

	STUDY GUIDE
PROGRAM	MBBS
MODULE TITLE	Locomotor-1
ACADEMIC YEAR	1 <sup>st</sup> Year, 2023
INTRODUCTION	The Locomotor system is one of the basic and most essential systems
	of the human body since it allows humans to move and perform
	various functions, some of which are necessary for survival. The
	understanding of the structures, their functions and biochemical
	aspects are crucial for physicians. This module attempts to build a
	solid foundation regarding knowledge of the Locomotor system and
	its clinical applications. This module will help the learners better
	understand the basis of limb-related disorders which they will study in
	Locomotor-2 in the 2 <sup>nd</sup> spiral of the curriculum. Ultimately this will
	provide a firm grasp on the underlying mechanisms of the relevant
	clinical conditions in their ward rotations and clerkships.
RATIONALE	Skeletal system disorders and muscular pathologies are commonly
	seen in primary and tertiary care settings. It becomes imperative for
	students to know the normal structure and functions so as to
	understand the disorders later in the curriculum.
	By the end of the module, 1 <sup>st</sup> year MBBS students will be able to
OUTCOMES	describe the structure (gross and microscopic), development,
	functions and molecular basis of the musculoskeletal system.
DEPARTMENTS	Anatomy
INVOLVED	Biochemistry
	<ul> <li>Physiology</li> </ul>

MODULE	BY the end of the module, students will be able to:
OBJECTIVES	
LECTURES	Introduction to the Musculoskeletal system
ANATOMY	<ul> <li>Discuss the division and functions of skeletal system</li> </ul>
	Enumerate the parts of axial and appendicular skeleton
	Define pectoral &pelvic girdle
	Describe the division and curvature of vertebral column
	<ul> <li>Discuss the types and number of vertebrae found in adults</li> </ul>
	Embryology Development of Paraxial Mesoderm& muscles
	<ul> <li>Define epiblast and hypoblast</li> </ul>
	Explain the differentiation of trilamina rgerm disc
	Discuss the formation of mesoderm and paraxial mesoderm
	• Discuss the developmental relation of hypaxial and epaxial
	muscles
	UPPER LIMB
	Clavicle (Osteology & muscle attachments)
	<ul> <li>Identify the features of Clavicle like borders, surfaces</li> </ul>
	and land marks used for side determination
	• Discuss the attachments of muscles on Clavicle, their nerve
	supply and actions
	Scapula (Osteology & muscle attachments)
	<ul> <li>Identify Scapula and its site</li> </ul>
	<ul> <li>Mention the bony landmarks of Scapula like borders,</li> </ul>
	surfaces & land mark used for side determination
	• Discuss the attachment of muscles on Scapula, their nerve
	supply and actions
	Humerus (Osteology & muscle attachments)

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<ul> <li>Identify Humerus and its side</li> </ul>
Mention its bony landmarks like borders, surfaces & land mark
used for side determination
• Discuss the attachment of muscles on humerus, their nerve
supply and actions
Sternoclavicular and Acromioclavicular Joints
Describe the structure of joints.
<ul> <li>Name the muscles acting on these joint</li> </ul>
<ul> <li>Describe the ligaments associated with the joints.</li> </ul>
<ul> <li>Explain the movements at these joint</li> </ul>
<ul> <li>Explain clinical aspects of these joint</li> </ul>
Pectoral Region
Enumerate the muscles of pectoral girdle
• Describe the attachments of muscle of pectoral girdle and its
neurovascular supply
<ul> <li>Discuss the clavi-pectoral fascia</li> </ul>
Describe the triangle of auscultation
<ul> <li>Describe the nerves and blood vessels of this region</li> </ul>
Anatomy of Shoulder joint & its movements
<ul> <li>Classify the type of shoulder joint</li> </ul>
<ul> <li>Describe the structure of shoulder joint</li> </ul>
Name the rotator cuff muscles
<ul> <li>Describe the movements of shoulder joint</li> </ul>
<ul> <li>Explain clinical aspects of the joint</li> </ul>
Breast Development, Gross and Histology
<ul> <li>Discuss the anatomy of breast</li> </ul>

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	<ul> <li>Explain the relation of breast within pectoral region</li> </ul>
	<ul> <li>Describe the blood supply &amp; lymphatic drain age o breast</li> </ul>
	<ul> <li>Discuss the relation of breast disease with axilla</li> </ul>
	<ul> <li>Explain the development of breast</li> </ul>
	<ul> <li>Discuss the histological features of breast</li> </ul>
A	xilla, boundaries and contents along with axillary artery and veins
	<ul> <li>Describe the position and shape of axilla</li> </ul>
	• Describe the boundaries of axilla, and the muscles forming
	these boundaries
	Discuss the formation, course and relations of Axillary vessels
	• Describe the groups of axillary lymph nodes and their
	arrangement
	Brachial Plexus
	• Describe the formation of brachial plexus, with its root
	value and divisions (roots, trunk, division, and cords)
	Enumerate the branches arising from the cords
	• Name the muscles and skin supplied by the branches of
	brachial plexus
	Development of limbs & joints and their congenital anomalies
	• Discuss the site and time of appearance of upper and lower
	limb buds
	<ul> <li>Define apical ectodermal ridge(AER)</li> </ul>
	Describe the mesenchymal proliferation under the influence
	of AER and differentiation into cartilaginous models of future
	limb bones
	Define the source of mesoderm forming the limb muscles
	• Discuss the hand plate and formation of digital rays resulting
	into digits
	• Describe the muscles involved in and process of rotation of

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	both limbs
	• Discuss the differentiation of mesenchyme to form fibrous,
	cartilaginous and synovial joints
	<ul> <li>Discuss the congenital anomalies of both limbs &amp;joints</li> </ul>
	Muscles of anterior compartment of arm & neurovascular supply
	<ul> <li>Enumerate the muscles of anterior compartment of arm</li> </ul>
	• Discuss the attachment of muscles, their nerves supply and
	their actions
	• Explain the course of musculocutaneous nerve, its branches
	and distribution
	<ul> <li>Predict the impact of lesions of main nerves of compartment</li> </ul>
1	Muscles of Posterior compartment of arm & neurovascular supply
	<ul> <li>Name the muscles present in the posterior compartment of</li> </ul>
	arm
	• Describe the actions performed by the muscles of posterior
	compartment of arm
	• Describe the nerve supply of the muscles of this compartment
	<ul> <li>Explain the course of vessels present in this</li> </ul>
	compartment
	<ul> <li>Discuss the clinical aspect related to the topic</li> </ul>
	Elbow Joint
	<ul> <li>Describe the morphological structure of the joint.</li> </ul>
	<ul> <li>Discuss the muscles acting on the elbow joint</li> </ul>
	<ul> <li>Explain the neurovascular supply of the joint</li> </ul>
	<ul> <li>Describe the carrying angle and applied aspect of this joint</li> </ul>
	Cubital fossa and Anastomosis around elbow joint
	<ul> <li>Describe the boundaries of cubital fossa</li> </ul>
	Describe the contents of cubital fossa

Discuss the clinical importance of the cubital fossa
Radius (Osteology & muscle attachments)
<ul> <li>Identify the bone</li> <li>Determine the side of bone</li> <li>Identify the features of bones &amp; muscles attached to bones</li> </ul>
<ul> <li>Describe the nerve supply and actions of muscles</li> <li>Discuss clinical significance of bones</li> </ul>
<ul> <li>Ulna (Osteology &amp; muscle attachments)</li> <li>Identify the bone</li> </ul>
<ul> <li>Determine the side of bone</li> <li>Describe the surfaces, borders and ends of the bone</li> </ul>
<ul> <li>Identify the bony landmarks of bone &amp; muscles attachment sites on the bone</li> </ul>
<ul><li>Describe the nerve supply and actions of muscles</li><li>Discuss clinical significance of this bone</li></ul>
Muscles of the anterior compartment of forearm & neurovascular
<ul> <li>Name the muscles present in the anterior compartment of forearm</li> <li>Explain the division of muscle layer in the anterior compartment</li> <li>Explain actions of the muscles of anterior compartment of forearm</li> <li>Discuss the nerve supply of the muscles of this compartment</li> <li>Describe the course of vessels present in this compartment along with the supply to the structures in</li> </ul>
<ul> <li>Discuss the clinical aspect related to the topic</li> </ul>

sup	ply
•	Name the muscles present in the posterior compartment
	forearm
•	Explain the division of muscle layer in the poste
	compartment
•	Explain actions of the muscles of posterior compartment
	forearm
•	Discuss the nerve supply of the muscles of this compartmen
•	Describe the course of vessels present in this
	compartment along with the supply to the structures in
	this compartment
•	Discuss the clinical aspect related to the topic
Osteo	logy of hand
Osteo •	logy of hand Describe the bony arrangement of hand
Osteo • Wrist ja	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand
Osteo • Wrist ja	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint
Osteo • Wrist ja •	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint
Osteo • Wrist ja • •	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp
Osteo • Wrist ja • •	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp Discuss the movements occurring at these joints
Osteo • Wrist ja • • •	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp Discuss the movements occurring at these joints Classify the intercarpal, metacarpal and interphalangeal jo
Osteo • Wrist ja • • • •	Iogy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp Discuss the movements occurring at these joints Classify the intercarpal, metacarpal and interphalangeal jo Discuss the clinical aspect related to the topic
Osteo • Wrist ja • • • • • • • • • • • • •	Iogy of hand Describe the bony arrangement of hand Oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp Discuss the movements occurring at these joints Classify the intercarpal, metacarpal and interphalangeal jo Discuss the clinical aspect related to the topic es and Spaces of Hand
Osteo • Wrist ja • • • • • • • • • • • • • • • • • • •	logy of hand         Describe the bony arrangement of hand         oint, Radioulnar ; small joints of hand         Describe the morphology of wrist joint         Discuss the neurovascular supply of wrist joint         Describe radioulnar joints and discuss its neurovascular supply         Discuss the movements occurring at these joints         Classify the intercarpal, metacarpal and interphalangeal joints         Discuss the clinical aspect related to the topic         es and Spaces of Hand         Discuss the muscles of hand
Osteo • Wrist ja • • • • • • • • • • • • • •	logy of hand Describe the bony arrangement of hand oint, Radioulnar ; small joints of hand Describe the morphology of wrist joint Discuss the neurovascular supply of wrist joint Describe radioulnar joints and discuss its neurovascular supp Discuss the movements occurring at these joints Classify the intercarpal, metacarpal and interphalangeal jo Discuss the clinical aspect related to the topic es and Spaces of Hand Discuss the muscles of hand Describe the spaces o fhand.

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Blood vessels and nerves of hand
<ul> <li>Enumerate the arterial supply of hand</li> </ul>
Describe the course and relations of radial and ulnar arteries
and its branches with relation to hand
<ul> <li>Discuss the formation of superficial and deep palmar arch,</li> </ul>
<ul> <li>Describe the veins of hand and their tributaries</li> </ul>
<ul> <li>Describe the nerves of the hand and the irinjuries</li> </ul>
Cutaneous supply of upper limb
<ul> <li>Describe the cutaneous supply and dermatomes of upper</li> </ul>
limb
Venous and Lymphatic drainage of upper limb
Explain the course of major superficial veins of upper limb
<ul> <li>Describe the applied anatomy of superficial veins of upper</li> </ul>
limb
<ul> <li>Describe groups and area of drainage of each group of</li> </ul>
lymph nodes
Nerve injuries of Upper limb
<ul> <li>Recall the different nerve of upper limb and their root value</li> </ul>
<ul> <li>Discuss the causes of nerve injuries in upper limb</li> </ul>
• Enumerate the common sites of injury of the most commonly
injured nerves
<ul> <li>Discuss the symptoms caused by these nerve injuries</li> </ul>
Surface Anatomy of Upper limb
<ul> <li>Perform surface markings for main vessels of upper limb</li> </ul>

Radi	JINNAH SINDH MEDICAL UNIVERSITY ology of upper limb
•	<ul> <li>Identify the normal bony land marks onX-Ray</li> </ul>
LOW	ER LIMB
Hip B	one (Osteology & muscle attachments)
•	Enumerate the parts of hipbone
•	<ul> <li>Discuss its side determination</li> </ul>
	<ul> <li>Describe in detail the osteology of each part of hipbone</li> </ul>
	<ul> <li>Discuss its muscle and ligamentous attachments</li> </ul>
•	<ul> <li>Discuss the clinical conditions related to Hipbone</li> </ul>
Hip je	oint; Movements & Anastomoses around Hip joint
	<ul> <li>Describe the formation of hip joint</li> </ul>
	<ul> <li>Describe the articular surfaces of hip joint</li> </ul>
	<ul> <li>Discuss the attachment of its joint capsule</li> </ul>
•	<ul> <li>Explain the ligaments stabilizing the hip joint</li> </ul>
	<ul> <li>Discuss the muscles acting on the hip joint and different</li> </ul>
	movements performed at the joint.
	<ul> <li>Describe its innervations and blood supply</li> </ul>
	• Describe the arterial anastomosis around the hip joint.
	• Discuss the clinical conditions associated with the hip joint.
Foi	rmation of lumbosacral plexus, & its injuries
•	<ul> <li>Discuss the formation of lumbar plexus</li> </ul>
	<ul> <li>List the branches of lumber plexus with their root values</li> </ul>
	<ul> <li>Discuss relation of the nerves with psoas major muscle</li> </ul>
	<ul> <li>List the structures supplied by lumbar plexus</li> </ul>
	• Explain the formation of sacral plexus
	<ul> <li>Describe the composition and relations of sacral plexus</li> </ul>

Enumerate branches of sacral plexus
<ul> <li>Discuss the cutaneous supply of lower limb</li> </ul>
Deep fascia of thigh
• Explain the arrangement and attachment of deep fascia of
thigh
<ul> <li>Discuss the location of saphenous opening and its relations</li> </ul>
<ul> <li>Describe the attachments of inguinal ligament</li> </ul>
• Discuss the clinical conditions associated with deep fascia of
thigh and inguinal ligament
Gluteal Region
<ul> <li>Describe the muscles of the gluteal region and their</li> </ul>
respective actions
<ul> <li>Discuss the nerves and blood vessels of the gluteal region</li> </ul>
• Enumerate different structures entering and leaving the
gluteal region
• Discuss the clinical conditions associated with the gluteal
region
Femur (Osteology & muscle attachments)
Identify the bone
Determine its side.
Describe its important landmarks
<ul> <li>Discuss the muscles and ligaments attached to it</li> </ul>
<ul> <li>Discuss the clinical conditions related to it</li> </ul>
Muscles of Anterior compartment of thigh (Femoral triangle,
femoral sheath & Neurovascular supply)
<ul> <li>Discuss the arrangement of thigh into compartments</li> </ul>

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• Explain the muscles of anterior compartment of thigh and
their respective actions
<ul> <li>Describe the innervation and blood supply of muscles of</li> </ul>
anterior compartment of thigh
<ul> <li>Describe Femoral triangle, its boundaries and contents</li> </ul>
<ul> <li>Describe Femoral sheath and its contents</li> </ul>
<ul> <li>Discuss the clinical conditions associated with anterior</li> </ul>
compartment of thigh, femoral triangle and femoral
sheath
Muscles of Posterior compartment of thiah and neurovascular
supply
• Explain the muscles of posterior compartment of thigh and
their respective actions
<ul> <li>Describe the innervation and blood supply of muscles of</li> </ul>
posterior compartment of thigh
• Discuss the greater and cruciate anastomoses at the back of
thigh
• Discuss the clinical conditions associated with the posterior
compartment of thigh
Knee joint, genicular anastomosis and locking, unlocking
Classify the knee joint
<ul> <li>Discuss its articular surfaces, the synovial capsule</li> </ul>
• Explain types of movement performed at knee joint and the
muscles responsible for it
<ul> <li>Describe the locking and unlocking mechanism</li> </ul>
<ul> <li>Discuss the neurovascular supply of knee joint</li> </ul>

Poplite	
	eal Fossa & its contents
•	Discuss the boundaries of popliteal fossa
•	Enumerate the contents of popliteal fossa
•	Discuss clinical conditions related to popliteal fossa (e.g. the
	Baker's cyst)
Tibia (	Osteology & muscle attachments)
•	Identify the bone and determine its side
٠	Describe its anatomical position
•	Identify its bony landmarks
•	Discuss the muscles and ligaments attached to Tibia
•	Discuss the fractures and other clinical conditions associated
	with it
Fibula	(Osteology & muscle attachments)
•	Identify bone and its side
•	Mark the attachment of muscles and ligaments
Anteri	or & Lateral compartment of leg (muscles, nerves and vessels)
•	Discuss the facial compartments of leg
•	Explain muscles of anterior and lateral compartment with its
•	Explain muscles of anterior and lateral compartment with its neurovascular supply
•	Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome
• • Poster	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome for compartment of leg
• • Posteri	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome for compartment of leg Enumerate the muscles of posterior compartment of leg
• Posteri •	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome for compartment of leg Enumerate the muscles of posterior compartment of leg Discuss the actions of muscles of posterior compartment of
• Poster •	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome <b>for compartment of leg</b> Enumerate the muscles of posterior compartment of leg Discuss the actions of muscles of posterior compartment of leg
• Poster •	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome <b>for compartment of leg</b> Enumerate the muscles of posterior compartment of leg Discuss the actions of muscles of posterior compartment of leg Describe nerves and vessels of the compartment
Poster • • Osteol	Discuss the facial compartments of leg Explain muscles of anterior and lateral compartment with its neurovascular supply Describe the compartment syndrome for compartment of leg Enumerate the muscles of posterior compartment of leg Discuss the actions of muscles of posterior compartment of leg Describe nerves and vessels of the compartment ogy of foot

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	Sole of foot & Nerves and Vessels of foot					
	<ul> <li>Describe the architecture of sole of foot.</li> </ul>					
	Enumerate the layers of sole of foot.					
	<ul> <li>Discuss the muscle present in the sole of foot.</li> </ul>					
	<ul> <li>Discuss the blood supply and nerve supply of sole of foot.</li> </ul>					
	Arches of foot					
	<ul> <li>Describe the architecture of arches of foot</li> </ul>					
	• Describe the bones which are responsible for forming these					
	arches					
	<ul> <li>Describe the ligaments which are holding these arches</li> </ul>					
	<ul> <li>Describe the function of the arches of foot</li> </ul>					
	<ul> <li>Describe Plantar Fascitis and relevant injuries</li> </ul>					
	Ankle joint, superior & Inferior Tibio-Fibular joint					
	• Describe the Ankle Joint, its type, articular surface and the					
	synovial capsule					
	• Discuss the Superior and Inferior Tibio-Fibular Joints, Sub-talar					
	Joint, transverse tarsal Joint					
	<ul> <li>Describe the movement performed and the muscles</li> </ul>					
	responsible for these movement					
	<ul> <li>Discuss the neurovascular supply of the joint</li> </ul>					
	Cutaneous supply of lower limb					
	<ul> <li>Describe in detail the cutaneous supply of lower limb</li> </ul>					
	Venous and lymphatic drainage of lower limb					
	Enumerate the superficial veins					
	<ul> <li>Discuss the course of great and small saphenous veins and</li> </ul>					
	their connections with the deep veins of the leg					

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	Explain clinical conditions related to the Superficial veins; like						
	venous thrombosis						
	Describe the lymphatic drainage of lower limb						
	Injuries of lower limb						
	Recall the different nerves of lower limb and their root value						
	<ul> <li>Discuss the causes of nerve injuries in lower limb</li> </ul>						
	• Enumerate the common sites of injury of the most commonly						
	injured nerves						
	<ul> <li>Discuss the symptoms caused by these nerve injuries</li> </ul>						
	Surface anatomy of lower limb						
	Mark the different joints of lower limb						
	<ul> <li>Mark the course of blood vessels of lower limb</li> </ul>						
	Mark the course of important nerves of lower limb						
Radiology of lower limb							
	<ul> <li>Identify the normal bony landmarks as seen on X-Ray</li> </ul>						
PHYSIOLOGY Membrane Potential							
	<ul> <li>Define Nernst Potential, Nernst equation</li> </ul>						
	Explain the significance of Nernst potential						
	<ul> <li>Define the origin of resting membrane potential</li> </ul>						
	<ul> <li>(Role of Na, K &amp; amp; Cl, Na-K ATPase pump)</li> </ul>						
	Action Potential (phases, generation & amp; propagation)						
	<ul> <li>Identify different phases of action potential</li> </ul>						
	Describe the generation & amp; propagation of action						
	potential						
	Define threshold potentials and all or none law						

#### 

## Physiological properties of skeletal muscle

- Define contractility (isometric & amp; isotonic) & amp; excitability
- Define summation (spatial & amp; temporal) & amp; fatigue
- Differentiate between tetanization, tetanus & amp; tetany
- Briefly describe the staircase phenomenon (Treppe)
- Define motor unit

#### Mechanism of skeletal muscle contraction

- Briefly describe the structure of Sarcomere
- Explain sliding filament mechanism & amp; power stroke
- Define troponin tropomyosin complex

#### **Neuromuscular Junction Transmission**

- List the components of neuromuscular junction
- Explain the sequence of events during transmission
- Define end plate potential
- Describe excitation contraction coupling
- Briefly describe the role of Sarcoplasmic reticulum

#### **Disorders of Neuromuscular Junction**

Identify disorders of neuromuscular junction ((Myasthenia gravis, Lambert Eaton syndrome)

#### Muscle adaptation to exercise

- Identify the types of muscle fibers (type I & amp ;II)
- Describe the effect of exercise on muscular blood flow
- Define the effect of training, endurance & amp; resistance on

	muscle fibers						
BIOCHEMISTRY	EXTRACELLULAR MATRIX						
	Glycosaminoglycans						
	<ul> <li>Describe the biochemical structure and composition of</li> </ul>						
	extracellular matrix						
	<ul> <li>Discuss the functions of extracellular matrix</li> </ul>						
	<ul> <li>Describe the structure of Glycosaminoglycans</li> </ul>						
	Classify the Glycosaminoglycans						
	Discuss the biochemical functions of Glycosaminoglycans.						
	• Discuss the clinical significance of the diseases associated						
	with Glycosaminoglycans						
	Collagen & Elastin						
	Describe the structure of Collagen & Elastin						
	Classify Collagen & Elastin.						
	Discuss the biochemical functions of Collagen & Elastin						
	• Discuss the clinical significance of the diseases associated						
	with Collagen & Elastin						
	VITAMIN C						
	Vitamin C						
	<ul> <li>Explain the dietary sources and daily recommended</li> </ul>						
	allowance of Vitamin C.						
	• Discuss the metabolism of vitamin C in the human body.						
	Describe the physical and chemical properties of vitamin C						
	• Discuss the biochemical functions of vitamin C specially with						
	respect to Collagen and extracellular matrix						
	Discuss the clinical significance of vitamin C deficiency						
	BONE METABOLISM						
	Vitamin D						

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	<ul> <li>Explain the dietary sources and daily recommended</li> </ul>						
	allowance of Vitamin D.						
	• Discuss the metabolism of vitamin D in the human body.						
	• Discuss the regulation of serum calcium in relation to bone						
	metabolism.						
	<ul> <li>Discuss the biochemical functions of vitamin D</li> </ul>						
	• Discuss the clinical significance of vitamin D deficiency and its						
	prevention.						
C	alcium &PO4- Metabolism						
	<ul> <li>Explain the dietary sources and daily recommended</li> </ul>						
	allowance of Calcium &PO4-						
	• Discuss the metabolism of Calcium &PO4- in the human body.						
	• Discuss the regulation of serum calcium in relation to bone						
	metabolism.						
	<ul> <li>Discuss the biochemical functions of Calcium &amp; amp;PO4-</li> </ul>						
	• Discuss the clinical significance of Calcium & amp; PO4-						
	deficiency and its prevention.						
	PROTEIN METABOLISM						
Re	eactions of Amino acids						
	<ul> <li>Describe various sources and utilization of amino acid.</li> </ul>						
	• Define and explain the reactions of amino acids (Domination,						
	Transamination etc.)						
	<ul> <li>Explain the nitrogen balance in the body</li> </ul>						
	Discuss the diagnostic value of plasma Aminotransferase						
	<ul> <li>Discuss the clinical significance of biomarkers</li> </ul>						
A	mmonia Metabolism						
	<ul> <li>Discuss the major sources of ammonia.</li> </ul>						

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	<ul> <li>Discuss the utilization, formation and secretion of ammonia in</li> </ul>					
	human body.					
	<ul> <li>Explain Ammonia metabolism and its detoxification</li> </ul>					
	<ul> <li>Discuss the clinical significance and management of</li> </ul>					
	Ammonia toxicity					
	Urea Cycle					
	<ul> <li>Discuss the process of amino acid oxidation and the</li> </ul>					
	production of urea.					
	<ul> <li>Describe the metabolic pathway of Urea synthesis</li> </ul>					
	Discuss the fate of urea					
	<ul> <li>Describe the regulation of urea cycle</li> </ul>					
	<ul> <li>Discuss the clinical significance of urea cycle disorders</li> </ul>					
	Phenylalanine & Tyrosine Metabolism					
	• Discuss the metabolism of Phenylalanine & Tyrosine and its					
	related disorders					
	<ul> <li>Discuss the metabolism of Melanin and its related</li> </ul>					
	disorder(Albinism)					
	<ul> <li>Discuss the metabolism of Thyroid hormones and their related</li> </ul>					
	disorder					
	<ul> <li>Discuss the metabolism of neurotransmitters and their related</li> </ul>					
	disorder					
	Metabolism & Disorders of Tryptophan					
	<ul> <li>Discuss the metabolism of tryptophan and its related disorders</li> </ul>					
	<ul> <li>Describe the importance of tryptophan derived biologically.</li> </ul>					
	important compounds					
	<ul> <li>Evolain clinical significance of disorders of trustenban</li> </ul>					
	Explain clinical significance of also dels of hyprophan					

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	<ul> <li>Metabolism of Sulphur Containing Amino Acids</li> </ul>					
	<ul> <li>Discuss the metabolism of Sulphur containing amino acids</li> </ul>					
	<ul> <li>Describe the functions of sulphur containing amino acids</li> </ul>					
	<ul> <li>List the steps of formation of cysteine and methionine</li> </ul>					
	• Explain clinical significance of disorders of sulphur containing					
	Amino acids					
	Metabolism of Sulphur Containing Amino Acids					
	<ul> <li>Discuss the metabolism of Sulphur containing amino acids</li> </ul>					
	<ul> <li>Describe the functions of sulphur containing amino acids</li> </ul>					
	<ul> <li>List the steps of formation of Cysteine and Methionine</li> </ul>					
	Explain clinical significance of disorders of sulphur containing					
	amino acids					
	Metabolism of Branched Chain Amino Acids					
	<ul> <li>Discuss the metabolism of branched chain amino acids</li> </ul>					
	<ul> <li>Describe the functions of branched – chain amino acids</li> </ul>					
	• Explain the clinical significance of disorders of branched					
	chain amino acids					
	Catabolism of Carbon Skeleton of Amino Acids					
	• Explain the catabolism of carbon skeleton of amino acids					
	<ul> <li>List the Glucogenic &amp; amp; Ketogenic amino acids</li> </ul>					
	Explain the significance of carbon skeleton of Amino acids					
	Describe the mechanism of entry of carbon skeleton in amino					
	acid metabolism					
	• Discuss the process of vitamin B12 as a co-factor and methyl					
	donor in metabolism of amino acids					
TUTORIALS	Extracellular Matrix (Glycosaminoglycans)					
BIOCHEMISTRY	Discuss the clinical importance of Glycosaminoglycans					

•	Interpret	clinical	conditions	correlated	with	their	laboratory
	investiga <sup>.</sup>	tions					

## Bone Minerals (Calcium & PO4- Abnormalities)

- Discuss the clinical importance of Calcium & PO4abnormalities
- Interpret clinical conditions correlated with their laboratory investigations

# Vitamin C & D

- Discuss the clinical importance of Vitamin C &D
- Interpret clinical conditions correlated with their laboratory investigations

## Protein Metabolism (Urea Cycle)

- Discuss the clinical importance of Urea Cycle
- Interpret clinical conditions correlated with their laboratory investigations

# Metabolic Abnormalities of Amino Acids (Phenylalanine and Tyrosine)

- Discuss the clinical importance of metabolic abnormalities of above Amino acids
- Interpret clinical conditions correlated with their laboratory investigations

# Metabolic Abnormalities of Amino Acids (Tryptophan, Sulphur containing & branched chain amino acids)

 Discuss the clinical importance of metabolic abnormalities of above amino acids

	Interpret clinical conditions correlated with their laboratory						
	investigations						
PRACTICALS	Histology of bone						
ΑΝΑΤΟΜΥ	<ul> <li>Define bone tissue</li> <li>Classify bone macroscopically (compact &amp;spongy)and microscopically</li> <li>Differentiate compact and sponay bone on the basis of cell</li> </ul>						
	and matrix						
	<ul> <li>Describe the arrangement of spongy and compact bone in different parts of long bones</li> <li>Define Periosteum &amp; Endosteum</li> </ul>						
	<ul> <li>Discuss bone formation, growth, remodeling &amp; repair</li> </ul>						
	Histology of cartilage						
	around substance						
	<ul> <li>Differentiate the 3 types of cartilage on the basis of</li> </ul>						
	differences in components and presence or absence of perichondrium						
	Discuss chondrogenesis, growth and repair						
PHYSIOLOGY	Introduction to power lab & performance of Nerve conduction						
	velocity						
	• Describe different parts of power lab & their application in						
	different experiments.						
	Determine nerve conduction velocity inhuman						
	Electromyogram (EMG)						
	Explain the physiology of muscle contraction & changes during						
	EMG recording						

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	Simple muscle twitch (SMT) & Fatigue							
	Define simple muscle twitch & summation							
	<ul> <li>Identify the graphs of SMT &amp; summation</li> </ul>							
	Summation & Tetanization							
	Define tetanization & fatigue							
	<ul> <li>Identify the graphs of tetanization &amp; fatigue</li> </ul>							
BIOCHEMISTRY	Estimation of Calcium & Phosphate							
	Outline the bio-techniques for detection of Calcium &							
	Phosphate in a sample							
	<ul> <li>Perform the estimation of serum Calcium &amp; Phosphate.</li> </ul>							
	• Interpret clinical conditions correlated with their laboratory							
	investigations.							
	Estimation of Alkaline Phosphatase							
	Outline the bio-techniques for detection of Alkaline							
	Phosphatase in a sample							
	<ul> <li>Perform the estimation of serum Alkaline Phosphatase.</li> </ul>							
	Interpret clinical conditions correlated with their laboratory							
	investigations							
	Chromatography							
	Describe the principle of chromatography							
	<ul> <li>Describe different types of chromatography and HPLC</li> </ul>							
	• Describe the instruments used in different types of							
	chromatography							
	Interpret clinical conditions correlated with their laboratory							
	investigations							
	Paper Chromatography							

	Describe the principle of paper chromatography						
	• Describe the	method of	performance	of paper			
	chromatography						
	Perform amino acids detection on paper chromatography.						
	• Interpret clinical conditions correlated with their laboratory						
	investigations						
INTERNAL	Internal assessment will contribute 20% of the marks to the final score.						
ASSESSMENT	The pattern of assessment will vary among the institutions.						
ANNUAL	Final Annual exam will consist of MCQs ( One Correct & One Best )						
EXAMINATION	and OSPE (observed + unobservedstations)						
COURSE	The module will be evaluated through a feedback form posted on						
EVALUATION	JSMU website						