

Modeling of Human Movement

MCEN 4228/5228

Fall 2021

Agenda

- Functional Anatomy Primer
 - Terminology
 - Muscle actions

Functional Anatomy

The study of body components needed to achieve or perform a human movement or functions.

Care about movement produced by muscle group,
not muscle location

Functional Anatomy

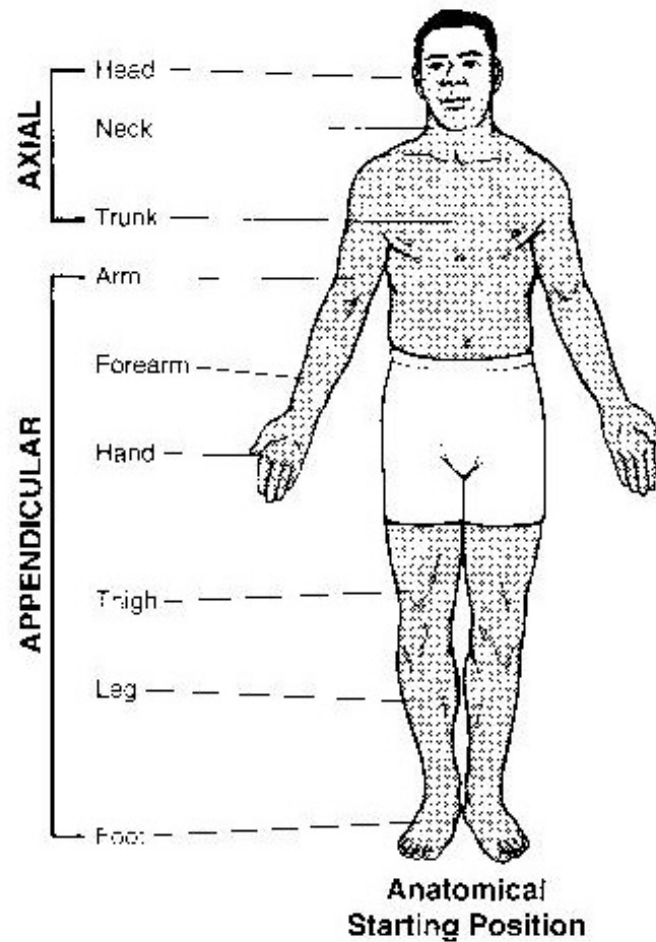
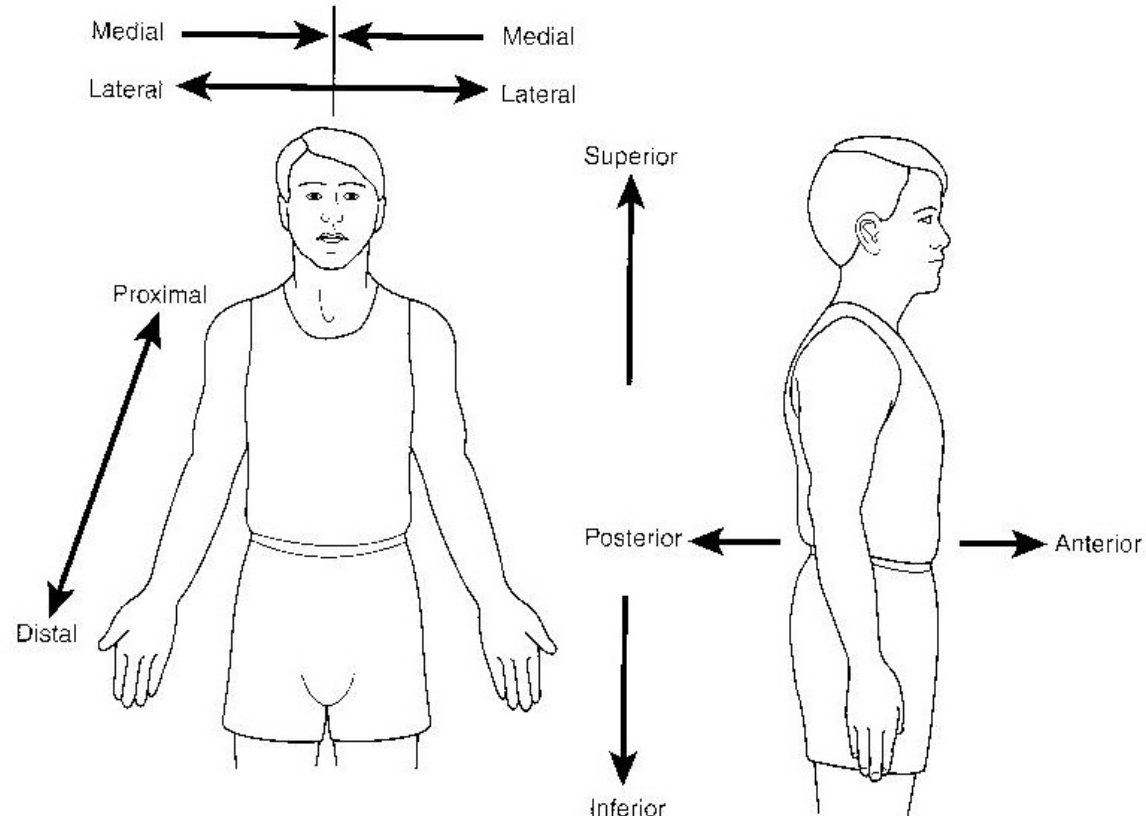


FIGURE 1-6 Anatomical vs fundamental starting position and fundamental starting positions serve as a reference description of joint movements.

Functional Anatomy

- Terms

- superior
- inferior
- anterior
- posterior
- medial
- lateral
- proximal
- distal
- superficial
- deep
- unilateral
- bilateral
- ipsilateral
- contralateral

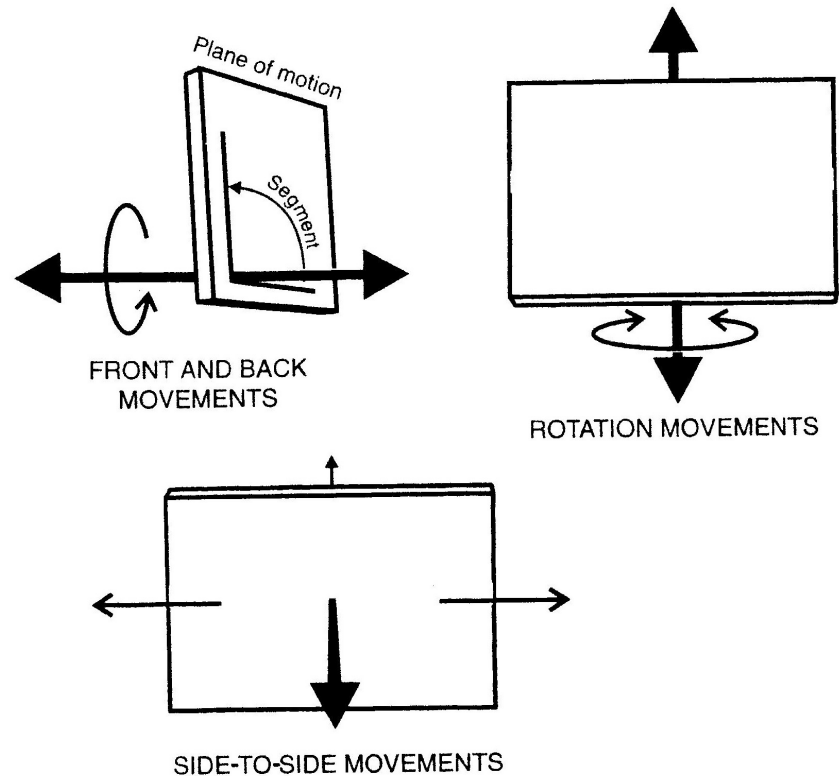


Functional Anatomy

Reference System

- origin
- axes
- planes

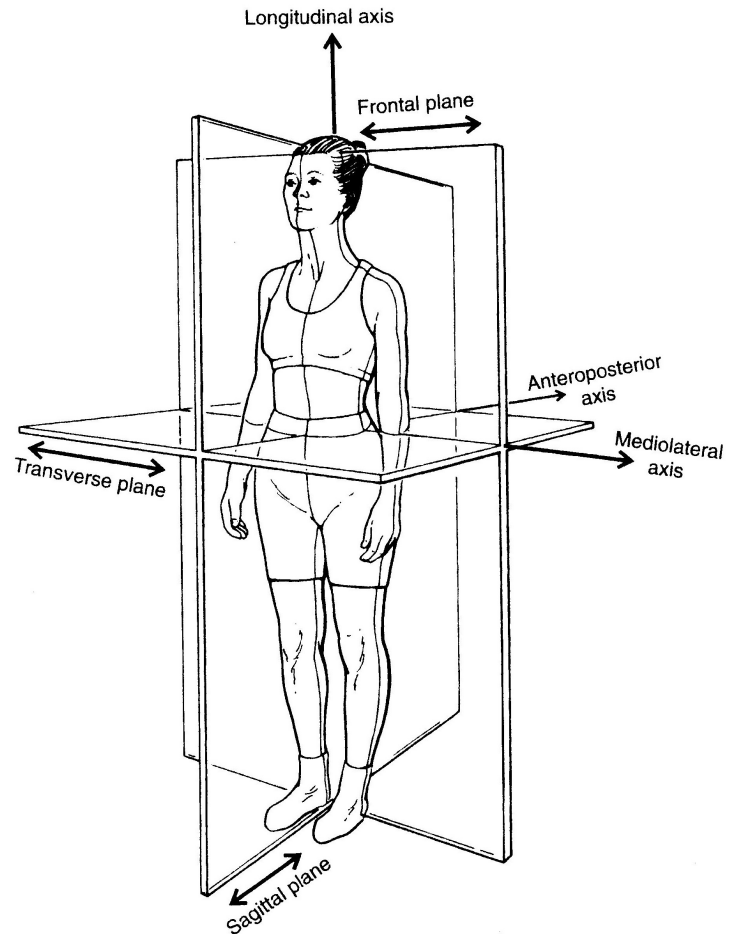
Movement takes place in a plane, *about* an axis *perpendicular* to the plane



Functional Anatomy

Reference System

- origin
 - Axes
 - planes
- Axes:
 - Longitudinal (Twist):
 - Head to toe
 - Mediolateral (Somersault)
 - Left to right
 - Anteroposterior (Cartwheel)
 - Front to back

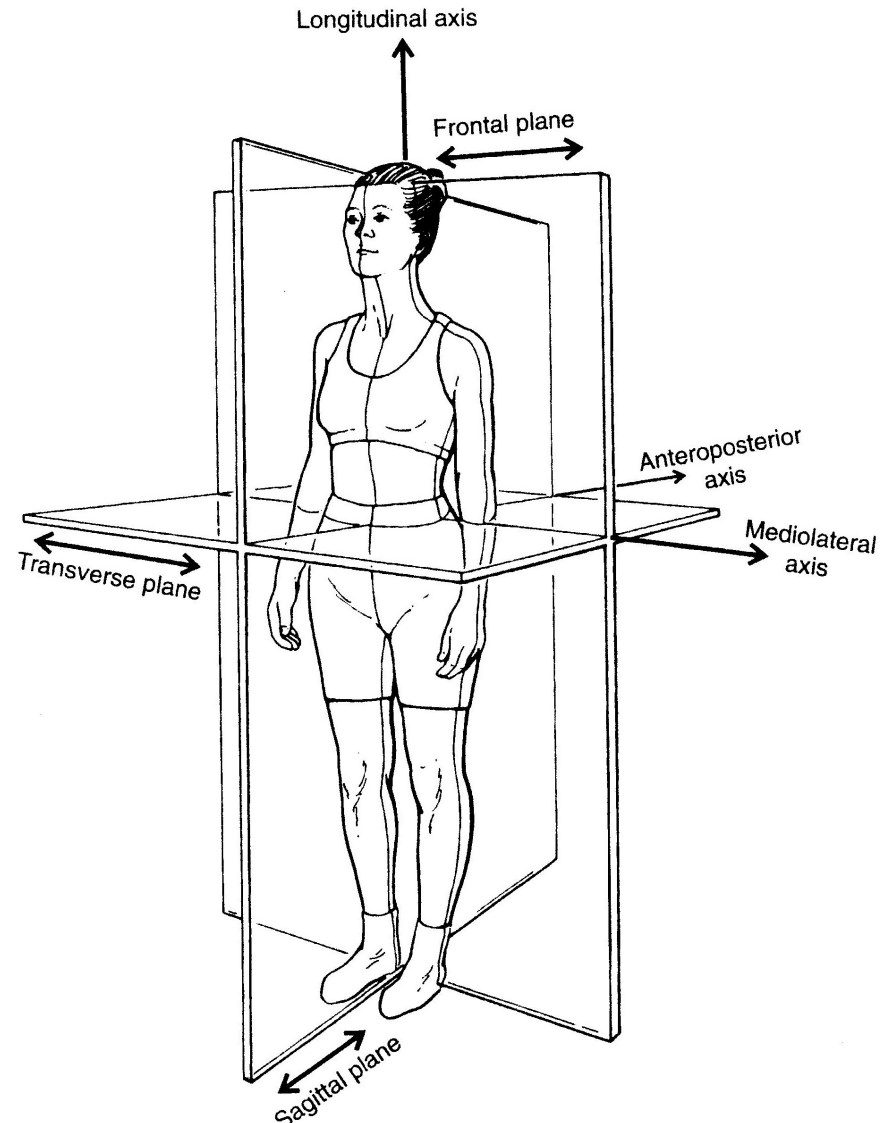


- Axes

- Longitudinal (Twist)
 - Head to toe
- Mediolateral (Somersault)
 - Left to right
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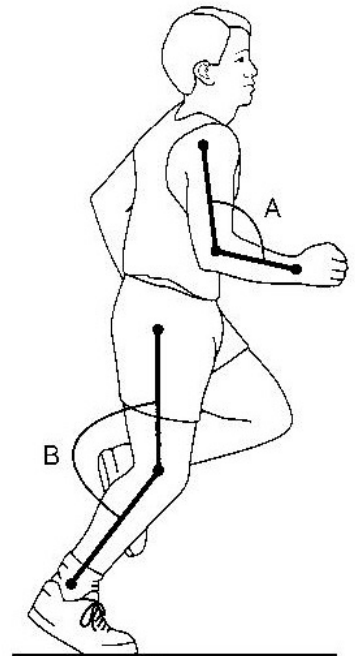
- Planes

- Frontal
 - Vertical
 - Anterior/posterior parts
- Sagittal
 - Vertical
 - Left/right parts
- Transverse
 - Horizontal
 - Upper/lower parts



Anatomical Terms

- Joint Position
 - To discuss joint position we define **joint angle**
 - **joint angle**: relative angle between two segments
- Joint Movement
 - **Flexion**: relative angle (joint angle) decreases
 - **Extension**: relative angle increases (straightening movement)



The position of the elbow joint to the wrist as it relates to the trunk is

- A) proximal
- B) medial
- C) inferior
- D) anterior

The position of the shoulder to the elbow as it relates to the wrist is

- A) proximal
- B) distal
- C) inferior
- D) anterior

Motion in the sagittal plane takes place about which axis?

Most human movements in running
take place in

Anatomy List

Know: bones (location) & muscles (locations & actions).

- **Bones:** humerus, radius, ulna, femur, tibia, fibula
- **Muscles:** Deltoid, Biceps (arm), Triceps, Rectus Femoris, Vastus Lateralis/Intermedius/Medialis, Gluteus Maximus, Gluteus Medius, Biceps Femoris, Semi-membranosus, Semi-tendinosus, Gastrocnemius, Soleus, Tibialis Anterior
- **Generically:** quads, hamstrings

Muscle Actions

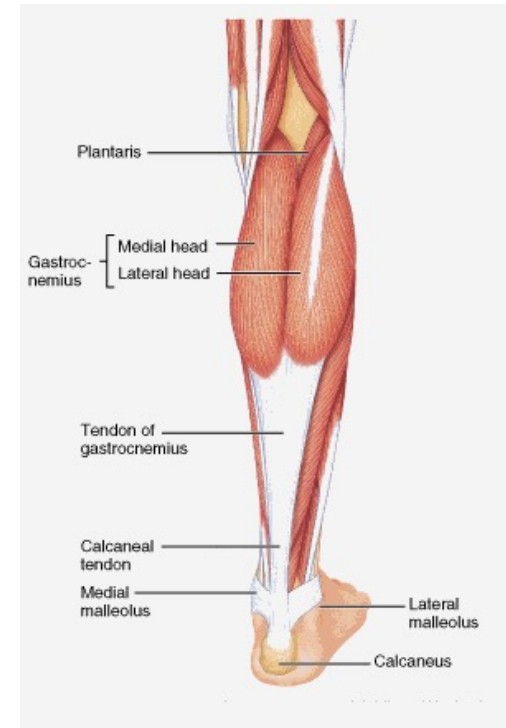
- Motors that move our limbs
- Example:
 - Push-up
 - Which joint?
 - Flexion/extension?
 - Which muscle?



Muscle Actions

Muscles:

- only exert pulling forces
- 3 actions: can exert force and
 - shorten (shortening/concentric)
 - stay the same length (isometric)
 - be lengthened or resist stretching (lengthening/eccentric)
- when not activated, muscles can be passively lengthened by other forces

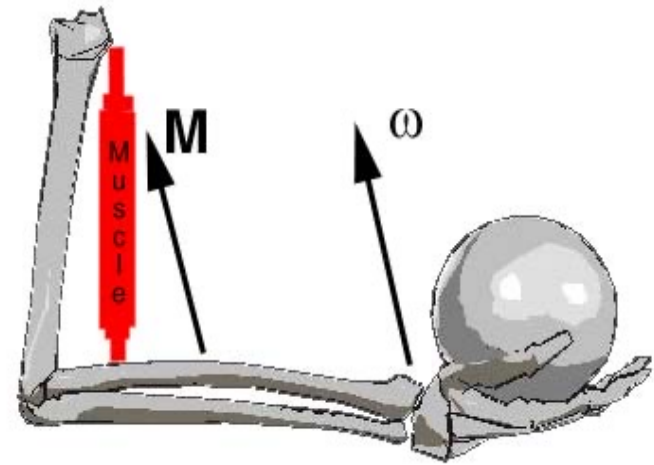


Shortening Muscle Actions

Isotonic = constant force
(artificial)

Isovelocity = constant
velocity (artificial)

Neither, i.e. variable force
and velocity
(most common)



Isometric Muscle Actions

Active, no length change

Muscle produces force, but does not overcome external load, so no movement develops.

Very common: examples?



Lengthening Muscle Actions

Active lengthening

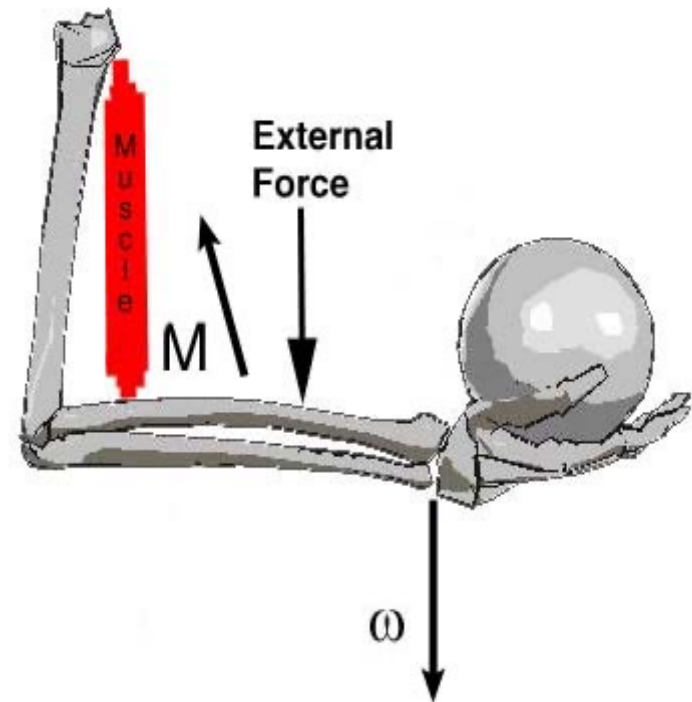
Muscles only exert pulling force,

But the opposing force can be greater than the muscle force, forcibly stretching the muscle.

Also very common.

High Risk for injury

Examples:



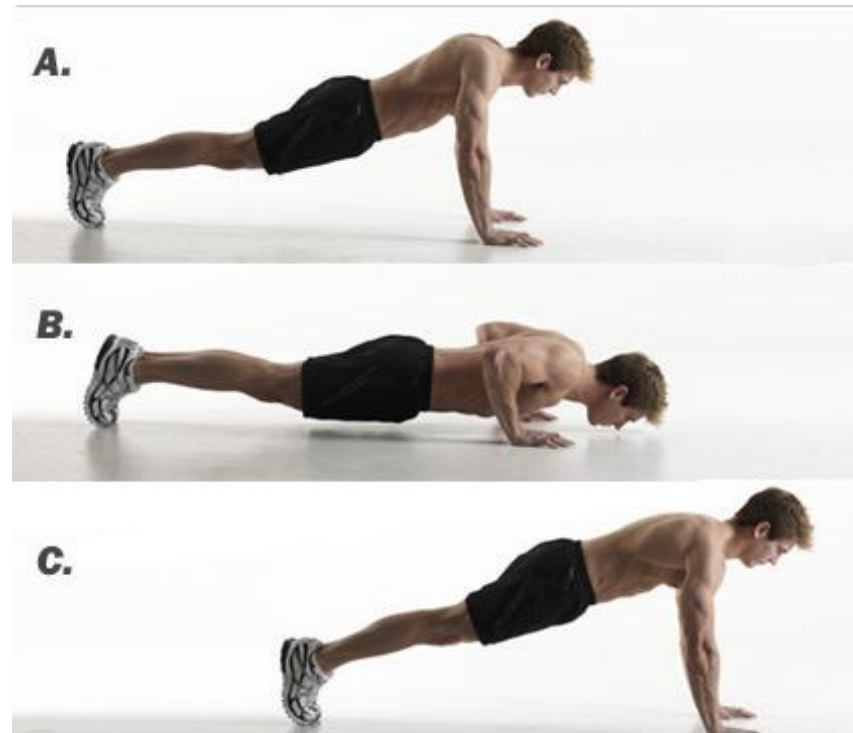
Non-Active Lengthening (Passive Stretch)



Push-up example

Push-up.....what is the primary arm muscle
during Elbow Flexion (A --> B)?
during Elbow Extension (B --> C)?

What type of contraction
(Shortening, Isometric, or
Lengthening)
during Flexion?
during Extension?



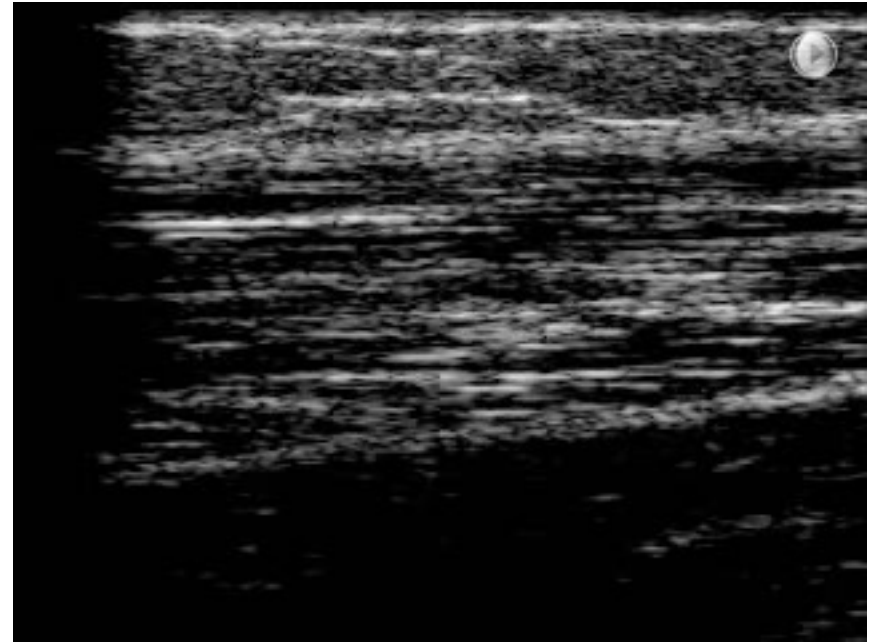
Leg press example

- What is the primary muscle involved?
- Describe its actions throughout one cycle.



Leg press example

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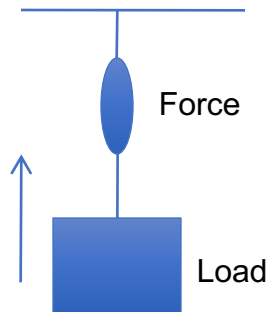


Muscle Actions

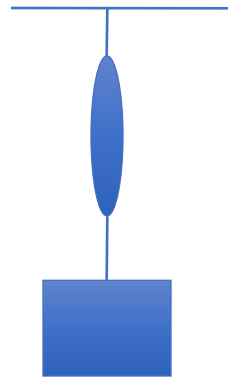
- only exert pulling forces
- 3 actions: can exert force and
 - shorten (shortening/concentric): **force > load**
 - stay the same length (isometric): **force = load**
 - be lengthened or resist stretching (lengthening/eccentric)

force < load

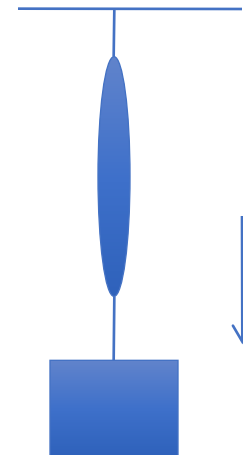
Force > load



Force = load



Force < load



A subject slowly bends over at the trunk.
What type of muscle action is occurring in the trunk extensors during the activity?

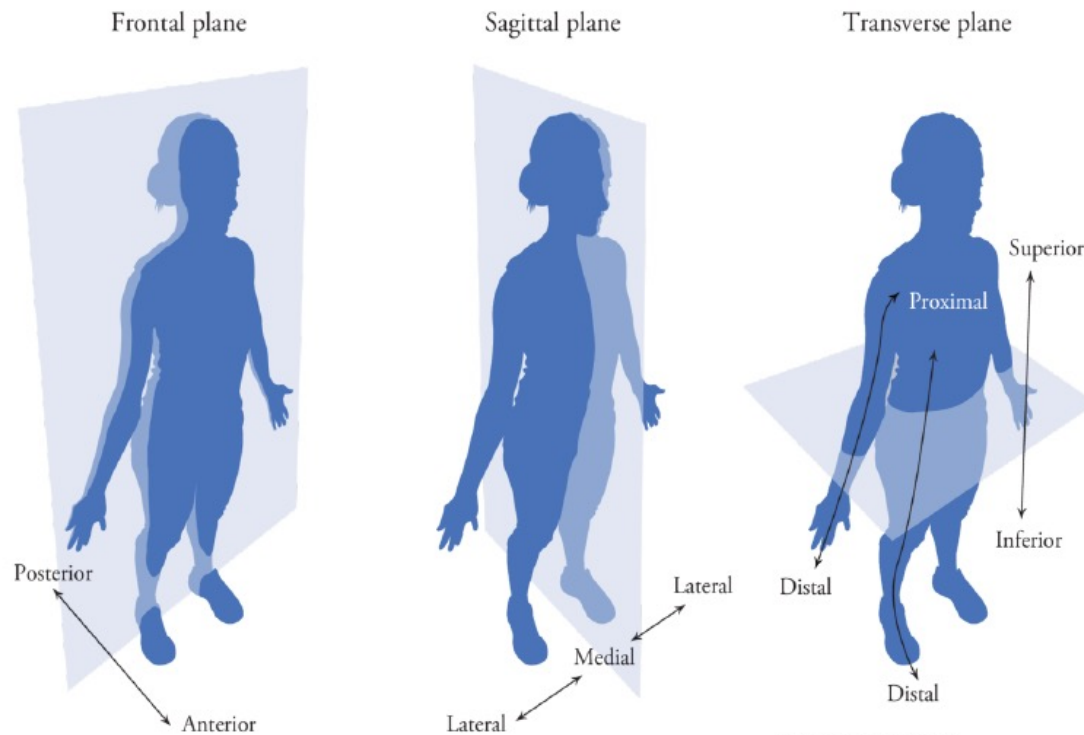
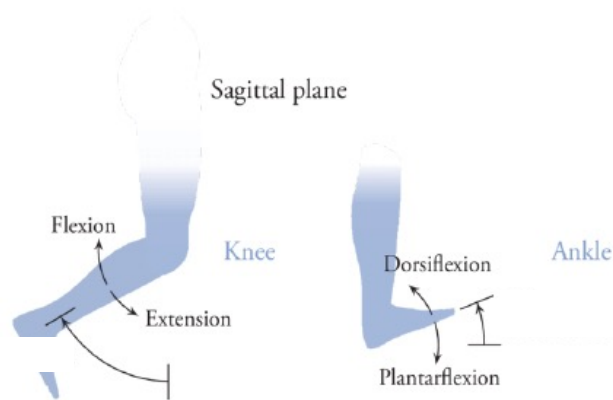
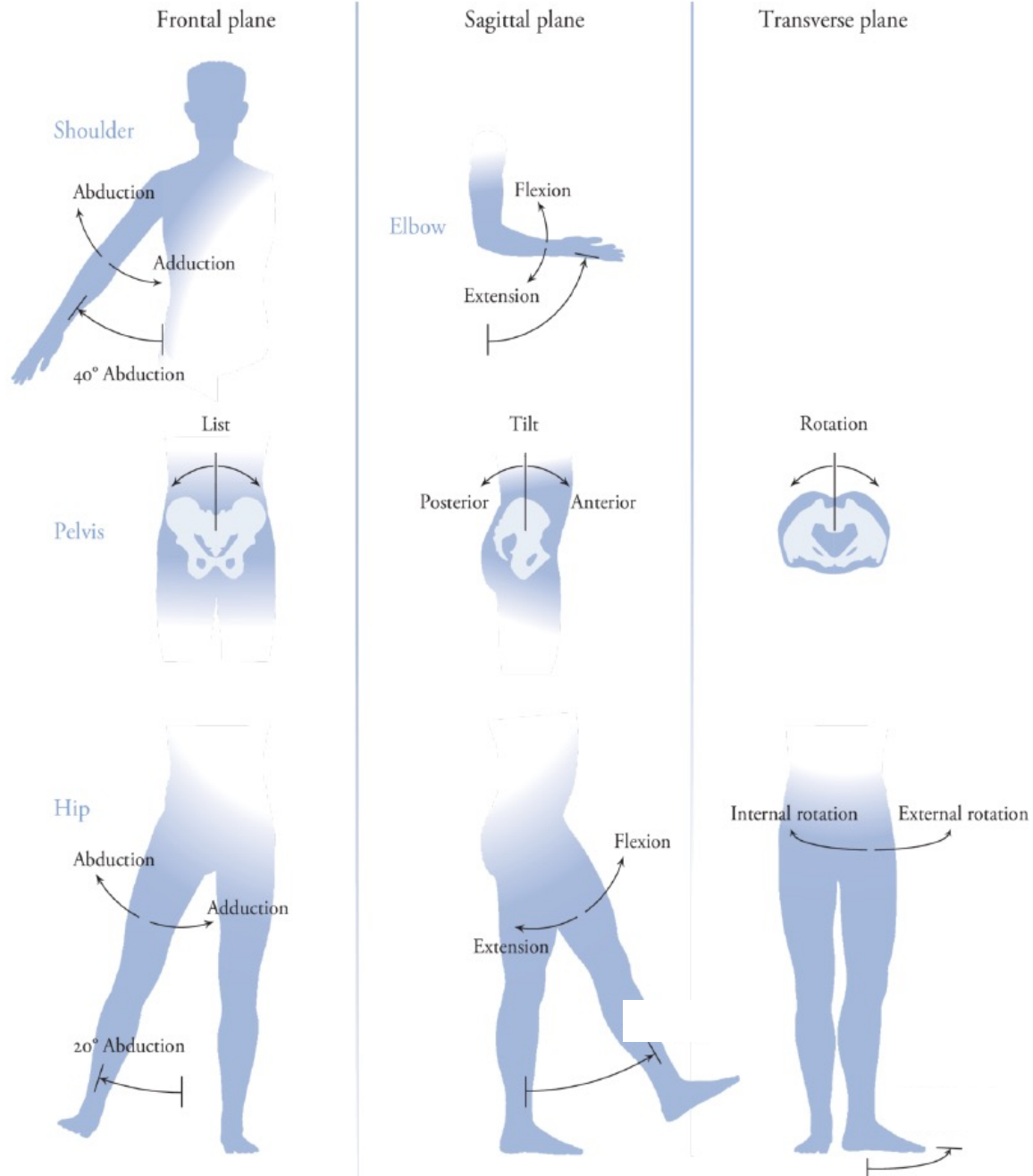


FIGURE 1.15 (ABOVE)
Anatomical planes and directions
in a human.

FIGURE 1.16 (OPPOSITE)
Motions of the shoulder, elbow,
pelvis, and hip in the frontal
plane (left), sagittal plane (center),
and transverse plane (right).

FIGURE 1.17 (LEFT)
Motions of the knee and ankle in
the sagittal plane.





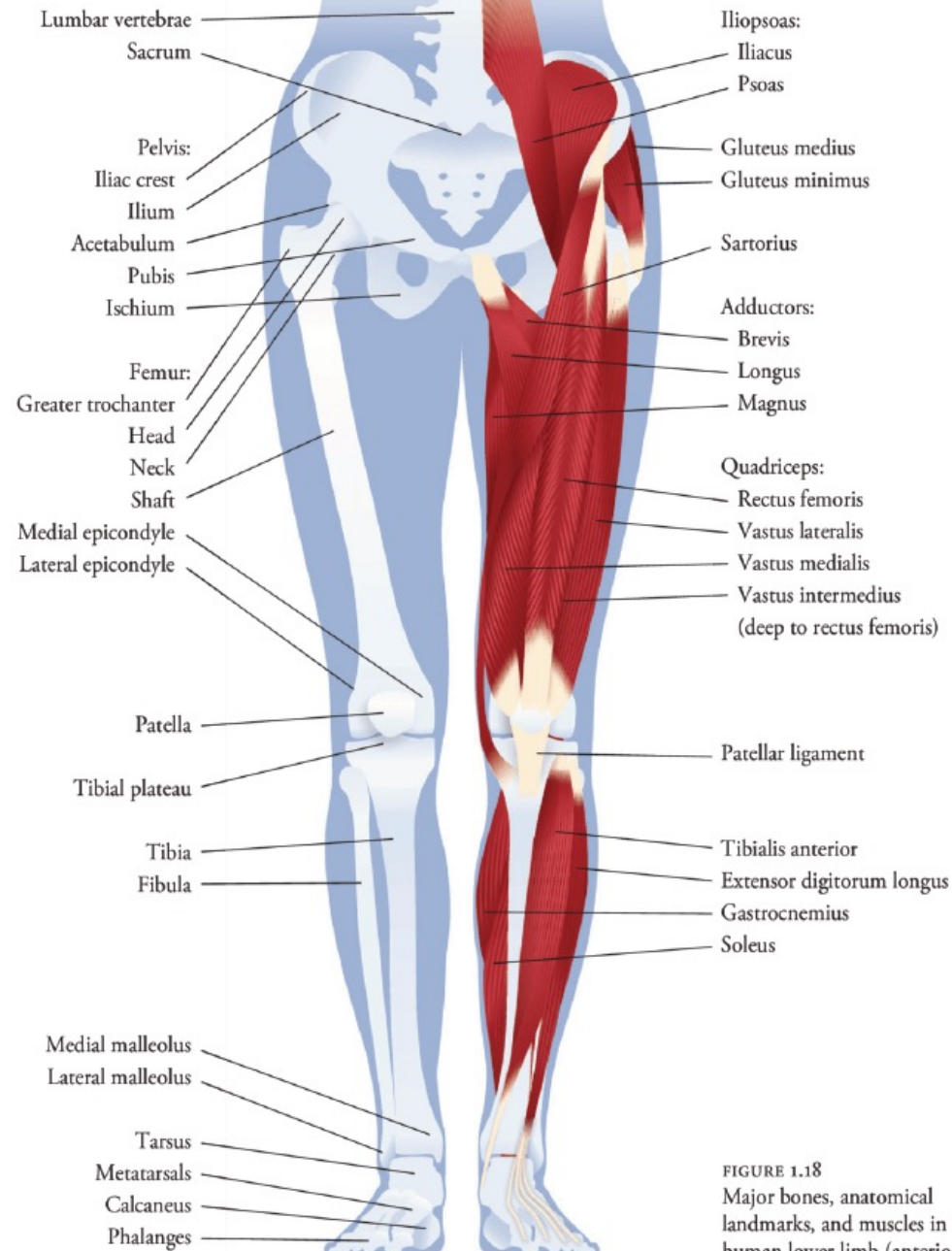


FIGURE 1.18
Major bones, anatomical
landmarks, and muscles in the
human lower limb (anterior view).

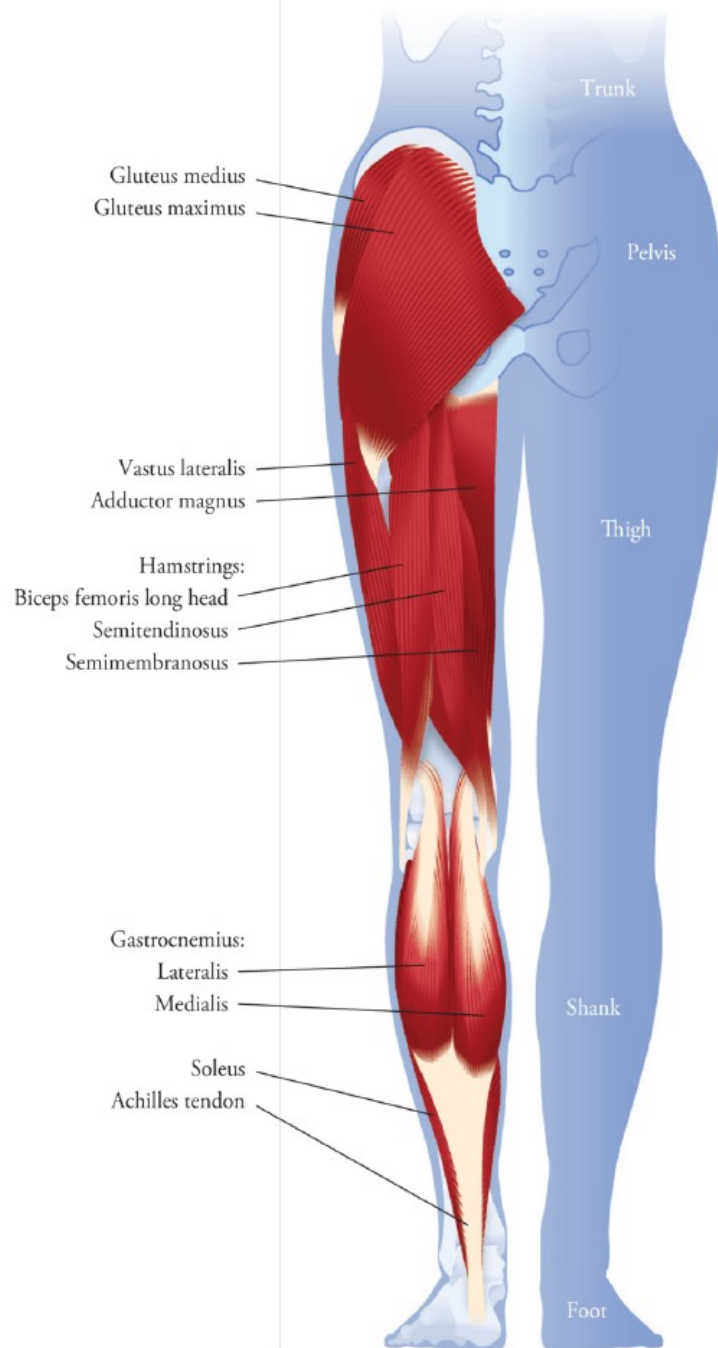


FIGURE 1.19
Body segments and major
muscles in the human lower limb
(posterior view).