### 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 and their functions are crucial for physicians. This module attempts to build a solid foundation regarding knowledge of the locomotor system and its clinical applications. It is directly linked to the Locomotor Two in the second spiral of the MBBS curriculum where there will be far more emphasis on clinical conditions. Concepts developed during this module will help the learners understand and apply the information in Orthopedics.

### Target Students

First year MBBS

### Duration

7 weeks, April – May 2019

### Module Outcomes

By end of the module, students will be able to:
- Predict loss of movement due to injury to various parts of the locomotor system based on their knowledge of its normal structure, function and biochemical mechanisms
- Identify common structures and features of the skeletal system on plain X rays

### Departments involved

Anatomy, Biochemistry & Physiology

### DEPARTMENT

**OBJECTIVES**

At the end of the week, the students should be able to:

### 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. **Clavicle Osteology Muscle Attachment:**
   - Identify the features of bone like borders, surfaces and landmarks used for side determination.
   - Discuss the attachments of muscles.
3. **Histology of Cartilage:**
   - Enumerate the general properties of cartilage
   - Discuss the histological differentiation of different types of cartilage and their locations.
   - Describe the process of growth of cartilage.
4. **Sternoclavicular and Acromioclavicular Joints:**
   - Classify type of these joints
• Describe the structure of these joints
• Name the muscles acting on these joints
• Explain the movements at these joints
• Explain clinical aspects of these joints
(5) Scapula Osteology & Attachment:
• Identify the bone.
• Identify the side of bone.
• Mention the bony landmarks of bone like borders, surfaces & landmark used for side determination.
• Discuss the attachment of muscles on scapula.

(6) Development of Paraxial Mesoderm & muscles: (Embryology)
• Define epiblast and hypoblast.
• Explain the differentiation of trilaminar germ disc.
• Discuss the formation of mesoderm and paraxial mesoderm.
• Explain myogenesis.
• Discuss the development of muscular system.

(7) Osteology of Humerus & Attachment:
• Identify the bone.
• Identify the side of bone.
• Mention the bony landmarks of bone like borders, surfaces & landmark used for side determination.
• Discuss the attachments of muscles.

(08) Pectoral Region (Anterior axio-appendicular):
• Enumerate the muscles of pectoral region
• Describe the attachments of muscle of pectoral region and its neurovascular supply.
• Explain the role of muscles of pectoral region in stabilizing the pectoral girdle.
• Discuss the clavipectoral triangle & fascia.
• Name the nerves and blood vessels of this region.

(09) Development of Joints & Muscles of Shoulder (Posterior axio-appendicular):
• Describe the development of joints & cartilage.
• Enumerate the Bones of shoulder
• Describe the muscles of shoulder.
• Describe the nerve supply of these muscles.
• Explain actions of the muscles of shoulder.
• Describe the triangle of auscultation.
Describe the clinical correlates of shoulder muscles.

(12) Anatomy of Shoulder joint & its Movements:
- Classify the type of shoulder joint.
- Describe the structure of shoulder joint.
- Describe the muscles acting on the joint/rotator cuff muscles.
- Explain the range of mobility.
- Describe the movements of shoulder joint.
- Explain clinical aspects of the joint.

(13) Histology, Bone:
- Identify different types of bones under microscope.
- Discuss histogenesis of Bone.
- Describe the process of Endochondral and Intramembranous Ossification.
- Describe ossification of long bones.

(14) Axilla, boundaries and contents along with axillary artery and vein:
- Describe the position, shape of axilla.
- Describe the boundaries and muscle forming the boundaries of axilla.
- Discuss the formation, course and relations of axillary vessels.
- Describe the arrangement and groups of axillary lymph nodes.

(15) Brachial Plexus / Brachial plexus injuries:
- Describe the formation of brachial plexus, with its root value and divisions (roots, trunk, division, and cords).
- Discuss the relation of brachial plexus in connection to clavicle (Supra, retro, infra clavicular parts).
- Enumerate the branches arising from the cords.
- Draw the brachial plexus.
- Name the muscles and skin supplied by the branches of brachial plexus.
- Discuss injuries to the plexus & the resultant deformities of upper limb.

(16) Muscles of anterior compartment of arm muscles & neurovascular supply:
- Identify the compartments of arm and how they are formed.
- Enumerate the muscles of anterior compartment of arm.
- Discuss the attachment of muscles, their nerves supply and their actions.
- Explain the course of musculocutaneous nerve, its branches and distribution.
- Discuss the large nerves of arm and
- Predict the impact of lesions of main nerves of compartment.

(17) Post compartment of arm, muscles & neurovascular supply:
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- Name the muscles present in the posterior compartment of arm.
- Describe the actions performed by the muscles of posterior compartment of arm.
- Explain the course of nerves & vessels of this compartment along with their specific area of supply.
- Discuss the clinical aspect related to this compartment

(18) **Breast Development, Histology & Gross:**
- Discuss the anatomy of breast.
- Explain the relation of breast within pectoral region.
- Describe the blood supply & lymphatic drainage of breast.
- Discuss the relation of breast disease with axilla.
- Explain the development of breast.
- Discuss the histological features of breast.

(19) **Histology of Muscles:**
- Distinguish the three types of muscle at the light and electron microscope levels based on distinctive features of each muscle fiber.
- Describe the structural basis of muscle striations.
- Discuss the structural elements that are involved in muscle contraction.
- Explain the organization and functions of the connective tissue related to muscle.

(20) **Osteology of Radius & Attachments of Muscle:**
- Identify the bones of forearm & hand.
- Determine the side of bones.
- Identify the features of bones.
- Identify the muscles attached to bones.
- Identify clinical significance of bones.

(21) **Osteology of Ulna & Attachment of Muscles:**
- Identify the bone.
- Determine the side of bone.
- Describe the surfaces, borders and ends of the bone.
- Identify the bony landmarks of bone.
- Identify the muscles attached to bone.
- Discuss clinical significance of bone.

(22) **Muscles of front of forearm and neurovascular supply:**
- Enumerate the compartments of forearm and how these compartments are formed.
- Discuss the muscles present in the anterior compartment of forearm.
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1. Explain the division of muscle layer in the anterior compartment.
2. Discuss the actions performed by the muscles of anterior compartment.
3. Explain the nerve supply of the muscles of this compartment.
4. Discuss the course of vessels present in this compartment along with the structures they supply.
5. Describe attachment and functions of flexor retinaculum.
6. Discuss the clinical correlates.

(23) Elbow Joint:
1. Identify the morphology of the joint.
2. Discuss the muscles acting on the elbow joint
3. Explain the neurovascular supply of the joint.
4. Describe the carrying angle and applied aspect of the joint.

(24) Cubital fossa & Anastomosis around elbow:
1. Describe the boundaries, contents and relationship among structures of cubital fossa.
2. Identify the surface anatomy of cubital fossa.
3. Discuss the clinical importance of the cubital fossa.
4. Describe formation of anastomosis around elbow joint.
5. Describe the collateral circulation in relation to this anastomosis.

(25) Muscles of the posterior compartment of forearm & neurovascular supply:
1. Name the muscles present in the posterior compartment of forearm.
2. Explain the division of muscle layer in the posterior compartment.
3. Explain actions of the muscles of posterior compartment of forearm.
4. Discuss the nerve supply of the muscles of this compartment.
5. Describe the course of vessels present in this compartment along with the supply to the structures in this compartment.
6. Discuss the clinical correlates.

(26) Lymphatic of upper limb:
1. Describe groups and area of drainage of each group of lymph nodes.
2. Discuss the commencement, course and termination of superficial lymphatic vessels.
3. Discuss the clinical conditions related to lymphatic channels of upper limb.

(27) Superficial veins of upper limb:
1. Discuss the normal Anatomy of veins of upper limb.
2. Difference between superficial and deep veins.
3. Explain the course of major superficial veins of upper limb.
Describe the applied anatomy of superficial veins of upper limb.

(28) Osteology of hand:
- Describe the bony arrangement of hand.

(29) Muscles & Spaces of Hand:
- Locate the different spaces of the hand on both palmar and dorsal aspects.
- Describe the spaces of hand.
- Discuss the clinical importance of these spaces.
- Describe the intrinsic muscles of hand and attachment of extrinsic muscles along with their action.

(30) Blood vessels and nerves of hand:
- Enumerate the arterial supply of hand.
- Discuss the course and relations of radial and ulnar arteries in hand.
- Branches of radial and ulnar arteries in hand.
- Formation of superficial and deep palmar arch, veins of hand and their tributaries.
- Describe the nerves of the hand and their injuries.

(31) Wrist joint, Radioulnar & Small joints of hand:
- Describe Wrist joint.
- Discuss the neurovascular supply of wrist joint.
- Describe radioulnar joints and discuss its neurovascular supply.
- Discuss the movements occurring at these joints.
- Explain Clinical correlates of wrist (carpal tunnel) and other joints.
- Classify the intercarpal, metacarpal and interphalangeal joint.

(32) 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.

(33) Cutaneous supply of upper limb:
- Describe in detail the cutaneous supply and dermatomes of upper limb.

(34) HipBone I & II (Osteology & Muscle Attachment):
- Enumerate the parts of hip bone.
- Discuss side determination.
- Describe in detail the osteology of each part of hip bone.
- Muscle attachment of hip bone.
- Discuss ligamentous attachments.
Discuss the clinicals related to bones.

(35) **Femur Osteology Attachment:**
- Identify the bone.
- Determine the side of the bone.
- Describe the anatomical position of the bone.
- Identify the bony landmarks.
- Discuss the muscles attached to the bone.
- Discuss the ligaments attached to the bone.
- Discuss the fractures and other clinical conditions associated with the bone.

(36) **Deep fascia of thigh, its modification. Inguinal ligament:**
- Explain the arrangement and attachment of deep fascia of thigh.
- 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.

(37) **Muscles of Anterior compartment of thigh femoral triangle, femoral sheath & Neuro vascular supply:**
- Discuss the arrangement of thigh into compartments.
- Explain the muscles of anterior compartment of thigh and their respective actions.
- Describe the innervation and blood supply of muscles of anterior compartment of thigh.
- Have concept of:
  - Femoral triangle, its boundaries and contents
  - Femoral sheath and its contents.
- Discuss the clinical conditions associated with anterior compartment of thigh, femoral triangle and femoral sheath.

(38) **Formation &Injuries lumbosacral:**
- 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.
- Describe the structures supplied by lumbar plexus.
- Explain the formation of sacral plexus.
- Describe the composition and relations of sacral plexus.
- Enumerate branches of this plexus.
- Discuss the cutaneous supply of lower limb.
- Discuss the injuries of lumbosacral plexus.
(39) Muscles & Nerve and vessels of medial compartment of thigh:
- Discuss the arrangement of thigh into compartments.
- Describe the muscles of medial compartment of thigh and their respective actions.
- Describe the innervations and blood supply of muscles of medial compartment of thigh.
- Discuss the clinical conditions associated with the medial compartment of thigh.

(40) Gluteal Region:
- Describe the location of gluteal region.
- Describe the bones and ligaments of gluteal region.
- Describe the muscles of the gluteal region and their respective actions.
- 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.

(41) Muscles of Posterior compartment of thigh and neurovascular supply:
- Explain the muscles of posterior compartment of thigh and their respective actions.
- Describe the innervation and blood supply of muscles of posterior compartment of thigh.
- Discuss the trochanteric and cruciate anastomosis at the back of thigh.
- Discuss the clinical conditions associated with the posterior compartment of thigh.

(42) Hip joints & movements, anastomoses around hip joint:
- Classify hip joint.
- Describe the Articular surfaces of hip joint.
- Discuss the attachment of joint capsule.
- Explain the ligaments stabilizing the joint.
- Discuss the muscles acting on the joint and different movements performed at the joint.
- Describe the innervation and blood supply of the joint.
- Describe the arterial anastomosis around the hip joint.
- Discuss the clinical conditions associated with the joint.

(43) Development of limbs & congenital anomalies:
- Discuss the site and time of appearance of upper and lower limb bud.
- Define apical ectodermal ridge (AER).
- 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 & foot plates and formation of digital rays resulting into digits.
Describe the process of rotation of limb and positioning of muscles.
Discuss the congenital anomalies of the limbs.

**Tibia Osteology & attachment:**
- Identify the bone.
- Determine the side of the bone.
- Describe the anatomical position of the bone.
- Identify the bony landmarks.
- Describe the muscles attached to the bone.
- Describe the ligaments attached to the bone.
- Discuss ossification of tibia and its primary and secondary ossification centers
- Discuss the fractures and other clinical conditions associated with the bone.

**Knee joint, genicular anastomosis and locking, unlocking:**
- Classify the joint
- Describe the articular surfaces of joint and the synovial capsule
- Explain type of movement performed and the muscles responsible for these movements
- Describe the locking and unlocking mechanism
- Discuss the neurovascular supply of knee joint.

**Popliteal Fossa & its content:**
- Discuss the boundaries of popliteal fossa.
- Enumerate the contents of popliteal fossa.
- Describe the relationship of the contents.
- Explain how popliteal artery can be palpated.
- Discuss clinical related to popliteal fossa like the Baker’s cyst.

**Fibula Osteology and attachment:**
- Identify the bone and its side determination.
- Mark the attachment of muscles and ligaments.
- Elaborate the joints formed by it.
- Describe the nerve injuries related to it.

**Superficial veins of lower limb (Small & great Saphenous vein):**
- Enumerate the superficial veins.
- Highlight the course of great and small saphenous veins.
Discuss their connections with the deep veins of the leg.

Explain clinical related to it like venous thrombosis.

(49) Osteology of foot:
- Discuss the bones forming the architecture of foot.
- Identify joints formed by these bones.
- Describe clinical related to it like flat foot and club foot.

(50) Anterior & Lateral compartment of leg (Muscles, nerves and vessels):
- Discuss the fascial compartments of leg.
- Explain muscles of anterior and lateral compartment with its neurovascular supply.
- Describe clinical (for example the compartment syndrome).

(51) Posterior compartment of leg
Enumerate the muscles of posterior compartment of leg.
- Discuss nerve supply of these muscles.
- Discuss the actions of muscles of posterior compartment of leg.

(52) 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.

(53) 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.
- Name the advices regarding the rehabilitation for plantar fasciitis.

(54) Ankle joint, superior & inferior tibiofibular joint:
- Describe the Ankle Joint, the type, articular surface and the synovial capsule
- Discuss the Superior and Inferior Tibio-Fibular Joints, Sub-talar Joint, transverse tarsal joint or mid-tarsal joint.
- Describe the movement performed and the muscles responsible for that movement
- Discuss the neurovascular supply of the joints.

(55) Nerve injuries of lower limb:
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- 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.
- Explain Sprain ankle.

### (56) Surface anatomy of lower limb:
- Mark inguinal ligament, femoral triangle, patellar tendon, & popliteal fossa.
- Mark the course blood vessels of lower limb, e.g. (Great saphenous)
- Palpate pulsation of the blood vessels (Femoral, popliteal, posterior tibial & dorsalis pedis arteries)
- Mark the course of important nerves of lower limb, e.g. (Sciatic nerve, common peroneal at fibular head)

## BIOCHEMISTRY

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>1. EXTRA CELLULAR MATRIX I &amp; II (ECM)</strong></td>
<td>Discuss the structure and biochemistry of extracellular matrix e.g. Glycosaminoglycans, Collagen and Elastin</td>
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<td><strong>2. VITAMIN C</strong></td>
<td>Describe the biochemical role of vitamin C with respect to Collagen and ECM</td>
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<td><strong>3. VITAMIN D &amp; PARATHYROID HORMONE: ROLE IN CALCIUM &amp; PO4- METABOLISM</strong></td>
<td>Discuss the basic relationship among vitamin D, PTH, calcium and Phosphate in relation to bone metabolism.</td>
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<tr>
<td><strong>4. REACTIONS OF AMINO ACID</strong></td>
<td>Describe the Deamination, Transamination &amp; all the other reactions of Amino Acid</td>
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<td><strong>5. AMMONIA METABOLISM</strong></td>
<td>Explain Ammonia metabolism and its detoxification</td>
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<td><strong>6. UREA CYCLE</strong></td>
<td>Describe the metabolic pathway of Urea along with its abnormalities</td>
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<tr>
<td><strong>7. METABOLISM &amp; DISORDERS OF PHENYLALANINE, TYROSINE</strong></td>
<td>Discuss the metabolism of Phenylalanine &amp; Tyrosine along with their disorders</td>
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<tr>
<td><strong>8. METABOLISM &amp; DISORDERS OF TRYPTOPHAN</strong></td>
<td>Discuss the metabolism of tryptophan along with its disorders</td>
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<tr>
<td><strong>9. METABOLISM OF SULPHUR CONTAINING AMINO ACIDS</strong></td>
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<thead>
<tr>
<th>PHYSIOLOGY</th>
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<tr>
<td><strong>MEMBRANE POTENTIAL</strong></td>
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<tr>
<td>• Define Nernst Potential, Nernst equation</td>
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<td>• Explain the significance of Nernst potential</td>
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<td>• Briefly state the origin of resting membrane potential</td>
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<tr>
<td><strong>ACTION POTENTIAL (PHASES, GENERATION &amp; PROPAGATION)</strong></td>
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<tr>
<td>• Describe the different phases of action potential</td>
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<td>• Given a graph, identify different phases of action potential</td>
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<td>• Define the following: generation &amp; propagation of action potential, threshold potentials &amp; all or none law</td>
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<tr>
<td><strong>PHYSIOLOGICAL PROPERTIES OF SKELETAL MUSCLE</strong></td>
</tr>
<tr>
<td>• Define contractility (isometric &amp; isotonic) &amp; excitability, fatigue, summation (spatial &amp; temporal) and motor unit</td>
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<td>• Differentiate among tetanization, tetanus &amp; tetany</td>
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<td>• Briefly describe the staircase phenomenon (treppe)</td>
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<tr>
<td><strong>MECHANISM OF SKELETAL MUSCLE CONTRACTION</strong></td>
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<tr>
<td>• Briefly describe the structure of Sarcomere</td>
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<td>• Explain sliding filament mechanism &amp; power stroke</td>
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<td>• Define troponin tropomyosin complex</td>
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<td><strong>NEUROMUSCULAR JUNCTION</strong></td>
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<tr>
<td>• List the components of neuromuscular junction</td>
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<td>• Explain the sequence of events during transmission</td>
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<td>• Define end plate potential</td>
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<td>• Describe excitation contraction coupling</td>
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<td>• Briefly describe the role of Sarcoplasmic reticulum</td>
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### DISORDERS OF NEUROMUSCULAR JUNCTION
- Define disorders of neuromuscular junction (Myasthenia Gravis, Lambert-Eaton syndrome)

### MUSCLE ADAPTATION TO EXERCISE
- Describe the types of muscle fibers (type I & II)
- Determine the effect of exercise on muscular blood flow
- Briefly state the effect of training, endurance & resistance on muscle fibers

### Anatomy
1. Differentiate the types of muscles histologically.
2. Identify the histological features of different types of cartilage.
3. Differentiate compact and spongy bone histologically.
4. Identify the microscopic features of Breast (mammary gland)

### BIOCHEMISTRY
1. Estimate serum Calcium, Phosphate and Alkaline Phosphatase.
2. Describe different types of chromatography and HPLC and performance of the paper chromatography.

### PHYSIOLOGY
1. **Introduction to power lab**
   - Describe different parts of power lab & their application in different experiments.
2. **Nerve conduction velocity**
   - Determine nerve conduction velocity in human
3. **Electromyogram (EMG)**
### Tutorials (Anatomy)

<table>
<thead>
<tr>
<th>X-Rays of upper &amp; lower limbs:</th>
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<tr>
<td>- Identify bones of both the limbs</td>
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<td>- Differentiate between hands and feet on X rays</td>
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<tr>
<td>- Identify normal appearance of all limb joints and joint space.</td>
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<td>- Identify the epiphyseal plate</td>
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### 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, quiz or OSPE.
- Internal evaluation carries 20% weightage in summative examination.

### Examination

MCQs and OSPE (observed + un observed).