JINNAH SINDH MEDICAL UNIVERSITY

STUDY GUIDE	
PROGRAM	**MBBS**
MODULE TITLE	**Locomotor System -1**
ACADEMIC YEAR	**1st Year, 2025**
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 2nd 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.
OUTCOMES	By the end of the module, 1st year MBBS students will be able to describe the structure (gross and microscopic),development, functions and molecular basis of the musculoskeletal system.
DEPARTMENTS INVOLVED	1. Anatomy 2. Biochemistry 3. Physiology
MODULE OBJECTIVES	**By the end of the module, students will be able to:**
LECTURES ANATOMY	**1. Introduction to the Musculoskeletal system** • Discuss the division and functions of skeletal system • Enumerate the parts of axial and appendicular skeleton • Define pectoral &pelvic girdle

	• Describe the division and curvature of vertebral column • Discuss the types and number of vertebrae found in adults **2. Embryology Development of Paraxial Mesoderm& muscles** • Define Epiblast and Hypoblast • Explain the differentiation of Trilaminar germ disc • Discuss the formation of mesoderm and paraxial mesoderm • Discuss the developmental relation of hypaxial and epaxial muscles **3. Histology of Bone** • Describe the histological classification of bone. • Describe the cells and matrix component. • Describe the site and histological structure of compact and spongybone. **4. Histology of Cartilage** • Define cartilage tissue. • Define perichondrium. • Describe the cells, fibers and matrix of cartilage. • Differentiate the three types of cartilage on the basis of histologicalfeatures and location. **5. UPPER LIMB** **Clavicle (Osteology & muscle attachments)** • Identify the features of Clavicle like borders, surfaces andbony prominences. • Determine the side of the bone. • Discuss the attachments of muscles on Clavicle. **6. Scapula (Osteology & muscle attachments)** • Identify the features of Scapula like borders, surfaces andbony prominences. • Determine the side of the bone.

- Discuss the attachment of muscles on Scapula

7. Humerus (Osteology & muscle attachments)

- Identify its bony landmarks (borders, surfaces & prominences)
- Determine the side of bone.
- Discuss the attachment of muscles on Humerus.
- Discuss the relation of axillary and radial nerve with the bone.

8. Sternoclavicular and Acromioclavicular Joints

- Describe the structure of joints.
- Name the muscles acting on these joint.
- Describe the ligaments associated with the joints.
- Explain the movements at these joint.
- Explain clinical aspects of these joint.

9. Pectoral Region

- Enumerate the muscles of pectoral girdle.
- Describe the attachments of muscle of pectoral girdle and its neurovascular supply.
- Discuss the clavi-pectoral fascia.
- Describe the triangle of auscultation.
- Describe the nerves and blood vessels of this region.

10. Anatomy of Shoulder joint & its movements

- Classify the type of shoulder joint.
- Describe the structure of shoulder joint.
- Describe the rotator cuff muscles.
- Describe the movements of shoulder joint.
- Explain clinical aspects of the joint.

11. Breast Development, Gross and Histology

- Discuss the anatomy of breast.
- Explain the relation of breast within pectoral region.
- Describe the blood supply & lymphatic drainage of breast
- Discuss the significance of axillary tail.

- Explain the development of breast
- Discuss the histological features of breast

12. Posterior Scapular Region

- Describe the attachments of muscles of posterior scapular region along with its innervation and actions.
- Describe the boundaries and contents of:
- ✓ Suprascapular foramen
- ✓ Quadrangular space
- ✓ Triangular space
- ✓ Triangular interval
- Describe the vessels of posterior scapular region.
- Describe the nerves of posterior scapular region.

13. Axilla, boundaries and contents along with Axillary artery and veins

- Describe the position and shape of Axilla
- Describe the boundaries of Axilla, and the muscles forming theseboundaries
- Discuss the formation, course and relations of Axillary vessels
- Describe the groups of Axillary lymph nodes and their arrangement

14. Brachial Plexus

- Describe the formation of brachial plexus, with its root valueand divisions (roots, trunk, division, and cords).
- Enumerate the branches arising from the cords.
- Name the muscles and skin supplied by the branches of brachialplexus.

15. Development of limbs & joints and their congenital anomalies

- Define apical ectodermal ridge (AER).
- Define the source of mesoderm forming the limb muscles.
- Discuss the site and time of appearance of upper and lower limb buds.

- Describe the mesenchymal proliferation under the influence of AER and differentiation into cartilaginous models of future limb bones.
- Discuss the hand plate and formation of digital rays resulting into digits.
- Describe the muscles involved in and process of rotation of both Limbs.
- Discuss the differentiation of mesenchyme to form fibrous, cartilaginous and synovial joints.
- Discuss the congenital anomalies of both limbs & joints.

16. Muscles of anterior compartment of arm & neurovascular supply

- Enumerate the muscles of anterior compartment of arm.
- Discuss the attachment of muscles, their nerves supply and theiractions.
- Explain the course of Musculocutaneous nerve, its branches anddistribution.
- Relate the impact of lesions of main nerves of compartment with the clinical conditions.

17. Muscles of Posterior compartment of arm & neurovascular supply

- Name the muscles present in the posterior compartment of arm.
- Describe the actions performed by the muscles of posterior compartment of arm.
- Describe the nerve supply of the muscles of this compartment.
- Explain the course of vessels present in this compartment.
- Discuss the clinical aspect related to the topic.

18. Elbow Joint

- Describe the morphological structure of the joint.
- Discuss the muscles acting on the elbow joint.

- Explain the neurovascular supply of the joint.
- Describe the carrying angle and applied aspect of this joint.

19. Cubital fossa and Anastomosis around elbow joint

- Describe the boundaries of Cubital fossa.
- Describe the contents of Cubital fossa.
- Discuss the clinical importance of the Cubital fossa.

20. Radius (Osteology & muscle attachments)

- Identify its bony landmarks (borders, surfaces & prominences)
- Determine the side of bone.
- Discuss the attachment of muscles on the bone.

21. Ulna (Osteology & muscle attachments)

- Identify the bone.
- Determine the side of bone.
- Describe the surfaces, borders and ends of the bone.

22. Muscles of the anterior compartment of forearm & neurovascularsupply

- Name the muscles present in the anterior compartment of forearm.
- Explain the division of muscle layer in the anterior compartment.
- Explain actions of the muscles of anterior compartment of forearm.
- Discuss the nerve supply of the muscles of this compartment.
- 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.

23. Muscles of the posterior compartment of forearm & neurovascularsupply

- Name the muscles present in the posterior compartment of forearm.
- Explain the division of muscle layer in the posterior compartment.
- Explain actions of the muscles of posterior compartment of

forearm.

- Discuss the nerve supply of the muscles of this compartment.
- 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.

24. Osteology of hand

- Describe the bony arrangement of hand.

25. Wrist joint, Radioulnar and small joints of hand

- Describe the morphology of wrist joint.
- Discuss the neurovascular supply of wrist joint.
- Describe Radio-ulnar joints and discuss its neurovascular supply.
- Discuss the movements occurring at these joints.
- Classify the intercarpal, metacarpal and inter-phalangeal joint.
- Discuss the clinical aspect related to the topic.

26. Muscles and Spaces of Hand

- Discuss the muscles of hand.
- Discuss the palmar aspect of wrist and hand.
- Explain the attachments of flexor retinaculum, palmar aponeurosis and fibrous flexor sheaths of fingers.
- Describe the spaces of hand.
- Discuss the clinical importance of these spaces.

27. Blood vessels and nerves of hand

- Enumerate the arterial supply of hand.
- Describe the course and relations of Radial and Ulnar arteries andits branches with relation to hand.
- Discuss the formation of superficial and deep palmar arch,
- Describe the veins of hand and their tributaries.
- Describe the nerves of the hand and the injuries.

28. Cutaneous supply of upper limb

- Describe the cutaneous supply and dermatomes of upper limb.

29. Venous and Lymphatic drainage of upper limb

- Describe the venous drainage of upper limb.
- Describe the lymphatic drainage of upper limb.
- Describe the applied anatomy of superficial veins of upper limb.
- Describe groups and area of drainage of each group of lymphnodes.

30. Nerve injuries of Upper limb

- List the different nerve of upper limb and their root value.
- Discuss the causes of nerve injuries in upper limb.
- Enumerate the common sites of injury of the most commonly injured nerves.

31. Surface Anatomy of Upper limb

- Perform surface markings for main vessels of upper limb.

32. Radiology of upper limb

Identify the normal bony land marks on X-Ray

BACK

- Describe the general characteristics of vertebrae.
- List the joints of vertebral column.
- Describe the ligaments of vertebral column
- Discuss the curvatures of vertebral column.
- List the layers of Superficial back muscles with its attachments and actions
- List the layers of intermediate and deep muscles with its actions

LOWER LIMB

33. Hip Bone (Osteology & muscle attachments)

- Enumerate the parts of hip bone.
- Determine the side of bone.
- Describe the surfaces, borders and prominences of the bone.
- Describe in detail the osteology of each part of hipbone.
- Discuss its muscle and ligamentous attachments.

- Discuss the clinical conditions related to Hipbone.

34. Femur (Osteology & muscle attachments)

- Identify the bone.
- Determine its side.
- Describe its important landmarks.
- Discuss the muscles and ligaments attached to it.
- Discuss the clinical conditions related to it.

35. Hip joint; Movements & Anastomoses around Hip joint

- Describe the formation of hip joint.
- Describe the articular surfaces of hip joint.
- Discuss the attachment of its joint capsule.
- Explain the ligaments stabilizing the hip joint
- Discuss the muscles acting on the hip joint and differentmovements performed at the joint.
- Describe its innervations and blood supply.
- Describe the arterial anastomosis around the hip joint.
- Discuss the clinical conditions associated with the hip joint.

36. Formation of Lumbosacral plexus, & its injuries

- Discuss the formation of lumbar plexus.
- List the branches of lumber plexus with their root values.
- Discuss relation of the nerves with Psoas major muscle.
- List the structures supplied by lumbar plexus.
- Explain the formation of sacral plexus.
- Describe the composition and relations of sacral plexus.
- Enumerate branches of sacral plexus.
- Discuss the cutaneous supply of lower limb.

37. Gluteal Region

- Describe the muscles of the Gluteal region and their respectiveactions.
- Discuss the nerves and blood vessels of the Gluteal region.

	• Enumerate different structures entering and leaving the gluteal region. • Discuss the clinical conditions associated with the gluteal region. **38. Deep fascia of thigh** • Explain the arrangement and attachment of deep fascia of thigh. • Discuss the location of Saphenous opening and its relations. • Describe the attachments of inguinal ligament. • Discuss the clinical conditions associated with deep fascia of thighand inguinal ligament. **39. Muscles of Anterior compartment of thigh (Femoral triangle,femoral sheath & Neurovascular supply)** • Discuss the arrangement of thigh into compartments • Explain the muscles of anterior compartment of thigh and theirrespective actions • Describe the innervation and blood supply of muscles of anteriorcompartment of thigh • Describe Femoral triangle, its boundaries and contents • Describe Femoral sheath and its contents • Discuss the clinical conditions associated with anterior compartment of thigh, femoral triangle and femoral sheath **40. Medial Side of Thigh (Adductor Compartment)** • Explain the muscles of medial compartment of thigh and their respective actions • Describe the innervation and blood supply of muscles of medial compartment of thigh **41. Muscles of Posterior compartment of thigh and neurovascular supply** • Explain the muscles posterior compartment of thigh and theirrespective actions. • Describe the innervation and blood supply of muscles of posteriorcompartment of thigh.

- Discuss the greater and Cruciate anastomoses at the back of thigh.
- Discuss Sciatic nerve in detail.
- Discuss the clinical conditions associated with the posterior compartment of thigh.

42. Tibia (Osteology & muscle attachments)

- Identify the bone and determine its side
- Describe its anatomical position.
- Discuss the ligaments attached to Tibia.
- Discuss the fractures and other clinical conditions associated with it.

43. Fibula (Osteology & muscle attachments)

- Identify bone and determine its side.
- Describe the surfaces, borders and bony prominences of bone
- Discuss the attachment of muscles on fibula

44. Knee joint, genicular anastomosis and locking, unlocking

- Discuss the articular surfaces of joint.
- Describe the ligaments of joint.
- Explain the movements performed at knee joint and the muscles responsible for it.
- Describe the locking and unlocking mechanism.
- Discuss the neurovascular supply of knee joint.
- Describe the clinical condition associated with the joint.

45. Popliteal 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).

46. Anterior & Lateral compartment of leg (muscles, nerves and vessels)

- Discuss the facial compartments of leg.
- Explain muscles of anterior and lateral compartment with its neurovascular supply.
- Describe the compartment syndrome.

47. Posterior 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

48. Osteology of foot

- Describe the bony arrangement of foot.

49. Dorsum of Foot

- Describe the muscles of dorsum of foot.
- Discuss the arterial supply of dorsum of foot.
- Discuss the nerve supply of dorsum of foot.
- Describe the dorsal venous arch of foot.

50. Sole of foot & Nerves and Vessels of foot

- Describe the architecture of sole of foot.
- Enumerate the layers of sole of foot.
- Discuss the muscle present in the sole of foot.
- Discuss the blood supply and nerve supply of sole of foot.

51. Ankle joint, superior & Inferior Tibio-Fibular joint

- Describe the Ankle Joint, its type, articular surface and ligaments
- Describe the tarsal tunnel, retinacula and arrangement of major structures at ankle joint.
- Discuss the Superior and Inferior Tibio-Fibular Joints, Sub-talar Joint, transverse tarsal Joint.
- Describe the movement performed and the muscles responsible forthese movement at the joints.
- Discuss the neurovascular supply of the joints.
- Discuss the clinical condition associated with the joints

	52. Arches of foot • Describe the architecture & functions of arches of foot. • Describe the bones which are responsible for forming these arches. • Explain the ligaments which are holding these arches. • Describe Plantar Fasciitis and relevant injuries. **53. Cutaneous supply of lower limb** • Describe in detail the cutaneous supply of lower limb. **54. Venous and lymphatic drainage of lower limb** • Enumerate the superficial veins. • Discuss the course of great and small saphenous veins and their connections with the deep veins of the leg. • Explain clinical conditions related to the Superficial veins; like venous thrombosis. • Describe the lymphatic drainage of lower limb. **55. Injuries of lower limb** • Name the different nerves of lower limb and their root values • Discuss the causes of nerve injuries in lower limb. • Enumerate the common sites of injury of the most commonly injured nerves. • Discuss the symptoms caused by these nerve injuries. **56. Surface anatomy of lower limb** • Mark the following: ✓ different joints of lower limb. ✓ course of blood vessels of lower limb. ✓ course of important nerves of lower limb. **57. Radiology of lower limb** • Identify the normal bony landmarks as seen on X-Ray
BIOCHEMISTRY	**EXTRACELLULAR MATRIX** **1. Glycosaminoglycan's** • Describe the biochemical structure and composition of

extracellularmatrix

- Discuss the functions of extracellular matrix
- Describe the structure of Glycosaminoglycan's
- Classify the Glycosaminoglycan's
- Discuss the biochemical functions of Glycosaminoglycan's.
- Discuss the clinical significance of the diseases associated withGlycosaminoglycan's

2. 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 withCollagen & Elastin

3. Vitamin C

- Explain the dietary sources and daily recommended allowance ofVitamin 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

4. Vitamin D

- Explain the dietary sources and daily recommended allowance ofVitamin D.
- Discuss the metabolism of vitamin D in the human body.
- Discuss the regulation of serum calcium in relation to bone metabolism.
- Discuss the biochemical functions of vitamin D
- Discuss the clinical significance of vitamin D deficiency and

its.

prevention.

5. Calcium &PO4- Metabolism

- Explain the dietary sources and daily recommended allowance ofCalcium &PO4-
- Discuss the metabolism of Calcium &PO4- in the human body.
- Discuss the regulation of serum calcium in relation to bone metabolism.
- Discuss the biochemical functions of Calcium & PO4-
- Discuss the clinical significance of Calcium & PO4- deficiencyand its prevention.

PROTEIN METABOLISM

6. Reactions of Amino acids

- Describe various sources and utilization of amino acid.
- Explain the reactions of amino acids (Deamination, Transamination etc.)
- Explain the nitrogen balance in the body
- Discuss the diagnostic value of plasma Aminotransferase
- Discuss the clinical significance of biomarkers

7. Ammonia Metabolism

- Discuss the major sources of ammonia.
- Discuss the utilization, formation and secretion of ammonia in human body.
- Explain Ammonia metabolism and its detoxification
- Discuss the clinical significance and management of Ammonia toxicity.

8. Urea Cycle

- Discuss the process of amino acid oxidation and the production ofurea
- Describe the metabolic pathway of Urea synthesis
- Discuss the fate of urea

- Describe the regulation of urea cycle
- Discuss the clinical significance of urea cycle disorders

9. Phenylalanine & Tyrosine Metabolism

- Discuss the metabolism of Phenylalanine & Tyrosine and its relateddisorders
- Discuss the metabolism of Melanin and its related disorder(Albinism)
- Discuss the metabolism of Thyroid hormones and their related disorder
- Discuss the metabolism of neurotransmitters and their related disorder

10. Metabolism & Disorders of Tryptophan

- Discuss the metabolism of tryptophan and its related disorders
- Describe the importance of tryptophan derived biologically important compounds
- Explain clinical significance of disorders of tryptophan

11. Metabolism of Sulphur Containing Amino Acids

- Discuss the metabolism of Sulphur containing amino acids
- Describe the functions of sulphur containing amino acids
- List the steps of formation of Cysteine and Methionine

Explain clinical significance of disorders of sulphur containing amino acids

12. Metabolism of Branched Chain Amino Acids

- Discuss the metabolism of branched chain amino acids
- Describe the functions of branched – chain amino acids
- Explain the clinical significance of disorders of branched chain amino acids

13. Catabolism of Carbon Skeleton of Amino Acids

- Explain the catabolism of carbon skeleton of amino acids
- List the Glucogenic & Ketogenic amino acids

	• Explain the significance of carbon skeleton of Amino acids • Describe the mechanism of entry of carbon skeleton in amino acidmetabolism • Discuss the process of vitamin B12 as a co-factor and methyl donor in metabolism of amino acids
PHYSIOLOGY	**1. Membrane Potential** • Define Nernst Potential, Nernst equation • Explain the significance of Nernst potential • Define the origin of resting membrane potential (Role of Na, K, Cl, Na-K ATPase pump) **2. Action Potential (phases, generation & propagation)** • Identify different phases of action potential • Describe the generation & propagation of action potential • Define threshold potentials and all or none law **3. Structure and Classification of nerve fibers** • Describe the structure of nerve fibers and their characteristics. • Classify nerve fibers on the basis of diameter and conduction velocity **4. Nerve injury, degeneration and regeneration of nerve fibers** • Describe the events of nerve injury. • Explain the process of nerve fiber degeneration and regeneration. **5. Physiological properties of skeletal muscle** • Define contractility (isometric and isotonic) and excitability • Define summation (spatial and temporal) and fatigue • Differentiate between tetanization, tetanus and tetany • Briefly describe the staircase phenomenon (Treppe) • Define motor unit **6. Mechanism of skeletal muscle contraction** • Briefly describe the structure of Sarcomere • Explain sliding filament mechanism and power stroke

	• Discuss the role of Troponin- Tropomyosin complex in skeletal muscle contraction **7. 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 **8. Disorders of Neuromuscular Junction** • Identify disorders of neuromuscular junction ((Myasthenia gravis,Lambert Eaton syndrome) **9. Muscle adaptation to exercise** • Identify the types of muscle fibers (type I & II) • Describe the effect of exercise on muscular blood flow • Define the effect of training, endurance & resistance on muscle fibers
PRACTICALS **ANATOMY**	**1. Histology of bone** • Define bone tissue • Classify bone macroscopically (compact &spongy) and microscopically • Differentiate compact and spongy bone on the basis of cells andmatrix • Describe the arrangement of spongy and compact bone in differentparts of long bones • Define Periosteum &Endosteum • Discuss bone formation, growth, remodeling & repair **2. Histology of cartilage** • Describe the components of cartilage that is cells, fibers and ground substance • Differentiate the 3 types of cartilage on the basis of differences

	incomponents and presence or absence of perichondrium • Discuss chondrogenesis, growth and repair
BIOCHEMISTRY	**1. Estimation of Calcium & Phosphate** • Outline the bio-techniques for detection of Calcium & Phosphate ina sample • Perform the estimation of serum Calcium &Phosphate. • Interpret clinical conditions correlated with their laboratory investigations. **2. Estimation of Alkaline Phosphatase** • Outline the bio-techniques for detection of Alkaline Phosphatase ina sample • Perform the estimation of serum Alkaline Phosphatase. • Interpret clinical conditions correlated with their laboratory investigations **3. Chromatography** • Describe the principle of chromatography • Describe different types of chromatography and HPLC • Describe the instruments used in different types of chromatography • Interpret clinical conditions correlated with their laboratory investigations **4. 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 laboratoryinvestigations
PHYSIOLOGY	**1. Introduction to power lab & performance of Nerve conduction velocity** • Describe different parts of power lab & their application in differentexperiments.

	• Determine nerve conduction velocity inhuman **2. Electromyogram (EMG)** • Explain the physiology of muscle contraction & changes during EMGrecording **3. Simple muscle twitch (SMT) & Fatigue** • Discuss the mechanism of simple muscle twitch and fatigue. • To record the graph of simple muscle twitch & fatigue in skeletal muscles. **4. Summation & Tetanization** • Discuss the mechanism of summation and tetanization. • To record the graph of summation and tetanization in skeletal muscles.
INTERNAL ASSESSMENT	• Internal assessment will contribute 20% of the marks to the final score. The pattern of assessment will vary among the institutions.
ANNUAL EXAMINATION	• Final Annual exam will consist of MCQs (One Correct & One Best) and OSPE (observed + unobserved stations)
MODULE EVALUATION	• The module will be evaluated through a feedback form posted on JSMU website