

Study Guide
Physiology
Department

First Year MBBS

Study Guide

Department of Physiology

First Year MBBS Session (2018-2019)

1. Departmental Introduction

The Physiology Department since inception of the college has made a steady and noteworthy progress. The department is headed by Prof. Dr. Farida Hafeez ably supported by a team of seasoned and experience teachers. This department is well known for providing not only world class training to the under-graduates but also in breeding curiosity to know the unknown. The faculty members of this department who are highly qualified and dedicated are the source of inspiration for all their students to seek guidance for their academic and professional excellence. They along with the Head of the Department have established an up-to-date laboratory as well as BIOPAC student lab that is an integrated life science teaching solution that includes hardware, software and curriculum materials that students and faculty use to record data from their own bodies, animals or tissue preparations. A post-graduate section has been established where, under permission from the NUMS University we hope to start our M.Phil (Physiology) classes in the very near future.

2. Vision/ Aim/ Mission

- To expedite the academic growth and development of the undergraduate students
- To enhance the culture of research in both under and post graduate students
- Development of trained medical faculty in basic sciences

3. Course Content

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First Professional MBBS Examination

PHYSIOLOGY

Table of Specifications for Annual First Professional Examination:

Theory

Time Allowed	=03 hrs	<i>(Including MCQs)</i>
Marks of theory paper	=90	
Internal assessment	=10	
Total marks	=100	
Pass Marks	=50	
25 x MCQs (on separate sheet)	(25 Marks)	Time =30 min
Q. No. 1,2,3,4,5,6,7,8,9		
(7x SAQs/SEQs (C1 & C2) = 07 marks each		
2 x SAQs/SEQs(C3) = 08 marks each) (65 Marks) Time = 2		
hours 30 minutes		

S No	Topic	NUMBER OF MCQs (25) (C1=10, C2=10, C3=5) 1 mark each	NUMBER OF SAQs/SEQs (09)	
			7x SAQs/SEQs (C1 & C2) = 07 marks each	2 x SAQs/SEQs (C3) = 08 marks each
1	Cell, Nerve muscle	06	01	Whole Course
2	Blood	08	01	
3	CVS	06	03	
4	Respiration + Environmental + Sports	05	02	
Total		25	07	02
Grand Total		25 (25 Marks)	09 (65 Marks)	

Theory: Internal Assessment (IA) Calculation

A	B	C	D
Roll No.	Name	All Modules/ Pre annual Exams or any other exam	Total Marks of internal assessment Out Of 10
Total Marks		Sum of Marks obtained x10/ sum of total marks in all exams	

Table of Specifications for Annual Professional Exam: Practical

Viva (Theory) 50 marks		Practical 40 marks					Total
Internal Examiner	External Examiner	OSPE (20)		Experiment al Physiology + Table Viva	Practical Procedur e	Practica l Journal	
		Observe d	Unobserve d				
25	25	10	10	12	5	3	90

Practical: Internal Assessment Calculation

A	B	C	D
Roll No.	Na me	OSPE /PTT/ Class tests throughout the year /Pre annual Exams or any other exam	Total Marks of internal assessment Out Of 10
Total Marks		Sum of Marks obtained x10/ sum of total marks in all exams	

Module I

Summary: Code	<i>YIMI</i>
Name	<i>Physiology</i>
Duration	<i>10 weeks</i>
Broad Themes of Module (Theme: a subject that is being integrated a majority of time of module)	Introduction 2. Cells and genetics 3. Blood 4. Loco motor (Upper limb)
Subject Themes	Cell, transport and general physiology + Genetics Nerve and membrane potential Muscle physiology Blood Immunity
Prerequisite Module	None
Mode of Information Transfer: MIT	
Lectures	
Tutorials (PTT)	
CBL	
Practicals	
Class tests	

Physiology learning outcomes:

GENERAL PHYSIOLOGY	<p>Know the functional organization of human body. Know the parameters needed for the control of the ‘internal environment’. Understand the principles of the mechanics of homeostasis Able to differentiate between positive and negative feedback as the control systems of the body Relate positive and negative feedback system with common examples Differentiate between composition of intracellular and extra cellular fluid</p> <p>Know the functional organization of human body. Know the parameters needed for the control of the ‘internal environment’. Understand the principles of the mechanics of homeostasis Able to differentiate between positive and negative feedback as the control systems of the body Relate positive and negative feedback system with common examples Differentiate between composition of intracellular and extra cellular fluid</p>
GENETICS	
CELL PHYSIOLOGY	<p>Comprehend organization of the physical structure of the cell (cell Membrane, cytoplasmic organelles, nuclear membrane, nuclear organelles) Understand the functional systems of the cells (ingestion, digestion, synthesis, extraction of energy from nutrients) Overview movements of cells (amoeboid, ciliary etc) Know the genes in the cell nucleus Explain the process of transcription and translation (synthesis) in the cells Understand the gene functions performed in the cells Comprehend the genetic control of cells functions and cells-reproduction Classify various modes of transport of substances across the cell-membrane Compare and contrast amongst the processes of osmosis, diffusion, facilitated diffusion, primary active transport, secondary active transport Relate the modes of transport with common examples in human body Appreciate the physiological significance of the transport of substances through the cell membrane</p>

BLOOD AND RELATED DISORDERS	<p>Appreciate the composition of blood and general functions of blood.</p> <p>Know different types of plasma protein.</p> <p>Comprehend composition of plasma protein and their functions and importance for the human body.</p> <p>Overview sites of hemopoiesis in the body during different stages of life along with composition and functions of bone marrow.</p> <p>Understand different types of blood cells, their physiological characteristics with functional differences.</p> <p>Know the formation, types and functions of hemoglobin along with its association with different kinds of anemia.</p>
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List of Practical:

Module 1

- Compound Microscope and study of Neubauer's chamber
- RBC count by Neubauer's chamber.
- WBC count-TLC
- Platelet count. (Demonstration only)
- Determination of Haemoglobin in the blood. (Sahili's method)
- Red cell indices.
- Estimation of haematocrit (PCV).
- Estimation of ESR.
- Determination of ABO & Rh blood groups.
- Estimation of bleeding & clotting time.
- DLC.
- Osmotic fragility of RBC
- Any other practical relevant to that Module
- List of Case Based Learning (CBL):

PBL 1

Mr. Zeeshan, a 43 years old mess waiter, reported in medical OPD with complaints of difficulty in standing for long duration while serving the meals, for last six months. His general physical examination revealed normal pulse, blood pressure and temperature. However, the doctor observed drooping of his eye lids. His symptoms ameliorated for several hours by administering a test dose of neostigmine. Laboratory investigations confirmed the presence of antibodies to nicotinic acetylcholine receptors in the blood and end plate potentials recorded on electromyography were weak. CT scan chest was normal. The physician managed the case conservatively by anticholinesterase drugs and patient responded to the treatment very well.

Learning objectives:

To learn the physiological basis of:

- Skeletal muscle contraction especially for sustained contractions while standing.
- Transmission of motor signals to skeletal muscle in nerve fibers.
- Neuromuscular transmission at NMJ.
- Factors/drugs that effect transmission at NMJ.
- Pathophysiology and treatment options of myasthenia gravis.

Resources:

- Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.
- Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.
- Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 2

A 6-year-old boy is brought to the family physician after his parents noticed that he had difficulty moving his arms and legs after a soccer game. About 10 minutes after leaving the field, the boy became so weak that he could not stand for about 30 minutes.

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Questioning revealed that he had complained of weakness after eating bananas, had frequent muscle spasms, and occasionally had myotonia, which was expressed as difficulty in releasing his grip or difficulty opening his eyes after squinting into the sun. After a thorough physical examination, the boy was diagnosed with hyperkalemic periodic paralysis. The family was advised to feed the boy carbohydrate-rich, low-potassium foods, give him glucose-containing drinks during attacks, and have him avoid strenuous exercise and fasting.

Learning objectives:

To understand Frank-Starling's law as applied to skeletal muscle mechanics.

To correlate electrolyte influences on skeletal muscle contraction.

To know details of contractile elements of skeletal muscles.

To gain insight into skeletal muscle fuel metabolism.

To understand force velocity relationship of skeletal muscles.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 3

A 32-year-old woman presents to her primary care physician's office with difficulty chewing food. She states that when she eats certain foods that require significant amount of chewing (e.g., meat), her jaw muscles become weak and "tired." After a period of rest, her jaw muscles regain their strength until she eats again. The patient is diagnosed with myasthenia gravis and is started on neostigmine, an acetylcholinesterase (AChE) inhibitor.

Learning objectives:

To define concepts of chronaxie and rheobase.

To differentiate between fast and slow muscle fibers characteristics.

To compare skeletal, smooth and cardiac muscle fiber properties.

To compare neuromuscular transmission of skeletal and smooth muscles.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 4

25

A 21-year-old man presents to a rural emergency center with a 1-day history of progressive stiffness of the neck and jaw, difficulty swallowing, stiff shoulders and back, and a rigid abdomen. Upon further questioning, the patient reports that the stiff jaw was the first symptom, followed by the stiff neck and dysphagia. On examination he is noted to have stiffness in the neck, shoulder, and arm muscles. He has a grimace on his face that he cannot stop voluntarily and an arched back from contracted back muscles. The physician concludes that the patient has "tetanic" skeletal muscle contractions. A 3-cm laceration is noted on his left foot. The patient reports sustaining the laceration about 7 days ago while he was plowing the fields on his farm. He has not had a tetanus booster. He is diagnosed with a tetanus infection, and an injection of the tetanus antitoxin is given.

Learning objectives:

To understand pathophysiology of tetanic muscle contractions.

To differentiate between concepts of tetany, tetanus and tetanization.

To understand mechanisms underlying muscle fatigue.

To gain insight into latch mechanism of smooth muscle contraction.

To identify factors relating to efficient smooth muscle contraction.

To elaborate hormonal factors governing smooth muscle contraction.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 5

A 14-year-old girl complained of fatigue and loss of stamina. Her appetite was marginal, as she was very conscious of maintaining her body weight at 96 pounds. Her monthly menstrual flow was always heavy and long, from its onset at twelve years of age. Relevant laboratory findings included the following:

Hematocrit (Hct) 28%

Hemoglobin (Hgb) 9 g/dL

Iron 16 µg/dL

Bone marrow iron Absent

Erythrocytes Small and pale

Suggested treatment for this patient of iron deficiency anemia included ferrous sulfate or ferrous gluconate for six months orally between meals, since food may reduce absorption. A well-balanced diet was also suggested, as well as a gynecological examination.

Learning objectives:

To identify various stages of erythropoiesis along with role of various growth and differentiation inducers.

To develop conceptual understanding of erythropoiesis regulation.

To develop a mind map of iron metabolism in human body.

To critically reflect on working definition of anemia.

To interpret clinical manifestations of anemia.

To identify hematologic picture in various types of anemia.

To elaborate pathophysiology of various types of anemias.

To develop a working knowledge of polycythemia.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 6

A 36 years lady consulted her physician with complaints of generalized weakness, easy fatigability for the last one year and recent development of sore throat and fever for 3 days. Her physical examination revealed pulse 98/min, temperature 101 F, respiratory rate 18/min and blood pressure 120/80 mm Hg. Her throat was red and congested. Her personal history revealed birth of five children in last 8 years. Her lab investigation reveal Hb 8.2 gm/dl with hypochromic microcytic RBCs (MCV=62 fl, MCH 21 pg, MCHC 27%), TLC was 16,200/ul with 82% neutrophils, 12% lymphocytes, 4% monocytes, 1% basophils and 1% eosinophils. She was advised oral antibiotics for one week and antianemics for 03 months.

Learning objectives:

To learn the physiological basis of manifestations of illness and body's immune response.

To learn the role of various leucocytes in acute bacterial infections.

To correlate fever and increased pulse rate with body's immune response.

To know the physiological basis of:

Inflammation

Pallor and tachycardia

Weakness & fatigability

To understand the causes of anemia, leucocytosis and deranged DLC.

To learn the mechanism of development of leucocytosis.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 7

A 10 years old boy came to OPD with high grade fever, sore throat and dysphagia to solids for past 04 days. History revealed that he had multiple similar episodes over past 02 yrs.

On examination, tonsils were swollen and enlarged. Lab. investigations were as under:

Count Showed

Normal Values

Neutrophils 80% (60-65%)

Eosinophils 1-5% (1-5%)

Basophils 0-1% (0-1%)

Lymphocytes 30% (20-40%)

Monocytes 1-6% (1-6%)

Lab report shows "neutrophilia". He was diagnosed as a case of "streptococcal tonsillitis".

Learning objectives:

To develop answers to following queries:

1. Which type of immunity was generated in this patient?
2. Why neutrophil count is increased in this patient? What is their role in this infection?
3. What are the classical signs of inflammation in above patient?
4. What is the role of helper T- Lymphocytes in streptococcal tonsillitis?
5. How complement system is activated in above scenario?
6. What are types based on morphology of W.B.C's?
7. Describe briefly the functions of different types of W.B.C.s.
8. What is the role of macrophage/antigen presenting cells in immunity?
9. What are different immune deficiency diseases?
10. What are autoimmune diseases?
11. Discuss briefly Immunization?

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

Module II

Summary: Code	<i>YIM2</i>
Name	<i>Physiology</i>
Duration	<i>10 weeks</i>
Broad Themes of Module (Theme: a subject that is being integrated a majority of time of module)	1.Thorax 2.Cardiovascular system
Subject Themes	Cardiovascular Physiology
Prerequisite Module	<i>YIM1</i>
Mode of Information Transfer: MIT	
Lectures	
Tutorials (PTT)	
CBL	
Practicals	
Class tests	

Physiology learning outcomes:

<p>Physiologic anatomy of heart and cardiac action potential</p>	<p>Appreciate the physiological arrangement of right and left hearts along with the parallel arrangement of systemic circulation.</p> <p>Know the physiologic anatomy of cardiac muscles, its functional syncytium and intercalated disc and difference between cardiac, skeletal and smooth muscles.</p> <p>Know the phases of action potential in cardiac muscle and autorhythmic cells/ conducting system of the heart along with comparison of action potential in different tissues of the heart.</p> <p>Associate movement of ions across the cell membrane with different phases of action potential.</p> <p>Comprehend importance and relationship between refractory period and mechanical periods.</p> <p>Know the mechanism of generation and propagation of cardiac impulse in conductive system of heart.</p> <p>Appreciate characteristics of spread of cardiac impulse through conductive system, atrial and ventricular myocardium and its association with the function of heart.</p>
<p>Cardiac cycle</p>	<p>To understand various cardiac events in relation to each other</p> <p>To understand and interpret cardiac cycle diagram</p> <p>Comprehend preload and afterload, its influence on stroke volume. The Frank-Starling's mechanism and role of autonomic regulation of heart rate and pumping action.</p> <p>Know about the myocardial bioenergetics.</p>

ECG	<p>Comprehend genesis of ECG, the way it is recorded and its relationship with the electrical axis of heart.</p> <p>Understand significance of waves, segments and intervals of ECG recording.</p> <p>Learn the concept of a vector and principles of the measurement of ECG vector.</p> <p>Appreciate relationship between vector and lead, type and locations of leads and principles for vector analysis.</p> <p>Know general principles of analysis of ECG.</p>
Arrhythmias	<p>Understand the basis of common cardiac arrhythmias, process that produce them and their clinical significance.</p> <p>Evolve the concept of sinus arrhythmia and its clinical significance.</p> <p>Appreciate principal changes in ECG during myocardial ischemia and infarction.</p> <p>Comprehend changes in ECG and cardiac function during common abnormalities in ionic composition of body fluids.</p> <p>Understand the pathophysiology of ectopic focus and its clinical significance.</p> <p>Know how and when to carry out cardiac massage and its significance.</p> <p>Appreciate the events of cardiac cycle and prospective changes in ECG, heart sounds, pressures and volumes during different phases thereof.</p>
Hemodynamics of circulation	<p>Know the organization of circulatory systems i.e. Greater (Systemic) and Lesser (Pulmonary) circulations along with accessory circulatory system (Lymphatic).</p> <p>The physiologic anatomy of different types of blood vessels and their importance.</p> <p>To know the relationship between flow, resistance and conductance.</p> <p>Have the concept of blood flow, its types and significance of turbulent and laminar flow, the concept of pressure gradient, resistance to blood flow and its significance.</p> <p>Understand the Physiology of vascular compliance? Changes in compliance of blood vessels with age and comparison between the compliance of arteries versus veins.</p> <p>Appreciate the origin of arterial pressure pulse and its propagation to the peripheral arteries.</p> <p>Know the factors damping the arterial pulse and abnormalities of arterial pulse.</p> <p>Know about the jugular venous pulse, its significance and differentiation from arterial pulse.</p>
Control of Local Blood	<p>To know about acute and chronic control of local blood flow</p> <p>To about theories of metabolic control of blood flow</p> <p>To know about active and reactive hyperemia</p> <p>To know the effects of blood flow control on total peripheral resistance</p>

Capillary dynamics	<p>Understand the principles of capillary dynamics, structure of Interstitium, Starling's forces for fluid exchange across the capillary membrane and factors affecting thereof.</p> <p>Have the concept of Starling's equilibrium, and how of the interstitial space is kept dry?</p> <p>Know the mechanism of formation of interstitial fluid, its composition and factors creating Starling's disequilibrium leading to the development of edema.</p> <p>Appreciate Types of edema, its pathophysiology and safety factors preventing edema formation.</p>
Cardiac output	<p>Understand the determinants of cardiac output and factors affecting cardiac output.</p> <p>Appreciate the mechanics of low and high cardiac outputs along with their effects on heart.</p> <p>Comprehend the factors affecting stroke volume, heart rate and total peripheral resistance.</p> <p>Understand Fick's principle for the measurement of cardiac output.</p>
Venous return	<p>Recognize the role of veins in blood flow, their functions and factors regulating venous return and significance of venous reservoirs.</p> <p>Appreciate the equality of cardiac output and venous return.</p> <p>To understand factors affecting venous return</p>

List of Practicals:

Module 2

Examination of the chest related to CVS

Examination of arterial pulse.

ECG recording & interpretation.

Measurement of arterial B.P

Effect of exercise & posture on BP

Examination of the apex beat

Auscultation of normal heart sounds.

JVP / Trippl response

Any other practical relevant to that Module

List of Case Based Learning Scenerios:

PBL 1

A 55 years old male was brought to cardiac emergency department with the history of severe left sided chest pain. His ECG showed ST segment elevation and significant Q waves in leads I, aVL and V6. These findings suggested that he sustained acute infarction of the left side of left ventricle. QRS complex was positive in lead aVF and predominantly negative in lead I. The treating doctor showed ECG to final year medical students and told that there was right axis deviation in the ECG as well.

Learning objectives

To know about basics of cardiac impulse generation and propagation

To understand ECG leads and normal ECG
To understand and interpret vector analysis
To know Physiological basis of ST segment shift (current of injury)
To understand ECG changes in acute myocardial infarction
To understand physiology of treatment of acute myocardial infarction

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.
Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.
Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 2

A 65 years old man suddenly woke up while sleeping during night due to severe breathlessness. On arrival to emergency, his blood pressure was 105/70 mm Hg and pulse rate 110 per minute. Auscultation of lungs revealed fine crepitations. Further investigations revealed a low cardiac output of 4 l/min and right atrial pressure of 10 mm Hg. After few days he developed pitting oedema of legs and sacral region. The patient was diagnosed as a case of heart failure.

Learning objectives:

To understand pathophysiology of heart failure

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To know about types and stages of heart failure

To understand Starling forces acting on capillary

To understand pathophysiology of pulmonary and systemic oedema

To understand role of kidney in heart failure

To understand physiology of treatment of heart failure

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.
Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.
Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 3

A 75 years old man comes into emergency department and faints. Five minutes later, he is alert. An electrocardiogram was recorded immediately. It showed 75 P waves of normal morphology per minute whereas QRS complexes were recorded at the rate of 35 per minute. Close observation of ECG revealed that QRS complexes were wide with high voltage and there was no relation between P waves and the QRS complexes.

Learning objectives:

1. To know the normal anatomy and physiology of heart.
2. To know about the generation and conduction of cardiac impulse.
3. To understand the physiological basis of normal electrocardiogram.
4. To know about vectorial analysis
5. To know about sinus arrhythmias.
6. To learn the pathophysiology of heart blocks.
7. To know the physiological basis of escape beats/rhythm.
8. To understand about ectopic beats/rhythm.
9. To learn the mechanisms of tachyarrhythmias.
10. To know about paroxysmal tachyarrhythmias

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.
Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic mode

PBL 4

A 73 years old man comes to emergency department complaining of chest pain, dyspnea on exertion and syncope. The patient has poorly managed hypercholesterolemia and 10 years history of hypertension.

Vital signs

Temperature 37 degree C

Pulse 85/min

RR 18/min

BP 100/75mmHg

Physical examination

Palpation of carotid upstroke reveals a pulse that is both decreased and late, relative to the apical impulse that is laterally displaced

A systolic murmur is present, loudest over the aorta, and peaking at mid-systole

Lungs are clear and there are no rales

Investigations

ECG: left axis deviation. No abnormalities in ST segment

Chest X-ray: Enlarged left ventricle and calcification of aortic valve

Doppler ultrasonography: A greatly increased velocity of flow during the systolic portion of the cardiac cycle. The left atrium and left ventricular chambers are enlarged. Left ventricular hypertrophy is present.

Cardiac enzymes: CK-MB, troponin-I and myoglobin levels are within normal ranges

Diagnosis: Aortic valve stenosis

Learning objectives:

To develop a working knowledge of:

1. Physiological anatomy of the heart
2. Cardiac cycle
3. Heart sounds and their relationship to events of cardiac cycle
4. Cardiac output & venous return
5. Concept of ventricular ejection and diastolic filling
6. Concept of pre-load and after-load
7. Cardiac work & pumping effectiveness of heart
8. Cardiomegaly and ventricular hypertrophy
9. Clinical examination of the cardiovascular system (CVS)
10. Types of murmurs
11. Pulmonary complications of cardiovascular disease
12. Differential diagnoses of dyspnea on exertion
13. Electrocardiogram (ECG)
14. Biochemical indicators of myocardial damage

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 5

A 68-year-old woman presents to the emergency center with shortness of breath, light-headedness, and chest pain described as being like "an elephant sitting on her chest." She is diagnosed with a myocardial infarction. She is given oxygen and an aspirin to chew and is not felt to be a candidate for thrombolytic therapy. Her heart rate is 40 beats per minute (bpm). Although there are P waves, they seem to be dissociated from the QRS complexes on the electrocardiograph (ECG). The patient is diagnosed with

complete heart block, probably as a result of her myocardial infarction. The patient is taken to the intensive care unit for stabilization, and plans are made for pacemaker insertion.

Learning objectives:

To understand concept of circus movements.

To define current of injury and know the significance of J point.

To gain insight into concept of re-entrant signals in heart muscle.

To elaborate factors resulting in cardiac impulse delay at AV node.

To list factors responsible for cardiac conduction blocks.

To classify various types of heart blocks.

To develop detailed knowledge of various types of AV nodal blocks.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 6

A 57-year-old man presents to the emergency center with complaints of chest pain with radiation to the left arm and jaw. He reports feeling anxious, diaphoretic, and shortness of breath. His past history is significant for type II diabetes mellitus and hyperlipidemia. On examination, the patient appears to be in moderate distress and anxious. His electrocardiograph (ECG) shows evidence of acute myocardial injury in the inferior leads. The emergency room physician suspects that the left anterior descending artery is involved.

Learning objectives:

To understand regulation of coronary circulation.

To develop an understanding of various neuronal receptors on coronary vasculature.

To gain insight into concepts of coronary steal syndrome and systolic stretch.

To identify ECG changes in myocardial infarction.

To apply concepts of vectorial analyses to abnormal ECG findings.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 7

A 60 years old lady presented in medical OPD with complaints of bilateral swelling lower limbs for the last about three months. She also gives history of epistaxis. Physical examination revealed pitting oedema over the legs. Laboratory investigations showed prolonged clotting time and decreased plasma proteins. Ultrasound abdomen revealed cirrhosis of the liver.

Learning objectives:

To know the various causes of bilateral swelling of lower limbs.

To know the relation of decreased plasma proteins with swelling of legs.

What is the cause of epistaxis in this problem?

To know the causes of pitting edema.

To know about the causes of non-pitting edema.

To know about forces acting upon capillary membrane.

To know about Starling's equilibrium.

To know about edema safety factors.

To know about lymphatic system.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

PBL 8

A 55 years old man presented in medical OPD of Military Hospital with dyspnoea, pallor swelling of legs for the past one month. On physical examination, he had pitting edema of legs and sacral region, and raised JVP. His chest radiograph showed marked enlargement of heart while ECG revealed Q wave in leads I, V3 and V4. Doppler Echocardiography revealed ejection fraction of 30%. Physician diagnosed that the patient was suffering from congestive cardiac failure due to past myocardial infarction.

Learning objectives:

To know pathophysiology of edema and its types.

To comprehend the mechanism of development of edema.

To know safety factors to prevent the development of edema.

To understand concept of preload, after load, ejection fraction and peripheral resistance.

To know changes in ECG presenting in the old myocardial infarction.

To understand changes in cardiovascular system in response to myocardial infarction that lead to changes in Starling's forces and development of edema.

To learn the mechanism of development of cardiomegaly and cardiac dilatation and changes leading to reduction in ejection fraction.

To understand pathophysiology of raised JVP in this patient.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.

Electronic modes

Module III

Summary: Code	<i>Y1M3</i>
Name	<i>Physiology</i>
Duration	<i>10 weeks</i>
Broad Themes of Module (Theme: a subject that is being integrated a majority of time of module)	Lower Limb Respiratory System
Subject Themes	Physiology of respiration Deep sea physiology Aviation/space physiology High altitude physiology Exercise physiology
Prerequisite Module	Y1M1&Y1M2

Mode of Information Transfer: MIT
Lectures
Tutorials (PTT)
CBL
Practicals
Class tests

Physiology learning outcomes:

Physiology learning outcomes: Introduction to Respiratory System	To know the functional anatomy of respiratory tract To understand the functions of various parts of respiratory system To highlight the non-respiratory functions of respiratory tract
Pulmonary Mechanics	To know the functions of respiratory muscles To understand various pressures acting on lungs and chest wall To understand the change in pressures during each phase of respiration To know the normal lung volumes/capacities To understand the concept of static v/s dynamic lung volumes/capacities
Pulmonary Compliance	To understand the concept of lung and chest wall compliance To know the composition & role of surfactant in alveolar surface tension To understand the concept of work of breathing
Respiratory Membrane & Diffusion of Gases	To study the layers of respiratory membrane To know the concept of diffusing capacity through respiratory membrane To study the factors affecting gas diffusion through respiratory membrane
Diffusion of gases & Oxygen transport	To know the mechanics of oxygen diffusion from alveoli to blood To understand the mechanism of oxygen transport in the arterial blood To know the mechanics of oxygen diffusion from blood to tissue fluid To study the mechanics of oxygen diffusion from tissue fluid in to cell
Oxygen transport & Dissociative curve	To study the role of Hb in oxygen transport To study the normal oxygen-hemoglobin dissociation curve To study the factors that shift oxygen-hemoglobin dissociation curve
Carbon dioxide transport	To know the various chemical form in which CO ₂ is transported in blood To study the normal CO ₂ dissociation curve To understand the concept of haldane effect
Nervous regulation of respiration	To study different group of neurons composing respiratory center To study the control of inspiration and respiratory rhythm To understand the role of pneumotaxic center in respiration To understand the regulatory mechanism of hering-breuer inflation reflex

Chemical regulation of respiration	To study the central chemosensitive area & its stimulation by CO ₂ and H ⁺ To know the role of peripheral chemoreceptors for control of respiration To study the composite effects of PCO ₂ , pH, & PO ₂ on alveolar ventilation
Pulmonary circulation V _a /Q	To understand pressure differences b/w pulmonary & systemic circulation To study the pulmonary blood flow and effect of hydrostatic pressure on it To understand the concept ventilation perfusion ratio
Hypoxia	To study various causes of hypoxia To know the effects of hypoxia on the body To study the role of oxygen therapy in different types of hypoxia
Cyanosis/Asphyxia/ Hypercapnia	To study the causes of cyanosis and asphyxia To study the hypercapnia & its association with various forms of hypoxia To study the effects of very high blood CO ₂ levels on respiratory center
Hazards at High Altitude	To study the change in composition of air at high altitude To study the effects of low oxygen pressure on the body To study the change of alveolar PO ₂ at different elevations
Acclimatization at High altitude	To study the mechanism of acclimatization of the body to low O ₂ To understand the cause of natural acclimatization in natives of H.A To study the principals of acclimatization
Respiratory adjustment during exercise	To study oxygen consumption and pulmonary ventilation during exercise To study the respiratory changes during exercise To study body's regulation of respiration during exercise
AMS/HAPE/HACE	To study the causes & clinical features of AMS/HAPE/HACE To understand the pathophysiological mechanism of development of AMS To study the various treatment modalities for AMS/HAPE/HACE

List of Practical:

Module 3

Examination of the chest related to respiratory system (respiratory rate)

Auscultation of breath sounds

Spirometry: Lung volumes and opacities

Spirometry: FEV₁ and FVC

Stethography.

PEFR Peak Expiratory Flow Rate

CPR

Any other practical relevant to that Module

List of Case Based Learning Scenerios:

PBL 1

A 10-year-old boy is brought to the emergency department because of difficulty in breathing that developed while playing football. The boy has a history of allergies, including a pollen allergy, but never previously showed this level of respiratory difficulty. He now complains of tightness in the chest. There is no family history of allergies or asthma. Both parents smoke cigarettes.

PHYSICAL EXAMINATION

Vital Signs: Temp 37°C, Pulse 120/min, Resp rate 30/min and shallow, BP 110/95 mm Hg

Physical Examination: Patient is wheezing, anxious, and short of breath. The wheezing is more prominent on exhalation, and there is an extended forced expiratory phase. The chest antero-posterior diameter appears large for age and size. The nasal mucosa is edematous, and the pharynx is coated with a clear postnasal discharge.

A beta2-adrenergic agent was administered by an inhaler, and the symptoms quickly subsided. The patient's anxiety was relieved, and heart rate and breathing rate returned to normal. The patient was scheduled for pulmonary function tests.

LABORATORY STUDIES

Spirometry: Normal values. When challenged with methacholine, however, a hyperreactive broncho constriction occurred with decreased FEV1, decreased forced vital capacity, and increased residual volume. Forced spirometry flow/volume loop: Scooping, diminished peak flow.

DIAGNOSIS : Asthma

Learning objectives:

After discussion you should be able to:

List the passages through which air passes from the exterior to the alveoli, and describe the cells that line each of them.

List the major muscles involved in respiration, and state the role of each.

Define the basic measures of lung volume and give approximate values for each in a normal adult.

Define lung compliance and airway resistance.

Compare the pulmonary and systemic circulations, and list some major differences between them.

Describe basic lung defense and metabolic functions.

Define partial pressure and calculate the partial pressure of each of the important gases in the atmosphere at sea level.

Define hypoxia and describe differences in subtypes of hypoxia.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

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Electronic modes

PBL 2

Mr. Ahmed, 25-years- old, young man of average built was enjoying good health. One day he decided to do some exercise and went for jogging in exercise. After about a round of one km, he felt severe palpitation and breathlessness. Becoming concerned, he went to hospital. His pulse was 100/min, BP – 145/85 mmHg and respiratory rate was 28/min. The doctor advised him spirometry at rest and as well as after exercise. Following were the findings:

At Rest

After Exercise

VT 500 ml

VT 1000 ml

IRV 3000 ml

IRV 4000 ml

ERV 1100 ml

ERV 1500 ml

IC 34500 ml

IC 50000 ml

VC 4600 ml

VC 6500 ml

Doctor reassured Mr. Ahmed and sent him to his home.

Learning objectives:

To know the respiratory muscles involved at rest and in exercise.

To co-relate the changes in thoracic cage, muscle movement and compliance of lung at rest and in exercise.

To understand the changes in pleural pressure, alveolar pressure and trans-pulmonary pressure at rest and in exercise.

To comprehend the concept of spirometry.

To know the values of lung volume and capacities at rest and in exercise.

To appreciate the limitation in spirometry.

To understand the compliances of lung and factors effecting it.

To comprehend the concept of work of breathing and factors effecting it.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 3

Ahmed returned to his apartment in the cold winter night. He turned on his old heater and shut all the windows and door. After having a sleep of 2 hours, he woke up and noticed that his vision became progressively blurred. When he got up he became much disoriented and fell down. One of his friends incidentally stopped by and found Ahmed unconscious and hyperventilating with a reddish complexion. He immediately took him out of the house and called for an ambulance. The duty doctor made a diagnosis of "CO poisoning" based upon history and examination. Ahmed was treated with hyper baric oxygen therapy.

Learning objectives:

To develop working knowledge of:

Causes of CO poisoning

Relate the symptoms to Carbon monoxide poisoning.

Physiological basis of CO poisoning in this patient.

Dynamics of Oxygen transport by the blood.

Understanding of oxygen-Hb dissociation curve and effect of CO on this curve.

Forms of transport of respiratory gases in blood including O₂, CO₂, CO & Nitrogen.

Assessment of how CO caused a reduction in the oxygen-carrying capacity of the blood.

Learning the physiological basis of treatment with hyper baric oxygen.

Compare the skin color of the patient in cyanosis, CO poisoning and methemoglobinemia.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

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Electronic modes

PBL 4 A 17-year-old student suspected of asthma has experienced reversible, periodic attacks of chest tightness with coughing, wheezing, and hyperpnea. She states that expiration is more difficult than inspiration. She is most comfortable sitting forward with arms leaning on some support. X-rays revealed mild over inflation of the chest. Results from laboratory and pulmonary function tests are as follows: Frequency 20 breaths/min Vital capacity (VC) 2.9 L FEV_{1.0} 1.4 L FEV_{1.0}/FVC 56% Functional residual capacity (FRC) 3.89 L Total lung capacity (TLC) 6.82 L PaO₂ 70 mm Hg PaCO₂ 26 mm Hg Pulse 108 b/min BP 120/76 mm Hg Intermittent use of a bronchial smooth muscle dilator (1:1000 epinephrines by nebulizer) for several days caused marked improvement, resulting in the following laboratory and pulmonary function tests:

VC 4.15 L FEV_{1.0} 3.1 L FEV_{1.0}/FVC >75% FRC 3.7 L TLC 5.96L PaO₂ 89 mm Hg PaCO₂ 38 mm Hg Pulse 129 b/min BP 122/78 mm Hg

Learning objectives:

To understand mechanics of pulmonary ventilation underpinning various lung pressures and volumes.

To acquire working knowledge of lung volumes and capacities.

To apply concept of ventilation perfusion ratio to physiological as well as pathological clinical constructs.

To critically reflect on obstructive vs. restrictive pathophysiology of lung diseases.

To discuss pathogenesis, presentation and treatment of asthma.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 5

A 24-year-old pregnant woman presented to the hospital in preterm labor and subsequently delivered a premature infant at only 27 weeks gestation (normal term pregnancy is 37-42 weeks). After the delivery, the infant cried, but it subsequently began to grunt and showed signs of hypoxia despite oxygen supplementation. The baby immediately was intubated by endotracheal tube and given surfactant down the endotracheal tube. The baby's hypoxia resolved, and he was transferred to the neonatal intensive care unit for further stabilization.

Learning objectives:

To know composition of pulmonary surfactant.

To understand concept of surface tension and its role in pulmonary ventilation.

To list changes in various pulmonary pressures at birth.

To understand pathophysiology of respiratory distress in infants.

To gain insight into treatment options for respiratory distress syndrome in infants.

To identify pathophysiological basis of retrolental fibroplasia.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 6

A 55-year-old man with a history of a chronic lung disease presents to his primary care physician with worsening shortness of breath. He was diagnosed about 1 year ago. He gives a history of smoking cigarettes (one pack a day for 30 years) but has no other medical problems. His general appearance is that of a thin male who appears to be in mild distress. His cardiac examination is normal, but he is noted to have an expanded anterior-posterior diameter of the chest with expiratory wheezes and breathing through pursed lips. A chest x-ray reveals hyper inflated lung fields bilaterally and no infiltrates. The patient's physician recommends spirometry to differentiate emphysema, which is an obstructive pulmonary disorder, from restrictive lung disease.

Learning objectives:

To understand pathophysiology of COPD.

To develop detailed knowledge of obstructive vs. restrictive lung disease.

To develop concept of FEV1/FVC ratio as a diagnostic tool for lung pathology.

To gain insight into treatment options for COPD.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 7

A 36-year-old woman presents to her primary care physician with complaints of shortness of breath, arthritic pain, and multiple skin lesions. The patient is short of breath on examination with a slightly low pulse oximetry reading, consistent with mild hypoxemia. She has multiple skin lesions, and a biopsy reveals noncaseating granulomas consistent with sarcoidosis. Chest x-ray findings revealing hilaradenopathy are also suggestive of sarcoidosis. The physician explains to the patient that he likely has a restrictive disease process, and recommends formal pulmonary function testing.

Learning objectives:

To list various obstructive vs. restrictive lung disease processes.

To understand concept of ventilation perfusion matching.

To develop knowledge of physiological and pathological pulmonary circulation shunts.

To list components of respiratory membrane.

To elaborate factors influencing diffusion of gases across respiratory membrane.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

Human Physiology: From Cells to Systems, 8th Edition by Lauralee Sherwood.

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Electronic modes

PBL 8

A patient presented in medical OPD with complaints of pain in joints, dizziness, vertigo, visual abnormalities and confusion. After taking his history it was found out that the patient was a diver and was exposed to rapid decompression (high rate of ascent) above 18,000 ft. So based on his symptoms the physician suspected him as a case of decompression sickness.

Learning objectives:

To understand the physiology of decompression.

Explain effects of high partial pressures of gases on body.

To know the effects of high partial pressures.

To know the effects of hypoxia.

To know the treatment of decompression.

Resources:

Guyton and Hall Textbook of Medical Physiology, 13th Edition by John E. Hall.

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Electronic modes

4. Resources / Books

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- Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science) by Kim E. Barrett, Susan M. Barman, Scott Boitano, Heddwen Brooks.
- Electronic modes

5. List of Faculty

1. **Prof. Dr. Farida Hafeez**
Head of Department
2. **Dr. Ambreen Tauseef**
Associate Prof.
3. **Dr. Huma Saeed Khan**
Associate Prof.
4. **Dr. Ayesha Akmal**
Assistant Prof.
5. **Dr. Farhat Khurram**
Assistant Prof.
6. **Dr. Qudsia Umaira**
Assistant Prof.
7. **Dr. Muhammad Ilyas**
Demonstrator
8. **Dr. Sidra Zahid**
Demonstrator
9. **Dr. Syeda Abeer Fatima**
Demonstrator
10. **Dr. Mehwish Qamar**
Demonstrator
11. **Dr. Amna Nadeem**
Demonstrator
12. **Dr. Haseeb Ahmed Khan**
Demonstrator
13. **Dr. Ayesha Khalid**
Demonstrator
14. **Dr. Umme Farwa**
Demonstrator
15. **Dr. Sarah Azam**
Demonstrator
16. **Dr. Aamina Quddus Qureshi**
Demonstrator
17. **Dr. Hurria Hannan Khalid**
Demonstrator
18. **Dr. Asma Khan**
Demonstrator
19. **Dr. Sarah Saad**
Demonstrator

6. Examination Schedule

1st Year MBBS Session (2018 – 2019) Academic Calendar-Amended

Weeks	Details	Dates	
		From	To
1	Inaugural Session	17 Dec 2018	
	Orientation / Documentation session	18 Dec 2018	21 Dec 2018
2-10	1 st Module (9 Weeks)	31 Dec 2018	03 Mar 2019
11	Co- Curricular Week	04 Mar 2019	10 Mar 2019
	Sports Day	8 March 2019	
12	1 st Module Exam (1 week)	11 Mar 2019	17 Mar 2019
13-21	2 nd Module (9 weeks)	18 Mar 2019	19 May 2019
	Ramadan	06 May 2019	04 June 2019
22	2 nd Module Exam (1 week)	20 May 2019	26 May 2019
23-25	3 rd Module (2/8 weeks)	27 May 2019	7 June 2019
	Eid Ul Fitr	05 June 2019	7 June 2019
26-29	Summer Vacations	10 June 2019	7 July 2019
30-34	3 rd Module (6/8)	8 July 2019	18 Aug 2019
	Eid ul Azha	12 Aug 2019 to 14 Aug 2019	
35	3 rd Module Exam (1 week)	19 Aug 2019	25 Aug 2019
	Anatomy	19 Aug 2019	
	Biochemistry	21 Aug 2019	
	Physiology	23 Aug 2019	
36	Prep Leave Pre-Annual Exam	26 Aug 2019	29 Sep 2019
37-38	Pre Annual Exam (Theory)	30 Sep 2019	08 Sep 2019
	Anatomy	30 Sep 2019	
	Biochemistry	02 Sep 2019	
	Physiology	05 Sep 2019	
	Practical	11 Sep 2019 to 13 Sep 2019	
	Ashoora	09 Sep to 10 Sep 2019	
39-42	Prep leave Annual Exam (04 Weeks)	14 Sep 2019	13 Oct 2019
	NUMS University Annual Exam	14 Oct 2019	30 Oct 2019



Lt Col (R)
Assistant Director Medical Education
(M. Saad Ullah Khan Sumbal)

7. Departmental Library

Physiology Department Library

S. No.	Book Name	Edition	Author
1.	Guyton and Hall	12 th Edition	JOHN E. HALL
2.	Guyton and Hall	13 th Edition	JOHN E. HALL
3.	Human Physiology	3 rd Edition	Slivertborn
4.	Principles of Physiology	3 rd Edition	Robert M. Berne Matthew N. Levy
5.	USMLE Step 1(Lecture notes)	2007-2008 Edition	KAPLAN
6.	Basis of Clinical Physiology	Volume 2	Professor M. Akram
7.	Manual of Experimental Physiology	1 st Edition	Prof. Dr. Shireen Khawar
8.	Manual of Experimental Physiology	4 th Edition	Prof. Dr. Zafar Ali Choudry
9.	Practical Physiology	1 st Edition	Prof. Dr. Shafiq Ahmed Iqbal
10.	Basis of Clinical Physiology	Volume 1	Prof. Dr. Muhammad Akram
11.	Basis of Clinical Physiology	Volume 2	Prof. Dr. Muhammad Akram
12.	ACSM's Resources for Clinical Exercise physiology		
13.	System wise SEQs and MCQs with key Reference: Physiology by Guyton	1 st Edition	Prof. Dr. Samina Malik
14.	Applicton & Lange's Review of PHYSIOLOGY	Twentieth Edition	David G. Penney
15.	Guyton and Hall Physiology Review	Third Edition	JOHN E. HALL
16.	Human Physiology (A Study Guide for Student)		M. Yusuf Abro
17.	Lab Manual Physiology (P-1)	Second Edition	M. Mazhar Hussain
18.	Clinical Electrophysiology		
19.	Lippincott's Illustrated Reviews Physiology		Robin R. Preston
20.	Review of Medical Physiology	Twentieth edition	William G. Ganong
21.	Board Review Series Physiology	2 nd Edition	Linda S. Costanzo
22.	Clinical Scenarios in Physiology		Saqib Sohail
23.	Essentials of Medical Physiology (JAYPEE)	5 th Edition	K Sembulingam Prema Sembulingam
24.	Study Guide for Understanding Statistics	Seventh Edition	Robert R. Pagano
25.	High-Yield Physiology		Ronald W. Dudek
26.	Nerve And Muscle Excitation	Second Edition	Douglas Junge
27.	Essentials of Medical Physiology	Volume 1	Mushtaq Ahmad
28.	Essentials of Medical Physiology	Volume 2	Mushtaq Ahmad
29.	MCQ's Physiology	2 nd Edition	Vijaya D Joshi
30.	Human Physiology (MCQ's)	4 th Edition	Lan C. Roddie
31.	Practical Physiology	Second Edition	G K PAL
32.	Ganong's (Review of Medical Physiology)	23 rd Edition	Kim E. Barrett
33.	Principles and Practice of Medicine	Seventeenth Edition	Christopher R. W. Edwards