



AUM

American University Of The Middle East

PES111

Biomechanics of human movement

Biomechanics is the science concerned with the internal and external forces acting on the human body and the effects produced by these forces.

Biomechanics : `the study of the movement of living things using the science of mechanics'

Mechanical principles are applied to:

- Human body
 - Structure
 - Function
-
- **a plane** of motion is a particular spatial direction or dimension of motion
 - **an axis** is an imaginary line around which motion occurs

ANATOMICAL POSITION

Anatomical terms for describing relations:

Anterior: towards the front (ventral).

Posterior: towards the back (dorsal).

Superior: towards the head.

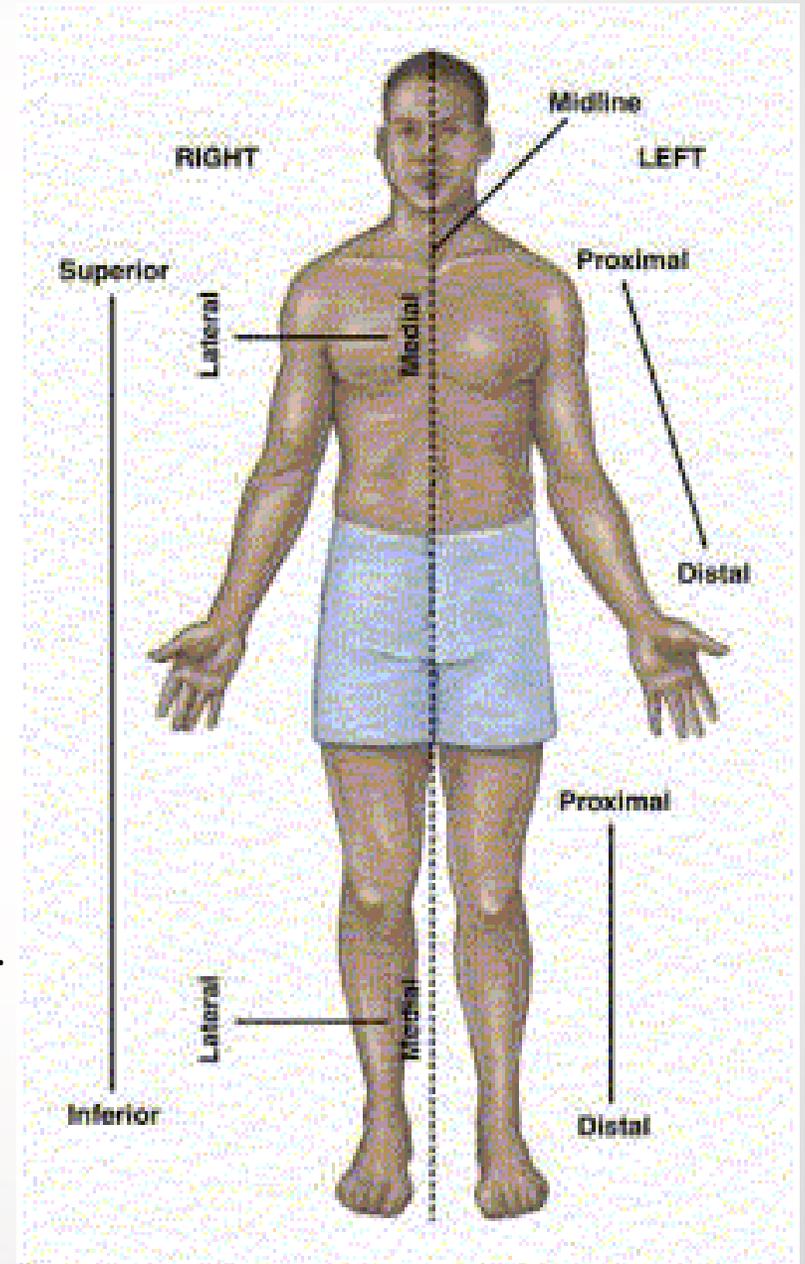
Inferior: towards the feet.

Medial: towards the median plane (near the middle of the body).

Lateral: away from the median plane (away from the middle of the body).

Proximal: near the trunk.

Distal: away from the trunk.



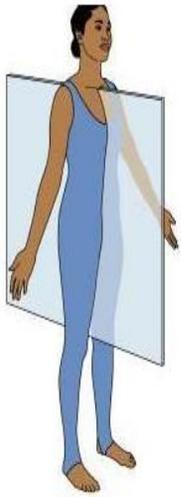


Video – The planes of motion

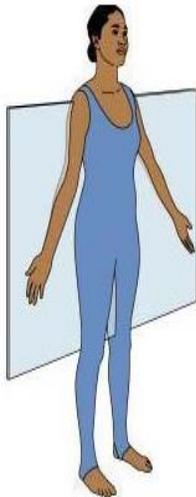
<https://www.youtube.com/watch?v=0SNnCr0-9AQ>

Body planes

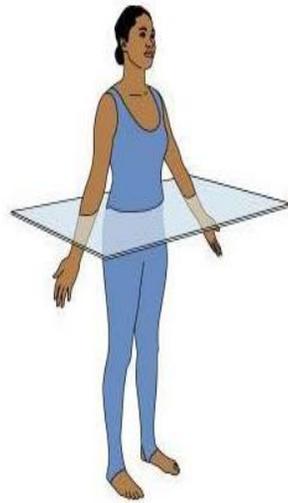
There are 3 different planes of motion: *sagittal, frontal, and transverse*.
In each plane, several different movements occur at the joints.



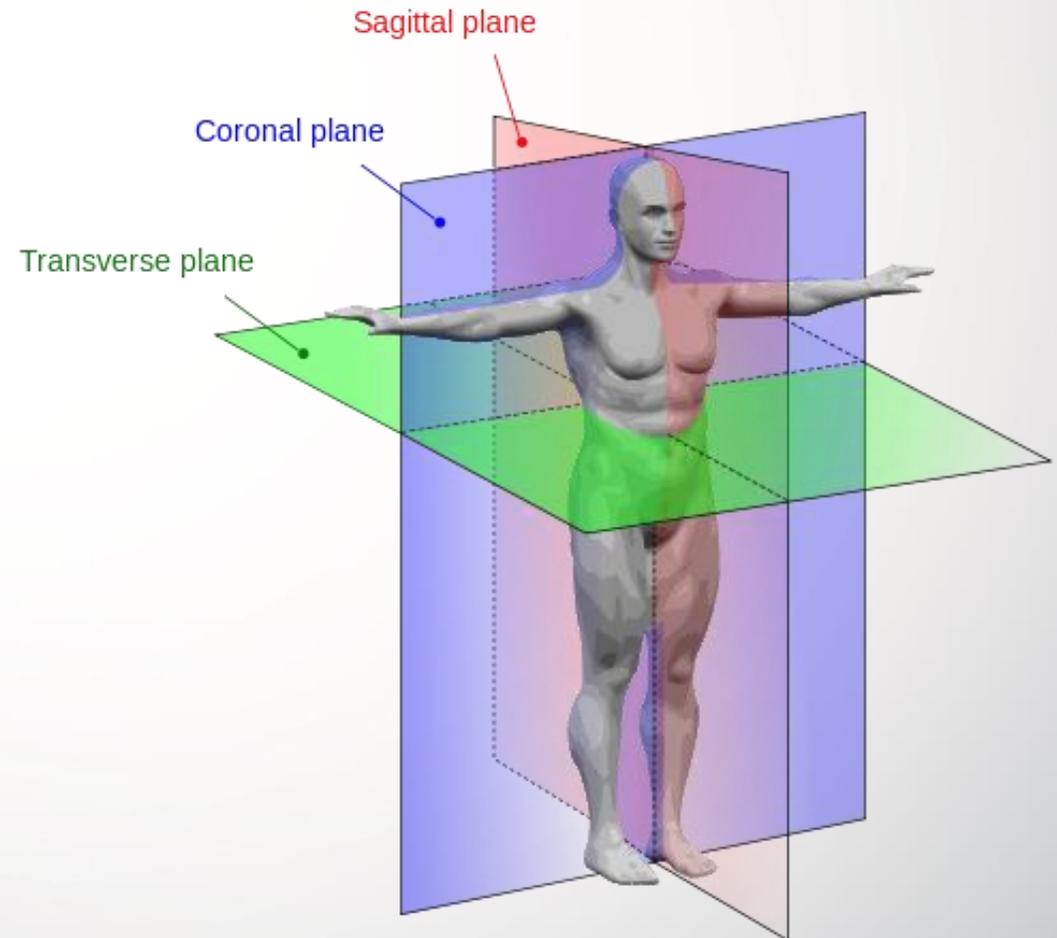
Mid-sagittal
or
Midline



Coronal
or
Frontal



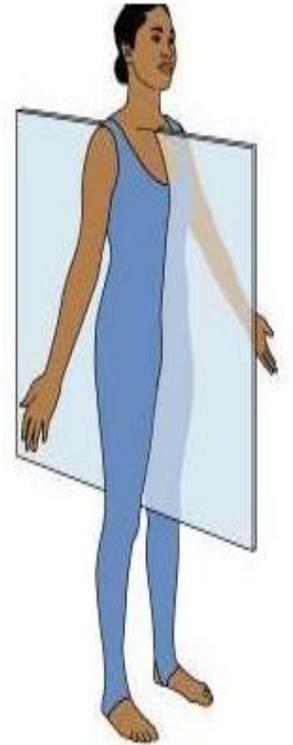
Transverse
or
Horizontal



Sagittal plane

Dividing the body into left and right halves using an imaginary line gives us the ***sagittal plane***.

Any forward and backward movement parallel to this line occurs in the ***sagittal plane***.



Mid-sagittal
or
Midline



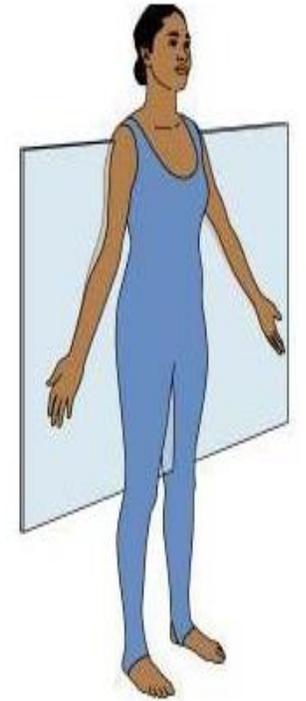
Sagittal:

- **Flexion:** Decreasing the angle between two bones
- **Extension:** Increasing the Angle between two bones
- **Dorsiflexion:** Moving the top of the foot toward the shin (only at the ankle)
- **Plantar flexion:** moving the sole of the foot downward (pointing the toes)

FRONTAL PLANE

With the same imaginary line as the sagittal, divide the body into front and back halves and you have the frontal plane.

Any lateral (side) movement parallel to the line will occur in the ***frontal plane***.



Coronal
or
Frontal



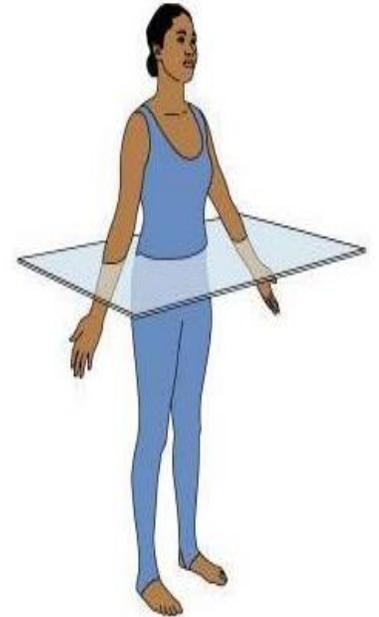
Frontal:

- **Adduction:** Motion toward the midline
- **Abduction:** Motion away from the midline of the body
- **Elevation:** Moving to a superior position (only at the scapula)
- **Depression:** Moving to an inferior position (only at the scapula)
- **Inversion:** Lifting the medial border of the foot
- **Eversion:** Lifting the lateral border of the foot

Transverse plane

The transverse plane, which divides the body into top and bottom halves.

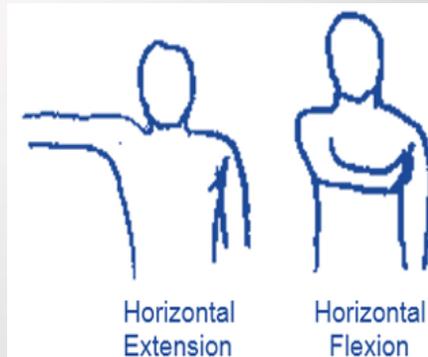
Movement parallel to the waistline, otherwise known as rotational movement (twisting), occurs in the ***transverse plane***.



Transverse
or
Horizontal

Transverse:

- **Rotation**- Internal (inward) or external (outward) turning about the vertical axis of the bone
- **Pronation**- Rotating the hand and wrist medially from the bone
- **Supination**-Rotating the hand and wrist laterally from the bone
- **Horizontal Flexion (adduction)**- From the 90-degree abducted arm position, the humerus is flexed (adducted) in toward the midline of the body in the transverse plane
- **Horizontal Extension(abduction)**- Return of the humerus from horizontal flexion

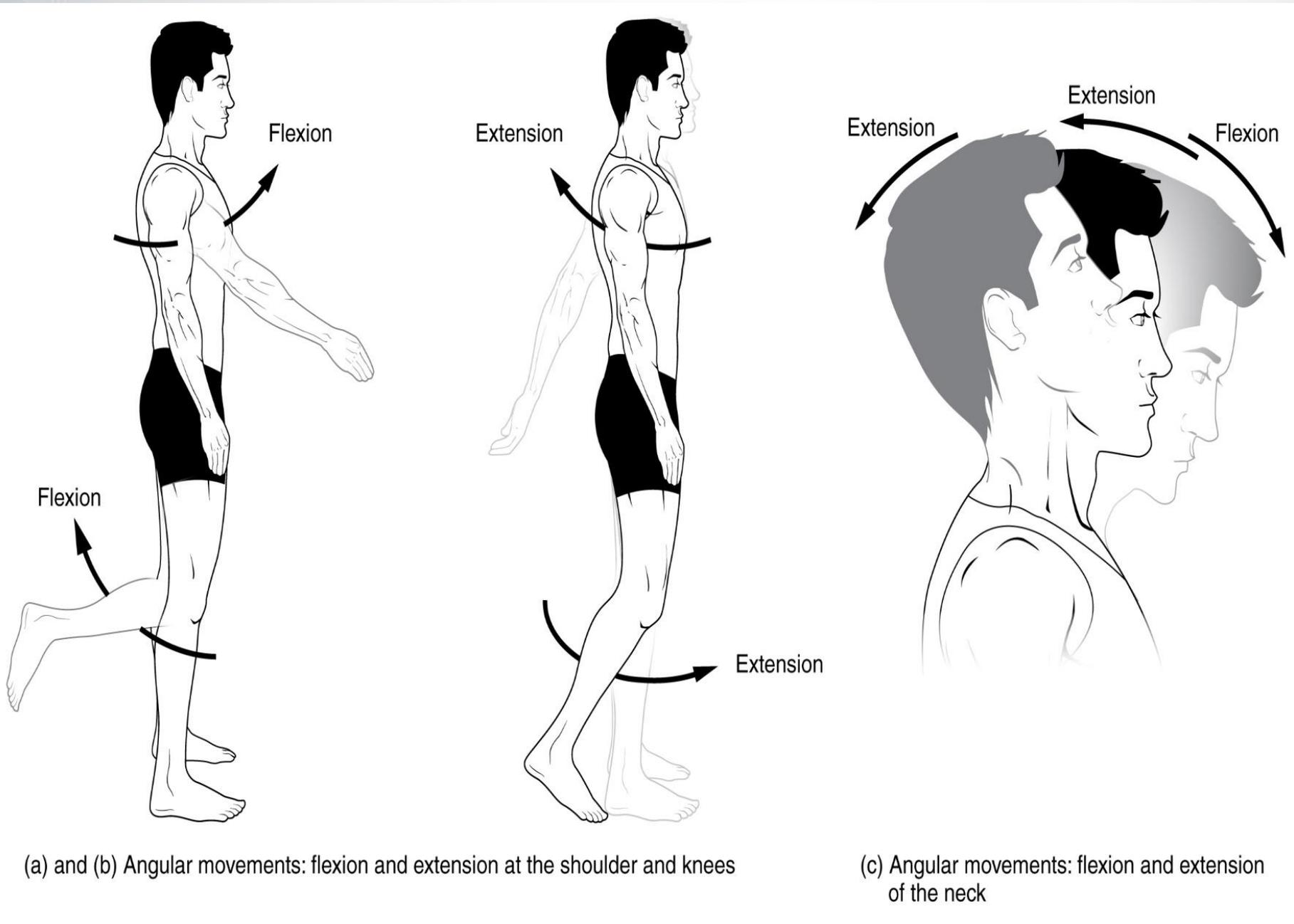


Plane	Action	Definition
Sagittal	Flexion	Decreasing the angle between two bones
	Extension	Increasing the angle between two bones
	Dorsiflexion	Moving the top of the foot toward the shin (only at the ankle joint)
	Plantarflexion	Moving the sole of the foot downward (only at the ankle joint)
Frontal	Abduction	Motion away from the midline of the body (or part)
	Adduction	Motion toward the midline of the body (or part)
	Elevation	Moving to a superior position (only at the scapulae)
	Depression	Moving to an inferior position (only at the scapulae)
	Inversion	Lifting the medial border of the foot (only at the subtalar joint)
	Eversion	Lifting the lateral border of the foot (only at the subtalar joint)

Plane	Action	Definition
Transverse	Rotation	Internal (Inward) or external (outward) turning about the vertical axis of bone
	Pronation	Rotating the hand and wrist medially from the elbow
	Supination	Rotating the hand and wrist laterally from the elbow
	Horizontal Flexion (adduction)	From a 90-degree abducted shoulder or hip position, the humerus or femur, respectively is flexed (adducted) in toward the midline of the body in the transverse plane
	Horizontal Extension (Abduction)	The return of the humerus or femur from horizontal flexion (adduction)
Multiplanar	Circumduction	Motion that describes a “cone”, combines flexion, extension, abduction, and adduction in sequence
	Opposition	Thumb movement unique to humans and primates

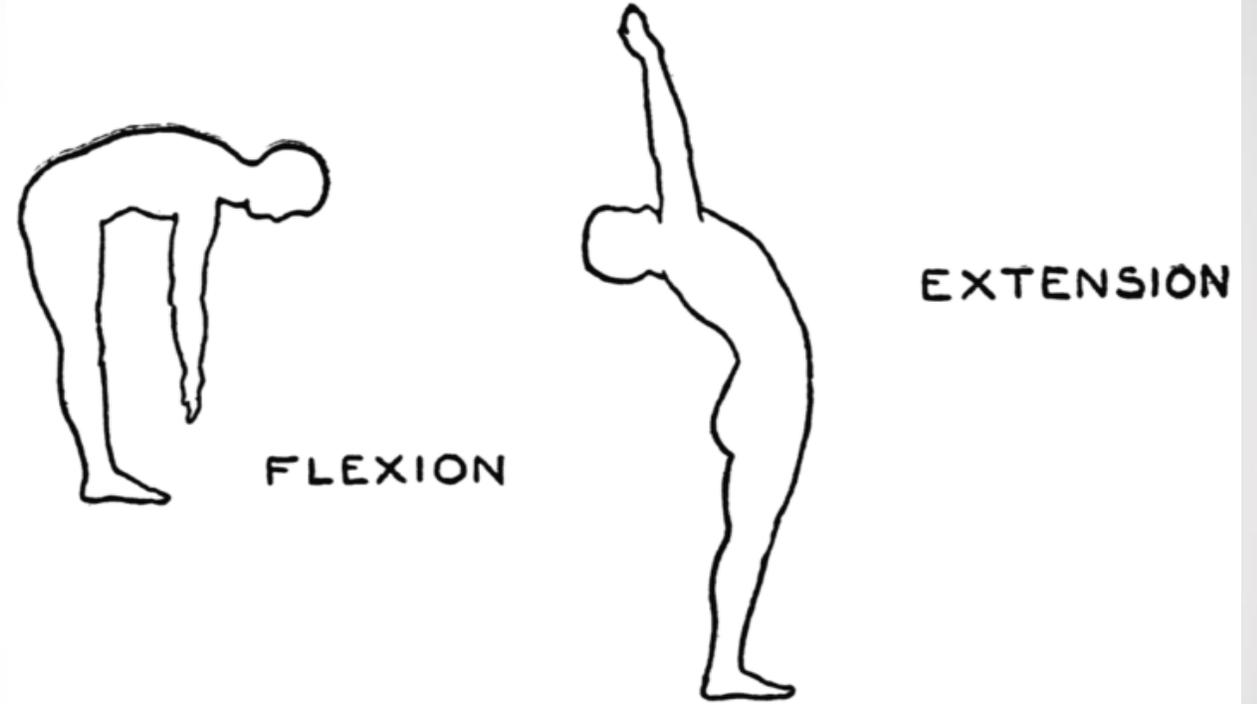
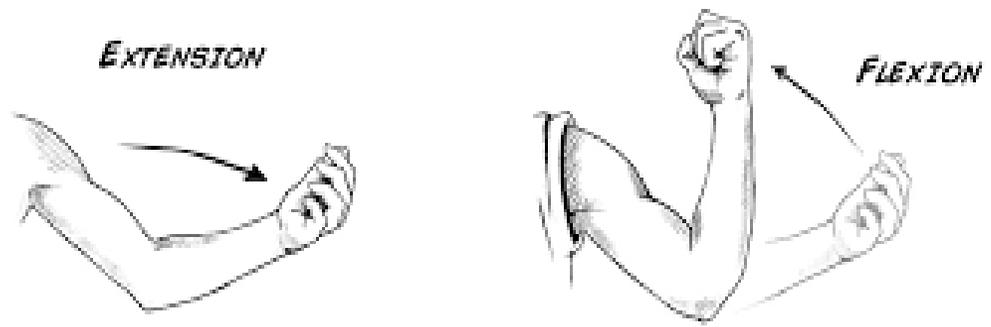
*Pronation of the foot is a combination of eversion and abduction, raising the lateral edge of the foot

*Supination of the foot is a combination of inversion and adduction, raising the medial edge of the foot

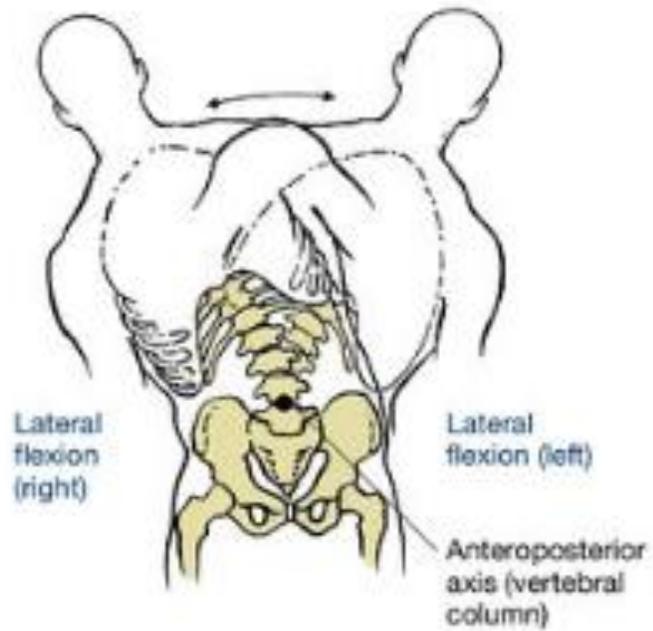


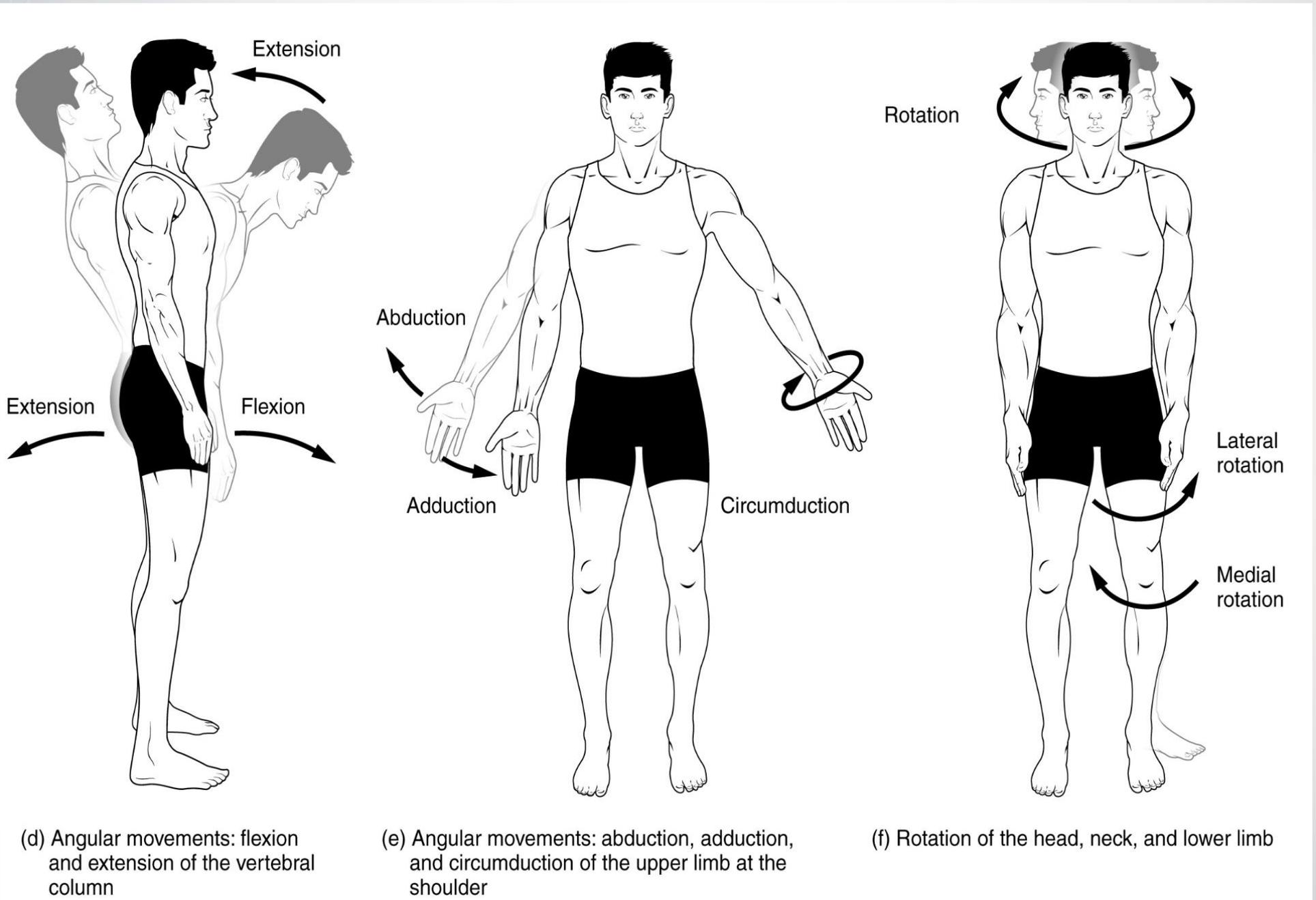
(a) and (b) Angular movements: flexion and extension at the shoulder and knees

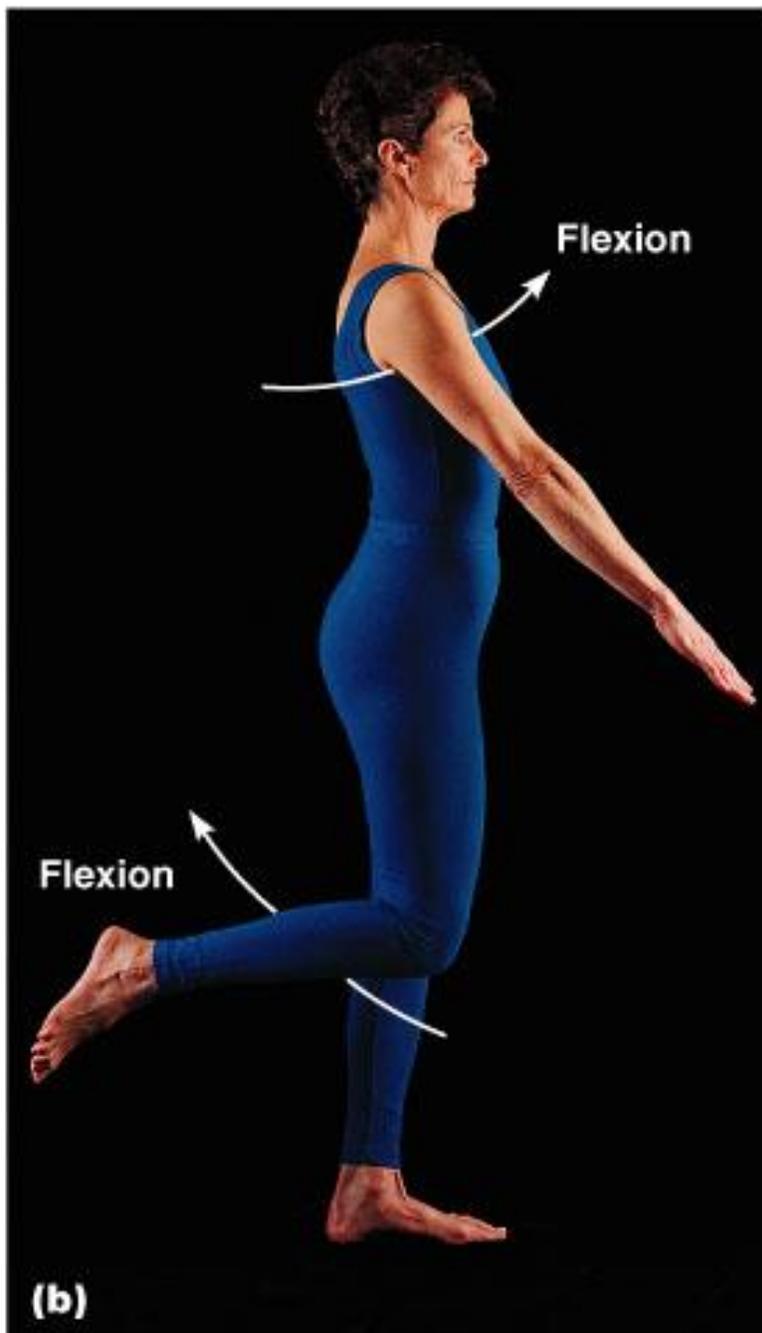
(c) Angular movements: flexion and extension of the neck

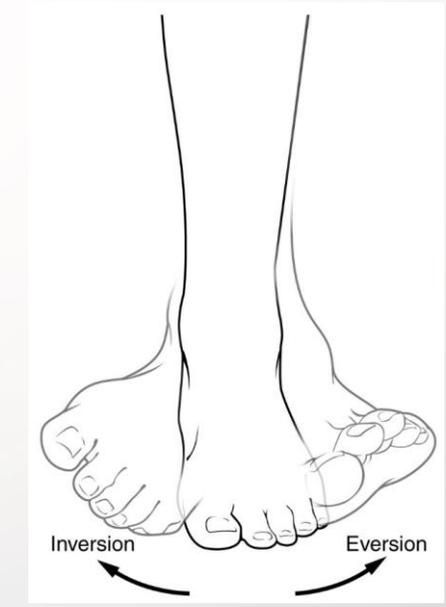
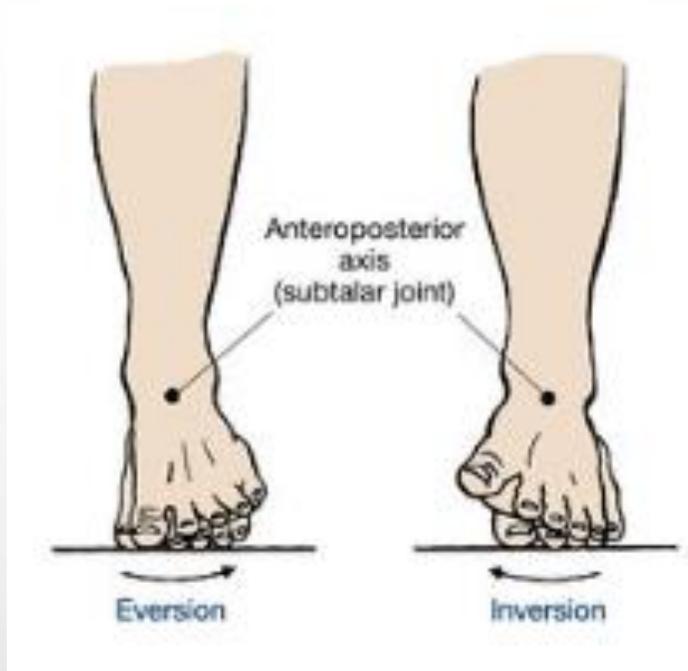
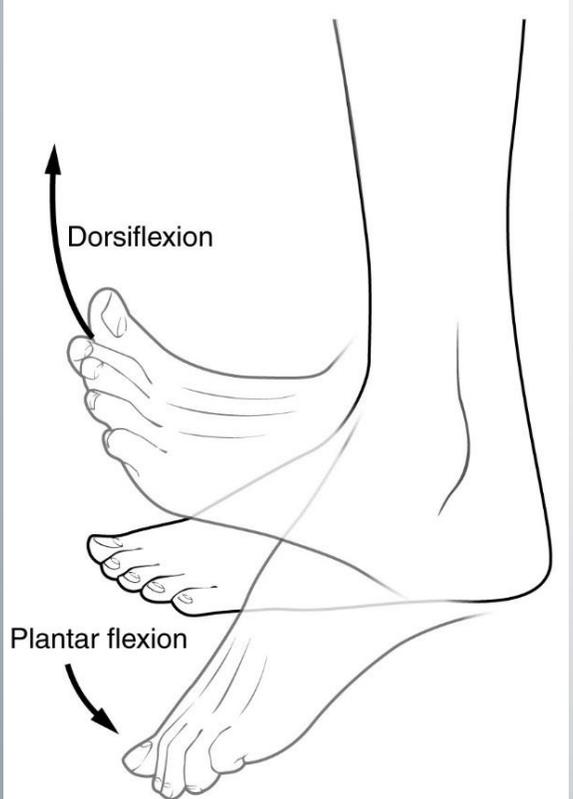
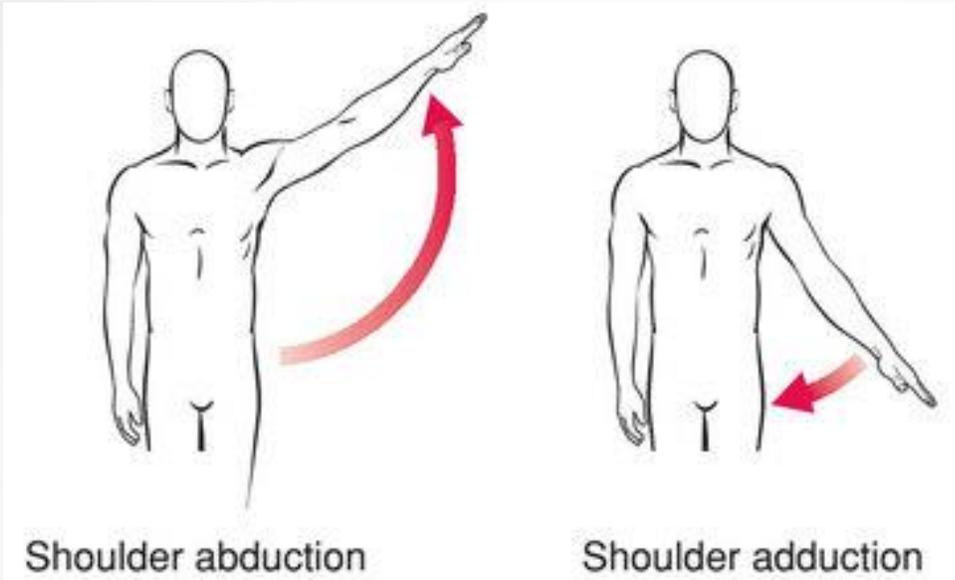


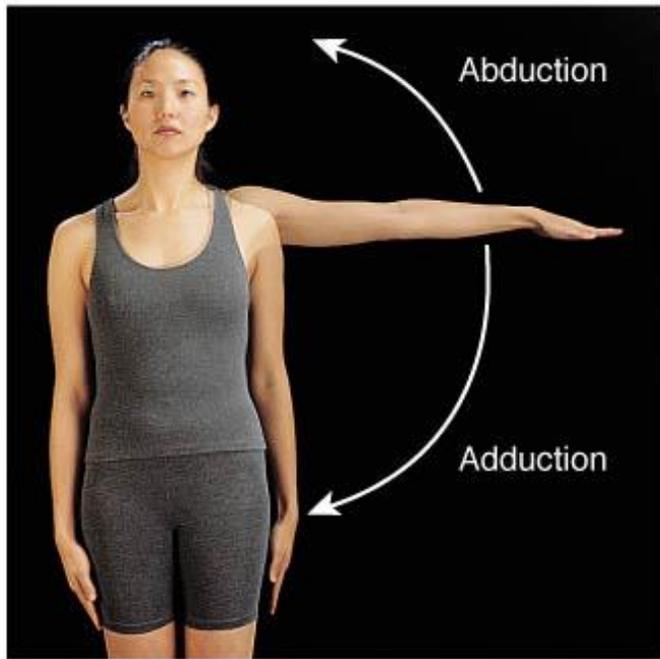
MOVEMENTS OF THE TRUNK.



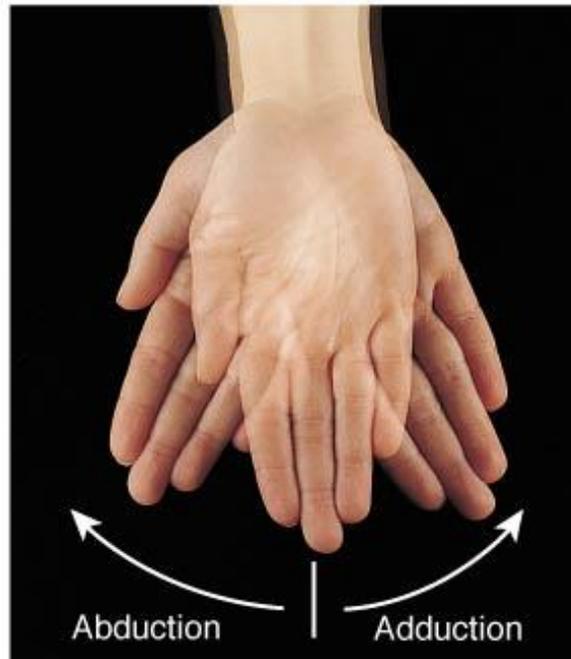




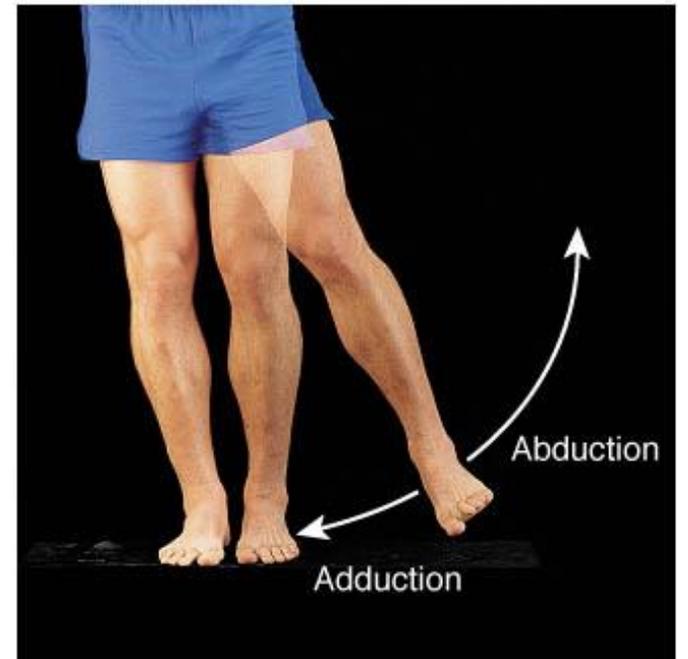




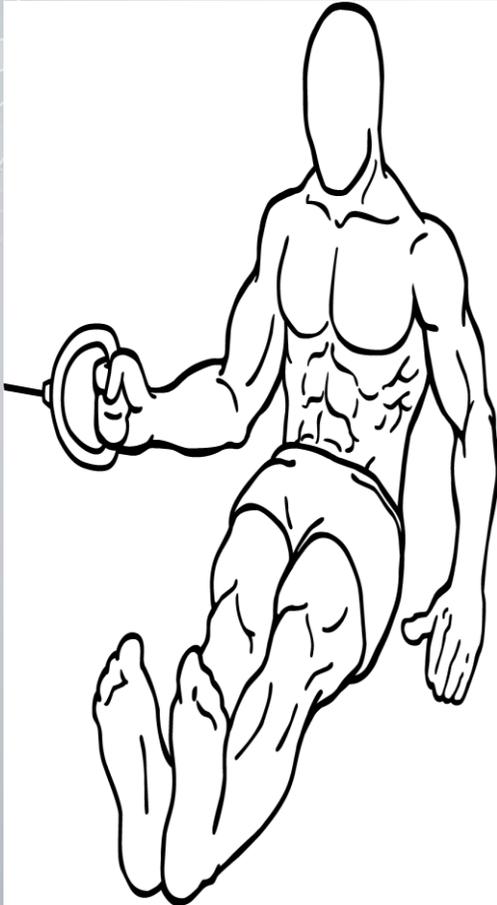
(a) Shoulder joint



(b) Wrist joint

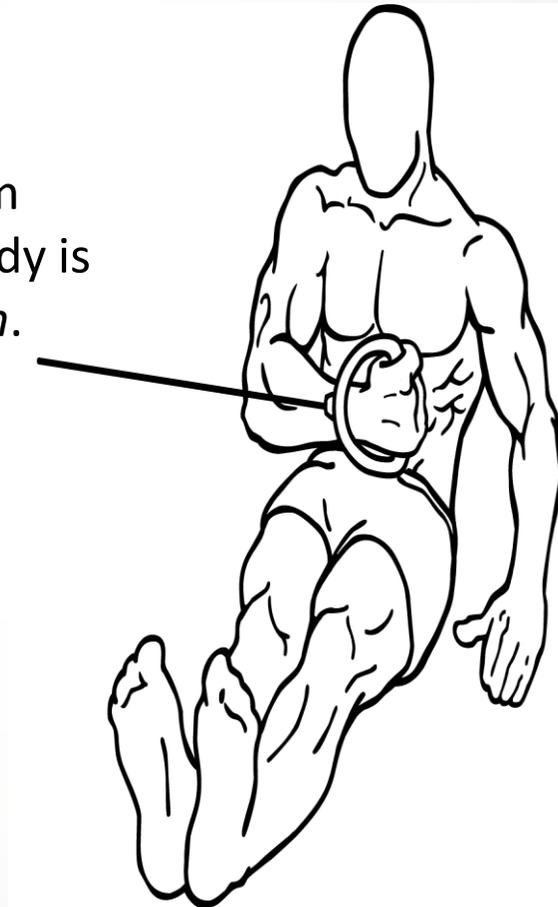


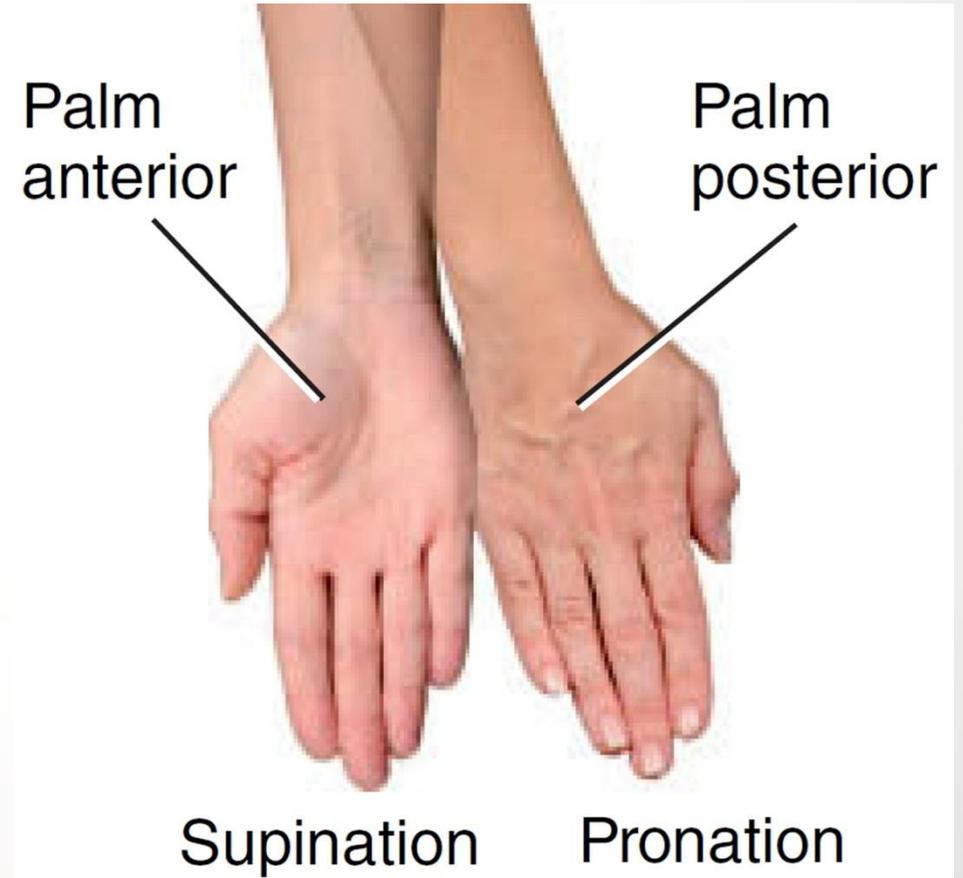
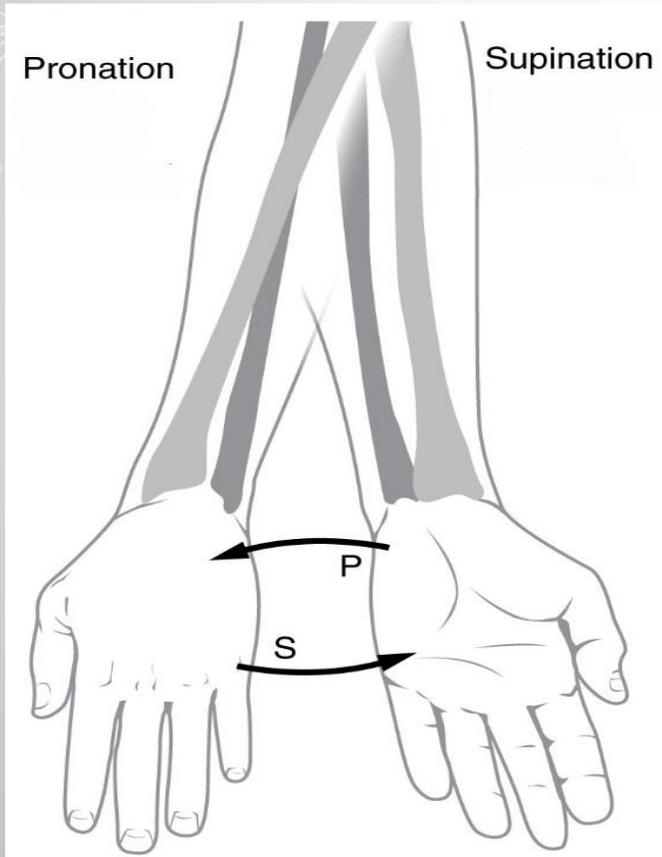
(c) Hip joint



Rotating the arm
away from the
body is *external
rotation*.

Rotating the arm
closer to the body is
internal rotation.

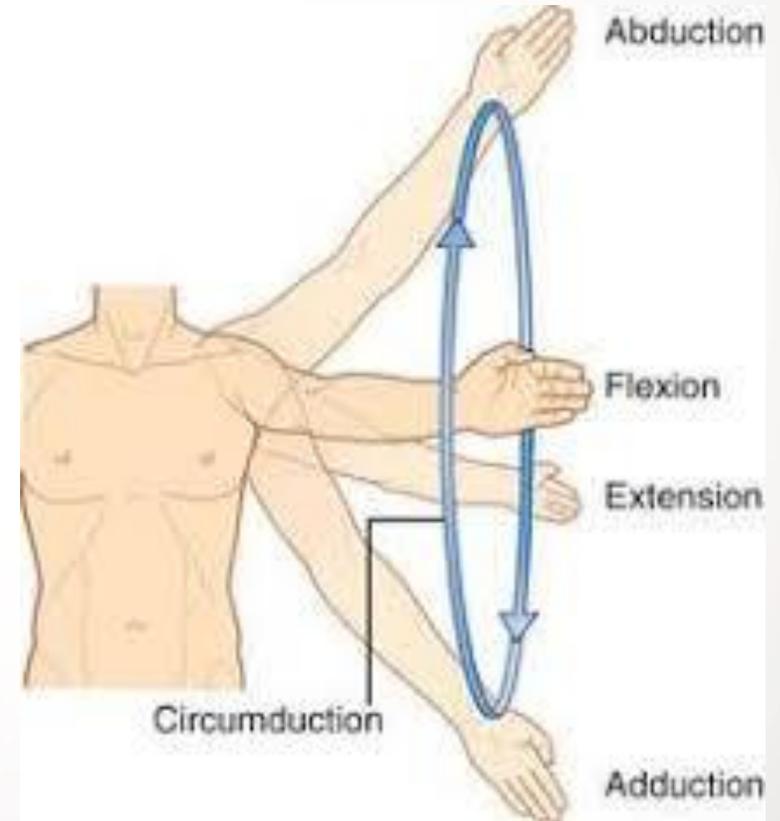




Circumduction

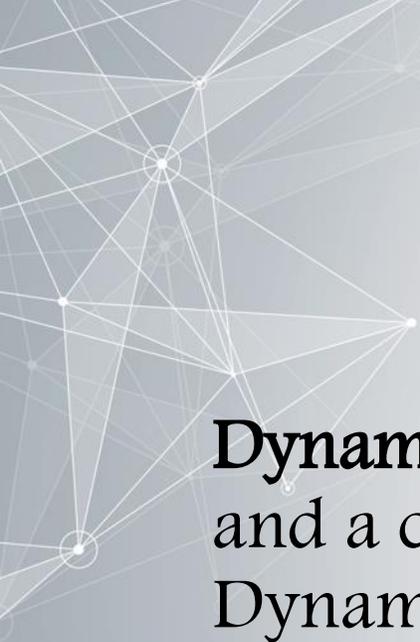


The swinging action made during a tennis serve is an example of *circumduction*



A ballerina,
demonstrating
plantar flexion of the
feet.





Types of muscle contractions

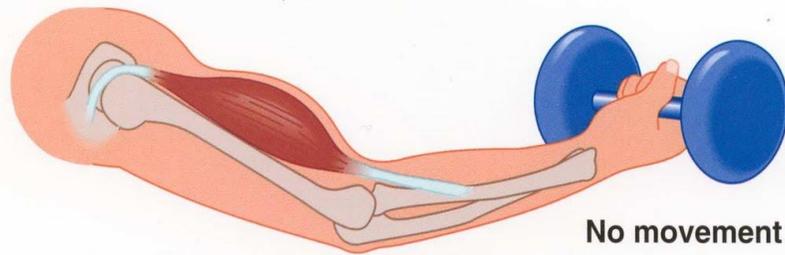
Dynamic exercise, also called isotonic: causes a muscle contraction and a change in the length of the muscle and the angle of the joint. Dynamic exercises are the most popular for increasing muscle strength and seem to be most valuable for developing strength.

Two kinds of dynamic muscle contractions:

- Concentric contraction
- Eccentric contraction

Isometric contraction

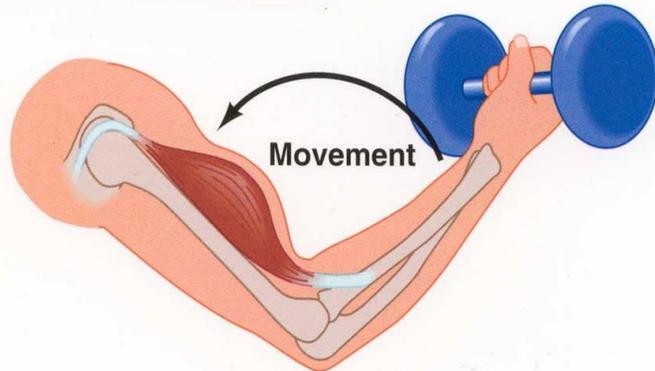
Muscle contracts
but does not shorten



No movement

(a)

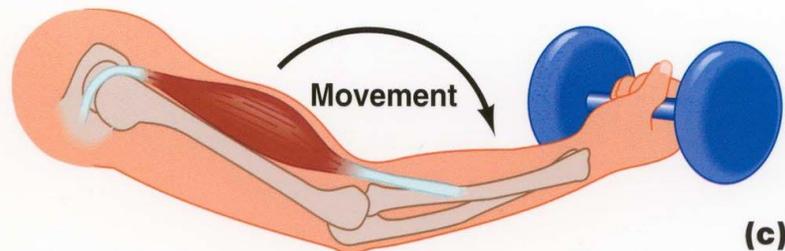
Concentric contraction



Movement

(b)

Eccentric contraction



Movement

(c)

Static or Isometric exercise: causes a muscle contraction without changing the length of the muscle or the angle in the joint on which the muscle acts.

For example: If during the squat the person stopped moving at a certain point (say halfway up) and held that position for 6 seconds, the quadriceps muscle would be contracting isometrically, it would still be under load/tension, but no movement would occur.

Concentric muscle Contraction occurs when the muscle applies enough force to overcome resistance and shortens as it contracts.

Eccentric muscle contraction occurs when the resistance is greater than the force applied by the muscle and the muscle lengthens as it contracts.

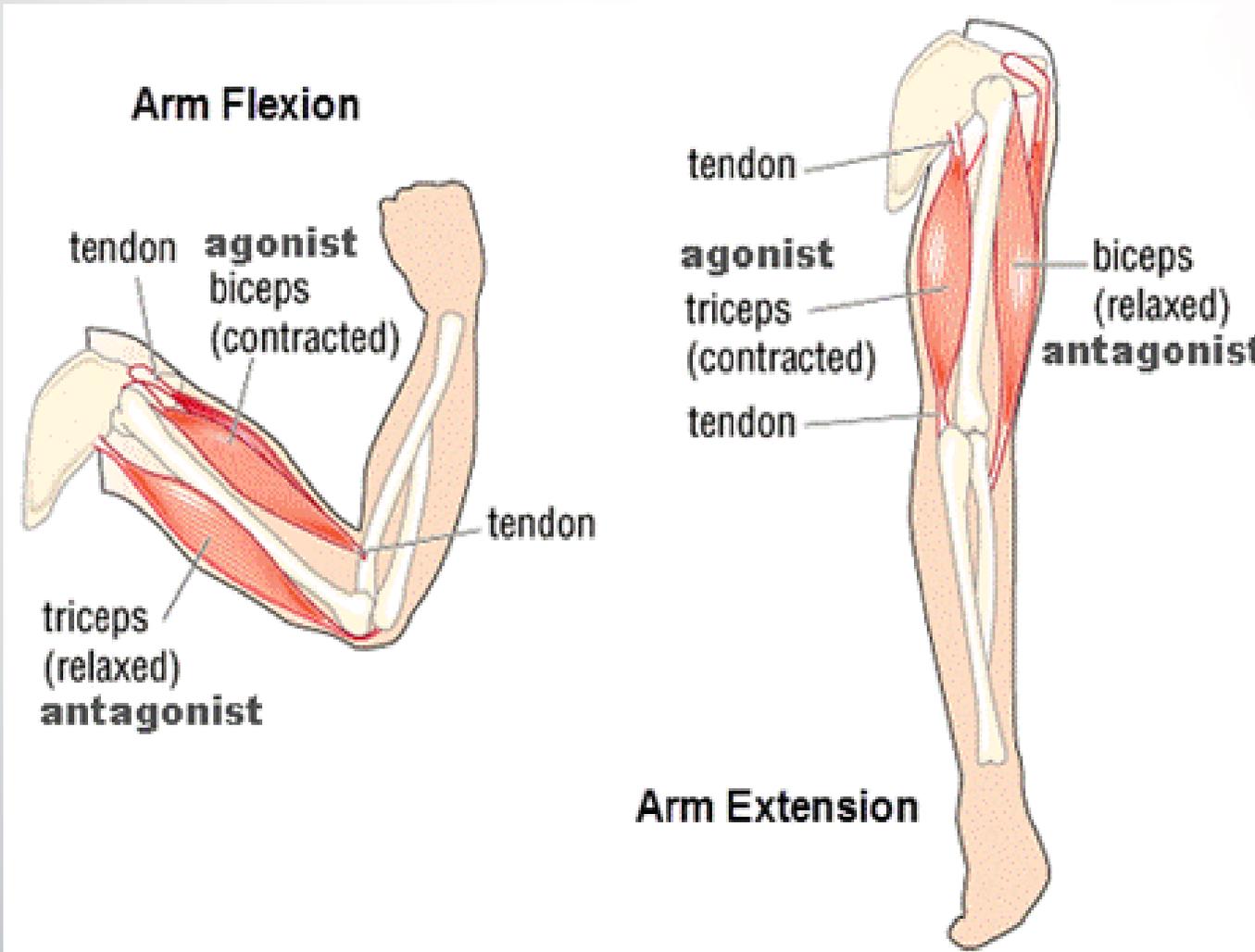
BODY MOVEMENTS

- MUSCLES ARE ATTACHED TO BONE OR CONNECTIVE TISSUE AT NO LESS THAN 2 POINTS
- **ORIGIN** – ATTACHED TO THE IMMOVABLE OR LESS MOVABLE BONE
- **INSERTION** – ATTACHED TO THE MOVABLE BONE
- DURING CONTRACTION THE INSERTION MOVES TOWARD THE ORIGIN

Types of Muscles

- **Prime mover** – responsible for movement in muscle group
- **Antagonist**- oppose or reverse a movement
 - When a prime mover is active its antagonist is relaxed
 - ex: biceps and triceps

Groups Action in Skeletal Muscle





Muscles:

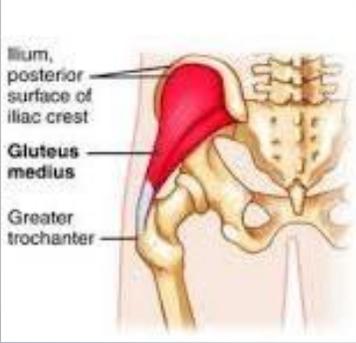
**Location, function and
exercise examples**



LOWER BODY MUSCLES

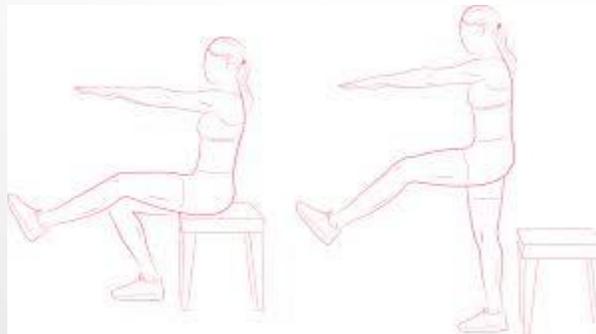
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Gluteus Maximus “glutes” 	<p>This muscle makes up the majority of the buttock muscle.</p> <p>It originates at the pelvis and inserts into the femur.</p>	<p>Extends the leg (behind the body).</p> <p>Lower part of the glutes helps in the external rotation and adduction of the leg.</p> <p>Upper part assists in leg abduction.</p>	<ul style="list-style-type: none"> -Based stand lunges -Glutes bridge 	<p>Avoid hyperextending the leg during the lunge</p> <p>While squatting, maintain neutral spine and avoid tacking the hips inside at the bottom part of the squat.</p>



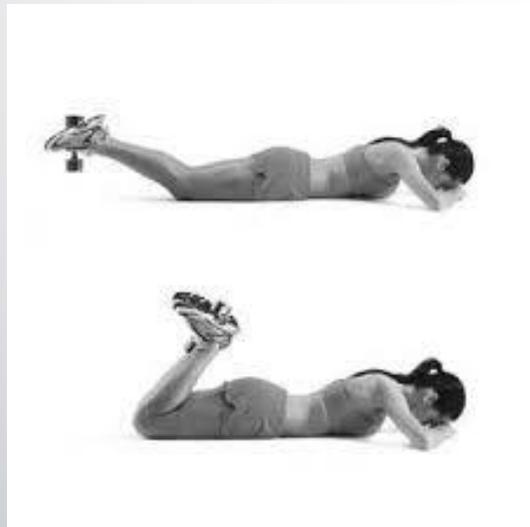
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
<p>Gluteus Medius “Outer hips”</p> 	<p>This muscle is underneath the gluteus maximus and also attaches at the pelvis and inserts on the femur.</p>	<p>This muscle brings the leg out to the side (abduction)</p>	<p>-Base standing splits, hip abduction.</p> <p>-On your side, side squat</p>	<p>Keep length in the sides of the torso, bringing the pelvis up to the side.</p>



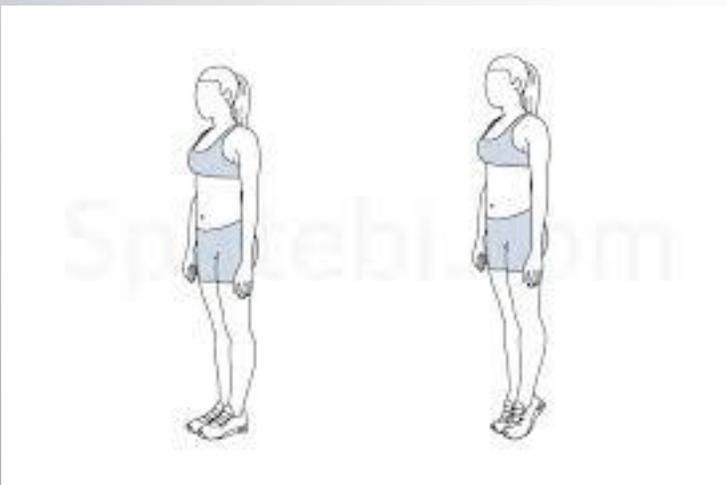
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Quadriceps 	4 muscle groups that originate at the pelvis and cross the hip and the knee.	Knee extension and hip flexion	<ul style="list-style-type: none"> -Squatting -Single leg squat -Leg extension 	Focus on straightening the knee and also avoid the knee from locking out



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Hamstrings 	Originate on the back side of the pelvis and cross the hip and the knee	Knee flexion and hip extension	<ul style="list-style-type: none"> -Laying down, prone: Leg curl -Deadlift 	<ul style="list-style-type: none"> Focus on tightening the back of the thigh. Avoid hyperextending the low back



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Gastrocnemius “calves” 	Primary muscle of the lower leg. Originates just above the knee, crosses the knee joint, then turns into the Achilles tendon.	Point the toes. This muscle assists in raising the heels	-calve raises	Keep the knees in the same positions. Focus on lifting the heel straight up.





UPPER BODY MUSCLES

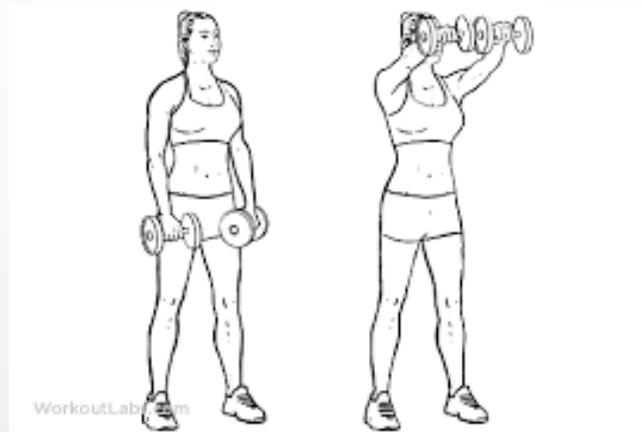
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Pectorals "Pecs" 	Front aspect of chest. Muscle runs from the sternum to the upper arm bone called Humerus.	Brings the arm across the chest (Sh. Adduction)	<ul style="list-style-type: none"> -Seated chest press or chest fly. -Barbell bench press. -Dumbbell bench fly 	Drop the shoulders away from the ears. Draw the scapulas back and down during the exercise.



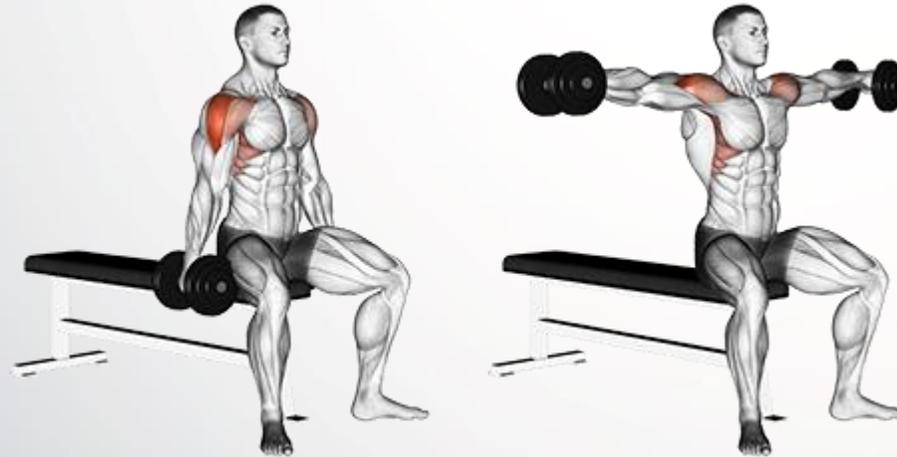
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Dorsi“Lats” 	from the low back at the pelvis & expanding up the back, then thinning out to come underneath the armpit and attach into the Humerus.	behind the body. Extends the arm.	(supine), pullovers. -Seated straight, arm pulleys. -Seated backward, pulling arms straight back. -Bent over row.	away from the ears. Bring scapulas together.



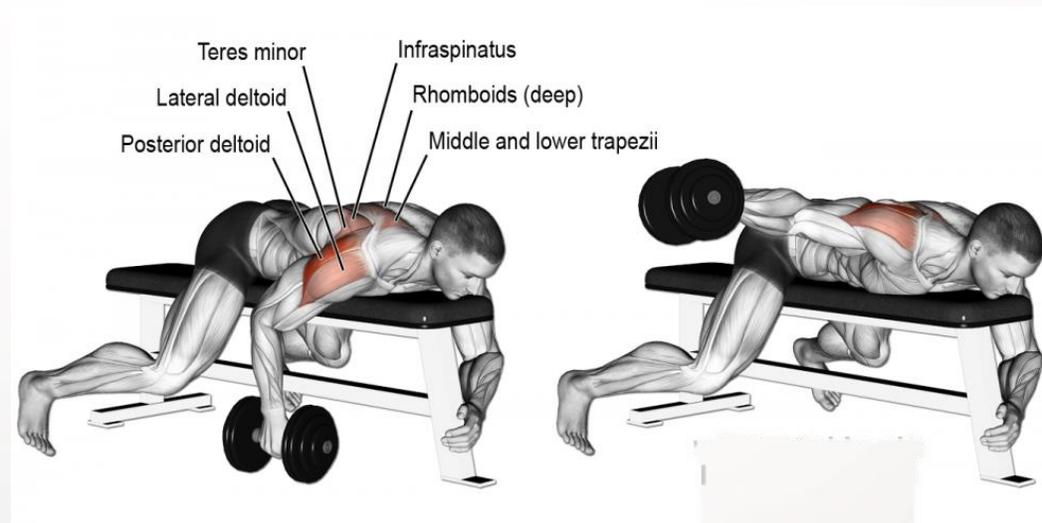
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Anterior deltoid 	Front upper part of the arm	Raising the arm up in front of the body (Sh. Flexion)	Front shoulder raise. Inverted on your back, (supine) front shoulder raise.	Drop the shoulders away from the ears. Bring scapulas together.



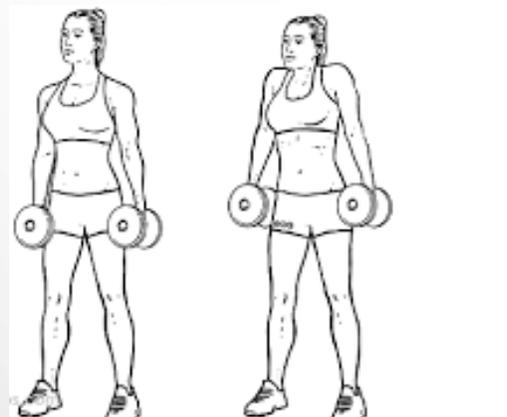
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Middle Deltoid 	Side upper part of the arm.	Raising the arm up and out to the side. (Sh. Abduction)	Lateral shoulder abduction. Supine front shoulder abduction.	Drop the shoulders away from the ears. Bring scapulas together.

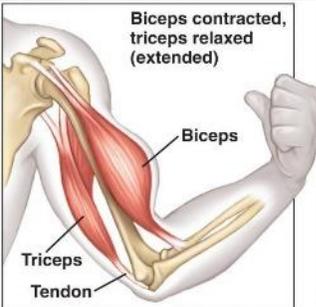


MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Posterior Deltoid 	Backside of the upper arm	Raising the arm behind the body. (Sh. Extension)	Shoulder extension. Kneeling backward, surfer lat pull.	Drop the shoulders away from the ears. Bring scapulas together.

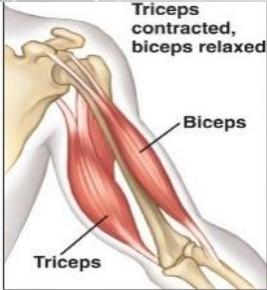


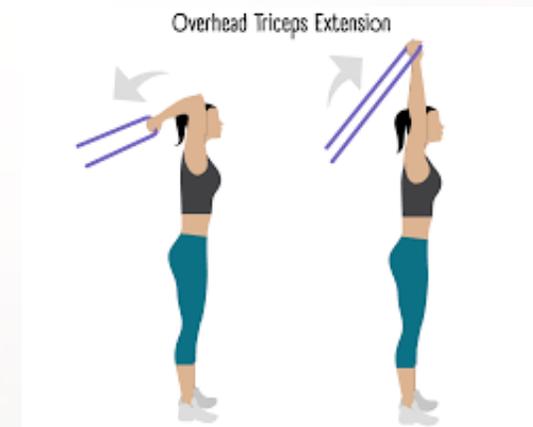
MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Trapezius 	<p>Upper section: Located at the back of the neck.</p> <p>Middle section: Located in the shoulders and upper back.</p>	<p>Hold and shrug the shoulders in place, move head back and sideways.</p> <p>Elevates and depresses the scapula</p>	<p>Shrug shoulders with dumbbells</p>	<p>Keep your back straight during the movement</p>



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
<p>Biceps</p> 	<p>Muscle running along the frontside of the upper arm. It crosses the shoulder and the elbow.</p>	<p>Flex the elbow (bend) Assist in raising the arm up in front of the body.</p>	<p>Dumbbell / barbell biceps curl.</p>	<p>Slide the shoulders away from the ears. As the elbows bend, maintain them on the sides, close to your body.</p>



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Triceps 	Muscle running along the backside of the upper arm. It crosses the shoulder and the elbow.	Extends (stretches) the elbow. Assist in raising the arm behind back.	<ul style="list-style-type: none"> -On your back (supine) triceps press. -Bent over triceps ex. -Triceps extension overhead. 	Slide the shoulders away from the ears. As the elbows straighten, maintain them on the sides, close to your body.





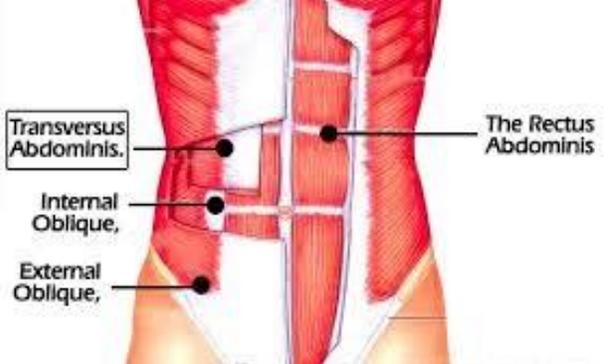
ABDOMINAL MUSCLES

MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Rectus Abdominis "ABS" 	Originates on the anterior (front) side of the body at the lower end of the sternum and attaches into the lower pelvis	Flexes the trunk forward	On your back (supine), roll up (sit ups/ crunches) Seated backward, sit up with cables.	Maintain the neck relaxed. Focus on rolling through the spine one vertebrae at a time, versus hinging upward.



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
External Obliques 	The external oblique muscles cover the sides of the abdominal area	Flexes and rotates the trunk. The external obliques rotate the body to the opposite side.	Seated lateral oblique twister. On your back (supine), twisted crunches. “Bicycle abdominal crunches”	Maintain the neck relaxed. Initiate the movement from the abdominals, and avoid over pulling with the arms.



MUSCLE	LOCATION	FUNCTION	EXERCISE EXAMPLES	TIPS TO IMPROVE FORM
Transverse Abdominis 	Muscle layer of the anterior and lateral (front and side) abdominal wall, which is deep to (layered below) the internal oblique muscle.	The muscle will compress the abdomen, bringing the navel to the spine.	On your back (supine), pull over crunch. Kneeling forward. Kneeling plank.	Maintain the neck relaxed. Initiate the movement from the abdominals, and avoid over pulling with the arms.

