PHYSIOLOGY

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.

Objectives

A.Knowledge :

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

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

B**. Skills At the end of the course the student shall be able to:**

At the end of the course the student will 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.

C. Attitude and communication skills:

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

1. show due respect to persons who volunteer to be examined for the purpose of learning clinical examination.
2. communicate effectively with peers and teachers
3. demonstrate the ability of teamwork

D. Integration:

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

List of systems included in Physiology:

- General Physiology
- Hematology
- Nerve-Muscle Physiology
- Gastro-Intestinal Physiology
- Cardiovascular physiology
- Respiratory physiology
- Renal Physiology
- Endocrine Physiology
- Reproductive Physiology
- Neurophysiology (Central Nervous System and Special Senses)
- Integrated Physiology

Syllabus

THEORY

General Physiology (PY 1.1-1.9) (8 hrs)

Structure and functions of a mammalian cell**;** Homeostasis, Intercellular communication**;** Apoptosis; Transport mechanisms across cell membranes; Fluid compartments of the body; pH & Buffer systems in the body; Evaluation of functions of the cells and products in clinical care and research.

Hematology: (PY 2.1 - 2.13) (16 hrs)

Components of blood: formation, regulation and functions; plasma proteins – origin, types, variations and functions; Hemoglobin- synthesis, variants, functions and its breakdown & Jaundice; Blood indices; Anemia and its classification; Hemostasis: mechanism, regulation & disorders Anticoagulants; Blood groups, blood banking and transfusion; Immunity: types, mechanism & regulation; ESR; Lymph-composition, circulation and functions

Nerve & Muscle Physiology: (PY 3.1 - 3.18) (10hrs)

Neuron and neuroglia: structures, types, functions; Resting membrane potential; Action potential in nerve, skeletal & smooth muscle; Nerve fibres: classification, functions & properties; nerve injuries, degeneration and regeneration in peripheral nerve; Neuromuscular junction: structure, transmission of impulses, neuro-muscular blocking agents, Myasthenia gravis; Muscle fibres: structure, types & functions; Muscle contraction; molecular basis (skeletal, smooth), Isotonic Vs. Isometric, Energy sources and metabolism, gradation of muscle activity; muscle dystrophy, Myopathies; Strength-duration curve

Gastrointestinal Physiology: (PY 4.1 - 4.10) (10hrs)

Functional anatomy and broad functions of digestive system, enteric nervous system; GI Secretions- composition, mechanism of secretion, functions, and regulation of saliva, gastric, pancreatic, intestinal juices and bile secretion; GI movements- types, regulation, functions, reflexes; role of dietary fibres; Digestion and absorption of nutrients; GI hormones- source,

regulation, functions; Gut-brain axis; structure and functions of liver and gall bladder; gastric function tests, pancreatic exocrine function tests & liver function tests, Pathophysiology - Achalasia cardia, peptic ulcer, gastro oesophageal reflux disease, vomiting, diarrhoea, constipation, Adynamic ileus, Hirschsprung's disease.

Cardiovascular Physiology: (PY 5.1 - 5.16) (25hrs)

Functional anatomy of heart; Pacemaker tissue and conducting system-generation, conduction of cardiac impulse; Properties of cardiac muscle; Cardiac cycle; ECG- recording, normal ECG, uses, cardiac axis, Abnormal ECG in common arrhythmias, changes with hypertrophy & MI; Haemodynamics; Heart rate- factors affecting, regulation; Cardiac output- factors, regulation, measurement; Blood pressure- components, determinants, factors, regulation and applied aspect, Regional circulation- autoregulation, microcirculation, lymphatic circulation, coronary, cerebral, capillary, skin, fetal, pulmonary and splanchnic circulation; Pathophysiology- shock, syncope, heart failure & coronary artery disease

Respiratory Physiology: (PY 6.1-6.10) (12hrs)

Functional anatomy of respiratory tract, dead space; Mechanics of respiration; Pressure volume changes during ventilation; Lung volume and capacities; Alveolar surface tension; Compliance; Airway resistance; alveolar ventilation, V/P ratio; Diffusion capacity of lungs; Transport of respiratory gases- Oxygen and Carbon dioxide; Neural and chemical regulation of respiration; Physiology of high altitude and deep sea diving; Principles of artificial respiration, oxygen therapy; Patho-physiology of dyspnoea, hypoxia, cyanosis, asphyxia, drowning, periodic breathing; Lung function tests & its clinical significance

Renal Physiology: (PY 7.1 - 7.9) (10hrs)

Structure and functions of kidney & juxta glomerular apparatus, role of renin-angiotensin system ; Renal blood flow; Mechanism of urine formation, concentration and diluting mechanism; Concept and significance of 'clearance' tests; Renal regulation of fluid and electrolytes & acid-base balance; Structure and innervation of urinary bladder, physiology of micturition, cystometry, and its abnormalities; Artificial kidney(dialysis) and renal transplantation; Renal Function Tests

Endocrine Physiology: (PY 8.1 - 8.6) (16 hrs)

Mechanism of action of steroid, protein and amine hormones; Synthesis, secretion, transport, physiological actions, regulation and effect of altered (hypo and hyper) secretion of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas and hypothalamus; Physiology of bone and calcium metabolism; Physiology of growth; Physiology of Thymus & Pineal Gland; Hormone function tests ; Obesity & metabolic syndrome; Stress response

Reproductive Physiology: (PY 9.1 - 9.12) (10hrs)

Sex determination; sex differentiation and their abnormalities; Puberty: onset, progression, stages; early and delayed puberty; Male reproductive system: functions of testis, spermatogenesis and its regulation, Cryptorchidism ; Female reproductive system: functions of ovary and its control, menstrual cycle: Hormonal, uterine and ovarian changes; Tests for ovulation; Physiological effects of sex hormones; Contraceptive methods for male and female; Effects of removal of gonads on physiological functions; Physiology of pregnancy, fetoplacental unit, pregnancy tests, parturition & lactation; Semen analysis; Causes and principles of management of infertility; Hormonal changes and their effects during perimenopause and menopause; Psychological and psychiatric disturbances associated with reproductive physiology.

Neurophysiology: (PY 10.1 - 10.20) (37 hrs)

Organization of nervous system; Sensory system: types, functions and properties of synapse, receptors, reflex; Somatic sensations & sensory tracts; Physiology of pain; Motor system: organization, motor tracts, mechanism of maintenance of tone, control of voluntary movements ; Posture and equilibrium & vestibular apparatus; Reticular activating system, Autonomic nervous system ; Spinal cord: functional organization and lesions ; Formation, circulation and function of CSF; Blood brain barrier; Neurotransmitters.

Organization, connections and functions of cerebral cortex, basal ganglia, thalamus, hypothalamus, cerebellum and limbic system and their abnormalities; Higher mental functions ; Physiology of sleep, memory, learning and speech and their disorders; EEG.

Special senses- Smell and taste sensation and their abnormalities; Functional anatomy of ear and auditory pathways & physiology of hearing, Deafness, hearing tests; Functional anatomy of eye, Image formation, Visual pathway and its lesions, Physiology of vision including acuity of vision, colour vision, field of vision, refractive errors, physiology of pupil; light reflex, accommodation reflex, dark and light adaptation; Auditory & visual evoked potentials

Integrated Physiology: (PY 11.1 - 11.14) (6 hrs)

Temperature regulation: mechanism, adaptation to altered temperature (heat and cold environment), mechanism of fever, cold injuries and heat stroke; Exercise- cardio-respiratory and metabolic adjustments during exercise (isotonic and isometric), exercise in heat and cold, physical training effects; Physiological consequences of sedentary lifestyle; Brain death; Physiology of Infancy*; Physiology of aging-free radicals and antioxidants*; Physiology of meditation*.

(* 'Non-core' competencies as per "Competency based Undergraduate Curriculum for the Indian Medical Graduate 2018: Medical Council of India").

PRACTICAL

The following list of practical is minimum and essential. Additional exercises can be included as and when feasible and required. All the practicals have been categorized as '**Procedures to be performed'** and '**Demonstrations'.** The procedures are to be performed by the students during practical classes to acquire skills. These would be included in the practical during University examination. Those categorized as 'Demonstrations' are to be shown to students during practical classes. Questions based on these would be given in the form of data, charts, graphs, problems and case histories for interpretation by students during university examination.

I. <u>Procedures to be performed by the students:</u>

a.**Haematology:**

1. RBC count
2. WBC Count
3. Differential Leucocyte Count
4. Estimation of haemoglobin
5. Blood grouping
6. Bleeding time
7. Clotting (Demonstration of fibrin thread)
8. Calculate RBC indices - MCV, MCH, MCHC.

b.**Procedures to be performed on human subjects:**

1. Mosso's ergography.
2. Recording of Blood Pressure, pulse rate at rest and effect of posture.
3. Effect of mild and moderate exercise on blood pressure, pulse rate and respiratory rate.
4. Demonstrate Harvard step test and describe the impact on induced physiologic parameters.
5. Record and interpret Lead II ECG. Given a normal ECG, determine cardiac axis.
6. Spirometry - Lung volumes and capacities, MVV and Dyspnoeic Index, Timed vital capacity.
7. Peak Expiratory Flow Rate
8. Demonstrate Basic Life Support in a simulated environment
9. Visual field by Perimetry

c.**Clinical Examination:**

1. Components of history taking and general physical examination
2. Examination of radial pulse
3. Examination of Cardiovascular system
4. Examination of Respiratory system
5. Examination of abdomen
6. Examination of Higher mental functions
7. Examination of Sensory system
8. Examination of Motor system including reflexes.
9. Examination of Cranial Nerves

II. Demonstrations:

I. Haematology:
   1. Erythrocyte sedimentation rate
   2. Haematocrit
   3. Reticulocyte count
   4. Platelet count
   5. Osmotic fragility

2. Record Arterial pulse tracing using finger plethysmography*
3. Stethography
4. Tests of cardiovascular autonomic functions*

(* 'Non-core' competencies as per "Competency based Undergraduate Curriculum for the Indian Medical Graduate 2018: Medical Council of India")

III. Interpretation- Charts, Problems, Graphs and Case histories.

Chart also includes - Interpret growth chart*, Interpret anthropometric assessment of infants*: (*these two charts are 'Non-core' competencies as per "Competency based Undergraduate Curriculum for the Indian Medical Graduate 2018: Medical Council of India")

IV. Computer assisted learning:

(i) **Amphibian nerve - muscle experiments and interpretation of graphs**

List of graphs on nerve-muscle experiments:

- Simple muscle twitch
- Effect of various strengths of stimuli on Simple muscle twitch
- Effect of changes in temperature on Simple muscle twitch
- Effect of two successive stimuli on muscle contraction
- Effect of multiple successive stimuli (treppe, clonus, tetanus)
- Study of fatigue in skeletal muscle
- Velocity of nerve conduction
- Effect of load on muscle
- Measurement of isometric contractions using nerve muscle preparation

(ii) **Amphibian cardiac experiments and interpretation of graphs**

List of graphs on cardiac experiments:

- Normal cardiogram
- Effect of temperature on frog heart
- Effect of Stannius ligatures
- Properties of cardiac muscle – all or none law, staircase effect, refractory period in a beating heart (extrasystole and compensatory pause), refractory period in a quiescent heart

- Effect of vagus on frog's heart
- Action of drugs on vagus (nicotine and atropine)
- Perfusion of isolated heart and effect of ions (NaCl, KCl, CaCl2)
- Perfusion of isolated heart and effect of drugs (adrenaline, acetyl choline, atropine followed by Ach)

SKILL CERTIFICATION:

The list of certifiable skills is given below. The general instructions, blank template, samples of certification checklist suggested for skill certification are provided as **Annexure -1.**

List and number of sessions for skill certification:

	Topics	Number required to certify as per MCI
PY5.12	Record blood pressure & pulse at rest and in different grades of exercise and postures in a volunteer or simulated environment	1each x 3
PY6.9	Demonstrate the correct clinical examination of the respiratory system in a normal volunteer or simulated environment	1
PY 10.11	Demonstrate the correct clinical examination of the nervous system: Higher functions, sensory system, motor system, reflexes, cranial nerves in a normal volunteer or simulated environment	1 each (total 5)
PY 10.20	Demonstrate (i) Testing of visual acuity, colour and field of vision and (ii) hearing (iii) Testing for smell and (iv) taste sensation in volunteer / simulated environment	1 each (total 4)

SUGGESTED AREAS FOR INTEGRATION:

As per the "Competency based Undergraduate Curriculum for the Indian Medical Graduate Medical Council of India"

EARLY CLINICAL EXPOSURE:

- **Clinical visits: 12 hours** (Suggested format for assessing participation in ECE sessions is provided as **Annexure-2**)

  Suggested hospital visits: (can include more)

  Anemia, Jaundice, Visit to blood bank, Computerized lung function tests, acid peptic disease, endoscopy procedure, dialysis unit, hemiplegia, etc.
- **Basic science correlations: 18 hours**

  Discussion based on case vignettes, graphs, clinical videos, patient in classroom setting, etc linked to various systems in physiology.

LOG BOOK:

Suggested Template of logbook is attached as annexure. The minimum elements that needs to be included are mentioned in the template provided for logbook.

TEACHING HOURS AND METHODS:

Theory	160 Hrs
Non-lecture teaching (small group teaching/tutorials/integrated learning/practical)	310 Hrs
Self directed learning	25 Hrs
Total	**495 Hrs**
Early clinical exposure	30 Hrs
Grand total	**525 Hrs**

SCHEME OF EXAMINATION:

Internal assessment:

(kindly refer section II for general guidelines)

Scheme for calculation of Internal assessment marks:

Theory (maximum marks)	**Marks**	**Practicals**	**Marks**
Theory written paper	30*	Practical exam and viva- voce	30**
Formative assessment		Formative assessment	
(Part completion tests/ (system-wise reviews)	10	Early clinical exposure + Skill certification	5
		Practical record	5
Total	**40**		**40**

Please note:

- *Prior to submission to the University, the marks for each of the three internal examination theory assessments must be calculated out of 30 marks, regardless of the maximum marks.
- **Prior to submission to the University, the marks for each of the three internal examination practical assessments must be calculated out of 30 marks, regardless of the maximum marks.
- Only the final marks out of 40 needs to be submitted to the University, separately for theory and practical for each internal assessment.

- Internal assessment should be based **on competencies and skills**.
- Regular periodic examinations shall be conducted throughout the course. There shall be **three internal assessment examinations** in each preclinical subject.
- An **average of the marks scored in the three internal assessment examinations** will be considered as the final internal assessment marks.

- At least 50% marks of the total marks **combined** in theory and practicals/clinical assigned for internal assessment is to be obtained in a particular subject to be eligible to appear for university examinations. A candidate who has not secured requisite aggregate in the internal assessment may be permitted to appear for another internal examination as a remedial measure. If he/she successfully completes the remediation measures prescribed by the Institution / University as the case may be, only then he/she is eligible to appear for University Examination.
- Students must secure **at least 50% marks of the total marks** (combined in theory and practical) assigned for internal assessment to be declared successful at the final university examination of that subject.
- The **third internal examination** is the **preliminary examination** to be conducted on the lines of the university examination.
- The students should be made aware of the **results** of internal assessment.
- Internal assessment marks will **reflect as a separate head** of passing at the university examination.
- The **internal examination marks** for the 1st, 2nd and 3rd internal examinations shall be **submitted** to the University on or before 15th December, 15th March and 15th July respectively.
- Level of participation in **early clinical exposure** must be assessed and contribute to the practical component as shown in the table above.
- A suggested **format** for **assessing participation in ECE** is shown in **APPENDIX 2 in section II.**
- The **scheme** for calculation of the **internal examination marks** is given the table above.
- A **clear record** of all components that add to the internal assessment marks needs to be maintained by the institution and retained by them for at least **5 years** after completion of the examination. Institutions may be asked to provide these details by the University as and when required.
- The internal and formative assessments provide ideal opportunities for students and teachers to identify learning gaps. Teachers should provide high quality **feedback** to each student to enable them to bridge these learning gaps.
- A suggested **format** for **providing feedback** is shown in **APPENDIX 3 section II.**
- Formative assessments also enable the early identification of students who are struggling to achieve the intended learning outcomes. Early and appropriate targeted **remediation** must be planned for such students.

UNIVERSITY EXAMINATIONS

TABLE SHOWING SCHEME FOR CALCULATION OF UNIVERSITY EXAMINATION MARKS

Theory (maximum marks)		**Practical (maximum marks)**	
Paper 1	100	**Practical exam** **(Practical I to IV)**	80
Paper 2	100	**Viva-voce**	40
TOTAL	**200**	**TOTAL**	**120**

- University examinations are to be designed with a view to ascertain whether the candidate has acquired the **necessary knowledge, minimal level of skills, ethical** and **professional values** with **clear concepts** of the fundamentals which are necessary for him/her to function effectively and appropriately as a physician of first contact.
- Assessment shall be carried out on an **objective basis** to the extent possible.
- Nature of questions will include different types such as structured essays, modified essays (case based), short essays and short answers questions.
- **Viva/oral examination** should assess the student's ability to explain key concepts with functional and clinical correlations. Viva should focus on application and interpretation.

Criteria for passing university examination

- The student must **secure at least 40% marks in each of the two theory papers** with **minimum 50% of marks in aggregate** (both papers together) to pass.
- The marks obtained in the viva examination will be added to the practical marks.
- The student **must secure a minimum of 50% of marks in aggregate in the viva and practical examination** (both combined) to pass.
- Students must secure atleast 50% marks of the total marks (combined in theory & practical) assigned for Internal assessment to be declared successful at the final university examination of that subject.

There shall be **one main examination** in an academic year and **a supplementary** to be held **not later than 90 days** after the declaration of the results of the main examination.

A. THEORY: 200 Marks

There shall be two theory papers of 100 marks each and duration of each paper will be of 3 hours.

Type of questions	Number of questions	Marks for each question	Total
Long essay	2	10	20
Short essay	10	5	50
Short answers	10	3	30
Total			100

B. **PRACTICAL: 80 Marks**

There shall be four practical sessions, each carrying 20 marks. The distribution of content and marks for the practical would be:

Practical I: (20 marks)

a.Clinical examination - I (CNS – sensory / motor/ reflexes / cranial nerve): **15marks**
b.Chart: Clinical case history / graphs / clinical charts: **5marks**

Practical II: (20 marks)

c.Clinical examination-II (CVS / RS): **15marks**
d.Clinical examination (general physical examination / abdomen examination): **5 marks**

Practical III: (20 marks)

e.Human experiment: **15marks**

- Mosso's ergography
- Effect of posture / exercise on BP and Pulse rate
- Estimate fitness using the Harvard step test
- Record and interpret Lead II ECG
- Spirometry and PEFR
- Perimetry
- Demonstrate BLS

f.Chart: Amphibian charts (nerve muscle / cardiac): **5 marks**

Practical IV: (20 marks)

g.Hematology (RBC count / WBC count / making a peripheral smear + DLC on the provided stained slide / BT + blood group / Hb + blood group): **15 marks**
h.Clinical problems: **5 marks**

Note: the 'procedures to be performed' for practical exam under different sections (I to IV) mentioned above needs to be strictly adhered to. The experiments kept under clinical examination should allow for an assessment of the marks allotted (and not be a very small component of the experiment for eg. "elicit a knee jerk" is not a complete experiment).

C. Viva-Voce Examination: 40 Marks
The viva-voce examination shall carry 40 marks and all examiners will conduct the examination. Viva should focus on application and interpretation. (viva marks to be added to practicals and not theory)

- Portions of Paper I - 20 Marks; Portions of Paper II - 20 Marks

Marks distribution for theory question papers:

Paper 1 (Max 100 marks)

Topics	Marks Allocated
General Physiology	05
Hematology	20
Cardiovascular Physiology	25
Respiratory Physiology	20
Gastrointestinal Physiology	15
Renal Physiology	15

Note: All the questions should be structured compulsorily. One short essay (5 marks) to be preferably a case vignette.

Paper 2 (Max 100 marks)

Topics	Marks Allocated
Nerve and muscle Physiology	12
Endocrine physiology	20
Reproductive physiology	15
Central nervous system	35
Special senses	10
Integrated Physiology	08

Note: All the questions should be structured compulsorily. One short essay (5 marks) to be preferably a case vignette.

Annexure 1

SUGGESTED FORMAT FOR CERTIFICATION OF SKILLS IN PHYSIOLOGY

General instructions

General information:

1. There are 13 skills that need to be certified in Physiology
2. These skills will be tested in normal, healthy volunteers or simulated environment
3. The focus will be on whether students perform the procedures correctly
4. Since these are skills that need to be recertified at the end of clinical training, this certification is a **"First level Certification"**

Role of the certifier:

1. Observe the student perform the skill without any prompting or interference
2. At the end of the assessment ask the specific questions that need to be asked (based on the skill checklist)
3. Grade the student (A, B, C, D – see below)
4. Give feedback to the student on the errors, if any, at the end of the skill assessment.
5. Fill in the Certification Sheet

Assessment

Professional conduct and communication:

1. Is the student adequately groomed
2. Does the student introduce him/herself, greet the subject and obtain consent?
3. Does the student use the hand sanitizer?
4. Does the student give clear instructions to the subject?
5. Does the student thank the subject?
6. Does the student use the hand sanitizer at the end of the session?

Skill specific assessment:

1. Has the student conducted the given assessment completely?
2. Has the student conducted the given assessment correctly?
   (for the above two points please refer to the checklist for the specific skill)
3. How do you rate the student for this session?

Grade	Explanation of Grade	Action to be taken
A	Student has performed the assessment **without any error**	Can be certified for skill
B	Student has performed the assessment **with minor errors** that need to be rectified	Re-assessment for parts that have been performed incorrectly
C	Student has performed the assessment **with major errors**	Re-assessment of whole skill
D	Student has **not been able to perform** the assessment	Re-assessment of whole skill

(Note: columns for 'number of attempts' can be added in the template attached below)

CERTIFICATION SHEET – Blank Template:

Name of Student: Phase of MBBS:

Subject:

Skill:

Competency Number:

Grading of Student (please circle the appropriate letter – A, B, C, D)

A	Student has performed the assessment without any error
B	Student has performed the assessment with minor errors that need to be rectified
C	Student has performed the assessment with major errors
D	Student has not been able to perform the assessment

SKILL CHECKLIST
Satisfactory (√), unsatisfactory (X)

Steps	**Attempt I Date:**	**Attempt II Date:**	**Attempt 'n' …….. Date:**
• •			
Grade			
Name and Signature of the assessor			
I have received detailed feedback on my performance including my grade, the errors that I have committed and actions to be taken. (student's signature)			

Certifiers name and signature with date of certification:

Signature, name and Roll No. of student

Annexure 2

SUGGESTED FORMAT FOR ASSESSING PARTICIPATION IN EARLY CLINICAL EXPOSURE SESSIONS

Session number: **Date:**

Roll No:

Setting:
Classroom/Hospital/Community

Department visited:

Lead **Dept:**
Anat/Physio/Biochem

Objectives

1.

2.

3.

1. Briefly describe what you learnt from this session/ clinical visit in relation to the objectives. (in 100-150 words)

2. Apart from the above learning, what did you observe that influenced (Positive/negative) you? (in 100-150 words)

SUGGESTED TEXT BOOKS

Note: A single text book may not cover the entire curriculum. Referring to more than one book is recommended.

TEXT BOOKS (latest editions)

1. Guyton and Hall. Text of Medical Physiology. South Asian edition. Mario Vaz, Anura Kurpad, Tony Raj.
2. Ganong's Review of Medical Physiology.
3. Vander's Human Physiology.
4. Principles of Medical Physiology. Sabyasachi Sircar
5. Text book of Medical Physiology. Indu Khurana
6. Text book of Medical Physiology. D Venkatesh, H H Sudhakar
7. Comprehensive text book of medical physiology. G K Pal. – single volume
8. Essentials of Medical Physiology. ABS Mahapatra
9. Berne and Levy Physiology. BM Koeppen, BA Stanton
10. Human Physiology. Lauralee Sherwood.

Reference books for practicals:

1. McLeod's Clinical Examination
2. Hutchison's Clinical Methods.
3. Text book of practical physiology. GK Pal and Pravati Pal
4. A textbook of Practical Physiology. CL Ghai