
2. Textbook of Physiology (Volume I and II) by Dr. A.K. Jain.
3. Understanding Physiology by Dr. R.L. Bijlani.
4. Manual of Practical Physiology for MBBS by Dr. A.K. Jain.
5. Hutchinson's Clinical Methods.

(B) REFERENCE BOOKS

1. Review of Medical Physiology by W.F. Ganong.
2. Samson Wright's Applied Physiology.
3. Experimental Physiology by D.T. Harris.
4. Clinical Haematology by Dacie.
5. Wintrobe's - Clinical haematology.

Appendix I – Course Contents Knowledge

UNITS		Must Know	Desirable to know
I. General Physiology			
1	Structure and function of a generalized cell	√	
2	Principles of homeostasis	√	
3	Intercellular communication and cell functions	√	
4	Apoptosis – programmed cell death.	√	
5	Transport mechanisms across cell membranes	√	
6	Fluid compartments of the body: ionic composition & measuring units	√	
7	Concept of buffer system	√	
8	Molecular basis of resting membrane and action potential	√	
II. Blood			
1	Composition and functions	√	
2	Plasma proteins: origin, forms, variations and functions	√	
3	Haemoglobin :synthesis and functions, breakdown, variations	√	
4	RBC: formation, functions, anemias & jaundice	√	
5	WBC: formation, functions, variation and leukemias	√	
6	Platelets: functions, variations, formation	√	
7	Hemostasis: mechanisms, anticoagulants, bleeding disorders (hemophilia, purpura)	√	
8	Blood groups: basics of blood grouping, clinical importance, blood banking and transfusion.	√	
9	Immunity: development, types, regulation	√	

UNITS		Must Know	Desirable to know
III. Nerve and Muscle Physiology			
1	Structure and functions of a neuron and neuroglia, nerve growth factor	√	
2	Nerve fibers: types, functions, properties	√	
3	Degeneration and regeneration in peripheral nerves	√	
4	Structure and transmission across neuro-muscular junction	√	
5	Neuro-muscular blocking agents		√
6	Pathophysiology of Myasthenia gravis		√
7	Types and structure of muscle fiber	√	
8	Action potential and properties in different muscle types (skeletal, cardiac & smooth)	√	
9	Molecular basis of muscle contraction, motor unit	√	
10	Mode of contraction (isometric and isotonic)	√	
11	Energy source and muscle metabolism		√
12	Gradation of muscular activity		√
13	Muscular dystrophy, myopathies		√
IV. Digestive system/Gastro intestinal tract (GIT)			
1	Structure and function of digestive system	√	
2	Composition, functions and regulation of : saliva, gastric, pancreatic and intestinal juice, bile secretion	√	
3	GIT movements, regulation and functions, dietary fiber, defecation reflex	√	
4	Digestion and absorption in GIT	√	
5	GIT hormones: source, regulation and functions	√	
6	Liver and gall bladder: structure and functions	√	
7	Gastric function tests, pancreatic exocrine function tests, liver function tests		√
8	Pathophysiology of peptic ulcer, gastro-oesophageal reflux disease, vomiting, diarrhoea, constipation, gastrectomy, cholecystectomy, mal-absorption syndrome, adynamic illeus, intestinal obstruction, Hirschsprung's disease		√

UNITS		Must Know	Desirable to know
V. Cardiovascular system (CVS)			
1	Heart: functional anatomy, chambers, sounds, pacemaker tissue	√	
2	Properties of cardiac muscle: morphological, electrical, mechanical and metabolic	√	
3	Electrocardiogram (ECG): physiological basis and applications, cardiac axis	√	
4	Abnormal ECG: heart blocks, arrhythmias, myocardial infarction		√
5	Haemodynamics of circulatory system	√	
6	Cardiovascular regulatory mechanisms: local & systemic	√	
7	Factors affecting and regulation of heart rate, cardiac output, blood pressure	√	
8	Echocardiography		√
9	Regional circulation: coronary, cerebral, capillary, skin, foetal, pulmonary and splanchnic circulation	√	
10	Pathophysiology of shock, syncope, heart failure	√	
VI. Respiratory system			
1	Functional anatomy	√	
2	Mechanics of normal respiration, pressure changes during ventilation, lung volumes and capacities, alveolar surface tension, compliance, airway resistance, ventilation, v/p ratio, diffusion capacity of lungs	√	
3	Transport of respiratory gases: oxygen and carbon dioxide transport	√	
4	Physiology of high altitude and deep sea diving	√	
5	Principles of artificial respiration, oxygen therapy, acclimatization and decompression sickness	√	
6	Pathophysiology- dyspnoea, hypoxia, cyanosis asphyxia; drowning, periodic breathing	√	
7	Lung function tests and their clinical significance		√
VII. Excretory system			
1	Structure and function of kidney	√	
2	Structure and function of a juxta glomerular apparatus, role of renin – angiotensin system	√	
3	Mechanism of urine formation involving processes of filtration, tubular re-absorption and secretion, concentration and diluting mechanism	√	

UNITS		Must know	Desirable to know
4	Renal clearance: significance and application	√	
5	Renal regulation of fluid and electrolyte, acid-base balance	√	
6	Innervation of urinary bladder, physiology of Micturition and its abnormalities	√	
7	Artificial kidney, dialysis and renal transplantation		√
8	Renal function tests		√
VIII.	**Endocrinology**		
1	Estimation and assessment of hormones		√
2	Physiological actions and effect of altered (hypo and hyper) secretion of pituitary gland. thyroid gland, parathyroid gland, adrenal gland. pancreas and hypothalamus	√	
3	Thymus, pineal gland and local hormones	√	
4	Function tests of thyroid gland, adrenal cortex, adrenal medulla and pancreas		√
IX.	**Reproductive system**		
1	Sex determination, sex differentiation and their abnormalities	√	
2	Puberty: control of onset, stages, delayed and precocious puberty	√	
3	Male reproductive system: testis, testicular functions and its control, spermatogenesis and factors influencing it	√	
4	Female reproductive system: ovaries, ovarian function and its control. Menstrual cycle: hormonal, uterine and ovarian changes	√	
5	Physiological effect of sex hormones	√	
6	Contraceptive methods (male and female)	√	
7	Physiological effects of removal of gonads		√

	UNITS	Must Know	Desirable to know
X.	**Nervous system**		
1	Organization of nervous system	√	
2	Functions and properties of synapse, reflex, receptors	√	
3	Somatic sensations, sensory tracts	√	
4	Motor tracts, mechanism of maintenance of muscle tone, control of body movements, posture and equilibrium, vestibular apparatus	√	
5	Structure and function of reticular system, autonomic nervous system (ANS)	√	
6	Spinal cord: functions, lesions-sensory and motor disturbances	√	
7	Functions of cerebral cortex, basal ganglia**,** thalamus, hypothalamus, cerebellum and limbic system and their abnormalities.	√	
8	EEG and Sleep	√	
9	Higher functions of nervous system (memory, learning, speech) and associated abnormalities	√	
10	Chemical transmission in the nervous system		√
XI.	**Special senses**		
1	Perception of smell and taste sensation	√	
2	Pathophysiology of altered smell and taste sensation		√
3	Functional anatomy of ear, mechanism of hearing	√	
4	Pathophysiology of deafness, hearing tests	√	
5	Functional anatomy of eye, physiology of image formation and color vision, refractory errors, visual reflexes- pupillary and light	√	
6	Effect of lesion in visual pathway	√	
7	Auditory & visual evoke potentials		√

	UNITS	Must Know	Desirable to know
XII.	**Integrated Physiology**		
(A)	Skin and body temperature regulation:		
	mechanism of temperature regulation	√	
	adaptation to altered temperature (heat and cold)	√	
	mechanism of fever, cold injuries and heat stroke	√	
(B)	Physiology of sports, exercise, yoga and meditation:		
	cardio-respiratory and metabolic adjustments during exercise, effects of physical training	√	
	physiological effects of yoga and meditation		√

Appendix II: Experimental/ Investigative Skills			
	UNITS	**Must Know**	**Desirable to know**
I.	**Hematology Experiments**		
1	Estimation of hemoglobin	√	
2	Determination of total erythrocyte count (TRBC)	√	
3	Determination of RBC indices (Blood standards)	√	
4	Determination of total leucocyte count (TLC)	√	
5	Preparation of a peripheral blood smear and Determination of differential leucocyte count (DLC)	√	
6	Determination of Arneth count	√	
7	Determination of bleeding time (BT) and clotting time (CT)	√	
8	Determination of blood groups (A,B,O and Rh system)	√	
9	Determination of specific gravity of blood		√
10	Determination of erythrocyte sedimentation rate (ESR) and packed cell volume (PCV)		√
11	Determination of osmotic fragility of red blood cells	√	
12	Determination of platelet count	√	
13	Determination of reticulocyte count	√	
14	Determination of absolute eosinophil count		√
15	Study of haemopoietic cells present in the bone marrow		√

	UNITS	Must Know	Desirable to know
II.	**ANIMAL EXPERIMENTS: Amphibian (Frog) Experiments: as graphs and charts**		
1	Effect of temperature on simple muscle twitch		√
2	Effect of two successive stimuli (of same strength)		√
3	Effect of increasing strength of stimuli		√
4	Effect of increasing frequency of stimuli (genesis of tetanus)		√
5	Effect of free load and after load		√
6	Effect of repeated stimuli (study of phenomenon of fatigue)		√
7	Determination of conduction velocity of sciatic nerve and effect of variables on it		√
8	Properties of cardiac muscle: refractory period. All or none law, extrasystole and compensatory pause, beneficial effect.		√
9	Regulation of heart, vagus dissection and effect of vagal and WCL stimulation		√
10	Effect of variables on frog's heart		√
III.	**HUMAN PHYSIOLOGY**		
A.	**Clinical Physiology**		
1	Elementary principles of clinical examination	√	
2	General physical examination	√	
3	General principles of Inspection/ Palpation/ Percussion/ Auscultation	√	
B.	**Nerve muscle physiology**		
1	Ergography and hand grip spring dynamography- study of phenomenon of human fatigue	√	
2	Recording of electromyography (EMG)		√

S.No	UNITS	Able to perform independently	Able to perform under guidance	Observe/ Demonstrate
C.	**Cardiovascular system (CVS)**			
1	Clinical examination of CVS	√		
2	Examination of arterial & venous pulses	√		
3	Measurements of arterial blood pressure	√		
4	Recording of 12 lead Electrocardiography (ECG) and its interpretation.		√	
D.	**Respiratory system**	√		
1	Clinical examination of respiratory system	√		
2	Stethography- study of respiratory movements and effect of various factors	√		
3	Assessment of ventilatory functions – vitalography	√		
4	Spriometry- study of lung volume and capacities	√		
5	Measurement of BMR			√
6	Cardio-pulmonary-cerebral resuscitation and artificial respiration.	√		
E.	**Abdominal system:** Clinical examination of abdomen	√		
F.	**Exeretory system**			
	Recording of body temperature	√		
G.	**Reproductive systems**			
	Pregnancy diagnostic test immunological test		√	

S.No	UNITS	Able to perform independently	Able to perform under guidance	Observe/ Demonstrate
H.	**Nervous System including Special Senses**			
1	Clinical examination of the nervous system and its physiological basis	√		
2	Examination of higher mental functions	√		
3	Examination of cranial nerves	√		
4	Examination of sensory system	√		
5	Examination of motor system including reflexes	√		
6	Clinical examination of special senses:			
(i)	Smell and taste	√		
(ii)	Tests for hearing	√		
(iii)	Ophthalmology:	√		
(a)	Clinical examination of the eye and pupillary reflex	√		
(b)	Visual acuity	√		
(C)	Perimetery- mapping out of visual field and blind spot	√		
(d)	Accommodation	√		
(e)	Fundoscopy			√
(f)	Colour vision and colour blindness	√		
7	Reaction (visual and auditory) and reflex time		√	
8	Electroencephalography (EEG)			√
9	Autonomic nervous system (ANS) Testing			√
10	Neuro- electrodiagnostic 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)			√
I.	**Others**			
	Tests for physical fitness: Cardio-respiratory responses to steady state exercise using step test, bicycle ergometer, treadmill	√		