Musculoskeletal Anatomy

Chapter 1
This Week

Monday - Anatomy (classroom)

Tuesday - Group Workout

Wednesday - Movement skill analysis

Thursday - Group Workout

Friday - Anatomy (classroom)
- **Human Anatomy**: The study of the structures that make up the human body and how those structures relate to each other.
The Musculoskeletal System

- The Musculoskeletal System is made up of
  - the **skeletal** system which includes bones and joints
  - the **muscular** system which contains the muscles

When bones come together, they form **joints**. Muscles cross these joints and pull on bones causing movement at the joints.
Terms and Concepts
Worth Knowing
Anatomical Position
Description
- Standing erect
- Facing forward
- Arms hanging at the sides
- Palms facing forward and the thumbs outward
- Legs straight
- Heels, feet and great toes parallel to each other

The starting reference point for describing the human body

It is universally accepted

It is used in all anatomical descriptions
Directional Terms
Reminder:

All directional terms are based on the assumption that the body is in the anatomical position.
Lateral-Medial

- **Lateral** – Away from the midline of the body
- **Medial** – Toward the midline

- E.g., Your ears are *lateral* to your cheeks and your cheeks are *medial* to your ears
Distal-Proximal

- **Distal** – Further from some specified region
- **Proximal** – Closer to some specified region

- E.g., With respect to the trunk, the hands are *distal* to the arms and the arms are *proximal* to the hands.
- E.g., The colon is the *distal* portion and stomach is the *proximal* portion of the digestive tract
Anterior-Posterior

- **Anterior** – In front of or front of your body
- **Posterior** – Behind or back of your body

- E.g., Your lips are *anterior* to your teeth and your teeth are *posterior* to your lips
- E.g., In the anatomical position, your palms are facing anteriorly
Superior-Inferior

- Superior – Above
- Inferior – Below

- E.g., Your lips are superior to your chin and your chin is inferior to your lips
- Supine
  - Lying on the back
  - E.g., Performing a bench press

- Prone
  - Lying face down
  - E.g., Preparing to perform a push-up
Internal - External

- Internal – located inside or further away from the surface
- External – located on or near the surface
Planes of the Body
Planes

- Imaginary flat surfaces that divide the human body

- They are used to:
  - divide the body for further identification of particular areas
  - describe different movements or actions

- Always refer to the body in the anatomical position
Median plane or midsagittal plane

- A vertical plane that bisects the body into equal right and left halves

- Sagittal plane is any plane parallel to the median plane
- Frontal plane
  - A vertical plane that bisects the body into front and back
  - It is at right angles to the median plane
- **Transverse plane or horizontal plane**

  - A horizontal plane that bisects the body into top and bottom

  - It is at right angles to both the median and coronal planes
Centre of gravity

- The point at which the median, frontal, and transverse planes intersect
Movements
- Movement around a joint may be around any one (or more) of three axes

- Most movements are found in pairs – for every movement, there is generally a movement that is opposite to it
Axes of Movement

- **Sagittal Axis**: passes horizontally from posterior to anterior and is formed by the intersection of the sagittal and transverse planes.

- **Frontal Axis**: passes horizontally from left to right and is formed by the intersection of the frontal and transverse planes.

- **Transverse Axis**: passes vertically from inferior to superior and is formed by the intersection of the sagittal and frontal planes.
Flexion-Extension

- **Flexion** - reduces the angle between two bones at a joint
- **Extension** - increases the angle between two bones at a joint

- Usually a sagittal plane movement
- E.g., Biceps curl
  - Lifting the weight reduces the angle at the joint = flexion
  - Lowering the weight increases the angle at the joint = extension
Dorsiflexion-Plantar flexion

- Modified flexion with respect to the ankle joint

- Dorsiflexion – bringing the top of the foot toward the lower leg or shin

- Plantar flexion – “planting” the foot
Abduction-Adduction

- **Abduction** – moving a segment away from the midline of the body
- **Adduction** – moving segment toward the midline of the body
- Frontal plane movement
- E.g., The motions of the arms and legs during a jumping jack
- Hint:
  - Abduct = “take away” from the midline
  - Adduct = “add” toward the midline
Circumduction

- A cone of movement that does not include any rotation
- Occurs when flexion-extension movements are combined with abduction-adduction movements
- E.g., Tracing an imaginary circle in the air with your index finger
  - The tip of your finger represents the base of the cone, while your knuckle forms the apex of this conical motion
Rotation

- Turning a bone along its longitudinal axis
- Medial rotation – rotation toward the midline
- Lateral rotation – rotation away from the midline
Pronation-supination

- Movements related to the forearm and hand

- **Pronation** – when the palm is moved to face posteriorly

- **Supination** – when the palm is moved to face anteriorly (Hint: you can hold a bowl of soup)
Inversion-Eversion

- Movements related to the sole of the foot

- **Inversion** – When the sole is turned inward (as when you "go over" on your ankle)

- **Eversion** – When the sole is turned outward or away from the median plane of the body
The Musculoskeletal System
The Bare Bones of Human Anatomy
The Function of the Skeletal System

1. Protection of the vital organs
2. Support and maintenance of posture
3. Providing attachment points for the muscles
4. Storage and release of minerals such as calcium and phosphorus
5. Blood cell production or haemopoiesis
6. Storage of energy
Bone is a living tissue complete with blood supply and nerves
The skeletal system is made up of the bones, cartilage, ligaments and joints of the body, and accounts for approximately 20% of body weight.

The skeleton roughly determines the shape and size of the body.

There are 206 bones in the skeleton and it is divided into two parts: the axial skeleton and the appendicular skeleton.
The Human Skeleton
Axial Skeleton
Axial Skeleton

- Skull
- Sternum
- Ribs
- Vertebral Column
Skull

- Divided into two parts:
  a) Cranium
  b) Face
a) Cranium

- Frontal Bone
- Parietal Bone
- Temporal Bone
- Occipital Bone
b) Facial Bones

- Lacrimal Bone
- Nasal Bone
- Zygomatic Bone
- Maxilla Bone
- Mandible Bone
Vertebral Column — 33 vertebrae in total

7 Cervical Vertebrae (of the neck)

12 Thoracic Vertebrae (of the chest)

5 Lumbar Vertebrae (of the lower back)

5 Sacrum (mid-line region of buttocks)

4 Coccyx (fused vertebrae of the tail bone)
Vertebral Column

- Vertebrae are arranged in a cylindrical column interspersed with fibrocartilaginous (intervertebral) discs

- Function:
  - Provides strong and flexible support for the body and the ability to keep the body erect. Support the head.
  - The point of attachment for ribs and muscles of the back
  - Protects the spinal cord and nerves
  - Absorbs shock through the intervertebral discs without causing damage to other vertebrae
Ribs

- Twelve pairs

- Made up of:
  - Bone
  - Cartilage, which strengthens the chest cage and permits expansion

- Curved and slightly twisted, making them ideal for protecting the chest area
Ribs

- All 12 pairs of ribs articulate with the thoracic vertebrae posteriorly and sternum anteriorly.
- Classified into three groups based on anterior attachment:
  - True ribs
    - 1-7
    - attach to both the vertebrae and the sternum
  - False ribs
    - 8-10
    - attach only to the sternum indirectly, through 7th rib
  - Floating ribs
    - 11 and 12
    - attach only to the vertebral column
The Ribs

Sternum

Xiphoid Process

True Ribs (1 - 7)

False Ribs (8, 9, 10)

Floating Ribs (11, 12)
Sternum

- Mid-line breast bone
- The clavicles and ribs one to seven articulate with the sternum
Appendicular Skeleton
Appendicular skeleton

Consists of:

- 1. The pectoral girdle (chest)
- 2. The upper limb
- 3. Pelvic girdle (hip)
- 4. The lower limb
Appendicular Skeleton
1. Pectoral Girdle

Consists of:

- Scapula (shoulder blade)
- Clavicle (collar bone)

- Allows the upper limb great mobility
- The sternoclavicular joint is the only point of attachment between the axial skeleton and the pectoral girdle
2. Upper Limb

- Humerus
  - The arm bone
  - Shoulder to elbow

- Radius and Ulna
  - The forearm bones
  - Elbow to wrist
  - Radius is located on the thumb side of the hand
  - When you pronate the forearm, the radius is actually crossing over the ulna – try it yourself
Upper Limb

- Carpals
- Metacarpals
- Phalanges
3. Pelvic Girdle

- Made up of 3 bones fused together: ilium, ischium and pubis.

- Supports the bladder and abdominal contents

- Attachment:
  - Posteriorly – join with the sacrum
  - Anteriorly – join to each other
  - Laterally – join to the head of thigh bone (femur) in a cup-shaped acetabulum
4. Lower Limb

■ Femur
  – Thigh bone
  – From hip to knee

■ Patella
  – Knee cap
  – Sesamoid bone in the tendon of the quadriceps (thigh) muscles
Lower Limb

- **Tibia and Fibula**
  - Leg bones
  - From knee to ankle
  - Tibia is medial and fibula is lateral

- **Medial malleolus and Lateral malleolus**
  - The distal ends of the tibia and fibula, respectively
  - Commonly referred to as the "ankle bones"
  - Can be easily palpated
Lower Limb

- **Tarsals**
  - Ankle bones
  - Calcaneus or heel bone
  - Talus

- **Metatarsals**
  - 5 bones of the foot
  - Unite with the toes

- **Phalanges**
  - Toe bones
  - Three per toe, except the big toe – proximal, middle, and distal
http://www.softschools.com/science/human_body/skeletal_system/
Effect of Fitness on Bone

- When bones are subjected to regular physical activity and habitual loads, they tend to become more dense and more mineralized.
  - E.g., Right forearm bones of right-handed tennis players are more dense than their left ones due to more frequent use.

- Inactivity works in the opposite direction, leading to a decrease in weight and strength.
  - E.g., Loss of bone mass has been noted in bed-ridden patients, inactive senior citizens, and astronauts.
Joints of the Human Body

A joint or articulation is where two or more bones come into contact or articulate with each other.

What is the main function of joints?
Joint Movement and Stability

- Joint movement is linked to joint stability. The more movement a joint has, the less stability it has and the greater the risk of injury.

- Discuss a high risk joint.
Types of Joints

- Joints are classified by the material that joins them:
  - **Fibrous joints**
    - Allow no movement
    - E.g., sutures of the skull
  - **Cartilaginous joints**
    - Allow limited movement
    - E.g., intervertebral discs
  - **Synovial joints**
    - Allow large range of movements
    - E.g., knee joint
Types of Synovial Joints

- Synovial are further classified into:

1. Hinge Joint
2. Pivot Joint
3. Condyloid Joint
4. Saddle-shaped joint
5. Ball and Socket Joint
6. Gliding Joint
1. Hinge Joint

- Uniaxial – movement one direction
- Bend (flex) or straighten (extend) in one direction only

- E.g., *humero-ulnar elbow joint*, interphalangeal joint
Pivot Joint

- Uniaxial
- One bone rotates around one axis

- E.g., head of radius rotating against ulna
Condyloid (Knuckle) Joint

- Biaxial – can move in two directions (flexion-extension, abduction-adduction)

- E.g., metacarpophalangeal joint
Saddle Joint

- Biaxial (flexion-extension, abduction-adduction)
- The bones set together as in sitting on a horse
- E.g., carpometacarpal joint of the thumb
Ball and Socket Joint

- Multiaxial (rotation in all planes)
- Has the greatest amount of movement
- A rounded bone is fitted into a cup-like receptacle
- E.g., shoulder and hip joints
Gliding Joint

- Uniaxial (permits gliding movements)
- Has the least amount of movement
- The bone surfaces involved are nearly flat
- E.g., intercarpal joints and acromioclavicular joint
Muscles of the Human Body
- Over 600 muscles in the human body
- Allow the skeleton to move
- Vary in size, shape and structure
- Make up about 40-50% of the weight of the body
Three Types of Muscle

- **Skeletal muscle**: used to move the skeleton, voluntary control, striated appearance

- **Cardiac muscle (heart)**: involuntary control, striated appearance

- **Smooth muscle**: involuntary, not striated, lines the walls of blood vessels and hollow organs
Muscles have four main functions:

1. Joint movement
2. Movement of substances in our body ex. food, feces, cardiac muscle pumps blood
3. To stabilize the skeleton
4. Generate body heat
Structure of Skeletal Muscle

- Fascia is a type of connective tissue that is located in-between and surrounding other tissues of the body such as muscles and bones.

- Fascia is made up of fibrous tissue, adipose tissue and fluid.
Structure of Skeletal Muscle
Both ends of a muscle are anchored to support structures by tendons.

Each muscle consists of many muscle fibers.

Each muscle fiber, in turn, consists of many myofibrils.

Sarcomeres, which represent the basic functional unit of muscles, extend from one Z disc to another.

The sliding of myosin filaments along actin filaments causes muscles to contract.

The heads of myosin molecules bind reversibly to special sites on actin filaments.
Muscle size

- Hypertrophy – muscles will get bigger with exercise (increase in myofibrils)

- Atrophy – muscles will get smaller with lack of exercise (decrease in myofibrils)
Origin and Insertion of Muscles

- Two attachment points for muscles:
  1. **Origin** is usually the more proximal attachment (the end that is closest to the centre of the body). This is the bone that usually stays fixed.
  2. **Insertion** is usually the more distal attachment (the end furthest away from the centre of the body). This is usually the moveable bone.
Muscles of the trunk
Rectus Abdominis

- Paired midline muscles
- Powerful flexor of the anterior abdominal wall
- Strengthening of the abdominal muscles is a very important part of back therapy, because the abdominals act to support the back
- Origin: pubis
- Insertion: 5th - 7th ribs and sternum
External Oblique

- **Origin:** lower eight ribs
- **Insertion:** ilium

**Functions:**
- Lateral bending of the abdomen
- Rotation of the abdomen
- Extension of the abdomen during forced inspiration
- Allow the development of a pregnant uterus
- Contract to help expel fecal contents from the rectum
Erector spinae muscles

- Important posterior neck muscles

- Origin: ribs, cervical, thoracic and lumbar vertebrae, ilium

- Insertion: ribs, cervical, thoracic and lumbar vertebrae

- Maintain your erect position
  - Also called anti-gravity muscles
  - When someone faints, these muscle no longer function and the body falls face forward to the ground
Muscles of the Upper Extremity

- **Anterior muscles:**
  - deltoid
  - pectoralis major
  - biceps brachii

- **Posterior muscles:**
  - trapezius
  - latissimus dorsi
  - triceps brachii
Deltoid

**Origin**: scapula, clavicle

**Insertion**: lateral humerus

Since the fibers run across the joint in several directions it is involved in most shoulder movements.
Pectoralis Major

**Origin:** sternum, clavicle, anterior ribs

**Insertion:** lateral humerus

Involved in all shoulder movements where the arm is brought forwards and upwards.
Biceps Brachii

Has two heads (hence *bi*-ceps)

**Origin:** Scapula

**Insertion:** radius

Crosses two joints – it is involved in both shoulder and elbow movement. It flexes (bends) the arm upwards at the shoulder and flexes (bends) the elbow.

Also supinates the forearm
Trapezius

- **Location:** posterior neck and upper back
- **Important lateral neck muscles**
- **Origin:** base of the skull, cervical and thoracic vertebrae
- **Insertion:** clavicle, scapula
- **Movements:**
  - Acting alone, tilt the head to the one side
  - Raise the shoulders
Latissimus Dorsi

- Brings the arm backwards and rotates the arm inwards
- Origin: sacrum, ilium, thoracic and lumbar vertebrae
- Insertion: humerus
- Good for rowing and swimming
Triceps Brachii

- Located on the posterior upper arm.
- Origin: scapula, humerus (has three heads)
- Insertion: ulna
- Helps move the arm backwards and straightens the elbow
Muscles of the Lower Extremity
Muscles of Lower Extremity

- Generally bigger than the upper extremity muscles.
- They bear the weight of the entire body and forcefully push off the ground to move forwards and upwards when walking.
Muscles of the Lower Extremity

- **Anterior Muscles**
  - iliopsoas
  - sartorius
  - quadriceps
  - tibialis anterior

- **Posterior Muscles**
  - gluteus maximus
  - hamstrings
  - gastrocnemius
  - soleus
Iliopsoas

- Deep muscle
- Important for standing, walking & running
- Hip flexor
- Origin: lumbar vertebrae, ilium
- Insertion: inner femur
Sartorius

- Origin: ilium
- Insertion: medial tibia
- Longest muscle in the body
  - Used to sit cross-legged
- Primary knee extensors
- Sartorius and Rectus femoris also aid in flexion of the hip
Quadriceps

- 4 muscles used to straighten the knee joint.
- Important for jumping and kicking

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<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
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<tbody>
<tr>
<td>Rectus femoris</td>
<td>Ilium</td>
<td>All four the same</td>
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<tr>
<td>Vastus lateralis</td>
<td>Femur</td>
<td>patella and</td>
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<tr>
<td>Vastus intermedius</td>
<td>Femur</td>
<td>upper tibia</td>
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<tr>
<td>Vastus medialis</td>
<td>Femur</td>
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Tibialis anterior

- Located front of leg
- Origin: lateral tibia
- Insertion: first metatarsal
- Pulls toes towards the shins
- Used in walking and running
Gluteus Maximus

- Largest of the three buttock muscles
- Moves thigh backwards and principal extensor of the hip
- Origin: posterior ilium, sacrum and coccyx
- Insertion: lateral femur
Hamstring group - 3 muscles

- Primary flexors of the knee
- Also extend the hip
- Powerfully used when running and kicking
Two main muscles in the calf

- Gastrocnemius
  - most superficial and most prominent
  - has two proximal heads
  - Origin: posterior femur
  - Insertion: calcaneus (via achilles tendon)

- Soleus
  - Origin: posterior tibia and fibula
  - Insertion: calcaneus via achilles tendon

Principal plantar flexors of the ankle
Summary

- Human anatomy deals with the structures that make up the human body (structure determines function)
- The bones, joints, and muscles that make up the musculoskeletal system allow numerous movements to occur, with varying degrees of:
  - Motion capabilities
  - Strength
  - Flexibility
- Bones provide the structural framework necessary for support
- Muscles supply the power
- Joints supply the mechanism that allows human movement to occur