Study Guide

FIRST PROFESSIONAL MBBS

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STUDY GUIDE

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Pak Red Crescent Medical & Dental College

48-KM Multan Road, Lahore-Pakistan.

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ANATOMY

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Introduction	Human anatomy is a field of science that studies the human body structures at three levels, macroanatomy, microanatomy, and developmental anatomy. Anatomy is an important lesson for medical students worldwide and they must learn anatomy including gross anatomy, histology, and embryology; these are the major part of the basic sciences of medicine. Many of the clinical specialists consider having enough knowledge of anatomy a prerequisite for performing safe and competent interventions in medicine. Learning anatomy practically and with clinical approach is necessary for medical students to decrease the medical errors. Knowing the importance and clinical uses of anatomy, on the other hand, could help students improve their skills.
Target Students	1st year MBBS
Course to be studied in first year MBBS	Gross Anatomy: Upper limb, Lower limb and Thorax General Histology General Anatomy General Embryology
Course Title	**Upper limb**
Duration	8 weeks
Learning outcomes	• Predict loss of movement due to injury to various parts of the upper limb based on their knowledge of its normal structure, function and biochemical mechanisms. • Identify common structures and features of the skeletal of upper limb on plain X rays
Learning objectives	At the end of the course student must be able to:
Upper Limb	**1. <u>BONES OF THE UPPER LIMB:</u>** • Identify the divisions of the upper limb and describe the bones in each region • List the bones and bony landmarks that articulate at each joint of the upper limb • List the bones involved in the formation of shoulder girdle • List a general function of each of the bones in the shoulder girdle. • List the 4 articulations of the shoulder region • Recognize the bone • Demonstrate the Anatomical position • Identify the site of bone

- Mention the bony land marks of bone like borders, surfaces and land marked used for bond determination.
- Discuss the attachments of muscles.
- Describe the ossification of
    - Clavicle
    - Scapula
    - Humerus
    - Radius
    - Ulna
    - Bones of hands
- Apply the knowledge of normal anatomy of bones to review key orthopedic injuries of the bones of the upper limb
    - Fractures
    - Dislocations
    - Ligamentous Injuries
- Identify key x-ray findings.
- Explain the structures at risk in a fracture involving the surgical neck of the humerus, midshafthumerus, medial epicondyle of the humerus?
- Distinguish between Smith's and colle's fracture involving radius and ulna.
- Evaluate the effect of fractures of scaphoid, hamate, metacarpals and phalanges.

2.<u>Fascia, Efferent Vessels, Cutaneous Innervation, And Myotomes of Upper Limb:</u>

- Describe the fascial compartments enclosing the major muscle groups of the upper limb; explain the functional and clinical importance of those compartments and their contents.
- Identify and locate the different modifications formed by the fascia of the upper limb.
- Describe the course of the main veins of the upper limb and contrast the functions of the deep and superficial veins. Identify the common sites of venous access and describe their key anatomical relations.
- Explain the lymphatic drainage of upper limb
- Describe the relation between drainage of superficial and deep lymphatics.
- Define myotome.
- Sketch cutaneous innervations of upper limb

3.<u>Pectoral and Scapular Regions:</u>

- Identify the scapular and pectoral region
- Enumerate the anterior axio appendicular muscles
- Describe their origin , insertion ,nerve supply and action
  Expalin the division of posterior shoulder muscles
- Enlist the posterior axio appendicular muscles
- Enumerate the scapulohumeral muscles

	• Identify and describe the origin, insertion, nerve supply and action of posterior shoulder muscles • Interpret the movements of scapula • Describe function of deltoid muscle • Enumerate the muscles forming rotator cuff • Explain the importance of rotator cuff regarding shoulder joint • Narrate the examination of paralysis of serratus anterior muscle • Locate triangle of auscultation • Describe the changes occurring due to the damage to spinal accessory nerve, thoracodorsal nerve, dorsal scapular nerve and axillary nerve. • Restate the rotator cuff injuries. • Explain why the shoulder joint can be easily dislocated • Identify the bones of the shoulder girdle and the shoulder joint in imaging studies including but not limited to CT, MRI and radiographic images. **4. Axilla:** • Describe the boundaries of axilla • Enlist the contents of axilla • Explain the relation and different branches of the axillary artery • Enumerate the arteries supplying shoulder and arm region • Descerибe the axillary lymphnode and their area of drainage • Draw the brachial plexus beginning with nerve roots and ending with terminal branches. • Label the nerve roots, trunks, divisions, cords, and the 5 main terminal nerves of the upper limb. • Identify the major muscle groups innervated by these terminal nerves • Identify the scalene muscles, and describe relationships to the first rib and to neurovascular structures. • Illustrate the arterial anastomoses around scapula • Describe the functional loss that may result from injury to upper or lower roots, cords, and/or terminal nerves. **5. Arm and Cubital Fossa:** • Identify the anterior and posterior aspect of arm • Enumerate the muscles of the arm • Describe the arterial supply of the arm • Demonstrate the site at which pulse of the brachial artery may be located • Discuss the venous drainage of the arm • Describe the nerve supply of the muscular compartments of the arm, and consider the effect a lesion would have on these nerves and the muscular compartments they serve. • Identify the location of cubital fossa • Describe the boundaries of cubital fossa • Enlist the contents of cubital fossa

	• Demonstrate and explain the Bicipitalmytotic reflex • Discuss the effects of dislocation of tendon of long head of bicep, rupture of tendon of bicep and biceps tendinitis. • Discuss the effects of fracture of humeral shaft. • Explain how to perform venupuncture in cubital fossa. • Identify the bones of the arm and elbow joint in imaging studies including but not limited to CT, MRI and X-ray images **6. Forearm:** • Narrate different compartments of the forearm • Enlist the muscles present in different compartments of the forearm • Recall the attachment, nerve supply and actions of the muscle of the forearm • Describe the detailed attachment of long flexors and extensors tendons of the forearm muscles • Enumerate the arteries responsible for supplying the forearm along with their branches. • Demonstrate the sites at which pulses of the radial and ulnar arteries may be locate • Interpret the superficial and deep veins of the forearm and their relation with each other • Describe the nerve supply of the muscular compartments of the forearm, and consider the effect of a lesion would have on these nerves and the muscular compartments they serve. • Explain about pronator syndrome, cubital tunnel syndrome • Identify anatomic structures in radiographic studies including X-ray, CT scans and MRI films. • Identify the bones of the forearm and hand in imaging studies including CT, MRI and radiographic images **7. Hand:** • Demonstrate and explain different grips of hand • Identify different fascias of the hand • list the different compartments of the hand • Recognize muscles present in different compartments of the hand • Recall the attachment, nerve supply and action of the muscles of the hand • Define the blood supply of the hand with formation of superficial and deep palmar arches • Explain the nerve supply of the hand and the effects which will be produced due to injuries to these nerves. • Narrate the formation of dupuytren contracture and its treatment • Describe the carpal tunnel syndrome and its effects on the hand • Locate the ulnar nerve at wrist and explain ulnar canal syndrome • Identify anatomic structures in radiographic studies including X-ray, CT scans and MRI films. **8. Joints of Upper Limb:**

	• Enumerate the joints ✓ Sternoclavicular joint: ✓ Acromioclavicular joint: ✓ Glenohumeral joint: ✓ Elbow joint: ✓ Proximal radioulnar joint ✓ Distal radioulnar joint: ✓ Wrist joint: ✓ Intercarpal joint: ✓ Carpometacarpal and intermetacarpal joint: ✓ Metacarpophalangeal and interphalangeal joints • Define terms for each of the joints (capsule, collateral ligaments, bursae) • Identify the major ligaments and other related structures of a joint. Explain what kind of movements occurs at the joints. • Enumerate the muscles producing movement at the joint • Describe the axis of movement of the joint • Perform movements occurring at the joint • Enlist the factors responsible for the stability of the joints • Describe the vascular pattern and major arteries. Describe the major anastomoses around each joint. • Discuss different dislocations related with the joint and there concequential effects on the position of the limb. • Recall different nerve injuries associated with dislocation of the joint • Identify different dislocations on an x-ray. **9. Clinical Anatomy of The Upper Limb:** • Expalin the functional loss of the muscles of the axillary walls resulting from lesions to the nerves innervating these muscles. • Describe the clinical significance of the axillary sheath in local anesthesia. • Determine the anatomical relationships that are important for successful insertion of a catheter for central venous access (infraclavicularsubclavian venipuncture). • Enlist the signs and symptoms of “thoracic outlet” syndrome. • Describe the signs and symptoms of an upper brachial plexus nerve lesion. • Explain the signs and symptoms of upper brachial plexus lesions when the C7 ventral ramus is involved. • Describe the signs and symptoms of a lower brachial plexus nerve lesion. • Explain how a cervical rib may contribute to the development of a lower brachial plexus lesion. • Explain why lymphedema may result from breast cancer surgery. • Explain the functional loss of the muscles of the shoulder and

	arm resulting from nerve lesions to these muscles. • Describe shoulder dislocation injuries, particularly anteroinferior dislocations, and explain the nerve injuries that might accompany shoulder dislocations. • Describe the ligamentous injuries in acromioclavicular (shoulder) separation. • Describe the signs of acromioclavicular separation. • Describe the signs of calcific supraspinatus tendonitis. • Explain the potential clinical consequences of fractures at the surgical neck, midshaft, supracondylar, and medial epicondylar regions of the humerus and be able to recognize them on a radiograph. • Describe the cause and signs of Volkmann's ischemic contracture. • Describe the anatomical location, mechanism and clinical sequences of elbow joint dislocation. • Explain which nerves are at risk during intravenous access of the basilic or cephalic veins in the cubital fossa. • Describe the motor and sensory deficits resulting from lesions of the musculocutaneous, radial, median and ulnar nerves in the arm. • List the sites commonly used for venipuncture in the upper limb. 21. Describe the basic mechanism of radial head subluxation ("nursemaid's elbow") in small children. • Describe the boundaries and contents of the "anatomical snuff box". • Describe the landmarks used when taking the radial pulse. • Describe the contribution, and clinical significance, of the superficial and deep palmar arterial arches in the blood supply of the hand. • Describe the tendon sheaths / bursae in the hand and fingers and their importance in the spread of infections. • Explain the anatomical mechanism of "carpal tunnel syndrome". • Describe the signs and symptoms of a carpal tunnel syndrome. • List the steps in performing an Allen Test and explain the importance of the test. • Describe the functional tests for integrity of the median, ulnar and radial nerves in the forearm. • Describe functional tests for the integrity of the median and ulnar nerves in the hand. • Recognize and describe mallet finger, swan neck deformity and boutonniere deformity on a radiograph. • Describe the signs and symptoms of lesions of the radial, median and ulnar nerves in the forearm. • Describe the signs and symptoms of lesions of the median and ulnar nerves at the wrist.

	• Describe the signs and symptoms of recurrent median nerve injury in the proximal palm. • Explain why radial nerve injury at/above the elbow decreases grip strength. • Recognize and describe Colle's fracture, Smith fracture and boxer's fracture on a radiograph. • Describe the presentation of Dupuytren's contracture and "trigger finger" (stenosing tenosynovitis). • Describe the cause of ulnar "claw-hand" deformity. • List the commonly fractured and most commonly dislocated bones in the carpus. • List the most commonly fractured bone of the upper limb. • Describe the pronator syndrome.
Surface Anatomy of Upper limb	Perform surface markings of anterior &posterior axillary folds, brachial artery, cubital fossa , median cubital vein, flexor retinaculum, radial &ulnar pulse ,anatomical snuffbox , cephalic &Basilic veins, dorsal venous arch and superficial &deep palmar arches , nerves of the upper limb : radial , ulnar, axillary
Practicals	**Conducted in the wet labs** **On cadavers :** • Dissect and identify different structures of upper limb • Identification of different structures in prossected specimens **In Museum:** Identification on upper limb models
Tutorials/ DSL	• **Discussion on clinical oriented problems** • **TBL** • **Visit to radiology department for observing normal X-ray findings and comparision with abnormal findings**
Internal Assessment	• Continuous monitoring of attendance and practical assessment in short groups. • It will be in the form of MCQs, assignments, stages/sub-stages, projects, OSPE. • Internal evaluation carries 20% weightage in summative examination.
Examination	SEQs, MCQs and OSPE (observed + un observed)
SUGGESTED READINGS:	
RESOURCES: **ANATOMY** **A. GROSS ANATOMY** 1. K.L. Moore, Clinically Oriented Anatomy	

B. HISTOLOGY
1. B. Young J. W. Health Wheather's Functional Histology

C. EMBRYOLOGY
1. Keith L. Moore. The Developing Human
2. Langman's Medical Embryology

Course	**Lower limb**
Duration	8 WEEKS
Learning outcomes	Predict loss of movement due to injury to various parts of the lower limb based on their knowledge of its normal structure, function and biochemical mechanisms Identify common structures and features of the skeletal of lower limb on plain X rays
Learning Objectives	Objectives At the end of the course student must be able to:
Lower limb	**2. <u>BONES OF THE LOWER LIMB:</u>** • Identify the divisions of the lower limb and describe the bones in each region • List the bones and bony landmarks that articulate at each joint of the lower limb • List the bones involved in the formation of pelvic girdle • List a general function of each of the bones in the pelvic girdle. • Demonstrate the Anatomical position • Identify the site of bone • Mention the bony land marks of bone like borders, surfaces • Discuss the attachments of muscles. • Describethe ossification of o Hip bone o Femur o Tibia o Fibula o Bones of foot • Apply the knowledge of normal anatomy of bones to review key orthopedic injuries of the bones of the lower limb o Fractures o Dislocations o Ligamentous Injuries • Identify key x-ray findings. • Explain the detail blood supply of head of femur and its clinical implication like Avascular necrosis. • Describe the intra capsular and extracapsular fractures of head of femur. • Explain coxavera and coxavalga. • Identify the main and important ligaments of the foot. • Describe Ostrigonum.

	2. **Thigh: anterior compartment** • Explain the arrangement and attachment of deep fascia of thigh • Describe fascia lata, itsattachments. • Describe the modifications of fascia lata? • Explain iliotibial tract, and Give its attachment and role? • Discuss the location of saphenous opening and its relations. • Describe the attachment of inguinal ligament. • Discuss the clinical conditions associated with deep fascia of thigh and inguinal ligament. • Explain how bleeding in the upper abdomen (such as from liver or spleen lacerations) can reach the pelvic peritoneal pouches. 3. **Venous drainage of lower limb:** • Differentiate between superficial and deep venous system. • Draw and label venous drainage of lower limb. • Enumerate the superficial veins. • Highlight the course of great and small saphenous veins an clinicals like varicose veins, venous cut down, and its usage in bypass grafting. • Discuss their connections with the deep veins of the leg • Describe DVT, factors contributing to its formation and its complications. • Define pulmonary embolism its fate and factors contributing to its formation. • Explain thrombophelibitis? 4. **Lymphatic drainage of lower limb.** • Differentiate between Superficial and deep lymphatic channels of lower limb. • Enumerate the different groups of lymph nodes in lower limb • Define different groups of inguinal lymph nodes with their drainage area. 6. **Gait cycle** • Explain different phases of gait cycle 7. **Anterior compartment of thigh:** • Discuss the arrangement of thigh into compartments. • Enlist the muscles of anterior compartment of thigh with their, origin, insertion, nerve supply and actions. • Describe the innervation and blood supply of muscles of anterior compartment of thigh • Enumerate the flexors of hip joint, explain their origin, insertion, action and nerve supply. • Enumerate the extensors of knee joint, explain their origin,

	insertion, action and nerve supply. • Explain quadriceps muscles in detail under the headings of origin, insertion, action, and nerve supply. 8. **Medial compartment of thigh:** • Name muscles of medial compartment of thigh, their origin, insertion, nerve supply and • Explain the PesAnserinus or guyrope muscles • Describe the boundries of adductor hiatus and the structures crossing this hiatus. • Name the hybrid muscles of thigh. 9. **Neurovascular structures of Anterior compartment of thigh:** • Define the boundaries of femoral triangle and its contents. • Describe the Formation of femoral sheath with its contents. • Eplain the Boundaries of femoral ring? • Define the Femoral canal, femoral hernia with all its clinical implications.. • Define Retro inguinal space and structures are passing through retroingunial space. • Recall Root value, course and branches of femoral nerve. • Describe the origin, course branches and termination of femoral artery and femoral vein? • Recall the boundaries of adductor canal, its extension with its contents. • Explain Psoas abscess its causes and where its pain gets referred. • Explain the concept of patellar tendon reflex with muscles and nerves involved. • Identify the patellar fractures and its abnormal ossification. 10. **Neurovascular structures of Medial compartment of thigh**. • Define Obturator nerve its origin, course branches and terminations. • Describe accessory or aberrant obturator artery? 11. **Gluteal region and posterior thigh:** • Describe the location of gluteal region • Enumerate the bones and ligaments of gluteal region. • Describe the muscles of the gluteal region and their respective actions. • Define the formation of greater and lesser sciatic foramens and the structures pass through greater and lesser sciatic foramens. • Name the abductors of thigh and describe them under the following headings, origin, insertions, nerve supply and their actions. • Enumerate the rotators of thigh (medial and lateral)

- Explain the Importance of the muscles inserted into the iliotibial tract.
- Explain origin, insertion, nerve supply and action of extensors of hip joint
- Enumerate the muscle of the posterior compartment of thigh/ hamstring muscles and give their origin, insertion, nerve supply and action.

12.**Neuro Vascular Structures of Gluteal and Posterior Thigh region**

- Draw and label cutaneous innervations of gluteal region?
- Draw and label lumbosacral plexues along with it root values.
- Enumerate Nerves of gluteal region. Give their origin area of supply and courses.
- Explain the anatomy of the arteries and veins of gluteal region
- Describe the lymphatic drainage of gluteal and thigh region.
- Describe the location of Trochanteric and ischial bursas.
- Illustrate the best location for intragluteal injection?
- Enumerate the hamstring injuries
- Describe the Trendlenberg sign, its causes and clinical significance.
- Discuss the trochanteric and cruciate anastomosis at the back of thigh.
- Discuss the clinical conditions associated with the posterior compartment of thigh

13. **Popliteal Fossa**

- Discuss the boundaries of popliteal fossa.
- Enumerate the contents of popliteal fossa.
- Describe the relationship of the contents in popliteal fossa.
- Explain the method tp palpate popliteal artery.
- Discuss important clinical conditions related to popliteal fossa e.g the Baker's cyst.
- Describe Injury to tibial nerve and its clinical picture.

14. **Anterior compartment of Leg:**

- Discuss the fascial compartments of leg
- Enumerate the muscles of anterior compartment of leg and give their origin, insertion, nerve supply and actions?
- Recall the blood supply of anterior compartment of leg
- Describe anatomy of the Nerves supplying anterior compartment of leg.
- Explain foot drop. Narrate the name and location of the nerve involved in it? Which nerve is involved and at which location?

15. Lateral compartment compartment:

- Describe the Muscles of the lateral compartment of leg, their origin, insertion, nerve supply and action.

	• Explain the Superficial peroneal nerve its origin, its branches and termination along with clinical picture after its lesion. • Enumerate the Everters and inverters of the foot, and joint at which this movement takes place. 16. **Posterior compartment of leg** • Enumerate the Superficial and deep muscles muscles of posterior compartment of leg. • Discuss nerve supply of muscles of posterior compartment of leg. • Discuss the actions of muscles of posterior compartment of leg. • What is peripheral heart explain it in detail. • Enumerate Nerves of the posterior compartment of the leg its branches, and course. • Explain compartment syndrome and describe its treatment? • Discuss Fibular nerve entrapment. • Write a note on shin splints? • Describe volkmans ischemic contracture? • Explain Ruptured calcaneal tendon • Elicit Calcaneal tendon reflex and recall its root value. 17. **Foot:** • Recall the layers of sole of foot along the muscles of each layerwith their origin, insertion, nerve supply and action. • Enumerate the Muscles of dorsum of foot. • Describe the location of the Dorsalispedis artery • Discuss the course and branches of Dorsalispedis artery. • Describe the formation of Superficial and deep planter arches (arteries). • Explain the anatomy of Medial planter and lateral planter nerves. • Write a note on planter fasciitis? • Explain Sural nerve graft and its importance • Explain Medial planter nerve entrapment and its symptoms. • Illustrate Planter reflex **18. Arches of foot:** • Describe the architecture of arches of foot and the factors responsible for their maintenance. • Elaborate the bones which are responsible for forming these arches. • Describe the ligaments which are holding these arches. • Describe the function of the arches of foot. • Describe Plantar Fasciitis and other relevant injuries. • Enlist the advices regarding the rehabilitation for plantar fasciitis.

19.Nerve injuries of lower limb:

- Explain the different nerve of lower limb and their root value.
- Discuss the causes of injuries.
- Enumerate the common sites of these nerve injuries
- Discuss the symptoms caused by these nerve injuries.
- Discuss the fracture of bones of lower limb.
- Explain Injuries of lower leg and ankle.
- Discuss Pott's fracture

19. **Joints of lower limb**

Hip joint

- Describe the articular surfaces of hip joint?
- Dedcribe the capsule of hip joint
- Discuss different ligament of hip joint and recall their attachment.
- Expalin movement at hip joint?
- Enumerate the muscles responsible for different movements at the hip joint?
- Describe the blood supply of the hip joint.
- Describe the Nerve supply of hip joint.
- Discuss the dislocation of hip joint
- Explain genu varum and genu valgum

Knee Joint

After the topic students must recall the

- articular surface of knee joint
- capsule of knee joint
- Names extracapsular and intracapsular ligaments of knee joint?
- Movements at knee joint?
- Muscles responsible for different movements at the hip joint?
- Blood supply of knee joint
- Nerve supply of knee joint
- Bursas around of knee?
- What is locking and unlocking mechanism of knee joint?
- What is unhappy triad of knee joint?
- What is patellofemoral syndrome

Tibiofibular joint

After the region students must recall the

- What are the articular surface of tibiofibular joint
- What are the ligaments involved in stabilization of tibiofibular joint
- Give the blood supply and nerve supply of tibiofibular joint

Ankle joint

- Describe the articular sufaces of ankle joint
- Explain the capsule of ankle joint
- Enumerate the ligaments of ankle joint
- Discuss various movements at ankle joint
- Explain sprain and discuss ligament, mostly involved in it.

Foot joint.

After the region students must recall the

- Subtalar joint, its articular surfaces, movements, axis of movements stabilizing factors etc.
- What are different joints of the foot
- What are the muscles responsible for eversion and inversion?
- What is hammer toe and claw toes
- Name the movements of joints of forefoot and muscle producing them

Clinical Anatomy of the Lower Limb

1. Describe and explain the safe and unsafe areas for gluteal intramuscular injections.
2. Differentiate between a Trendelenburg sign and a Trendelenburg test.
3. Explain a "waddling gait" and the cause of it.
4. Describe the blood supply of the hip joint and the clinical implications of its changing blood supply with age.
5. Describe the cruciate anastomosis and its clinical importance.
6. Describe the clinical significance of an intracapsular versus an extracapsular fracture of the femoral neck.
7. Describe the congenital dislocation of the hip and its clinical features.
8. Describe the course of a femoral hernia and how it differs from an inguinal hernia.
9. Describe the consequence of nerve lesions of the lumbosacral plexus on lower limb function and sensation.
10. List the areas for examination in both male and female with enlarged inguinal lymph nodes.
11. Determine which nodes will first receive lymph drainage from a testicular carcinoma, and how this differs from drainage from an infected scrotum.
12. Describe the nerve impingements and their consequences resulting from lumbosacral disc herniations.
13. Describe the patellar tendon reflex.

	14. Describe the significance of the prepatellar, suprapatellar and infrapatellarbursae. 15. Describe the function of the anterior and posterior cruciate ligaments. 16. Describe a “Baker’s cyst” and explain possible sequelae. 17. List the nerves involved in the patellar tendon reflex arc. 18. Describe the “unhappy triad” in knee joint injury. 19. Describe the anterior and posterior drawer sign and the ligament they are testing. 20. Explain the consequence of a lesion of the common fibular nerve at the neck of the fibula. 21. Explain the consequence of a lesion of the superficial and deep fibular nerves just distal to their origin. 22. Explain the consequence of a lesion of the tibial nerve in the popliteal fossa. 23. Describe the consequence of “anterior compartment syndrome”. 24. Describe the development of varicose veins. 25. List the two ligaments most commonly damaged during an inversion sprain. 26. Describe hallux valgus and hallux varus. 27. Describe the tarsal tunnel and its contents. 28. Describe the development of the limbs from the lateral intraembryonic mesoderm and myotomes of the somites. 29. Describe congenital talipes (clubfoot), amelia / meromelia, cutaneous syndactyly, osseous syndactyly, brachydactyly, polydactylyand limb deformities caused by amniotic bands.
Surface anatomy of lower limb	The Students should be able to mark the following: • Inguinal ligament • Femoral triangle • Patellar tendon • Popliteal fossa. • The course blood vessels of lower limbe.g(great saphenous) • Palpate pulsation of the blood vessels(femoral,popliteal,posteriortibial&dorsalispedis arteries) • Mark the course of important nerves of lower limb(e.g sciatic nerve ,common peroneal at fibular head)
Practicals	**Conducted in the wet labs** **On cadavers :** • Dissect and identify different structures of Lower limb limb • Identify different structures in prossected specimens **In Museum:** Identify various structures on lower limb models

Tutorials/ DSL	**Discussion on clinical oriented problems** **TBL** **Visit to radiology department for observing normal X-ray findings and comparision with abnormal findings**
Internal Assessment	• Continuous monitoring of attendance and practical assessment in short groups. • It will be in the form of MCQs, assignments, stages/sub-stages, projects, OSPE. • Internal evaluation carries 20% weightage in summative assessment
Examination	SEQs, MCQs and OSPE (observed + un observed)
Suggested readings	**GROSS ANATOMY** K.L. Moore, Clinically Oriented Anatomy
Course	**Thorax**
Duration	6 WEEKS
Outcomes	Thorax Students having comprehensive knowledge about pleura, lungs, heart and mediastinum. They should be able to identify radiological anatomy on radiographs, CT and MRI.
Learning Objectives	At the end of the course student must be able to:
Thorax	**1.Pleura** • Define pleura and classify its types • Describe pleural cavity • Identify visceral pleura • Demonstrate parietal pleura and its parts • Explain lines of pleural reflection **2.Lungs** • State anatomical features of lungs • Describe roots of lungs • Identify hilum of the lung and pulmonary ligament • Enlist the structures of tracheobronchial tree • Describe the arterial supply and venous drainage of lungs • Summarize the lymphatic drainage of lungs • Recall the nerve supply of lungs **3.Clinical anatomy of pleurae** • Discuss injuries of cervical pleura and apex of lung • Identify injury to other parts of pleurae • Describe pulmonary collapse • Differentiate pneumothorax, hydrothorax and hemothorax

	• Explain thoracocentesis and its limitations • Describe insertion of a chest tube • Define pleurectomy and pleurodesis • Explain thoracoscopy • Define pleuritis (pleurisy) **4.Clinical anatomy of lungs and tracheobronchial tree** • Identify variations in lobes of lung • Discuss appearance of lungs, inhalation of carbon particles and irritants • Describe auscultation of lungs and percussion of thorax • Explain aspiration of foreign bodies • Describe bronchoscopy • Recall lung resections • Define segmental atelectasis • Define pulmonary embolism • Explain lymphatic drainage of pleural adhesion • Define hemoptysis • Describe bronchogenic carcinoma • Discuss lung cancer and its involvement of mediastinal nerves • Recognize pleural pain • Identify normal anatomical structures on chest X-ray **5.Overview of mediastinum, Middle mediastinum and pericardium** • Enlist the divisions and subdivisions of mediastinum • Define middle mediastinum and enumerate its contents • Differentiate fibrous pericardium and serous pericardium • Recognize pericardiophrenic ligament • Identify pericardial cavity • Classify pericardial sinuses • Explain vasculature of pericardium • Discuss innervations of pericardium **6.Clinical anatomy of mediastinum and pericardium** • Understand Levels of Viscera Relative to Mediastinal Divisions • Define Mediastinoscopy and Mediastinal Biopsies • Conclude Widening of Mediastinum and its causes • Interpret Surgical Significance of Transverse Pericardial Sinus • Identify Exposure of Venae Cavae • Define Pericarditis, Pericardial Rub, and Pericardial Effusion • Discuss Cardiac Tamponade • Describe Pericardiocentesis • Recall Positional Abnormalities of the Heart **7.Heart-- Anatomical features and chambers** • Identify the external features of heart like apex, base, borders and surfaces • Categorize Internal features of heart • Determine Fibrous skeleton of heart

	• Identify the Sulci of heart • Recognize Right atrium, Right ventricle, Left atrium, Left ventricle of heart • Locate Semilunar valves **8.Neurovasculature and conducting system of heart** • Recall Arterial Supply of Heart • Describe the Variations of the Coronary Arteries • Describe the Coronary Collateral Circulation • Discuss the Venous Drainage of the Heart interpret the Innervation of the Heart • State the Lymphatic Drainage of the Heart. • State the Stimulating, Conducting and Regulating System of the Heart **9.Clinical anatomy of the heart** • Define Cardiac Catheterization • Discuss Embryology of the Right Atrium • Identify Septal Defects (Atrial Septal Defects, Ventricular Septal Defects) • Demonstrate Percussion of Heart • Narrate Stroke or Cerebrovascular Accident • Interpret Basis for Naming Cusps of the Aortic and Pulmonary Valves • Recognize Valvular Heart Disease • Recall Mitral Valve Insufficiency (Mitral Valve Prolapse) • Distinguish Pulmonary Valve Stenosis and Pulmonary Valve Incompetence • Differentiate between Aortic Valve Stenosis and Aortic Valve Insufficiency • Discuss Echocardiography • Describe Coronary Angiography • Describe Coronary Artery Disease or Coronary Heart Disease • Explain Myocardial Infarction • Discuss Coronary Atherosclerosis • State Slowly Progressive Coronary Artery Disease • Recall Angina Pectoris • Explain Coronary Bypass Graft • Determine Coronary Angioplasty • Summarize Collateral Circulation via the Smallest Cardiac Veins • Identify Electrocardiography • Describe Coronary Occlusion and Conducting System of Heart • Recognize Artificial Cardiac Pacemaker • Define Restarting Heart • Explain Fibrillation of Heart and Defibrillation of Heart • Describe Cardiac Referred Pain **10.Superior mediastinum and its contents** • Identify Thymus, Trachea and Esophagus

	• Differentiate right and left brachiocephalic veins • Locate superior vena cava (SVC) • Compare ascending aorta and arch of the aorta • Recall arch of the azygos vein • Distinguish brachiocephalic trunk, left common carotid artery and left subclavian artery • Identify right and left vagus nerves • Determine right and left phrenic nerves **11.Posterior Mediastinum and Its Contents** • Identify descending Thoracic Aorta • Locate Esophagus • Explain Thoracic Duct And Lymphatic Trunks • Summarize azygous system of veins (azygos vein, hemi-azygos vein, accessory hemi-azygos vein) • Identify Posterior mediastinal lymph node • Describe thoracic sympathetic trunk **12.Anterior Mediastinum Clinical Anatomy of Superior, Posterior and Anterior Mediastinum** • Identify sternopericardial ligaments • Classify Variations of Great Arteries(Branches Of Arch Of Aorta, Anomalies Of Arch Of Aorta) • Explain Aneurysm of Ascending Aorta • CategorizeCoarctation of Aorta • Describe Injury to Recurrent Laryngeal Nerves • Recall Blockage of Esophagus • Describe Laceration of Thoracic Duct and Variations of Thoracic Duct • Summarize Alternate Venous Routes to Heart • Distinguish Age Changes in Thymus • Define Aortic Angiography • Interpret Radiography of Mediastinum • Identify anatomical structures on CT and MRI of Mediastinum
Surface anatomy of Thorax	• Mark apex of lung • Compare fissures of both lungs • Locate borders of lung • Distinguish visceral and parietal pleura • Mark the different borders of the heart • Mark large vessels in thorax • Hold the heart in anatomical position
PRACTICALS	**Conducted in the wet labs** **On cadavers:** • Dissect and identify different structures of thorax • Identification of different structures in prossected specimens **In Museum:**Identification on thorax models

Tutorials/ DSL	• **Discussion on clinical oriented problems** • **TBL** • **Visit to radiology department for observing normal X-ray findings and comparison with abnormal findings** • **Visit to Cardiology department to observe different cardiac patients, Auscultate heart sounds** • **To observe open heart surgery**
Internal assessment:	• Continuous monitoring of attendance and practical assessment in short groups. • It will be in the form of MCQs, assignments, stages/sub-stages, projects, OSPE. • Internal evaluation carries 20% weightage in summative assessment
	• SEQs, MCQs and OSPE (observed + un observed) **Examination**
Suggested readings:	**GROSS ANATOMY** K.L. Moore, Clinically Oriented Anatomy.
Course Duration Learning outcome Learning objective **GENERAL EMBRYOLOGY**	General Embryology 13 weeks Clinically, the applied aspect of **embryology** is very **important** and gives purposeful **significance** to the learning of **embryology**. One of the main purposes of studying **embryology** is to understand congenital anomalies including their etiology, so that the congenital anomalies can be prevented. At the end of the course student must be able to: **<u>Gametogenesis- I</u>** • Define Spermatogenesis • Describe the detailed Structure of sperm. • Describe the process of Spermatogenesis &Spermiogenesis. • Compare male& female gametes. • Overview the Abnormal gametes **<u>Gametogenesis II</u>** • Define Oogenesis • Describe in detail the prenatal& postnatal maturation of oocytes. **<u>Ovulation</u>** • Exlain briefly the process of ovulation • Differentiate and describe different stages of development of ovarian follicle, • Discuss the formation corpus luteum and its significance. • Describe the Phases of ovarian cycle. **<u>Female reproductive cycle:</u>** • Describe Phases of menstrual cycle • Correlate the cyclic changes occurring in the ovary with that of uterus with their endocrine control

	Fertilization: • Explain the process of Transportation and maturation of gamete • Describe Phases& results of fertilization. • Discuss artificial/ assisted Fertilization e.g. IVF, IUI etc. **1st week of development:** • Discuss the formation of zygote • Correlate the transport of zygote from ampulla of fallopian tube with the uterine cavity and cleavage. • Discuss the results of implantation at abnormal site • Describe cleavage and blastocyst formation **2nd Week of Development:** • Define implantation • State normal site of implantation. • Explain the formation of outer and inner cell masses • Discuss the further development of outer cell mass (trophoblast), • Differentiate syncytiotrophoblast and cytotrophoblast with its microscopic appearance • Describe the process of implantation (day wise change) • State the differentiation of embryonic pole and development of bilaminar germ disc with formation of Epiblast and hypoblast along with their cavities (amniotic cavity and primary yolk sac) • Discuss the development of the chorionic sac and formation Primary chorionic villi • Enumerate the abnormal sites for implantation (ectopic pregnancy) and the different diagnostic tools. **3rd week of Development** • Define the gastrulation (formation of three germ layers). • Discuss the development of primitive streak and related congenital anomalies. (SacrococcygealTeratoma) • Describe the development of notochordal process, notochord canal, prechordal plate and cloacal membrane. **Development of notochord and Neurulation:** • Explain the formation of neural plate, tube and discuss clinical conditions related to it. • Describe the Formation of the following: o Neural crest and their derivatives o Neural tube o Somites o Intra embryonic coelom o Blood cells and blood vessels o Secondary and tertiary chorionic villi • Describe folding of embryo and its results **Germ layers derivatives:** • Enlist the derivatives of surface ectoderm, neuroectoderm& neural crest • Enumerate the derivatives of mesoderm.

	• Discuss the Development of somites. • Discuss formation of intermediate mesoderm and enlist its derivatives • Explain the folding of embryo. • Describe formation of primitive gut. • Enlist the derivatives of endoderm. **4th-8th week of development:(Organogenesis)** • Explain the Closure of neuropores, organ appearance and its clinical correlates **Fetal assessment:/Prenatal diagnosis** • Discuss prenatal diagnosis • Identify the types of prenatal diagnosis. • Differentiate between amniocentesis, chorion villus sampling, cordocentesis, ultrasonography,maternal AFP levels. • Describe the indications and goal of prenatal diagnosis **9th-38th week of development (Fetal period)** • Define fetal period • Discus the factors affecting fetal period. • Explain the Tissue and organ development week wise. • Describe the different milestone in development of fetus. • List the causes of fetal loss **Placenta:** • Describe the changes that occur in the endometrium of mother with formation of deciduasanddecidual reaction. • Describe the different types of chorionic villi. • Explain the development of placenta, both the fetal and maternal part. • Describe the functions of placenta. • Describe the placental circulation. **Fetal membranes:** • Specify the development and functions of fetal membranes, chorion, amnion • Describe amnion &chorion. • Describe the formation and function of amniotic fluid and its disorders • Discuss the development of chorion and its complications. • Discuss the disorder of related to amniotic fluid volume. **Twins and multiple pregnancies:** • Explain different types of twinning and multiple gestations with their reasoning and clinical conditions related to it. **Teratology:** • Define teratogenesis. • Classify the teratogens. • Describe the basic principles of teratogenesis • Enlist the Environmental factors responsible for teratogenesis **Genetics:**

SPECIAL EMBRYOLOGY	• Explain related terms of embryology. • Identify steps of cell division:Mitosis (prophase, prometaphase, metaphase,anaphase,telophase) • Explain the significance of mitosis. • Define Meiosis. • Differentiate first and second meiotic divisions. • State the phases of meiotic divisions. • Justify the importance and result of meiosis in both sexes. • Differentiate between mitosis and meiosis • Define cell cycle. • Explain various stages of cell cycle. • Explain the events of somatic cell division. • Discuss the significance of S phase of cell cycle. • Relate phases of cell cycle with the basis of development of cancer • Explain the Chromosomal abnormalities • Explain Numerical and structural abnormalities **Skeletal system:** • Describe the development of skull. • Differentiate between the Neurocranium, and Viscerocranium. • Discuss the Clinical anatomy related to it. • Describe the development of limbs. • Describe the development of vertebral column, Ribs & Sternum. **Muscular system:** • Discuss the Development of skeletal muscles. • Describe the development of smooth & cardiac muscles **Integumentary system:** • Describe the development of skin, hair and nail. • Give details of Development of mammary gland and the abnormalities related to it.
Tutorials	Conducted in museum on Embryology models Discussion of various cases related to chromosomal anomalies, congenital anomalies.
RESOURCES	**EMBRYOLOGY** 1. Keith L. Moore. The Developing Human 2. Langman's Medical Embryology
Course Duration	General anatomy 8 weeks
Outcome	To learn about the history of anatomy. To identify various planes of the body which will help to understand different movements of the body? To come across different types of bones, joints, muscles,vessels and various other structures present in the body.

Objectives	At the end of the course student must be able to **1.Introduction to Anatomy** • Discuss the history of anatomy • Discuss anatomy including its various branches and state their practical application in different fields of medicine • Define the various radiological techniques related to anatomy such as: Plain and contrast radiographs, Radio-opaque media, Special X-ray techniques like Barium meal and Angiography, Ultrasonography, Computerized Tomography, Magnetic Resonance Imaging, Endoscopy • Discuss the integration of structures and functions of human body by relating with the arrangement of different levels organization. • Identify the different anatomical planes • Define the movements occurring at various joints of body (flexion, extension, abduction, adduction, rotation) • Identify movements occurring at specific joints (pronation, supination, inversion, eversion) • Identify the planes at which the movements occur. **2.Skeletal system:** • Describe the parts of appendicular and axial skeleton • Discuss the functions of bone • Classify bones on the basis of shape, development, region and structure • Describe general concepts of development and ossification of bones • List the parts of young bone • Explain the blood supply of long bones **3.Joints:** • Classify joints on the basis of structure, regions and functions. • Discuss the characteristics of synovial joints • Classify synovial joints on the basis of structure and movement • Define dislocation, sprain and inflammation of joints **4.Musclar system:** • List the components of muscular system. • Classify the muscles according to: o Their shape o Direction of fibres and their actions. • Explain the principles of innervation and blood supply of muscles • Describe the following terms: Ossification, Ligament, Aponeurosis, Raphe, Fascia, Tendon, Synovial sheath, Bursa **5.Vascular system:** • Define the Arteries, Arterioles, Capillaries, Veins, Venules, Anastomosis. **6.Nervous system:** • Enlist the basic divisions of Nervous system

Course	• Define the various components of CNS and PNS • Describe the structure of Neuron • Classify neurons on the basis of number of processes and length of fibers. • Define a nerve and its coverings. • Differentiate between myelinated and unmyelinatedfibres. • Enlist various types of Neuroglia and state their functions **7.Introduction to lymphatic system:** • Define lymphatic system, lymphatics and lymph nodes • Describe the structure of lymph nodes • Enlist various lymphoid tissues and organs • Identify large lymphatic channels • Identify the role of lymphatics in the spread of cancer **8.Integumentary system and its parts, function, appendages and fascia:** • Define the term integumentary system • Discuss the function of the skin • Differentiate between epidermis & dermis • Discuss the significance of tension lines • Discuss the main determinant of skin color. • Identify the appendages of the skin. • Differentiate between superficial & deep fascia.
Duration	**General Histology** 26 weeks
Outcome	The knowledge that students will derive from this course will extend what they learn in Gross Anatomy. In addition, the study of cells, tissues and organs will correlate with information on their function that theyreceive in this and other courses. This course will also provide basic knowledge concerning the structure and function of normal cells, tissues and organs, which is a prerequisite for the study of their pathology
Objective	At the end of the course student must be able to **1.Introduction to histology:** • Define Histology and its importance • Explain the concept of organization of cells to tissue, tissues to organ and organs to system. • Identify the parts of microscope • Describe the structural organization of cell membrane and discuss the function of the components • Describe different stages of tissue preparation • Enlist various types of stains

- Describe H&E staining

2.Cell:

- Differentiate b/w prokaryotic & eukaryotic cell
- Describe Shape, structure & size of human cells
- Discuss Microscopic Structure of cell membrane. (fluid mosaic model).
- Expalin transport across the cell membrane
- Describe Cell nucleus (size, shape, structure, position & number), nuclear envelope, chromatin & nucleolus.
- Interpret the Morphology of Cytoplasmic Organelles including mitochondria, ribosomes, ER, GA, endosomes, lysosomes, peroxisomes, proteasomes & centrioles)
- Understand the following terms:
    - Pseudohypoparathyroidism& dwarfism
    - Chromatin analysis
    - Karyotyping
    - Laminopathies
    - Osteogenesisimperfecta
    - Jaundice
    - Lysosomal storage disorders
    - Alzheimers&huntingtons disease
    - Myoclonic epilepsy
    - Neonatal adrenoleukodystrophy
    - Zellweger syndrome.
- State cytoplasmic inclusions including stored food materials & pigments
- DescribeCytoskeleton (microfilaments, intermediate filaments & microtubules)
- Explain Cell surface contacts or Cell Junctions.
- Define the terms: anticancer drugs, hemosiderosiszonulaoccludence protein deficiency.
- Explain Cell renewal, Cell division and Cell cycle
- Define Cell death
- Define the following clinical terms:
    - Atresia,
    - Hypertrophy
    - Atrophy
    - Hyperplasia
    - Hetaplasia
    - Differentiation
    - Anaplasia
    - Neoplasia
    - Neoplasms
    - Metastasis
    - Mitogenic growth factors,

- Proto-oncogenes
- Trisomy 21
- Bcl-2 family of proteins

3.Epithelium:

- Define epithelium.
- Classify covering & glandular epithelium.
- Discuss bullous diseases
- State the Polarity of epithelial cells including apical, lateral & basal domains
- Explain the Structure of basement membrane
- Understand the terms: celiac diseases, kartegener syndrome, chronic bronchitis
- Differentiate b/w secretion & excretion
- Explain the General structure of endocrine glands
- Classify Glands (exocrine & endocrine)
- Classify exocrine glands on basis of morphology of duct, secretory portions, secretory products, mode of secretion
- Define the terms: acne, adenocarcinoma , neoplasia

4.Connective Tissue:

- Classify C.T (embryonic, proper & specialized)
- Enlist Components of C.T (cells & extracellular matrix)
- Outline the C.T cells (resident & migrant cells)
- Define The following
  - Scarring
  - Giant cells
  - Synthesis of immunoglobulins
  - Inflammation
  - Keloid
  - Genetic disorders
- Recall Extracellular matrix (C.T Fibres& ground substance)
- Enlist the Types of collagen proteins fibrillar, sheet forming & anchoring)
- Enumerate the Types of collagen fibers (collagen, elastic & reticular)
- Understand the clinicals: Marfan syndrome, Hurler syndrome,edema
- Differentiate between Embryonic C.T (Mesenchymal&Mucoid)
- Describe C.T proper (loose, dense, reticular &adipose)
- Define: Tendonitis, lipomas, obesity.

5.Cartilage:

- Define Perichondrium
- Recall Cartilage cells, chondrocytes and Extracellular matrix
- Classify cartilage (Hyaline costal and articular, elastic & fibrocartilage)
- Define terms: osteoarthritis, cartilage regeneration, calcification.

6. BONE:

	• Discuss Periosteum&endosteum • Discuss Bone cells (osteoprogenitor, osteoblasts, osteocytes & osteoclasts) • Define theterms: osteosarcoma, osteopetrosis, osteoporosis, osteitis fibrosa cystic, osteogenesis imperfecta. • Explain the Microscopic structure of spongy bone and compact bone (haversion system) • Define osteomalacia. • Explain the Bone formation (intramembranous &intracartilaginous ossification) • Discuss Growth of bones (in length & diameter) • Define the clinical terms: bone fractures, hormonal influence, rheumatoid arthritis **6.Muscular Tissue:** • Classify the muscular tissue (striated & non striated) • Discuss microscopic structure of smooth and cardiac muscles. • Define: hypertrophy, hyperplasia, Myastheniagravis. • Describe the microscopic structure of skeletal muscles • Differentiate different type of muscles. • Define the terms: Duchenne dystrophy, muscle dystrophy, leiomyoma **7.Circulatory system:** • Differentiate capillaries with their locarions. • Discuss the General structural pattern of arteries & Veins • TDescribe the lymph vascular system • Define terms: murmurs, thrombus, emboli atherosclerosis, hypertension, diabetic microangiopathy, inflammation , Arteriosclerosis & atherosclerosis **8.Lymphoid Tissue:** • Enlist the Components of Immune systems • Describe the Cells of immune system (T & B lymphocytes) • Define Lymphatic tissue and nodules • Define the terms: innate immunity, grafts, AIDS, Digeorge syndrome, • Describe the Microscopic picture of thymus & lymph node. • Describe Microscopic picture of spleen and tonsils • Differentiate structure of lymphoid organs on basis of histology. • Recall the terms: tonsillitis, spleenomegaly, metastatic cancer cells, lymphomas, lymphadenopathies. **8.Nervous Tissue** • Explain the Structure of Neuron • Classify neurons. • Describe Myelinated&unmyelinated nerve fibers • Classify Nerve terminations (motor & sensory nerve endings) • Discuss types of Synapses • Define terms : Parkinson disease,local aesthetics, depression

	&anxiety disorders, • Recall Histology of Peripheral nerve fiber and ganglia (sensory & autonomic) • Classify Neuroglial cells • Explain Grey & white matter • Describe Blood brain barrier • Describe Meninges and Choroidal plexus • Define terms: Astrocytoma, Alzheimer disease,multiplesclerosis,hydrosclerosis,neuroma. • Explain cerebral cortex (pyramidal & non pyramidal cells, 6 cortical layers) • Describe Spinal Cord and Cerebellum **9.Integumentary system:** • Enumerate the Cells of skin • Define Layers of epidermis and Dermis • Explain the Microscopic structure of thick skin and thin skin. • Define the terms: friction blisters, psoriasis, albinism. • Describe Microscopic structure of hair and nails. • Differentiate between Sebaceous and sweat glands • Explain structure of Mammary gland • Define the terms: melanoma, merkel cell carcinoma, pemphigous, cutis laxa, scleroderma, alopecia, cystic fibrosis, acne vulgaris **10.Respiratory System:** • Recall the Respiratory epithelium • Describe the Nasal cavity • Enlist the cell in Olfactory epithelium • Describe structure of Nasopharanx and Tracheobronchial tree • Recall histology of Epiglottis, Larynx, Trachea and Lungs • Define anosmia,, hyposmia, singers nodule, asthma, Atelactasis, fat embolism syndrome, infant respiratory distress syndrome, emphysema, pleuritis, Adenocarcinoma
RESOURSCES	**A. HISTOLOGY** 1. B. Young J. W. Health Wheather's Functional Histology 2. Junquera 3. LaiqHussain

STUDY GUIDE

PHYSIOLOGY

FIRST PROFESSIONAL MBBS

Pak Red Crescent Medical & Dental College

48-KM Multan Road, Lahore-Pakistan.

Physiology	
Introduction	Physiology is the study of the normal functioning of a living organism and its component parts, including all its chemical and physical processes. The term physiology literally means "knowledge of nature." Aristotle used the word in this broad sense to describe the functioning of all living organisms, not just of the human body. However, Hippocrates considered the father of medicine, used the word physiology to mean "the healing power of nature," and thereafter the field became closely associated with medicine. By the sixteenth century in Europe, physiology had been formalized as the study of the vital functions of the human body.Today we benefit from centuries of work by physiologists who constructed a foundation of knowledge about how the human body functions.A few decades ago we thought that we would find the key to the secret of life by sequencing the human genome.
Course to be studied in first year MBBS	1. Cell &Membrane Physiology 2. Nerve Physiology 3. Muscle Physiology 4. Blood Physiology 5. Respiratory Physiology 6. Heart Physiology 7. Circulatory Physiology 8. Skin & Temperature Regulation
Teaching strategies	• Interactive Lectures. • Tutorials. • Clinical Integration. • Seminars • Assignments • Presentations
Target students	1st year MBBS
Duration	36 weeks
Assessment	• MCQs • SEQs • Viva Voce • Assignments • Presentations • Open Book Examination • Internal evaluation carries 20% weightage in summative examination. • Continuous monitoring of attendance and academics in tutorials
Learning	1. Guyton and Hall Textbook of Medical Physiology 13th Edition 2. Ganong's Review of Medical Physiology 23rd Edition

Resources	3. Berne and Levy Physiology 7th Edition 4. Fundamentals of Human Physiology by Laurali Sherwood 4th Edition 5. Essentials of Medical Physiology by Prof. Dr. Mushtaq Ahmad 6. Physiology by Linda and Costanzo

Course title	**Cell & Membrane Physiology**
Introduction	Cells, the smallest living entities, are the living building blocks for the immensely complicated whole body. Thus, cells are the bridge between chemicals and humans.The maintenance of constant volume and composition of the body fluidCompartments (Internal environment) is termed as homeostasis. The function of the human body represents complex processes at multiple levels. Humans inhabit many different environments and often move between environments, the body must be able to rapidly adapt to the challenges imposed by changes in ambient temperature and availability of food and water. Such adaptation requires coordination of the function of cells in different tissues and organs as well as their regulation.
Target students	1st year MBBS
Duration	02 Weeks 02 days (14 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To discuss functional organization of the humanbody and control of the “internal environment” 2. To discuss cell organelles and their functions 3. To understand electrochemical gradient, and how it is used to determine whether the transport of a molecule or ion across the plasma membrane is active or passive 4. To explain genetic control of protein synthesis, cell function and cell reproduction
Learning objectives	**At the end of the course student must be able to:** Describe The Lipid Barrier of the Cell Membrane, and Cell Membrane Transport Proteins Explain Diffusion Define “Active Transport” of Substances Through Understand Basic Physics of Membrane Potentials Discuss Resting Membrane Potential of Nerves

	Discuss Nerve Action Potential Describe Propagation of the Action Potential Explain Plateau in Some Action Potentials Explain the Rhythmicity of Some Excitable Tissues— Repetitive Discharge Tell Special Characteristics of Signal Transmission in Nerve Trunks Understand Recording Membrane Potentials and Action Potentials **Cell physiology** Name the different fluid compartments in the human body. Define moles, equivalents, and osmoles Define pH and buffering. Understand electrolytes and define diffusion, osmosis, and tonicity. Understand in general terms the basic building blocks of the cell: nucleotides, amino acids, carbohydrates, and fatty acids Understand higher-order structures of the basic building blocks: DNA, RNA, proteins, and lipids. Understand the basic contributions of these building blocks to cell structure, function, and energy balance. Name the different fluid compartments in the human body. Explain Control systems of the body Describe Functional Organization of the Human Body and Control of the "Internal Environment Draw the structure of cell membrane and give the functions of each component of cell memberane Give the different types of Cell junctions Describe the organelles and their functions Explain the different type ofLocomotion of cells APOPTOSIS—PROGRAMMED CELL DEATH,

	CANCER

Course Title	**Nerve Physiology**
Introduction	The human nervous system consists of billions of nerve cells (or neurons) plus supporting (Neuroglial) cells. They are responsible for the electrical signals that communicate information about sensations, and that produce movements in response to those stimuli, along with inducing thought processes within the brain.
Target students	1st year MBBS
Duration	02 Weeks (12 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To understand the parts of a neuron and their functions. 2. To discuss the various types of nerve fibers, types of glia and their functions. 3. To discuss properties of action potential 4. To explain membrane potentials and action potentials 5. To describe the changes in ionic channels that underlieelectrotonic potentials, the action potential, and repolarization. 6. To discuss patterns of propagation of nerve impulse
Learning objectives	At the end of the course student must be able to: • Name the parts of a neuron and their functions • Name the various types of glia and their functions. Describe the chemical nature of myelin, and summarize the differences in the ways in which unmyelinated and myelinated neurons conduct impulses Define orthograde and retrograde axonal transport and the molecular motors involved in each. Describe the changes in ionic channels that underlie electrotonic potentials, the action potential, and repolarization. List the various nerve fiber types found in the mammalian nervous system. Describe the function of neurotrophins

Course Title	**Muscle Physiology**
Introduction	The muscular system is the biological system of humans that produces movement. The muscular system is controlled through the nervous system, although some muscles, like cardiac muscle, can be completely autonomous. Muscle is contractile tissue and is derived from the mesodermal layer of embryonic germ cells. Its function is to produce force and cause motion, either locomotion or movement within internal organs. Much of muscle contraction occurs without conscious thought and is necessary for survival, like the contraction of the heart or peristalsis, which pushes food through the digestive system. Voluntary muscle contraction is used to move the body and can be finely controlled, such as movements of the finger or gross movements that of the biceps and triceps
Target Students	1st year MBBS
Course Title	**Muscle Physiology**
Duration	02 Weeks (12 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To differentiate the major classes of muscle in the body. 2. To describe the organization of skeletal muscle, including the structural features/proteins within the skeletal muscle fiber that link the contractile elements to the extracellular matrix and bone to effect movement. 3. To illustrate the molecular and electrical makeup of muscle cell excitation–contraction coupling. 4. To explain the neuromuscular junction, and explain how action potentials in the motor neuron at the junction lead to contraction of the skeletal muscle. 5. To describe Contraction and Excitation of Smooth Muscle
Learning objectives	At the end of the course student must be able to: • Differentiate the major classes of muscle in the body. Describe the molecular and electrical makeup of muscle cell excitation–contraction coupling Define thick and thick filaments and how they slide to create contraction. Differentiate the role(s) for Ca2+ in skeletal, cardiac, and smooth muscle contraction Appreciate muscle cell diversity.

	Describe the main morphologic features of synapses Distinguish between chemical and electrical transmission at synapses. Describe fast and slow excitatory and inhibitory postsynaptic potentials, outline the ionic fluxes that underlie them, and explain how the potentials interact to generate action potentials. Describe fast and slow excitatory and inhibitory postsynaptic potentials, outline the ionic fluxes that underlie them, and explain how the potentials interact to generate action potentials. Define and give examples of direct inhibition, indirect inhibition, presynaptic inhibition, and postsynaptic inhibition. Describe the neuromuscular junction, and explain how action potentials in the motor neuron at the junction lead to contraction of the skeletal muscle Define and explain denervation hypersensitivity List neurotransmitters and the principal sites in the nervous system at which they are released. Describe the receptors for catecholamines, acetylcholine, 5-HT, amino acids, and opioids. Summarize the steps involved in the biosynthesis, release, action, and removal from the synaptic cleft of the various synaptic transmitters. Define opioid peptide, list the principal opioid peptides in the body, and name the precursor molecules from which they originate. Describe the classification of sensory receptor Name the types of sensory receptors found in the skin, and discuss their relation to touch, cold, warmth, and pain Define generator potential Explain the essential elements of sensory coding. Describe the components of a reflex arc.

	Describe the muscle spindles and their role in the stretch reflex. Describe the muscle spindles and their role in the stretch reflex. Define reciprocal innervation, inverse stretch reflex, clonus, and lengthening reaction

Course Title	**Blood Physiology**
Introduction	Blood is a connective tissue in fluid form. It is considered as the 'fluid of life' because it carries oxygen from lungs to all parts of the body and carbon dioxide from all parts of the body to the lungs. It is known as 'fluid of growth' because it carries nutritive substances from the digestive system and hormones from endocrine gland to all the tissues. The blood is also called the 'fluid of health' because it protects the body against the diseases and gets rid of the waste products and unwanted substances by transporting them to the excretory organs like kidneys.
Target students	**1st year MBBS**
Course title	**Blood Physiology**
Duration	06 Weeks (36 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To explain the components of blood and lymph, their origins, and the role of hemoglobin in transporting oxygen in red blood cells. 2. To understand the significance of immunity, particularly with respect to defending the body against microbial invaders. 3. To relate the roles and mechanisms of innate, acquired, humoral, and cellular immunity. 4. To understand the basis of inflammatory responses and wound healing. 5. To discuss the molecular basis of blood groups and the reasons for transfusion reactions. 6. To explain the process of hemostasis that restricts blood loss when vessels are damaged, and the adverse consequences of intravascular thrombosis.
Learning objectives	**At the end of the course student must be able to:** • Discuss Blood composition,plasma and plasma proteins • Describes the blood cells, their formation and functions in order to investigation of anaemias, infections and leukaemias • Compare between plasma protein fractions, their origin and functions so as to understand disturbances of their production • Classify blood groups so as to identify the blood groups of patients and

	donors for the purpose of safe blood transfusion • Explain the mechanisms of haemostasis and blood coagulation so as to be aware by diseases arising from excessive bleeding or intravascular clotting. • Understand the significance of immunity, particularly with respect to defending the body against microbial invaders Delineate the roles and mechanisms of innate, acquired, humoral, and cellular immunity.and Understand the basis of inflammatory responses and wound healing.

Course Title	**Respiratory Physiology**
Introduction	Respiration involves the sum of the processes that accomplish ongoing passive movement of O2 from the atmosphere to the tissues to support cell metabolism, as well as the continual passive movement of metabolically produced CO2 from the tissues to the atmosphere. The respiratory system contributes to homeostasis by exchanging O2 and CO2 between the atmosphere and the blood. The blood transports O2 and CO2 between the respiratory system and the tissues.
Target students	**1st year MBBS**
Duration	04 Weeks (24 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To relate the anatomical structure/function relationships of the upper and lower components of the respiratory system. 2. To compare and contrast the pulmonary and bronchial circulatory systems. 3. To define the different pressures in the respiratory system. 4. To relate the different volumes in the lung, and describe how they are measured. 5. To explain physical principles of gas exchange including diffusion of oxygen and carbon dioxide through the respiratory membrane 6. To discuss transport of oxygen and carbon dioxide in blood and tissue fluids 7. To explain the role of central and peripheral chemoreceptors in regulating respiration. 8. To describe ventilatory control during special circumstances (e.g., exercise and high altitude) 9. To discuss Aviation, High-Altitude and Space Physiology 10. To memorize physiology of deep-sea diving and other hyperbaric conditions
Learning objectives	**At the end of the course student must be able to:** • Locate the pre-Bötzinger complex and describe its role in producing

	spontaneous respiration. • Identify the location and probable functions of the dorsal and ventral groups of respiratory neurons, • the pneumotaxiccenter, and the apneustic center in the brain stem • List the specific respiratory functions of the vagus nerves and the respiratory receptors in the carotid • body, the aortic body, and the ventral surface of the medulla oblongata. • Describe and explain the ventilatory responses to increased CO_2 concentrations in the inspired air. • Describe and explain the ventilatory responses to decreased O_2 concentrations in the inspired air. • Describe the effects of each of the main non-chemical factors that influence respiration. • Describe the effects of exercise on ventilation and O_2 exchange in the tissues.

Course Title	**Heart Physiology**
Introduction	Cardiovascular system includes heart and blood vessels. The heart is the pump that imparts pressure to the blood to establish the pressure gradient needed for blood to flow to the tissues. Like all liquids, blood flows down a pressure gradient from an area of higher pressure to an area of lower pressure.Heart is a muscular organ that pumps blood throughoutthe circulatory system. It is situated in between two lungs in the mediastinum. It is made up of four chambers, two atria and two ventricles. The musculature of ventricles is thicker than that of atria. Force of contraction of heart depends upon the muscles.
Target students	1st year MBBS
Duration	03 Weeks (18 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To describe heart as a pump 2. To discuss function of the heart valves 3. To explain Rhythmical Excitation of the Heart 4. To discuss electrical activity in ventricular muscle and SA node 5. To label Normal Electrocardiogram 6. To identify the abnormalities of ECG 7. To analyze vectorial analysis of ECG 8. To describe cardiac arrhythmias and their electrocardiographic interpretation
Learning objectives	**At the end of the course student must be able to:** Describe the structure and function of the conduction system of the heart and compare the action potentials in each part. Describe the way the electrocardiogram (ECG) is recorded, the waves of

	the ECG, and the relationship of the ECG to the electrical axis of the heart. Name the common cardiac arrhythmias and describe the processes that produce them. List the principal early and late ECG manifestations of myocardial infarction and explain the early changes in terms of the underlying ionic events that produce them Describe the ECG changes and the changes in cardiac function produced by alterations in the ionic composition of the body fluids **The Heart as a Pump** Describe how the sequential pattern of contraction and relaxation in the heart results in a normal pattern of blood flow. Understand the pressure, volume, and flow changes that occur during the cardiac cycle. Explain the basis of the arterial pulse, heart sounds, and murmurs Delineate the ways by which cardiac output can be up-regulated in the setting of specific physiologic demands for increased oxygen supply to the tissues, such as exercise. Describe how the pumping action of the heart can be compromised in the setting of specific disease states. **Blood as a Circulatory Fluid & the Dynamics of Blood & Lymph Flow** Describe the components of blood and lymph, their origins, and the role of hemoglobin in transporting oxygen in red blood cells. Understand the molecular basis of blood groups and the reasons for transfusion reactions. Delineate the process of hemostasis that restricts blood loss when vessels are damaged, and the adverse consequences of intravascular thrombosis Identify the types of blood and lymphatic vessels that make up the circulatory system and the regulation and function of their primary constituent cell types.

	Describe how physical principles dictate the flow of blood and lymph around the body. Understand the basis of methods used to measure blood flow and blood pressure in various vascular segments. Understand the basis of disease states where components of the blood and vasculature are abnormal, dysregulated, or both. **Cardiovascular Regulatory Mechanisms** Outline the neural mechanisms that control arterial blood pressure and heart rate, including the receptors, afferent and efferent pathways, central integrating pathways, and effector mechanisms involved. Describe the direct effects of CO2 and hypoxia on the vasomotor areas in the medulla oblongata. Describe how the process of autoregulation contributes to control of vascular caliber Identify the paracrine factors and hormones that regulate vascular tone, their sources, and their mechanisms of action **Circulation Through Special Regions** Define the special features of the circulation in the brain, coronary vessels, skin, and fetus, and how these are regulated. Describe how cerebrospinal fluid (CSF) is formed and reabsorbed, and its role in protecting the brain from injury Understand how the blood–brain barrier impedes the entry of specific substances into the brain. Delineate how the oxygen needs of the contracting myocardium are met by the coronary arteries and the consequences of their occlusion. List the vascular reactions of the skin and the reflexes that mediate them. Understand how the fetus is supplied with oxygen and nutrients in utero, and the circulatory events required for a transition to independent life after birth.

Course Title	PULMONARY PHYSIOLOGY
Introduction	The circulatory system contributes to homeostasis by serving as the body's transport system. The blood vessels transport and distribute blood pumped through them by the heart to meet the body's needs for O2 and nutrient delivery, waste removal and hormonal signaling. The highly elastic arteries transport blood from the heart to the organs and serve as a pressure reservoir to continue driving blood forward when the heart is relaxing and filling. The mean arterial blood pressure is closely regulated toensure adequate blood delivery to the organs. The amount ofblood that flows through a given organ depends on the caliber (internal diameter) of the highly muscular arterioles that supply the organ. Arteriolar caliber is subject to control so that flow to particular organs can be variably adjusted to best serve the body's needs at the moment. The thin-walled capillaries are the actual site of exchange between blood and surrounding tissue cells. The highly distensible veins return blood from the organs to the heart and serve as a blood reservoir.
Target students	1st year MBBS
Duration	04 Weeks (24 Lectures)
Learning outcomes	At the end of the course student must be able: 1. To describe vascular distensibility and functions of the arterial and venous systems 2. To relate microcirculation and lymphatic system: capillary fluid exchange, interstitial fluid, and lymph flow 3. To discuss local and humoral control of blood flow by the tissues 4. To explain nervous regulation of the circulation and rapid control of arterial pressure 5. To discuss role of the kidney in long-term regulation of arterial pressure and in hypertension 6. To describe cardiac output, venous return, and their regulation 7. To explain muscle blood flow and cardiac output during exercise; the coronary circulation and ischemic heart disease 8. To understand Cardiac Failure 9. To memorize Heart valves and heart sounds 10. To explain Dynamics of valvular and congenital heart defects 11. To discuss circulatory shock and physiology of its treatment
Learning objectives	**At the end of the course student must be able to:** • Describe the manner in which O2 flows "downhill" from the lungs to the tissues and CO2 flows "UPhill" from the tissues to the lungs. • Describe the reactions of O2 with hemoglobin and the

	oxygen–hemoglobin dissociation curve. • List the important factors affecting the affinity of hemoglobin for O2 and the physiologic significance of each. • List the reactions that increase the amount of CO2 in the blood, and draw the CO2 dissociation curve forarterial and venous blood. • List the principal buffers in blood and, using the Henderson–Hasselbalch equation, describe what is unique about the bicarbonate buffer system • Define alkalosis and acidosis and outline respiratory and renal compensatory mechanisms in response to alkalosis and acidosis • Define and calculate Respiratory exchange ratio

Course Title	**Skin &Temperature Physiology**
Introduction	Humans, usually in environments cooler than their bodies, must constantly generate heat to maintain their body temperatures. Also, they must have mechanisms to cool thebody if it gains too much heat from heat-generating skeletal muscle activity or from a hot external environment. Body temperature must be regulated because the rate of cellular chemical reactions depends on temperature and because overheating damages cell proteins. The hypothalamus is the major integrating center for maintaining both energy balance and body temperature
Target Students	1st year MBBS
Duration	04 days (04 Lectures)
Learning outcomes	At the end of the course student must be able to: 1. To discuss the mechanisms by which heat is produced in and lost from the body. 2. To enlist the temperature-regulating mechanisms, and describe the way in which they are integrated under hypothalamic control to maintain normal body temperature. 3. To discuss the pathophysiology of fever.
Learning objectives	**At the end of the course student must be able to:** • Define body temperature and normal average and range of body temperature • Describe the mechanism of heat production and heat loss • Describe how the body responds to changes in set-point (e.g.a fever). • Describe the process by which sweat is produced (including the role of the **sympathetic cholinergic fibers**);Describe thermoregulation in terms

	of a control system, including identification of the 1. Controlled variable 2 Set point

Learning Resources **Physiology**	**1. Guyton and Hall Textbook of Medical Physiology 13th Edition** **2. Ganong's Review of Medical Physiology 23rd Edition** **3. Berne and Levy Physiology 7th Edition** **4. Fundamentals of Human Physiology by Lauralee Sherwood 4th Edition** **5. Essentials of Medical Physiology by Prof. Dr. Mushtaq Ahmad** **6. Physiology by Linda and Costanzo**
Assessment	• MCQs • SEQs • Viva Voce • Assignments • Presentations • Open Book Examination • Internal evaluation carries 20% weightage in summative examination. • Continuous monitoring of attendance and academics in tutorials

Course Title	**Aviation, High Altitude, Space Physiology and Deep sea diving**
Introduction	The aim of the course is to develop basic understanding of the functions of the body and their applications in management of patients and to develop skills in assessing the physiological functions of systems of the body and basic clinical examination. Careful observation is the back bone of scientific method and so one of the aims of conducting experiments is to acquire an aptitude for careful observation.
Target students	**1st year MBBS**
Learning outcomes	1. Learn and acquire skills to understand basis of physiology 2. Acquire an aptitude for careful observation. 3. Gain skills in recording an experiments, tabulating and condensing data. 4. Learn to draw valid conclusions from available data. 5. Apply Physiological learning to health and community problems.
Learning objectives	Describe the Effects of low oxygen pressure On the body Enlist the type of hypoxia and explain each of them Explain acute and chronic mountain sickness Enlist the EFFECTS OF ACCELERATORY FORCES ON THE BODY IN AVIATION AND SPACE PHYSIOLOGY Explain the Physiology of Deep-Sea Diving and Other Hyperbaric Conditions

STUDY GUIDE

BIOCHEMISTRY

FIRST PROFESSIONAL MBBS

Pak Red Crescent Medical & Dental College

48-KM Multan Road, Lahore-Pakistan.

Title	**Biochemistry Study Guide**
Introduction	Biochemistry is an emerging science, related to the chemical processes taking place in human body. Biochemistry helps to understand the complexity of life. It enables us to know how the cells, tissues and organs work in coordination, and keeps our body work normally. It is the recent field of science with lot of research advancements. It helps us to know the molecular events occurring in our body, so that we can understand better the causes of the abnormal processes resulting in the disease. Also we can find the cure of various diseases by knowing them at molecular level.
Target students	1st year MBBS
Course to be studied in first year MBBS	• Cell and Physicochemical aspects • Chemistry of Carbohydrates, • Chemistry of Proteins, • Chemistry of Lipids, • Chemistry of Nucleotides • Extracellular matrix • Heme chemistry and metabolism • Enzymology • Vitamins • Minerals and • Nutrition
Course title	**BIOCHEMICAL ASPECTS OF CELL**
Duration	8 lectures
Learning outcomes	1. To study the molecular and functional organization of cell and its subcellular organelles. 2. To study the membrane and its phenomena 3. To understand the transport mechanisms across the cell 4. To describe the methods to study cell biochemistry
Learning objectives	At the end of the course student must be able to: 1 Understand biochemical composition and functions of cell

	and cell membranes Define chemistry of signals and receptors, signal transduction Compare different types of membrane transports Learn methods to study cell biochemistry

Course title	**ACID BASE BALANCE AND BODY FLUIDS**
Duration	07 lectures
Learning outcomes	1. To understand the concept of pH, pKa and buffers 2. To describe the body buffer systems 3. To know the basis of acidosis and alkalosis
Learning objectives	At the end of the course student must be able to: 1. Apprehend ionization of water, weak acids and bases, pH and pH scale 2. Identify body buffers, their mechanism of action, acid base regulation 3. Learn to calculate Henderson-Hesselbach equation, biochemical actions for control of water and electrolyte balance 4. Compare different types of 5. particles and solutions and Gibbs Donnanequilibrium
Course title	**BIOCHEMISTRY OF CARBOHYDRATES**
Duration	10 lectures
Learning outcomes	1. To define carbohydrates, to know their general properties, isomerism, and biomedical importance. 2. List the monosaccharides of biological importance and learn their properties. 3. List the oligosaccharides and disaccharides of biological importance and learn their properties. 4. Study the chemistry and properties of various polysaccharides. 5. Study the chemistry and functions of proteoglycans.
Learning objectives	At the end of the course student must be able to: 1. Define carbohydrates, their biochemical function and classification 2. Learn monosaccharide nomenclature, isomerism, chemical properties 3. Compare structure and function of different monosaccharide, oligosaccharides and polysaccharides. 4. Explain biochemical 5. roles of Heteropoly saccharides and homopoly saccharides
Course title	**BIOCHEMISTRY OF AMINO ACIDS AND PROTEINS**

Duration	14 lectures
Learning outcomes	1. To know what are proteins and their biomedical importance. 2. To learn what are amino acids, their classification structure, functions, and properties. 3. To learn the classification and properties of proteins. 4. Learn the structural organization of protein. 5. To understand protein folding and misfoldingalongwithmisfolding diseases 6. To study plasma proteins and immunoglobulins.
Learning objectives	At the end of the course student must be able to: 1. Define proteins and their biochemical roles 2. Classify amino acids, structure and function of immunoglobulin and plasma proteins 3. Learn protein separation techniques 4. Determine hemoglobin structure, hemoglobinopathies, collagenopathies
Course title	**BIOCHEMISTRY OF NECLEIC ACIDS AND NUCLEOTIDES**
Duration	7 lectures
Learning outcomes	To study the structure, functions and diseases associated with **a)** Collagen **b)** Elastin **c)** Fibrillin-1 as a protein of microfibrills **d)** Glycosaminoglycans (GAGs) **e)** Proteoglycans **f)** Glycoproteins
Learning objectives	At the end of the course student must be able to: **1.** Define nucleotides, their biochemical role, structure and function **2.** Map out synthesis and clinical roles of purines and pyrimidines **3.** Relate structure and functions of nucleic acids (DNA & RNA)
Course title	**BIOCHEMISTRY OF LIPIDS**
Duration	14 lectures
Learning	1. To classify of lipids and their general biological functions 2. To understand fatty acids: definition, nomenclature, classification,

outcomes	chemical and physical properties, isomerism in fatty acids, role of saturated and unsaturated fatty acids in health and disease, role of trans fatty acids in coronary heart disease, omega-3 and omega-6 fatty acids and the importance of their dietary use. 3. To define nutritionally essential fatty acids and their functions 4. To describe eicosanoids and their biological functions along with their significance in health and disease 5. To understand physical and chemical properties of fats and oils (triacyglycerols), saponification, iodine number and acid number of fats, rancidity of fats 6. To study structure and biologic functions and significance of phospholipids, glycolipids, sulfolipids, and gangliosides 7. To know lipid peroxidation and its significance
Learning objectives	At the end of the course student must be able to: 1. Define lipids and their classification, biochemical action, structure and function 2. Elaborate biochemical roles of steroids, eicosanoids, lipoproteins and lipid per oxidation
Course title	**Heme Chemistry and Metabolism**
Duration	11 lectures
Learning outcomes	**1.** To understand chemistry and biosynthesis of heme and other porphyrins including disorders of heme biosynthesis (Porphyrias). **2.** To study important hemoproteins found in body along with their principal biologic functions; structure and function of hemoglobin and myoglobin, and types of hemoglobin, Hemoglobin A_{1c}. **3.** To understand oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen-binding capacity of hemoglobin. Methemoglobin (metHb) and methemoglobinemia. **4.** To study bilirubin metabolism **5.** To describe hyperbilirubinemias **6.** To understand hemoglobinopathies
Learning objectives	At the end of the course student must be able to: 1. Define enzymes, isoenzymes, their properties and regulation of activity, coenzymes and cofactors 2. Classify enzymes, enzyme inhibitors, define their therapeutic uses and application in clinical diagnosis 3 Comprehend enzyme deficiency diseases

Course title	**HEAMOGLOBIN METABOLISM**
Duration	13 lectures
Learning outcomes	**1.** To study introduction, classification and nomenclature of enzymes including definitions of enzymes and IU of enzyme activity; Enzyme Commission Classification of enzymes along with main subclasses. **2.** To learn properties of enzymes including chemical nature, active site, Catalytic efficiency, Specificity, Proenzymes, and Kinetic properties.Coenzymes and cofactors: Coenzymes derived from various vitamins along with the examples of enzymes requiring these coenzymes; and metal cofactors. Isozymes and their clinical significance. Allosteric enzymes and their biological significance. **3.** To study factors affecting enzyme activity. **4.** To understand types of enzyme inhibitors and their biomedical importance **5.** To describe mechanism of enzyme action and kinetics of enzyme activity **6.** To understand regulation of enzyme activity To learn therapeutic use of enzymes and diagnostic application of determination of enzyme activities of certain enzymes in plasma
Learning objectives	At the end of the course student must be able to: Define porphyrins, heam, types and functions of hemoglobin, its synthesis and structure, its breakdown, bile pigments Differentiate types of hemoglobinopathies, porphyrias and jaundice
Course title	**VITAMINS AND MINERALS**
Duration	8 lectures
Learning outcomes	1. To study chemistry of purines, pyrimidines, their types and structure 2. To understand structure and functions of nucleotides and nucleosides (excluding metabolism) 3. To study natural and synthetic derivatives of purines and pyrimidines and their biomedical role 4. To learn structure, functions and types of nucleic acids (excluding metabolism)
Learning	At the end of the course student must be able to:

objectives	1. Classify vitamins, their chemical structure and functions, their daily requirements, sources and their deficiency related diseases 2. Identify different minerals in human nutrition, their sources, biochemical actions and recommended daily allowance
Course title	**NUTRITION**
Duration	06 lectures
Out comes	**1.** To study energy metabolism **2.** To understand Balanced diet **3.** To describe the role of proteins in nutrition **4.** To elaborate the role of fats and lipids in nutrition **5.** To describe the role of carbohydrates in human nutrition **6.** To learn calculation of caloric requirement **7.** To study obesity and food additives
Objectives	At the end of the course student must be able to: 1. Define balance diet, caloric requirements of body, nutritional requirements in pregnancy and lactation 2. Summarize protein energy malnutrition, compare marasmus, kwashiorkor and marasmic- kwashiorkor
Course title	**EXTRACELLULAR MATRIX**
Duration	15 lectures
Learning outcomes	**1.** To study general features of vitamins as essential nutrients. **2.** To study classification of vitamins according to their physicochemical nature and biochemical functions **3.** To describe important dietary sources and recommended dietary allowances of vitamins. **4.** To understand intestinal absorption, transport and storage of vitamins. **5.** To elaborate mechanism of action of vitamins and their biochemical functions in body. **6.** To learn disorders associated with vitamin deficiency and hypervitaminoses.
Learning objectives	At the end of the course student must be able to: a. Identify types of collagen, its structure, biosynthesis, degradation and related disorders

	b. Explain characteristics of elastin, fibrillin, GAGs, glycoprotein and their related disorders