



I. Introduction

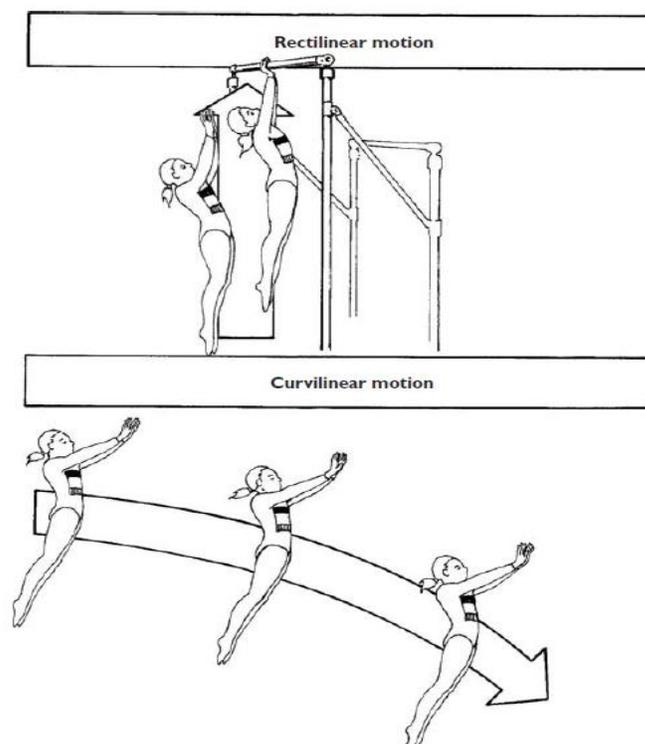
In biomechanics, understanding motion requires precise terminology and reference systems. This lecture introduces the fundamental kinematic concepts that form the basis for describing human movement. These include the **forms of motion**, the **standard reference terminology**, and **joint movement terminology** used throughout biomechanics and kinesiology.

II. Forms of Motion

A. Linear Motion

Pure linear motion involves uniform motion of the system of interest, with all system parts moving in the same direction at the same speed. Linear motion is also referred to as **translation motion**. When a body experiences translation, it moves as a unit, and portions of the body do not move relative to each other.

- **Linear:** along a line that may be straight or curved, with all parts of the body moving in the same direction at the same speed.
- **Translation:** linear motion.
- **Rectilinear:** along a straight line.
- **Curvilinear:** along a curved line

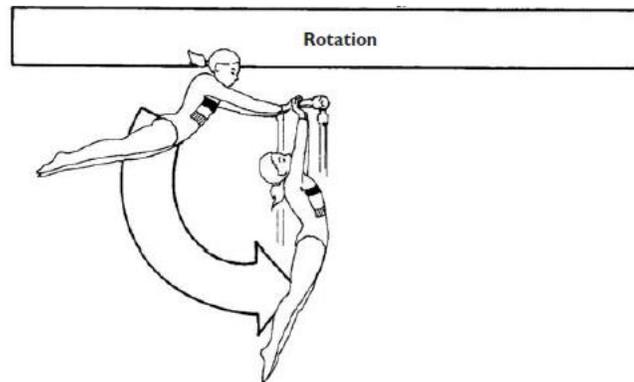




B. Angular Motion

Angular motion is rotation around a central imaginary line known as the **axis of rotation**, which is oriented perpendicular to the plane in which the rotation occurs.

- **Angular:** involving rotation around a central line or point.
- **Axis of rotation:** imaginary line perpendicular to the plane of rotation and passing through the center of rotation.



C. General Motion

Most human movement is general motion, a complex combination of linear and angular motion components.

- **General motion:** involving translation and rotation simultaneously.

III. Standard Reference Terminology

To describe human motion accurately, standardized reference positions, planes, and axes are used. The anatomical reference position and directional terms provide a consistent basis for identifying movement directions and positions of body segments.

A. Anatomical Reference Position

The anatomical reference position is an erect standing position with all body parts, including the palms of the hands, facing forward. It is considered the starting point for all body segment movements.

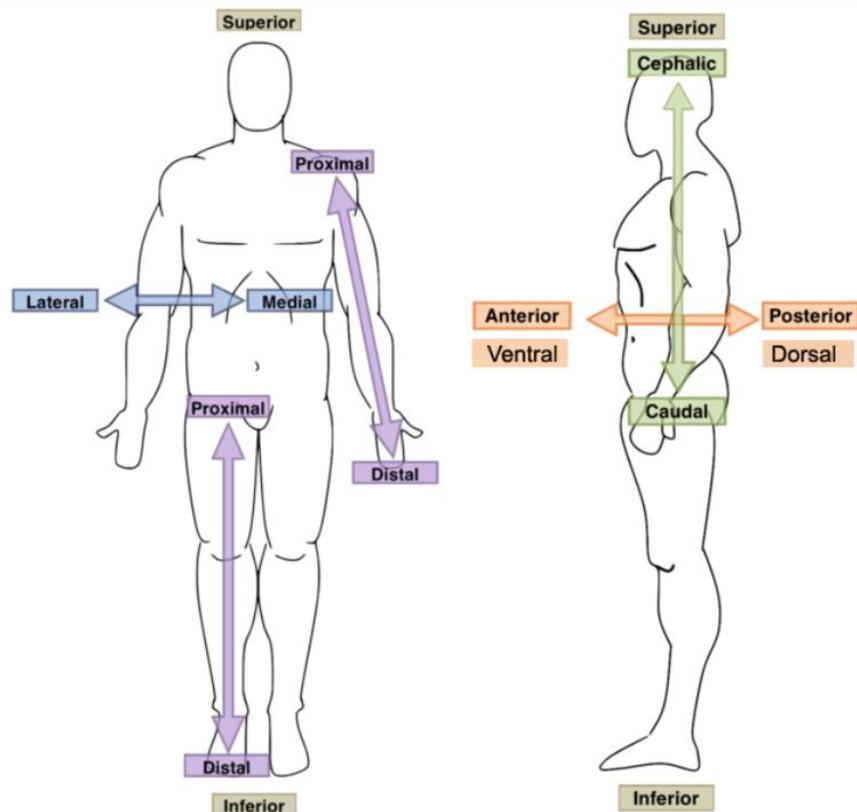


B. Directional Terms

Directional terms are used to describe the position of body parts in relation to each other.

Common Directional Terms include:

- **Superior:** closer to the head.
- **Inferior:** closer to the feet.
- **Anterior (ventral):** toward the front of the body.
- **Posterior (dorsal):** toward the back of the body.
- **Medial:** toward the midline of the body.
- **Lateral:** away from the midline of the body.
- **Proximal:** closer to the trunk.
- **Distal:** farther from the trunk.
- **Cephalic/Caudal:** Equivalent to closer to the head and closer to the tail.

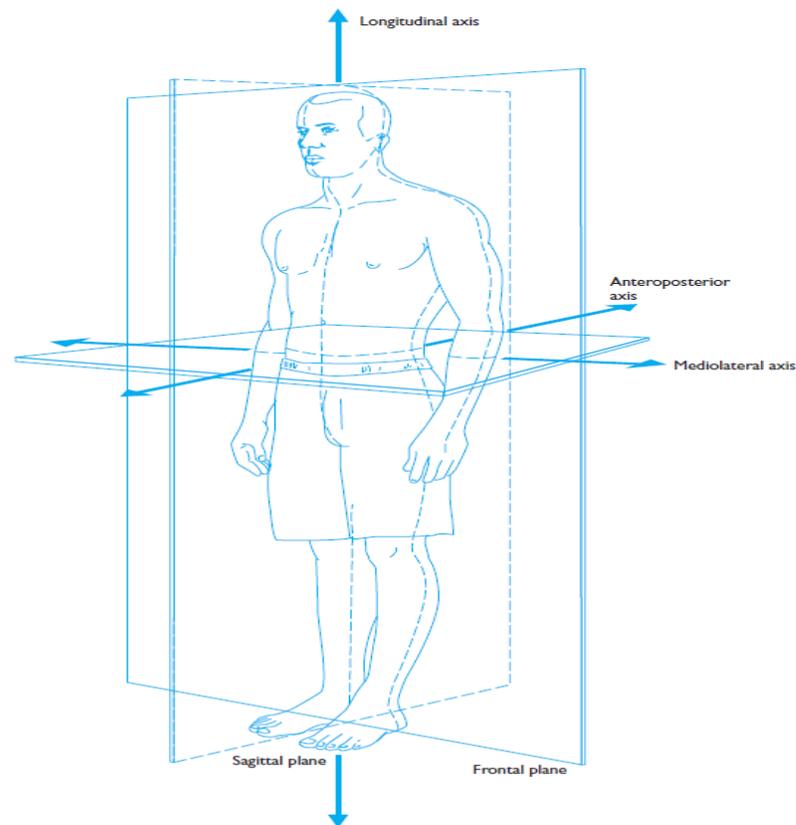




C. Anatomical Reference Planes

Three imaginary cardinal planes are used to divide the body: sagittal, frontal, and transverse planes.

1. **Sagittal Plane:** Divides the body into left and right halves. Movements in this plane are typically flexion and extension.
2. **Frontal Plane:** Divides the body into front and back halves. Movements include abduction and adduction.
3. **Transverse Plane:** Divides the body into upper and lower halves. Movements include rotations.



D. Anatomical Reference Axes

Axes are imaginary lines that pass through the body around which rotational movement occurs.

- **Mediolateral Axis:** runs side to side, perpendicular to the sagittal plane.
- **Anteroposterior Axis:** runs front to back, perpendicular to the frontal plane.
- **Longitudinal Axis:** runs vertically; perpendicular to the transverse plane.



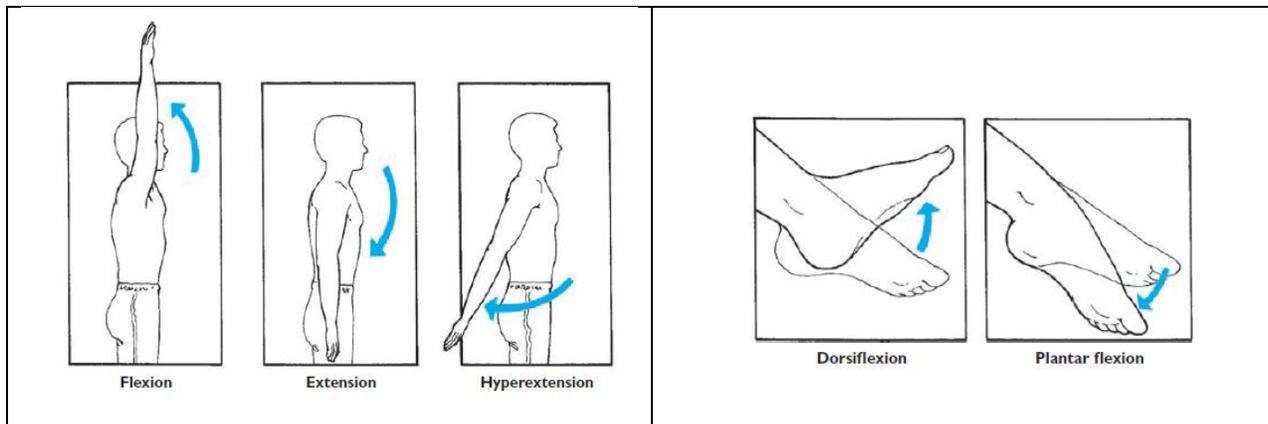
IV. Joint Movement Terminology

Joint movement terminology describes movements that occur primarily within each of the three major reference planes.

A. Sagittal Plane Movements

The sagittal plane divides the body into left and right halves and includes movements that occur in this plane.

- **Flexion:** A movement that decreases the angle between two body segments. For example, bending the elbow or knee.
- **Extension:** The opposite of flexion, it increases the angle between two body segments, such as straightening the arm or leg.
- **Hyperextension:** Movement beyond the anatomical position, where the body part moves past its normal range of motion. For instance, bending the head backwards beyond the normal range.
- **Dorsiflexion:** Movement of the foot bringing the toes closer to the shin (e.g., standing on heels).
- **Plantarflexion:** Pointing the toes away from the body, such as when standing on tiptoe.



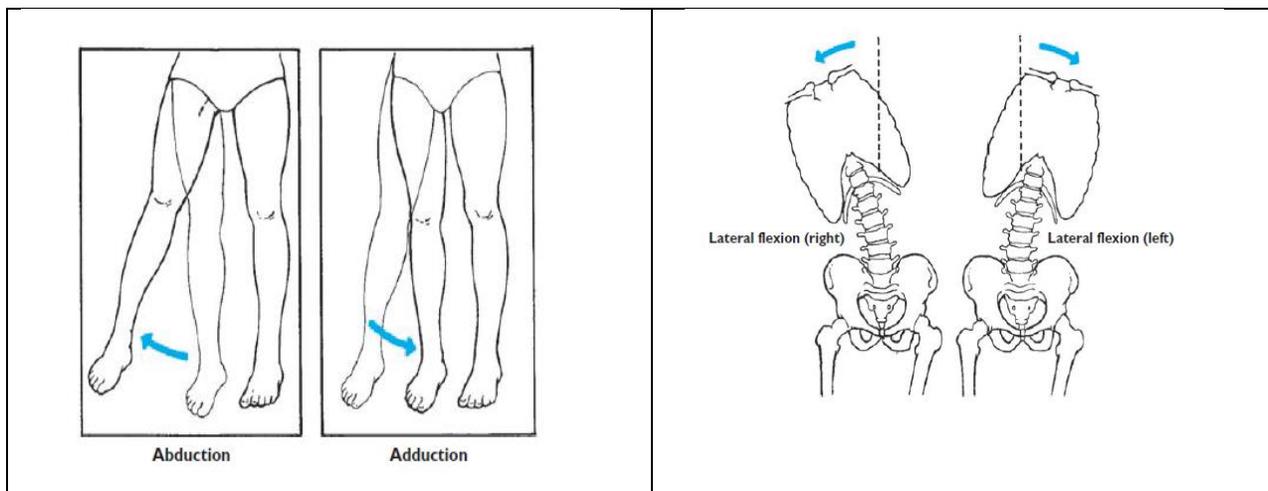
Sagittal plane movements at the shoulder.

Sagittal plane movements of the foot.

B. Frontal Plane Movements

The frontal plane divides the body into front and back halves and involves movements such as:

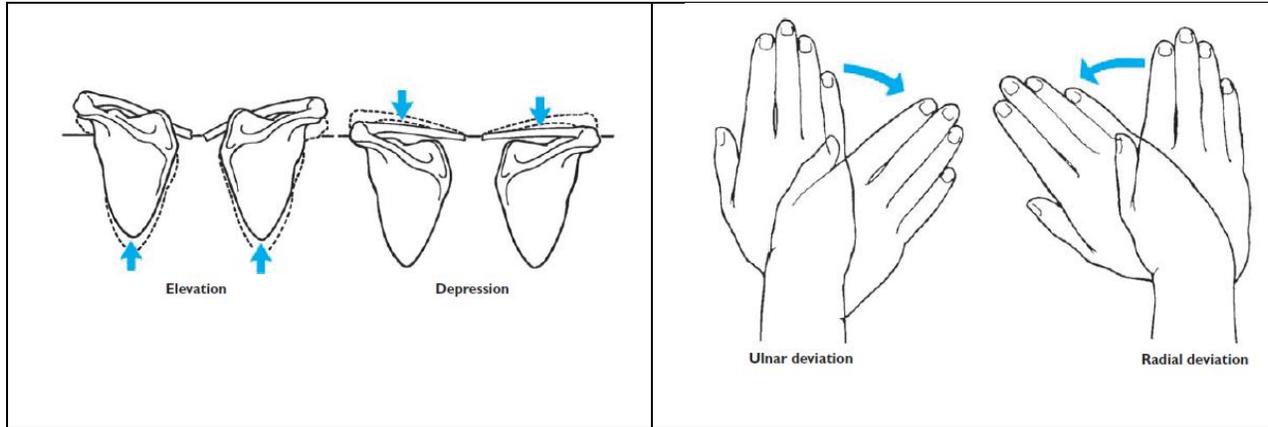
- **Abduction:** Moving a body segment away from the midline of the body. For example, raising the arms out to the side.
- **Adduction:** Bringing a body segment toward the midline of the body, such as bringing the arms back to the side after abduction.
- **Lateral Flexion:** Side bending of the trunk to the left or right.



Frontal plane movements at the hip.

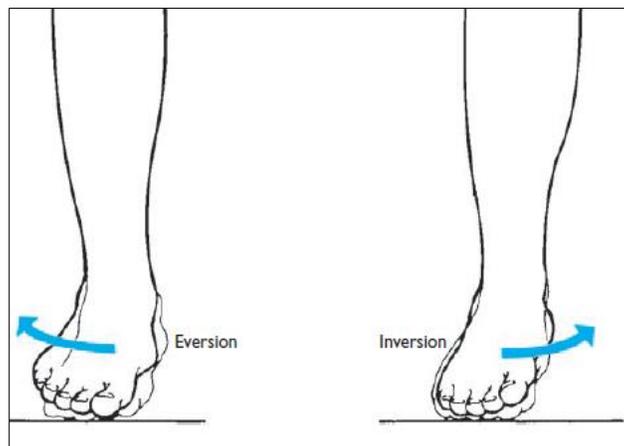
Frontal plane movements of the spinal column.

- **Elevation and Depression:** Movement of the shoulder girdle upward (elevation) and downward (depression).
- **Radial and Ulnar Deviation:** Movement of the wrist toward the thumb (radial) or toward the pinky (ulnar) (Figure 2-11).
- **Eversion and Inversion:** Movements of the foot. Eversion moves the sole of the foot outward, and inversion moves it inward.



Frontal plane movements of the shoulder girdle.

Frontal plane movements of the hand.



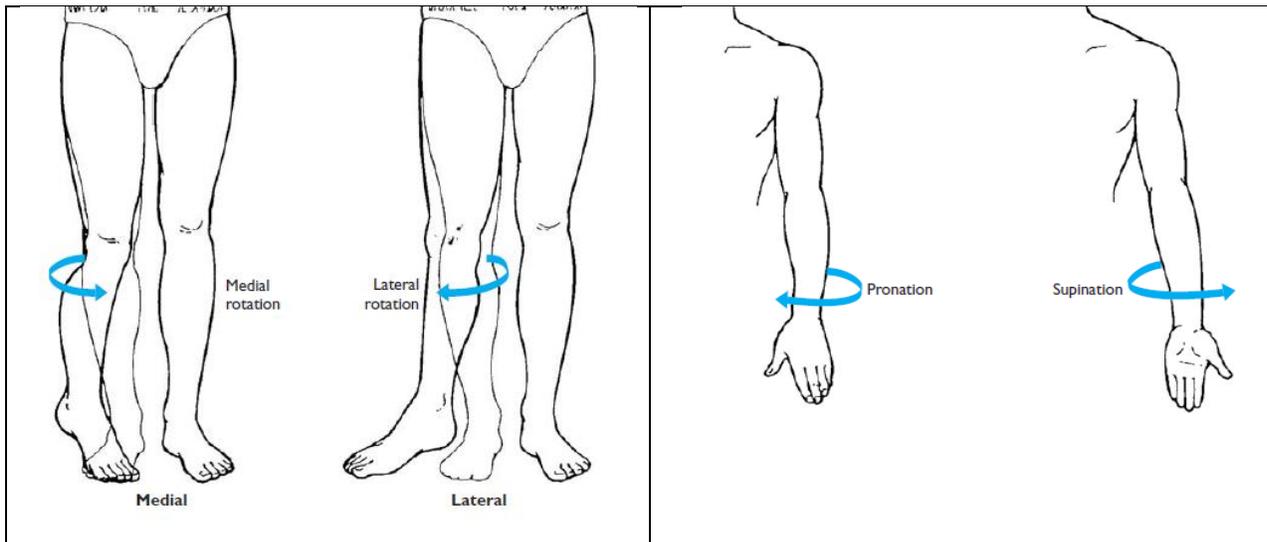
Frontal plane movements of the foot.

C. Transverse Plane Movements

The transverse plane divides the body into top and bottom halves. Movements in this plane are rotational around a vertical axis:

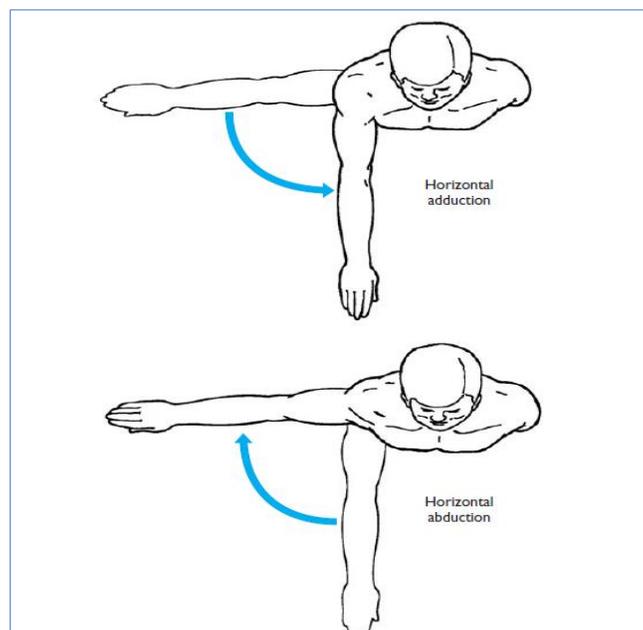
- **Left and Right Rotation:** Movements of the head, neck, and trunk in a rotational manner, like turning the head left or right.
- **Medial and Lateral Rotation:** Rotation of a limb toward the body's midline (medial) or away from it (lateral), often applied to the hip or shoulder joints.

- **Supination and Pronation:** Specific to the forearm. Supination turns the palm upward, while pronation turns it downward.
- **Horizontal Abduction and Adduction:** Occurs when the arm or thigh is flexed, and the movement takes place in the transverse plane from an anterior to lateral position (abduction) or from lateral to anterior (adduction).



Transverse plane movements of the leg.

Transverse plane movements of the forearm.

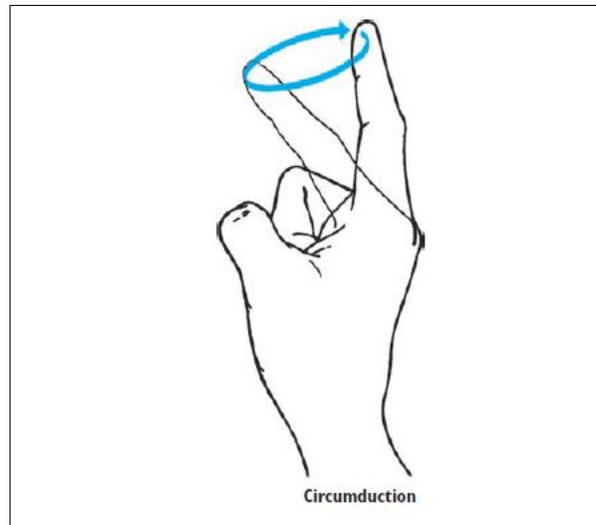


Transverse plane movements at the shoulder.



D. Additional Movements:

- **Circumduction:** Circular movement involving flexion, extension, abduction, and adduction. This is seen when tracing a circle with a finger or the arm.



Circumduction of the index finger at the metacarpophalangeal joint.