HUBS 191 Lecture Material

This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture,
it is NOT a substitute for the lecture !

Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo

HUBS191

Lecture 10: Musculoskeletal system: Form and Action at Joints

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Lecture objectives

- Explain the relationship between the form and function of muscle
- Describe how skeletal muscles can influence movements at a synovial joint
- Describe some of the major muscles of the upper and lower limbs and their roles

Recap

- Synovial joints:
  - Are formed by bones, joint capsule & synovial membrane/fluid, hyaline cartilage, ligaments and (sometimes) fibrocartilage)
  - 7 types, based on movements possible

- ROM
  - bone end shape
  - ligament location and length
  - body surface contact
  - muscles

- Skeletal muscle
  - made of cells = fibres
    - bundled to form fasicles
    - bundled to form muscles
  - voluntary control
  - shortening causes movement at a joint
  - attaches to bone via tendons

How does skeletal muscle cause movement at synovial joints?

- Attaches to bone (lever)
- Muscle structure (length, number of fibres, arrangement of fibres)
- Type of contraction (roles/action)
- Where it crosses a joint (location)

Anatomical levers

- Bone = lever
- Joint = pivot or fulcrum
- Muscle contraction = applied force/pull
- Weight of what is being moved = load (external or internal)

Lever arrangement determines function

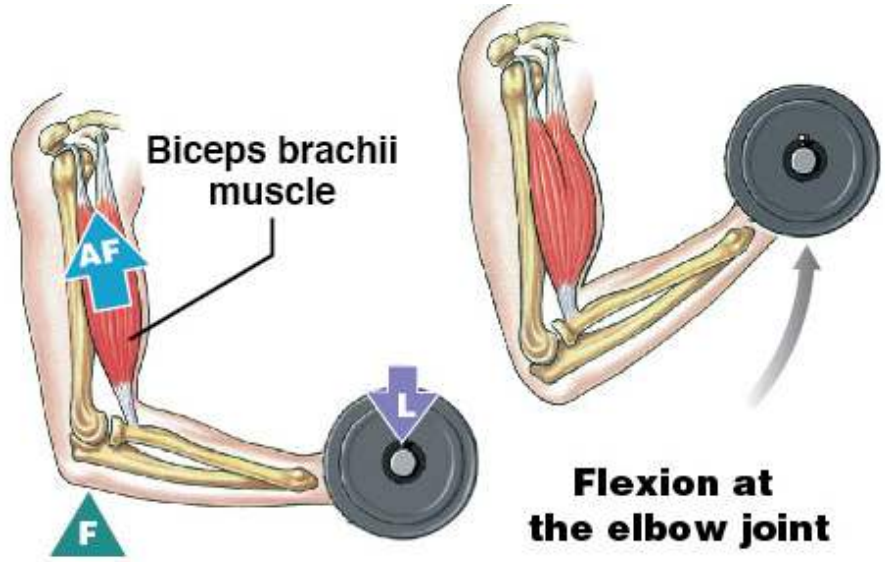
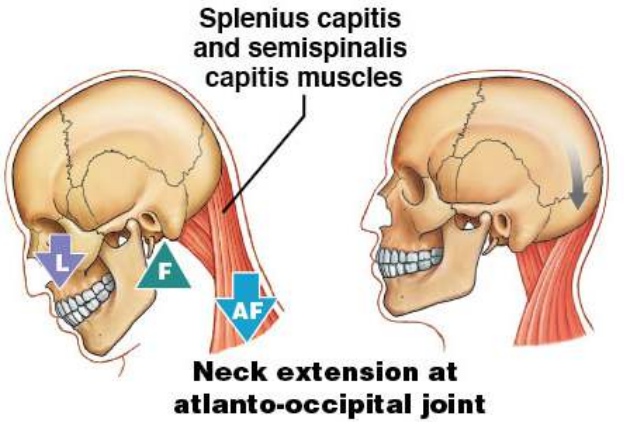
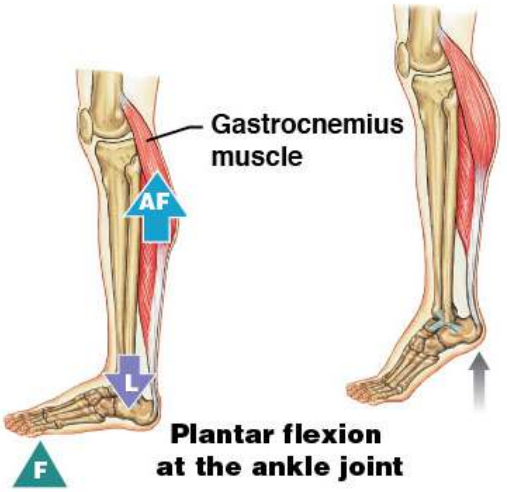


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 395.

Classes of levers

- First
  - Stabilises joint position
  - Fulcrum between force and load
  - E.g. see-saw, scissors
- Second
  - Effective at overcoming heavy loads
  - Load between fulcrum and force
  - E.g. wheelbarrow, bottle opener
- Third
  - Large range of movement; speed
  - Force between fulcrum and load
  - E.g. tweezers, fishing rod





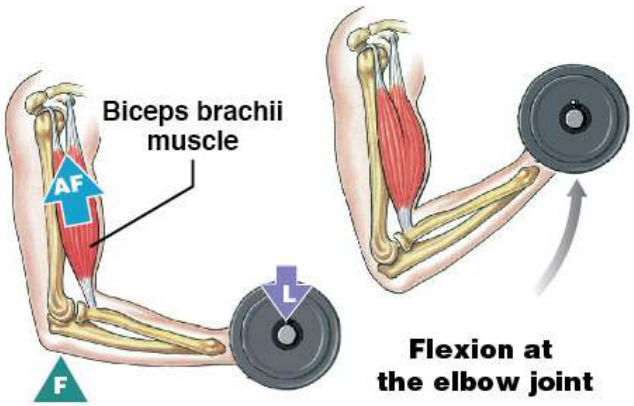


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 395.

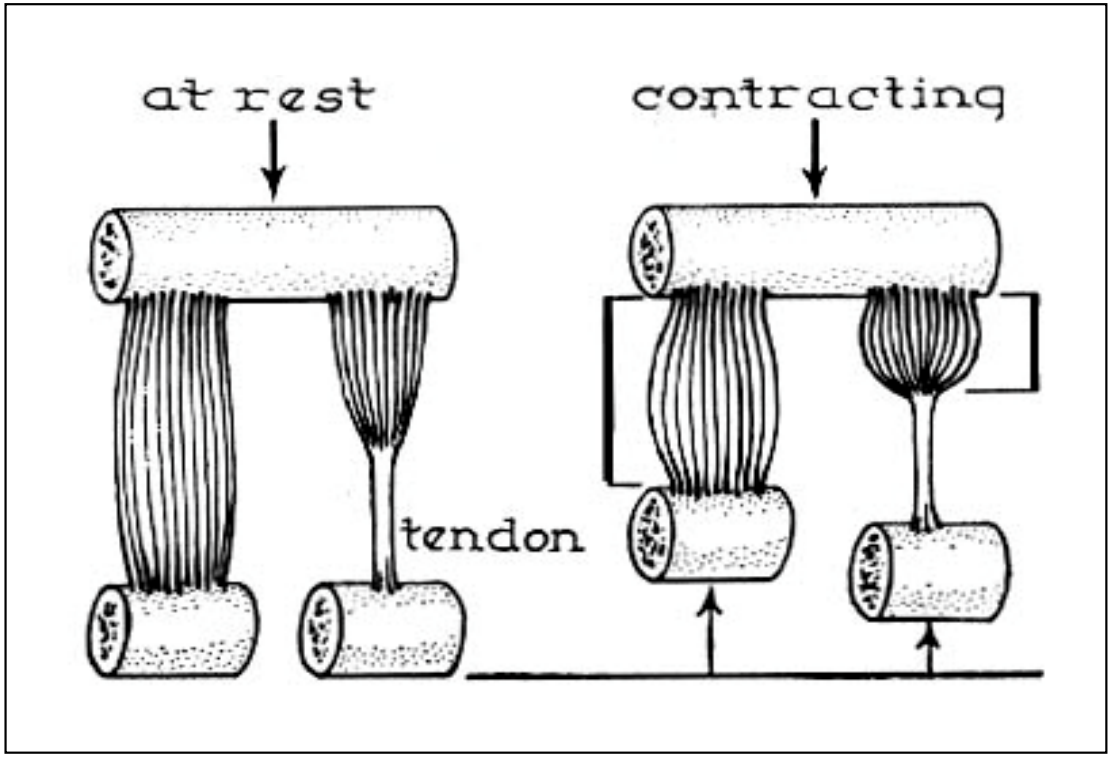
Muscle form determines function

Depends on

1. Length of muscle fibres
2. Number of muscle fibres
3. Arrangement of muscle fibres

1. Length of muscle fibres

- Fibres can shorten up to 50% of resting length
- If large ROM required = long muscle fibres



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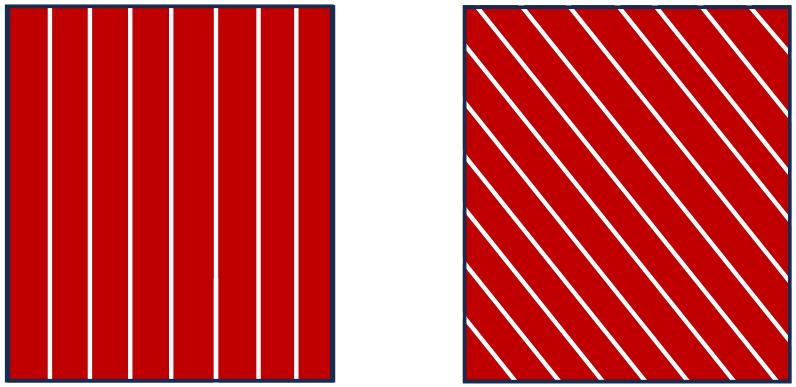
2. Number of muscle fibres (CSA)

- Tension is directly proportional to the cross-sectional area (CSA)
- Greater number of fibres
  - greater CSA
  - greater tension

Arrangement of muscle fibres

- Parallel
  - Fibres arranged vertically between muscle tendons/attachments
  - Smaller CSA, greater shortening
- Pennate
  - Fibres arranged obliquely between muscle tendons/attachments
  - Greater CSA, lesser shortening



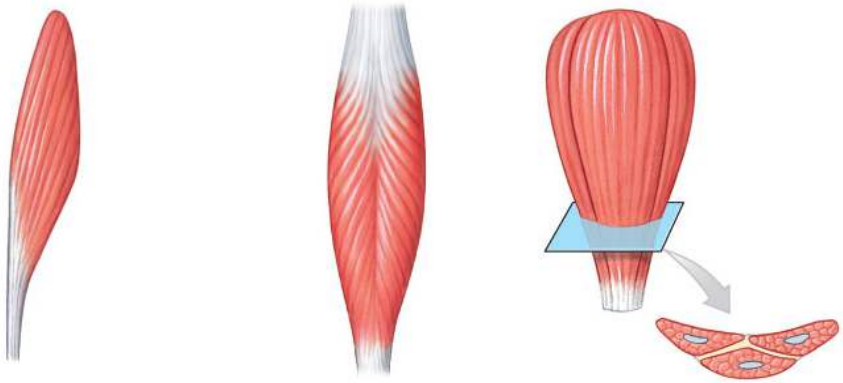


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 394

Types of muscle action

Muscle can contract in three ways

- Concentric
- Eccentric
- Isometric

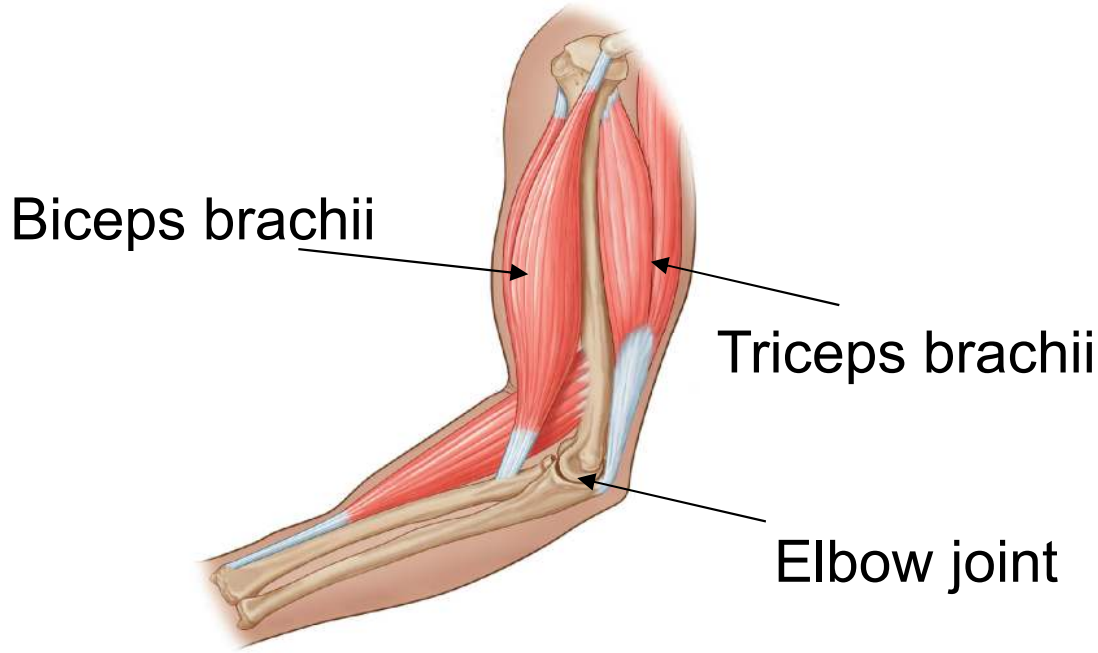
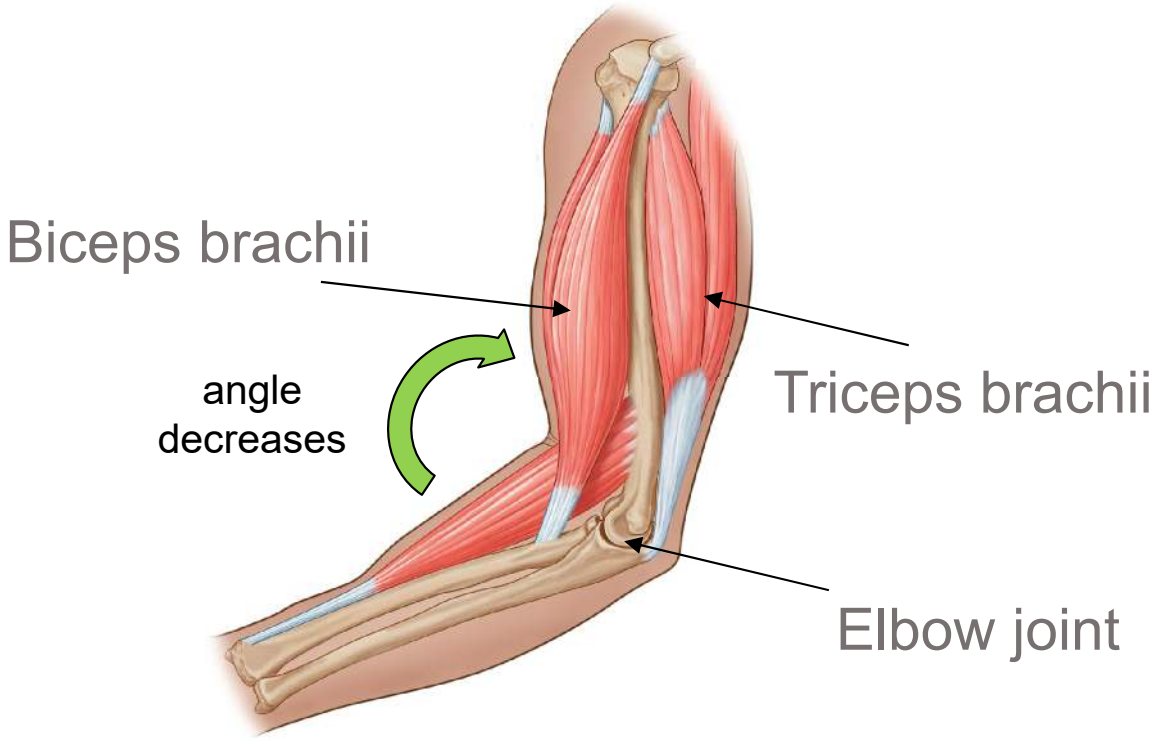


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 396.

Concentric

- Muscle is active, develops tension
- Tension is greater than load
- Muscle shortens
- Change in joint position

Elbow flexion: Biceps brachii contracts concentrically



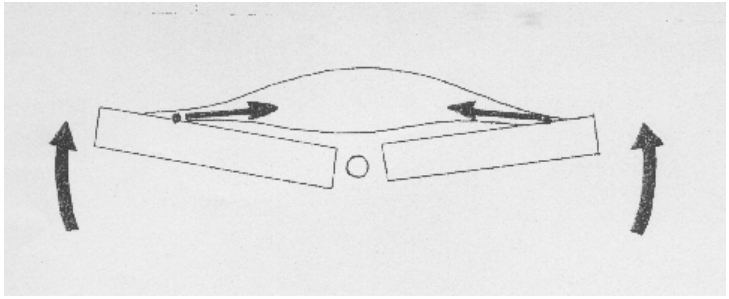


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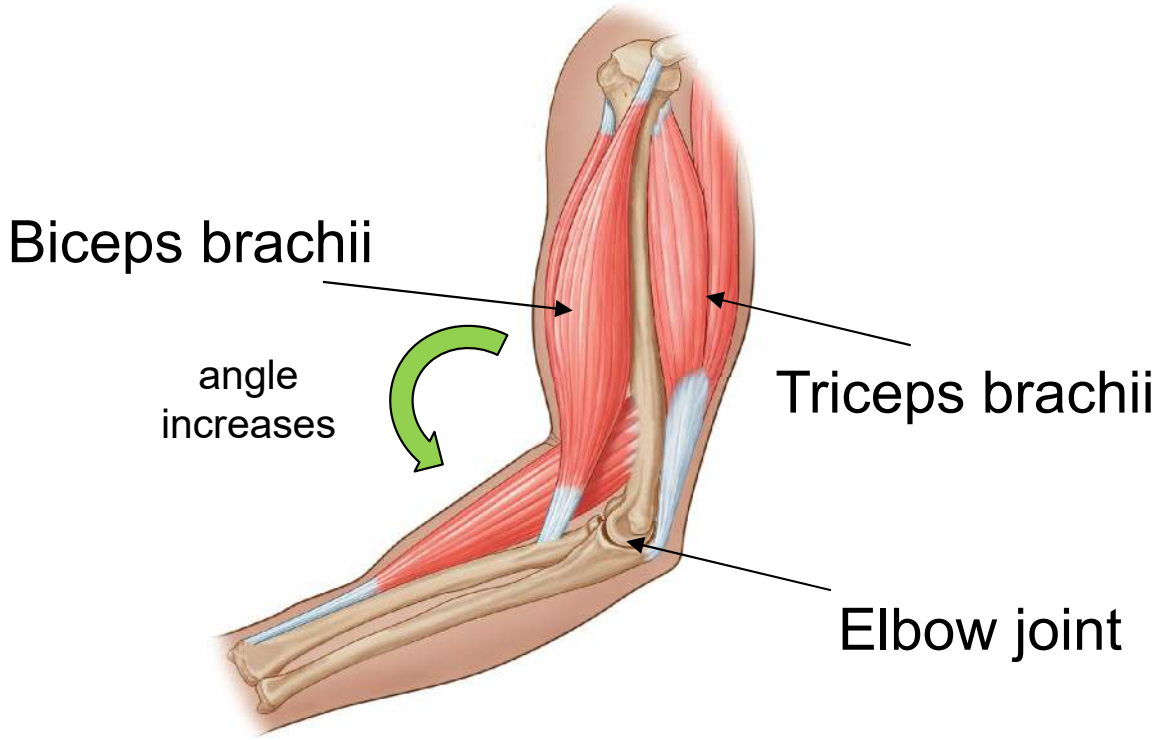
Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 396.

Eccentric

- Muscle is active, develops tension
- Tension is lesser than load
- Muscle elongates
  - pull in opposite direction by another muscle/gravity
- Change in joint position

Elbow extension: Biceps brachii contracts eccentrically



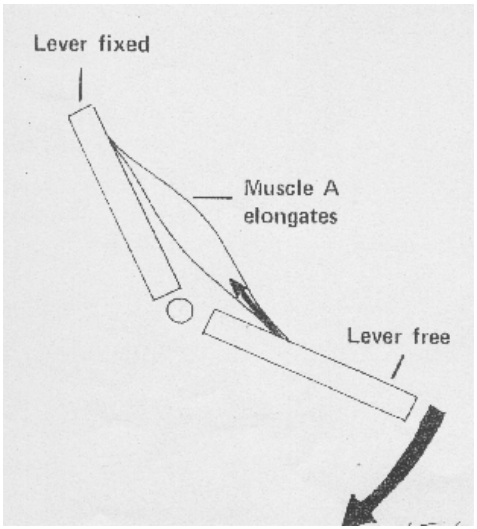
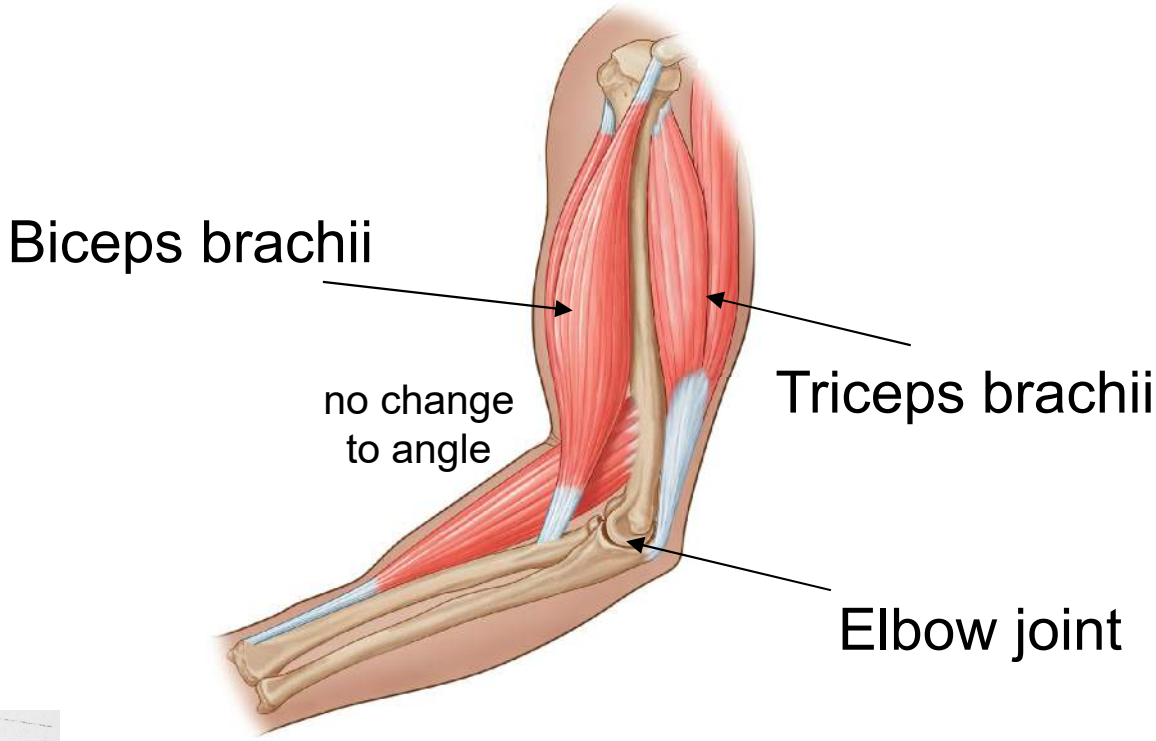


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 396.

Isometric

- Muscle is active, develops tension
- Tension does not outweigh load
- No change in length of muscle
- No change in joint position

Holding the elbow joint still
Biceps brachii contracts isometrically



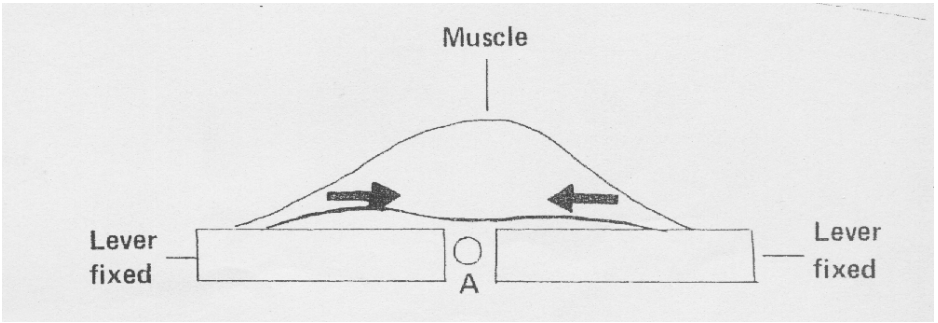


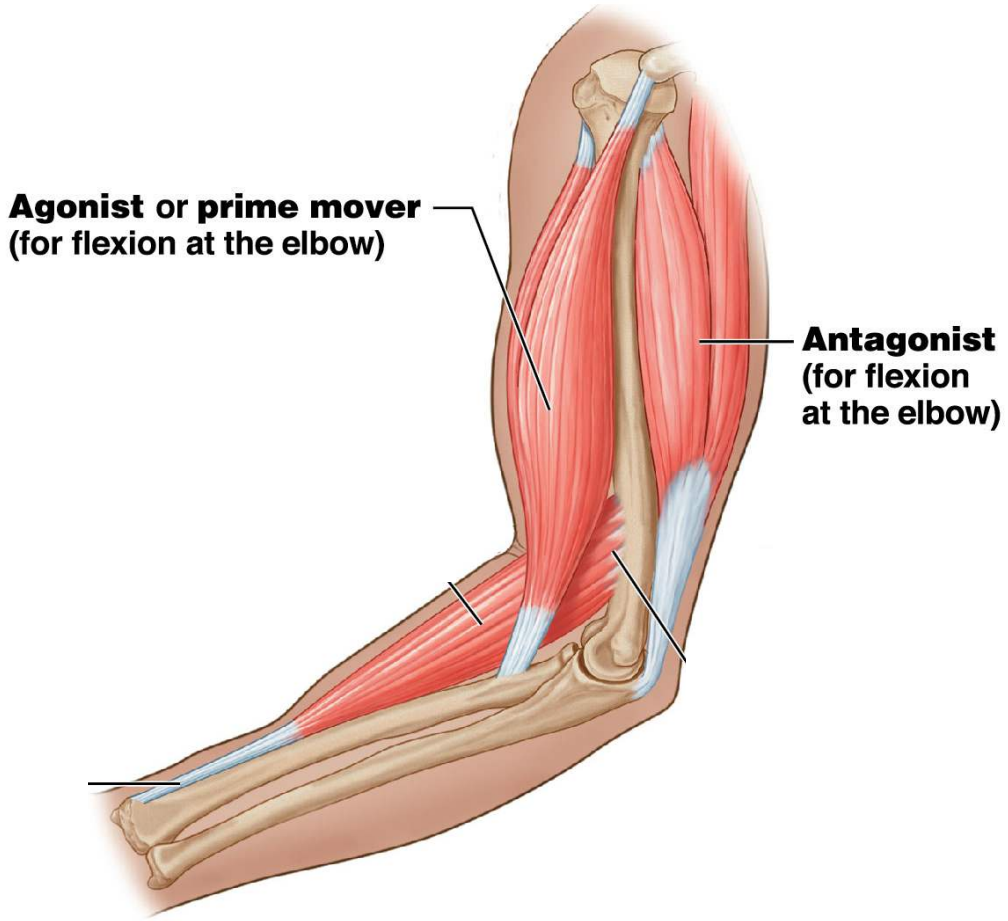
Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 396.

Types of muscle roles

Muscle can have different roles at a joint

- Agonist
  - creates movement
- Antagonist
  - opposes/controls movement
- Stabiliser
  - holds joint still
- Neutraliser
  - stops unwanted movement

Agonists and antagonists



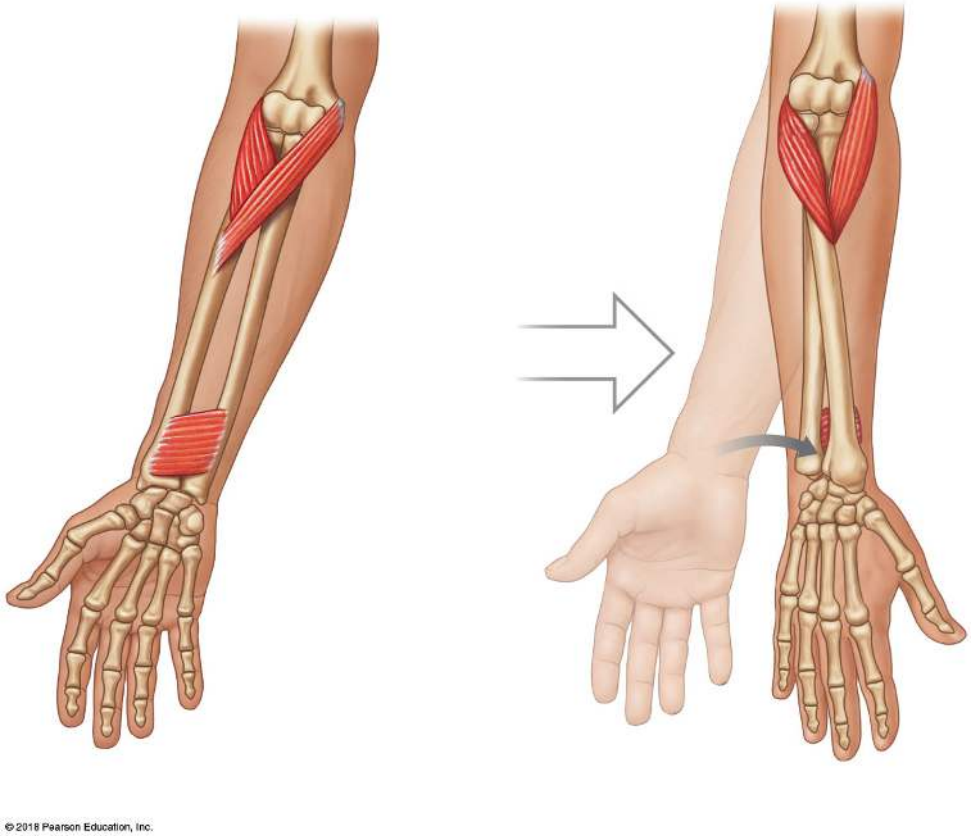
- Agonist
  - Act concentrically to create a movement at a joint
  - E.g. biceps brachii shortens
- Antagonist
  - Act eccentrically to oppose and control the movement
  - E.g. triceps brachii lengthens

Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 396.

Stabilisers

- Holds a joint still
- Prevents movement of joint
- E.g. holding a heavy book
  - Biceps brachii role = stabilizer
  - Biceps brachii action = isometric
  - No change in length of biceps brachii
  - No movement at elbow joint

Neutralisers



- Eliminates an unwanted movement caused by another muscle
- E.g. Biceps brachii flexes the elbow and supinates the forearm
  - Drinking from a glass:
    - Flexion – yes!
    - Supination – no!
  - Pronator muscles in forearm act as neutralisers to prevent supination, but still allow flexion.

Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 423.

True or false?

- Nodding your head is an example of a class 1 lever
- Neutralisers stop unwanted movement
- Isometric contraction results in a change in joint position

What muscles are you expected to know for HUBS191?

- ~650 named skeletal muscles in the human body
- We will look at **9 muscle groups**
  - **4 groups** contain multiple muscles
  - = **16 named muscles**

- You need to know
  - Name of muscle
  - Location
  - Concentric action at a joint

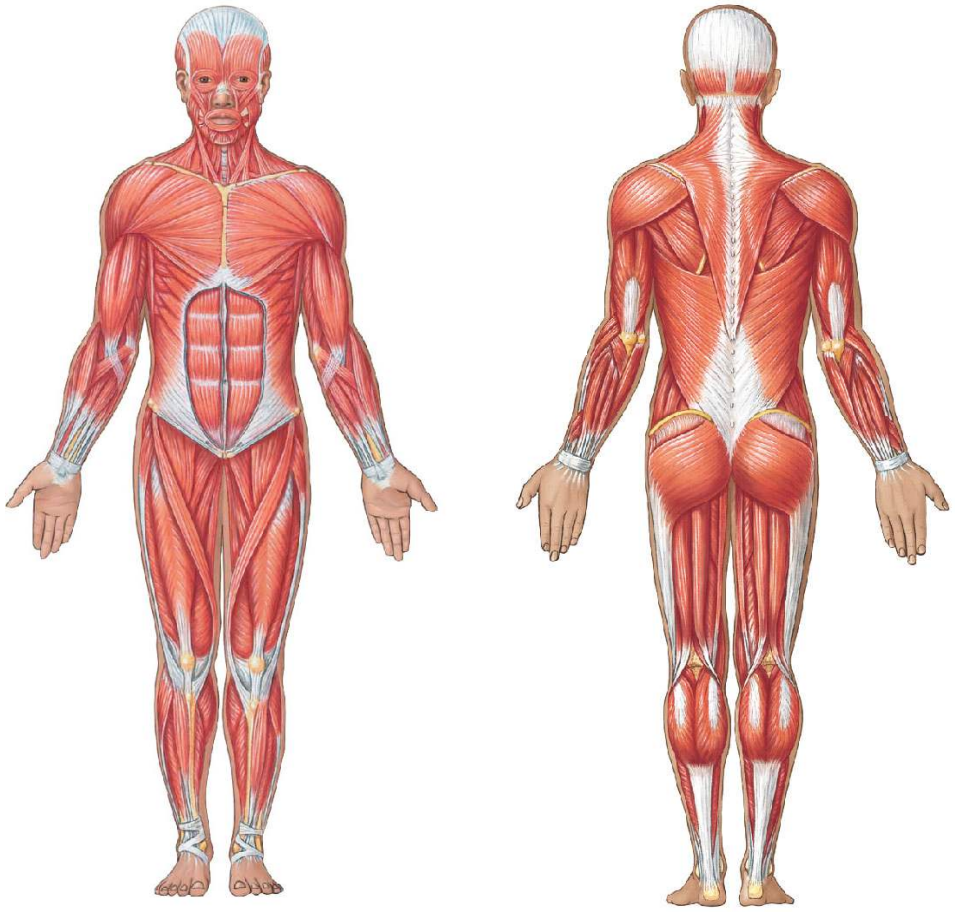


Image source: Martini et al., Visual Anatomy and Physiology (3rd ed) Pearson; pg 398 & 399.

Concentric actions of muscles

ANTERIOR
FLEXION

MEDIAL
ADDUCTION

LATERAL
ABDUCTION

POSTERIOR
EXTENSION

*(Applies for all joints **except** for the **knee**)*

Biceps brachii

- Origin
  - Scapula
- Insertion
  - Radial tuberosity
- Movement:
  - Shoulder = flexion
  - Elbow = flexion
  - Radioulnar joints = supination

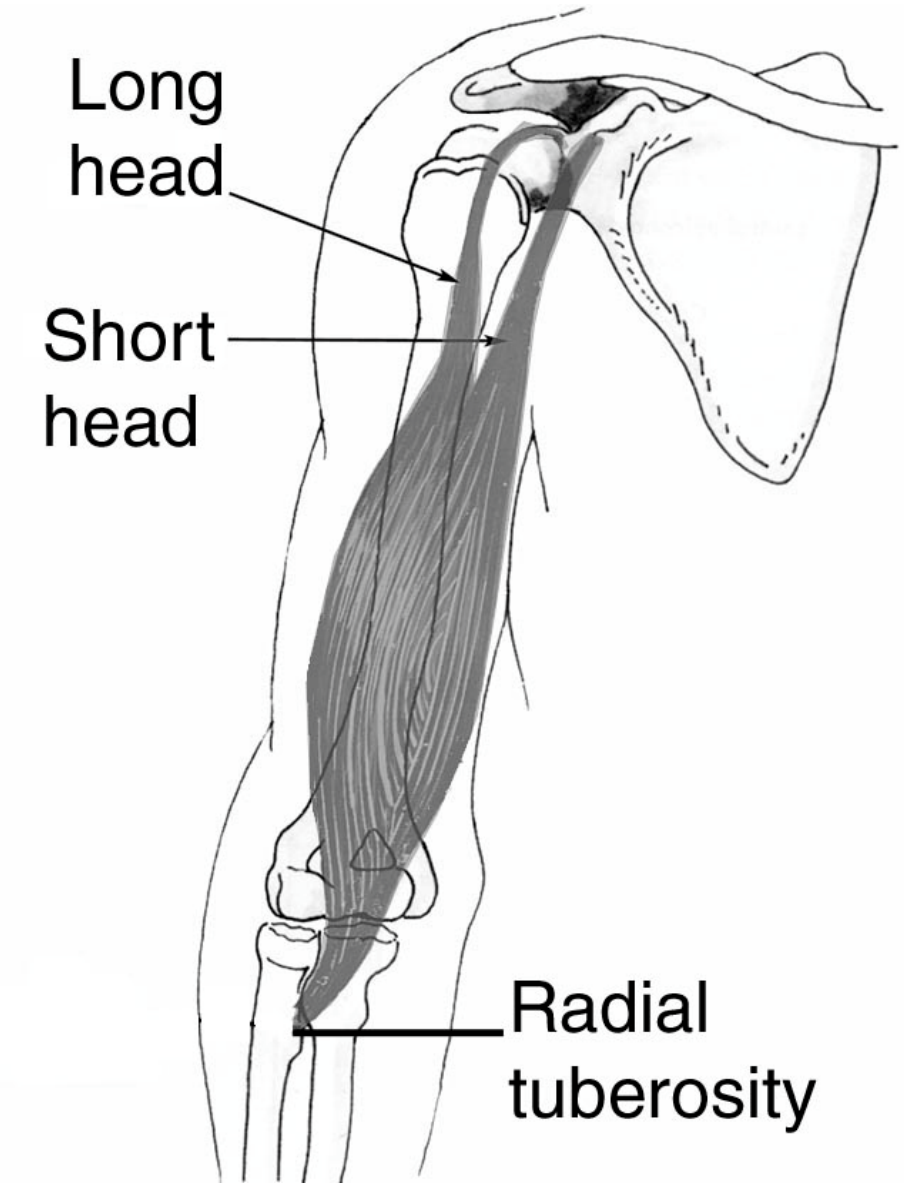


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Triceps brachii

- Origin
  - Scapula & humerus
- Insertion
  - Olecranon process of ulna
- Movement:
  - Shoulder = extension
  - Elbow = extension

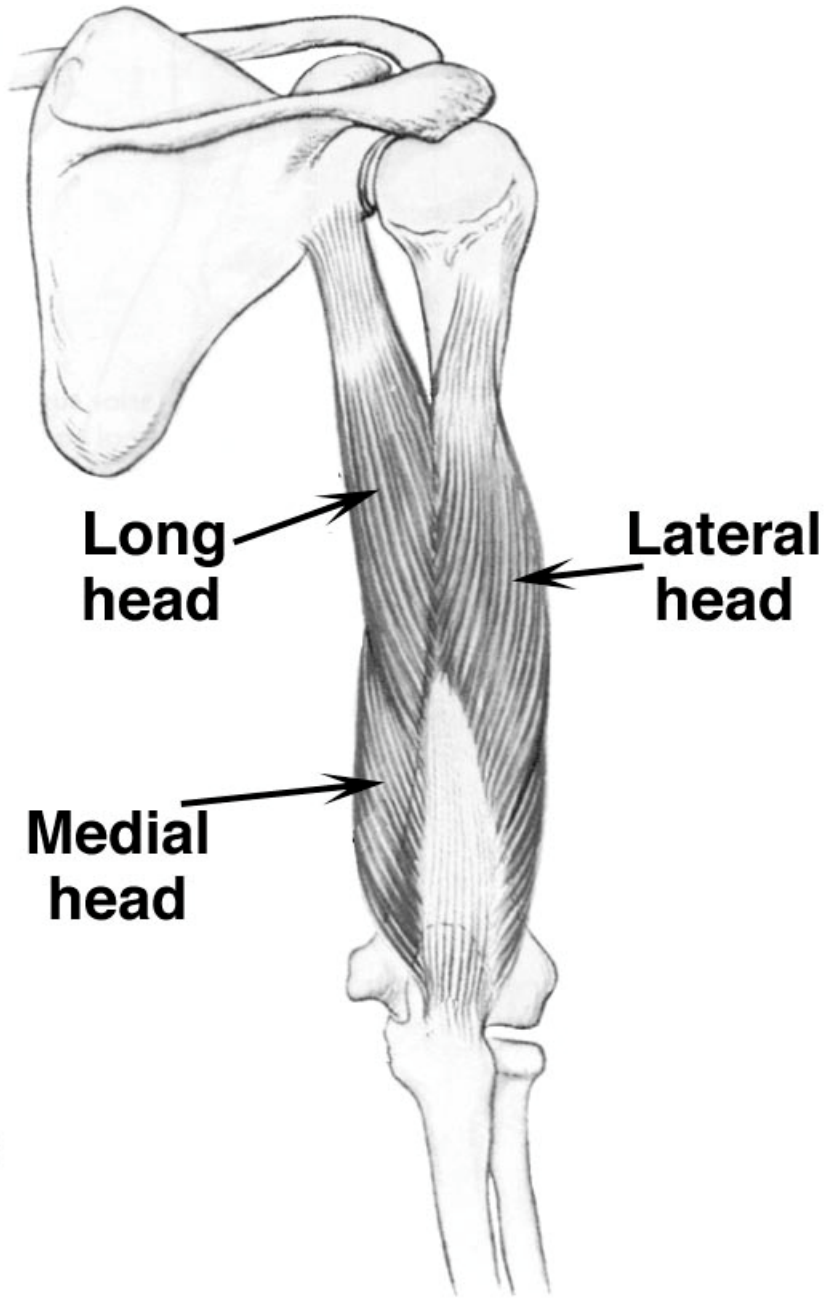
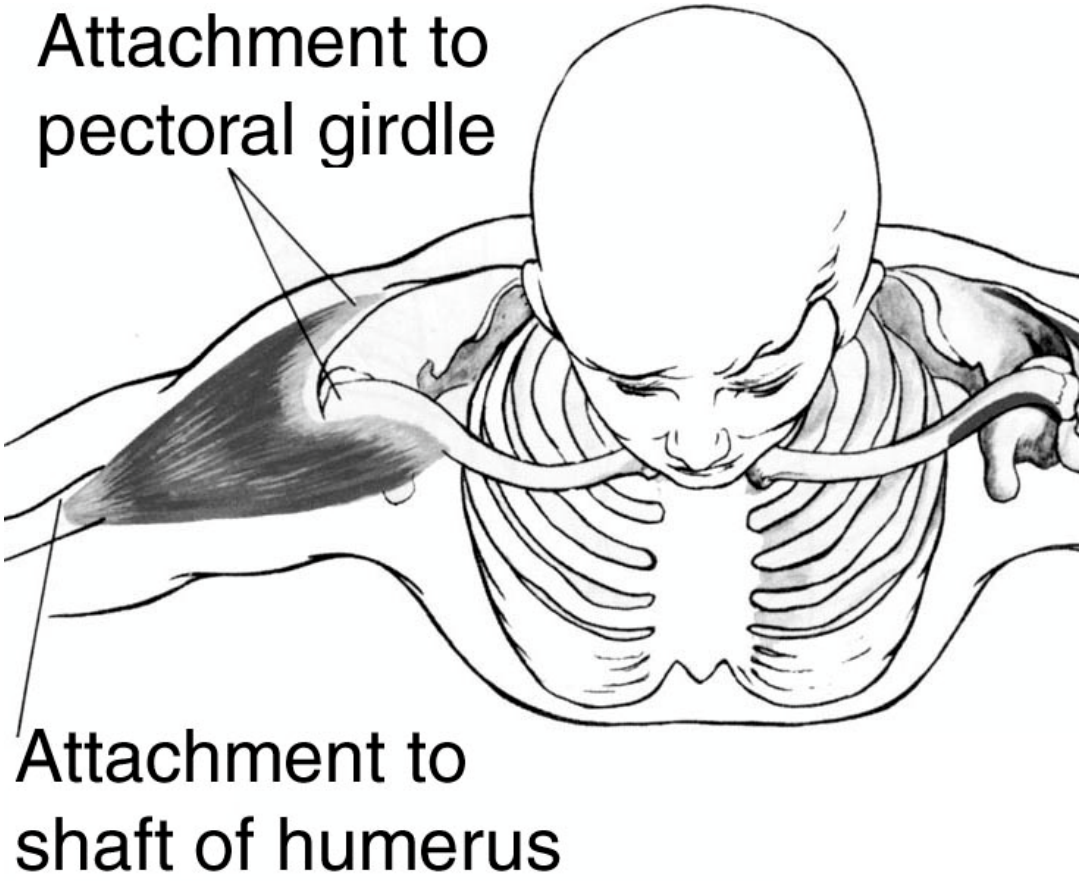


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Deltoid

- Origin
  - Scapula & clavicle
- Insertion
  - Deltoid tuberosity
- Movement:
  - Shoulder
    - Flexion (anterior fibres)
    - Abduction (lateral fibres)
    - Extension (posterior fibres)



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Iliopsoas

- Iliacus + Psoas major
- Origin
  - iliac fossa and lumbar vertebrae
- Insertion
  - femur
- Movement:
  - Hip = flexion

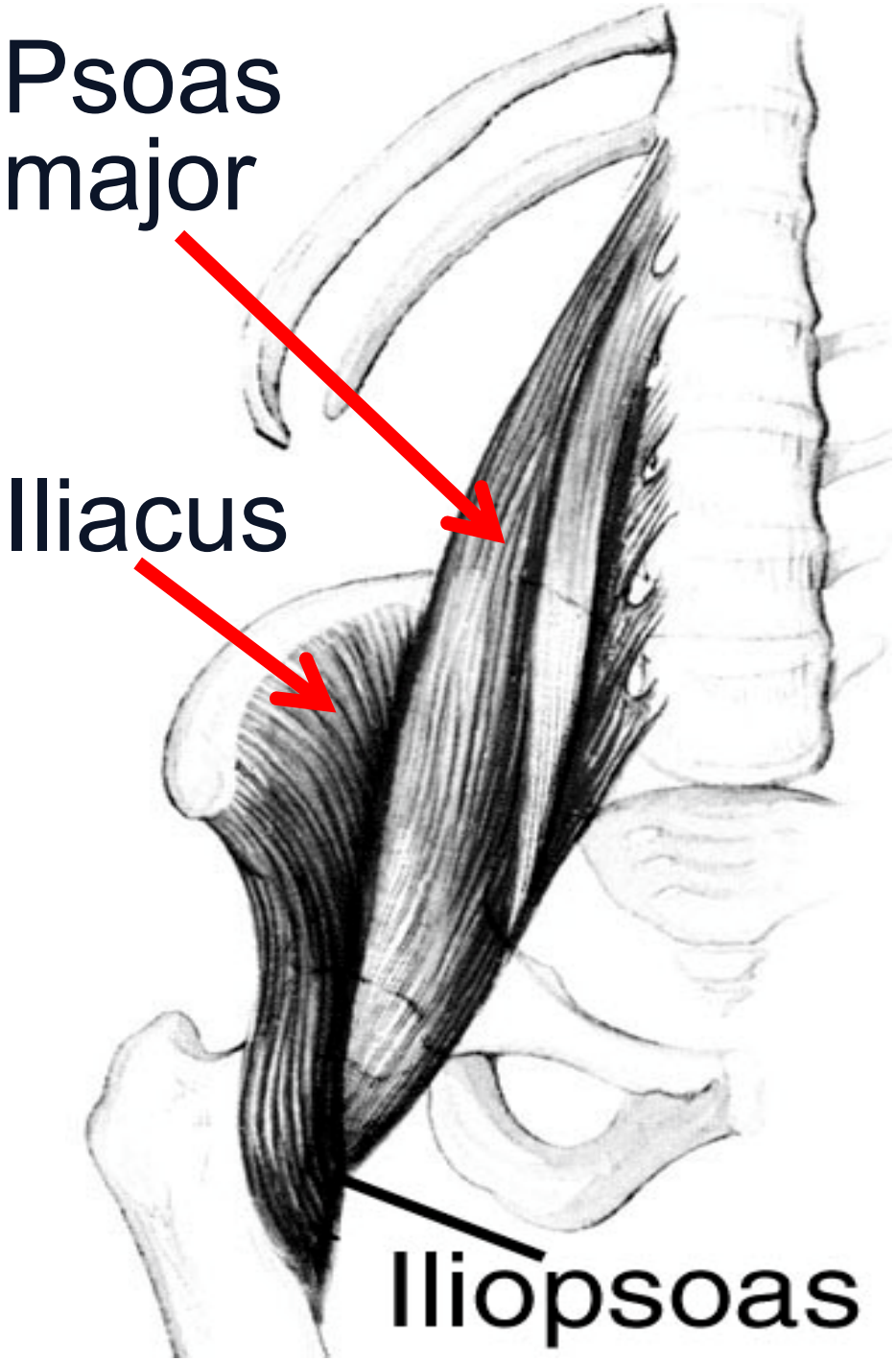


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Gluteus maximus

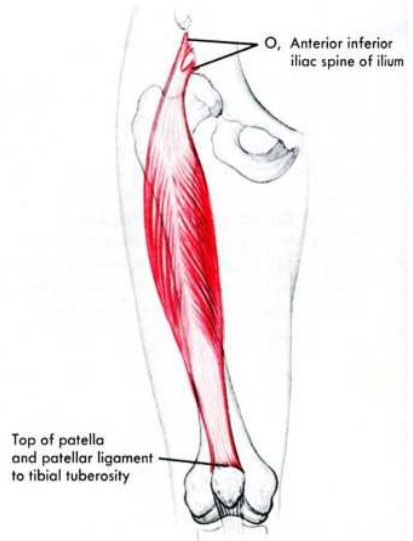
- Origin
  - Ilium & sacrum
- Insertion
  - Femur
- Movement:
  - Hip = extension

Posterior view of hip

Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

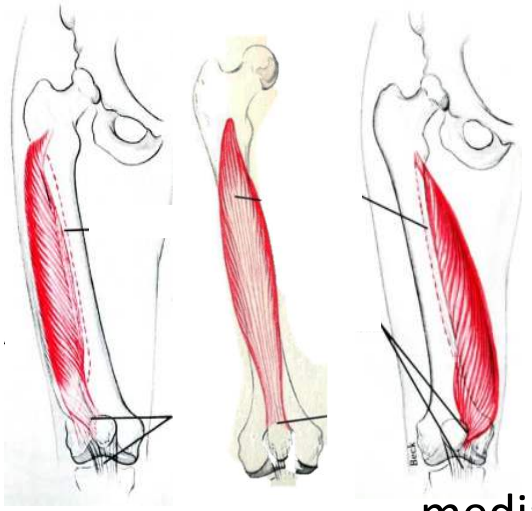
Quadriceps femoris

- Origin
  - Rectus femoris = ilium
  - Vastus medialis, intermedius and lateralis = femur
- Insertion
  - Tibial tuberosity
- Movement:
  - Hip = flexion (rectus femoris only)
  - Knee = extension



rectus femoris

vastus muscles



lateralis

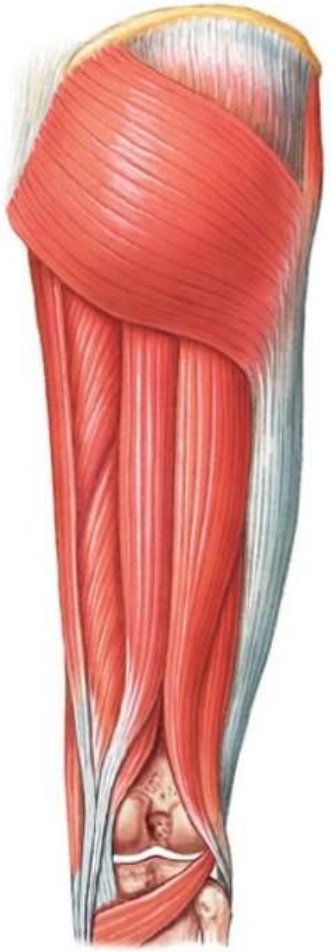
intermedius

medialis

Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Hamstrings

- Origin
  - Ischium (+ femur for biceps femoris)
- Insertion
  - Tibia (semimembranosus and semitendinosus)
  - Fibula (biceps femoris)
- Movement:
  - Hip = extension
  - Knee = flexion + rotation (when knee is flexed)



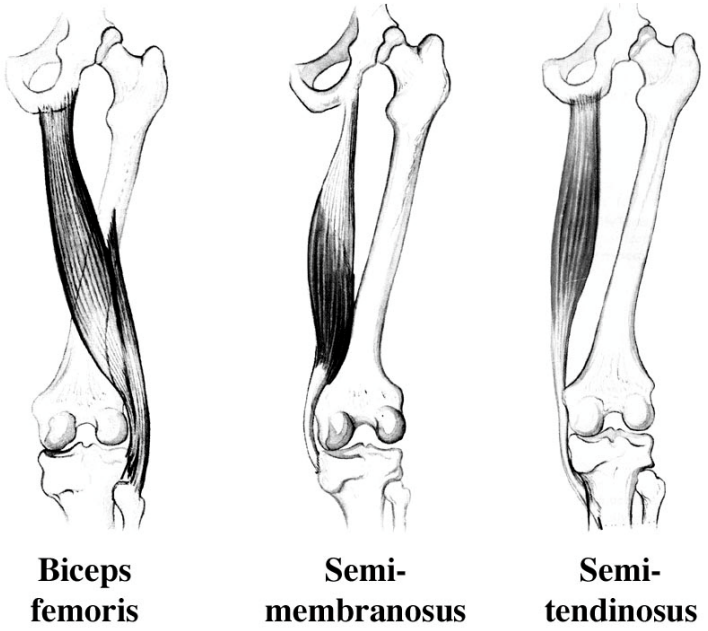


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Tibialis anterior

- Origin
  - Tibia
- Insertion
  - Tarsals
- Movement:
  - Ankle = dorsiflexion

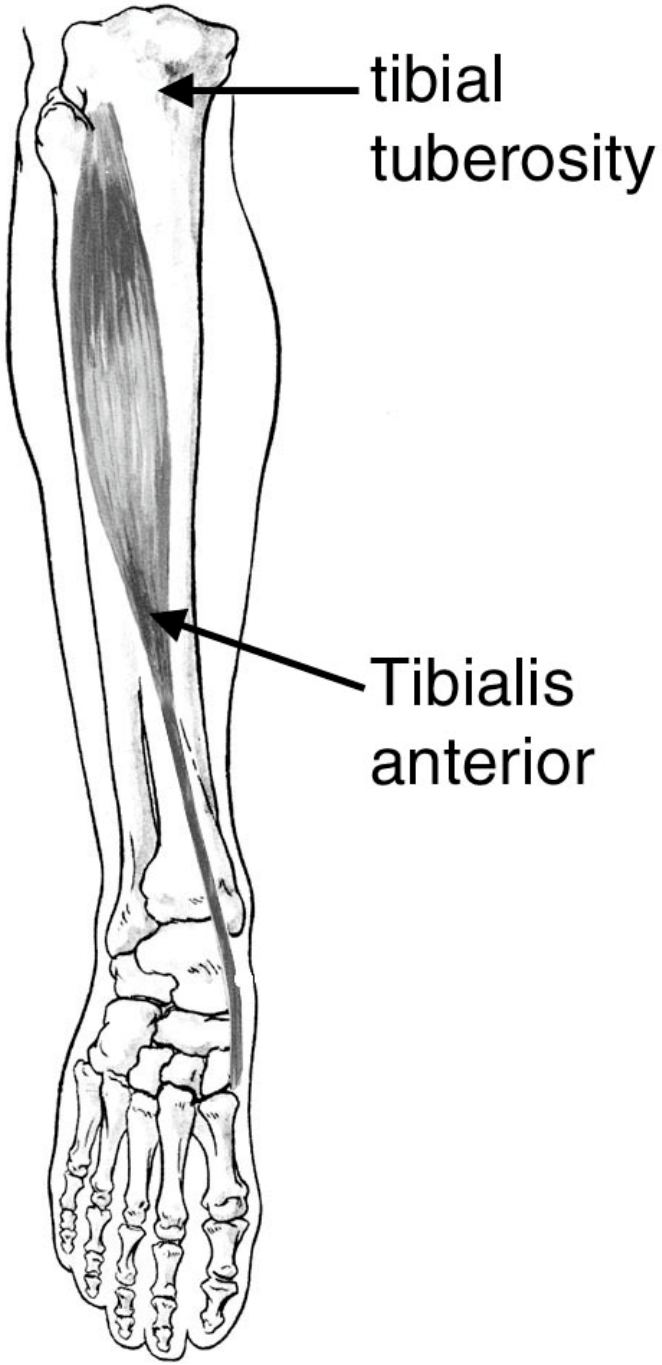


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Triceps surae

- Gastrocnemius & Soleus
- Origin
  - Condyles of femur (Gastrocnemius)
  - Tibia & fibula (Soleus)
- Insertion
  - Calcaneus via calcaneal/Achilles tendon
- Movement:
  - Knee = Flexion (Gastrocnemius only)
  - Ankle = plantarflexion

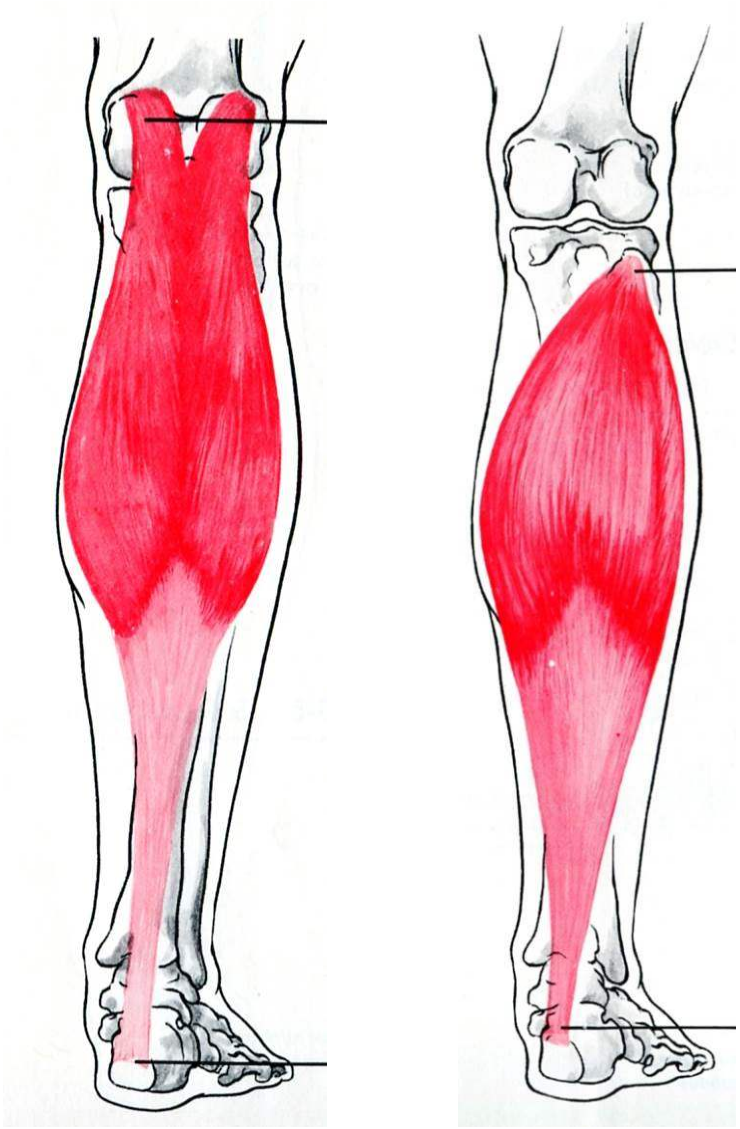


Image source: Thompson, Manual of Structural Kinesiology (10th ed) McGraw Hill.

Joint	Muscle(s)	Location (relative to joint)	Principal movement (concentric)
Shoulder	Deltoid Biceps brachii Triceps brachii		
Elbow	Biceps brachii Triceps brachii		
Hip	Iliopsoas Gluteus maximus Rectus femoris Hamstrings		
Knee	Quadriceps femoris Hamstrings Gastrocnemius		
Ankle	Tibialis anterior Triceps surae		

Preparation for Gait Cycle

Movement	Agonist(s)	Antagonist(s)
Hip flexion	Iliopsoas & rectus femoris	Gluteus maximus & hamstrings
Hip extension		
Knee flexion		
Knee extension		
Ankle plantarflexion		
Ankle dorsiflexion		

Practice essay

The ankle is an important region of the lower limb. Write an essay on the structure and function of the ankle, including the following components:

i) Compare the structure of the ankle joint to the hip, noting differences in bones, muscles and movement. (3)

ii) Outline the changes in position of the ankle joint throughout both swing and stance phases of the gait cycle, including the roles of muscles. (3)

iii) Describe how severe damage to the tibialis anterior would impact the normal gait cycle. (2)

For tomorrow, brain storm i) then turn it into 1 short paragraph.

Summary

- The structure, location and type of contraction of muscle influences the movements it produces at a joint
- Muscle action and role changes depending on the movement
- There are 16 named muscles to know in HUBS191

HUBS191