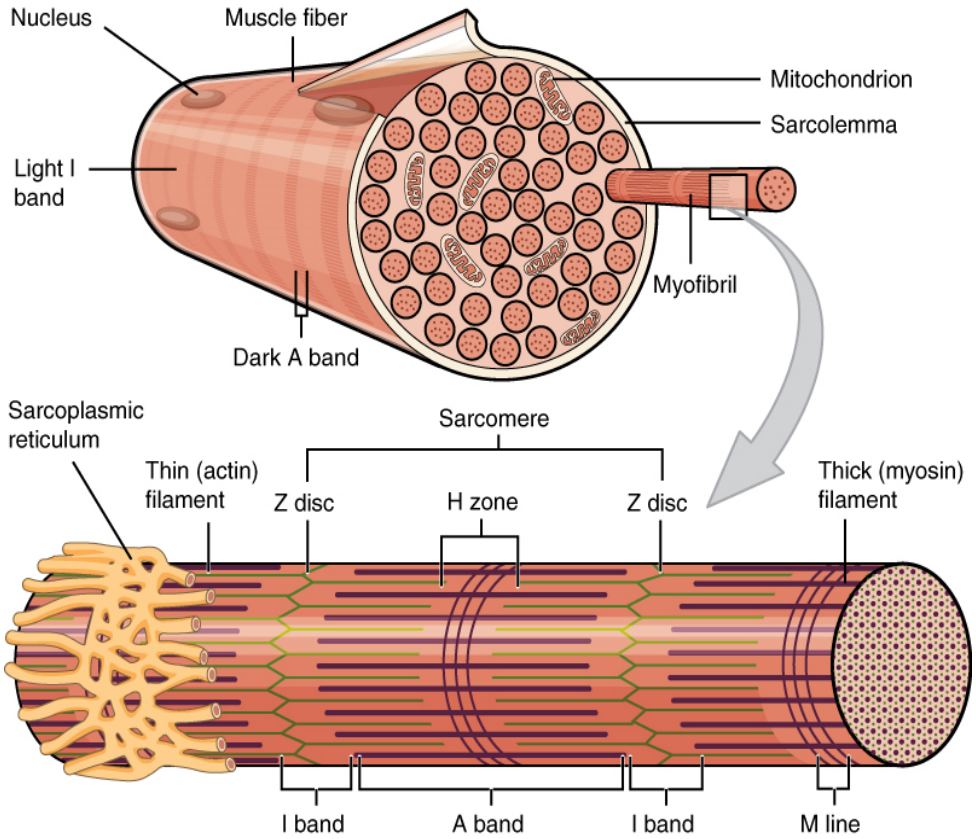
BIOLOGY 1103/1109
Human Anatomy and Physiology I

UNIT 15

Muscle Anatomy & Movement



Muscular system
Objectives

1. Describe the levels of muscle organization: fascia, fascicles, muscle fibres.
2. Describe the following structures of a muscle cell: sarcolemma, sarcoplasm, nuclei, mitochondria, sarcoplasmic reticulum, myofibrils, myofilaments, sarcomere.
3. Describe the following structures of a sarcomere: Z line, I band, A band, H zone, M line.
4. Describe the basic structure of the thick and thin filaments and their primary protein components.
5. Specify four factors which determine the type of movement accomplished by a muscle.
6. Specify some of the criteria used in the naming of muscles.
7. Describe, using specific examples, 16 types of movements characteristic of skeletal muscle contractions.

Types of Muscle Tissue

I. Smooth

In organs; involuntary

II. Striated (Skeletal)

Linked to bones; voluntary

III. Cardiac

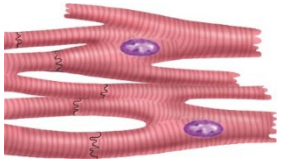
In the heart; involuntary

Movement

MOVEMENT ENVOLVES ***MUSCLE***

THERE ARE 3 TYPES OF MUSCLE:

CARDIAC

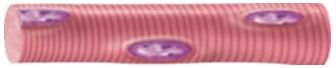


INVOLUNTARY
HEART

SMOOTH

INVOLUNTARY
INTESTINES
BLOOD VESSELS
BLADDER
EYE (inside the eye)
UTERUS etc.

SKELETAL



VOLUNTARY
MUSCLES ATTACHED TO BONES

*IT IS THE **SKELETAL MUSCLES,** TOGETHER WITH THE **BONES & JOINTS,** THAT ACCOMPLISHES **MOVEMENT***

Skeletal muscles

- Attached to bones via tendons
- Cells = muscle fibers
- Able to contract or relax
- Produce force that causes movement
- Striated

Factors determining the type of movement performed by a muscle

I. Type of ___joint___

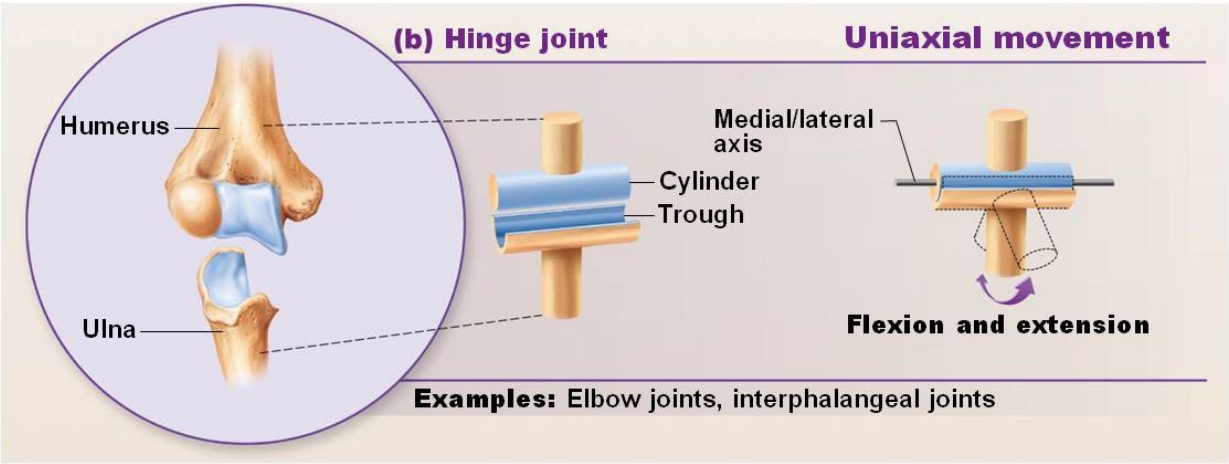
II. ___Orientation___ of the muscle

III. Action of other muscles close by

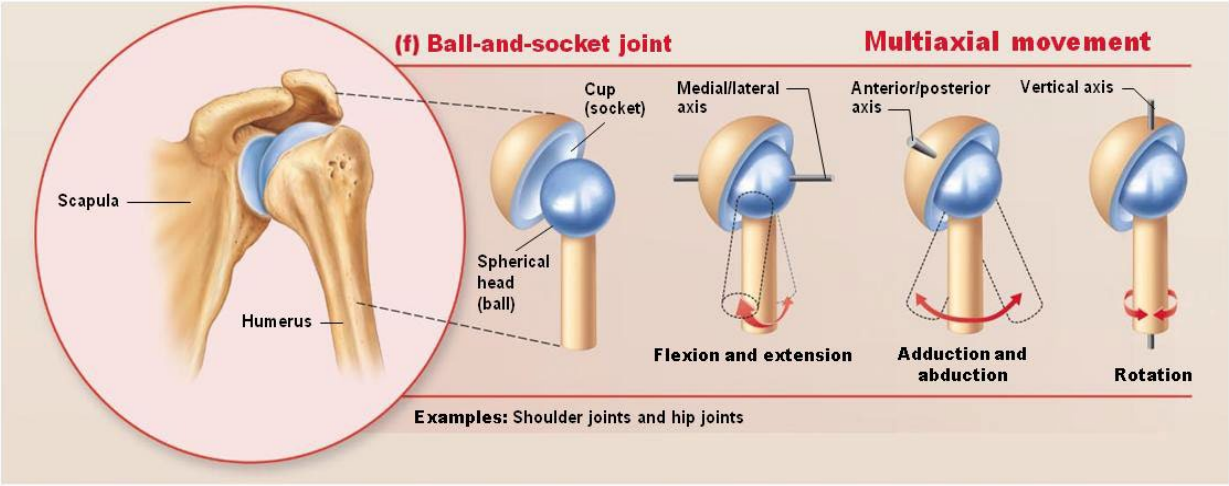
IV. Muscle tension

Factors determining the type of movement performed by a muscle

type of joint



Angular movement



Angular, circumduction and rotation movement

Marieb, Focus figures 8.1b,f

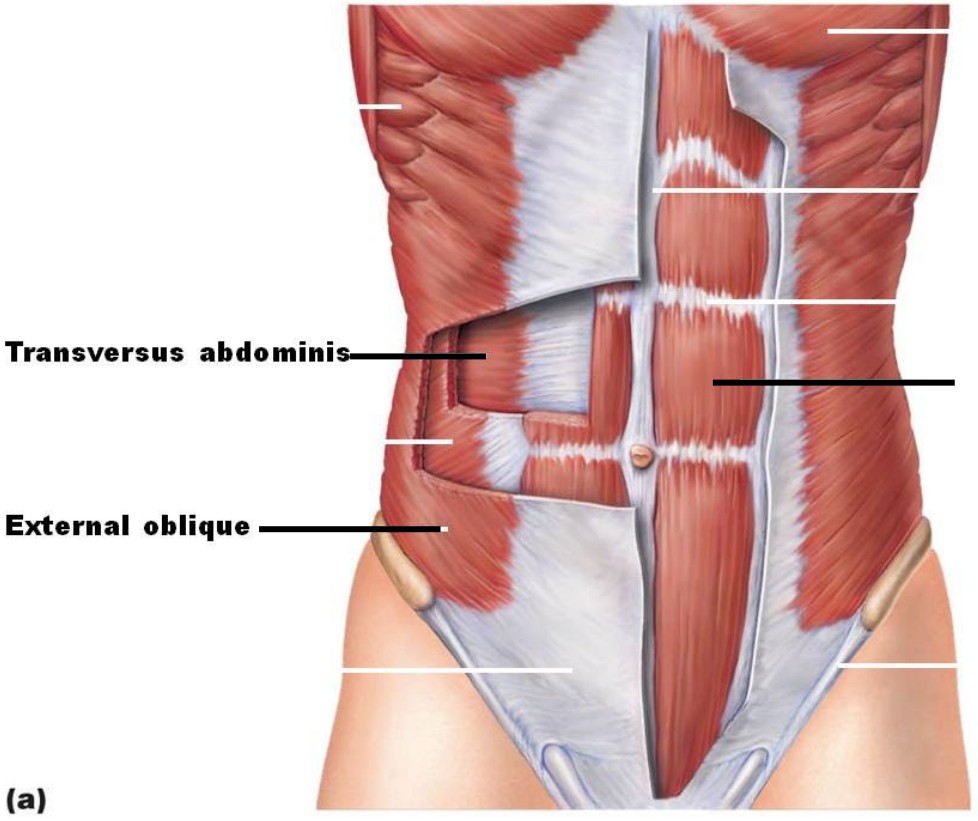
Types of synovial joints

summary of movements

Type	Allowed Movement
Gliding	Gliding
Hinge	Angular (flexion and extension)
Pivot	Rotation
Ellipsoidal	Angular (flex., ext., abd., add. and circumduction)
Saddle	Angular (flex., ext., abd., add. and circumduction)
Ball-and-Socket	Angular (flex., ext., abd., add., circumduction) and rotation

Factors determining the type of movement performed by a muscle

orientation of the muscle fibers (cells)



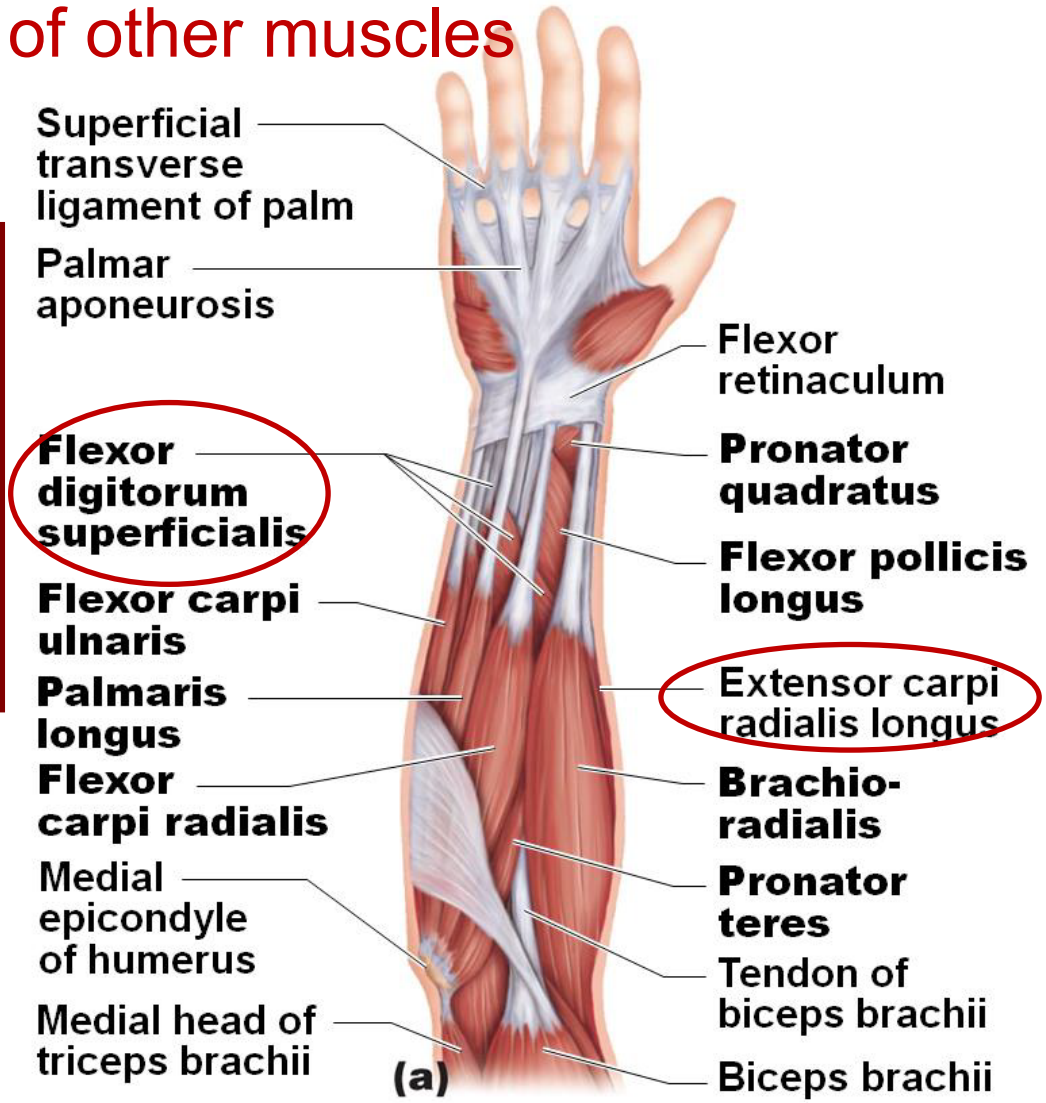
Marieb, Figure 10.12a

- Depending on the orientation, different abdominal muscles perform different types of movements.

Factors determining the type of movement performed by a muscle

action of other muscles

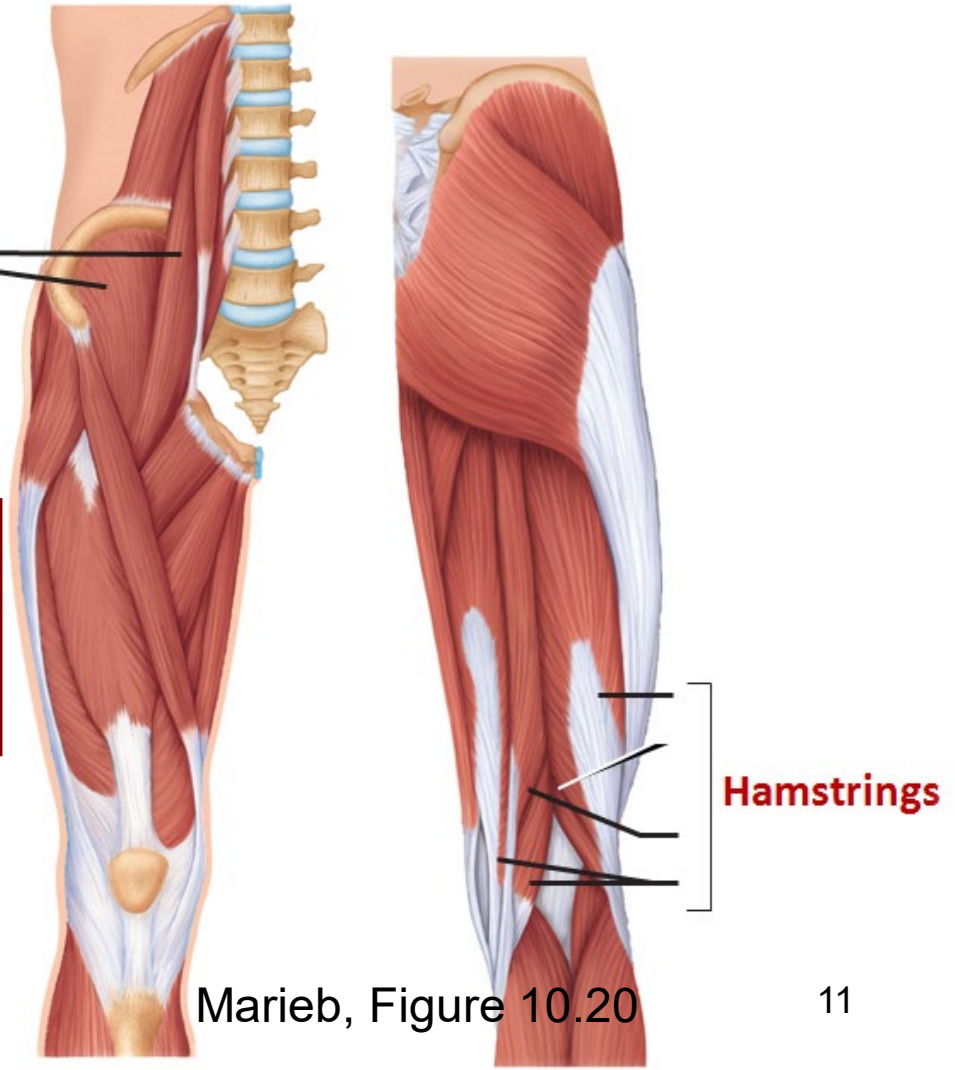
- For *flexor digitorum superficialis* to flex the fingers without flexing the hand, *extensor carpi radialis longus* needs to contract.



Marieb, Figure 10.16a

Factors determining the type of movement performed by a muscle

muscle tension



- For *psoas major* to flex the thigh fully, the hamstrings need to relax.

Marieb, Figure 10.20

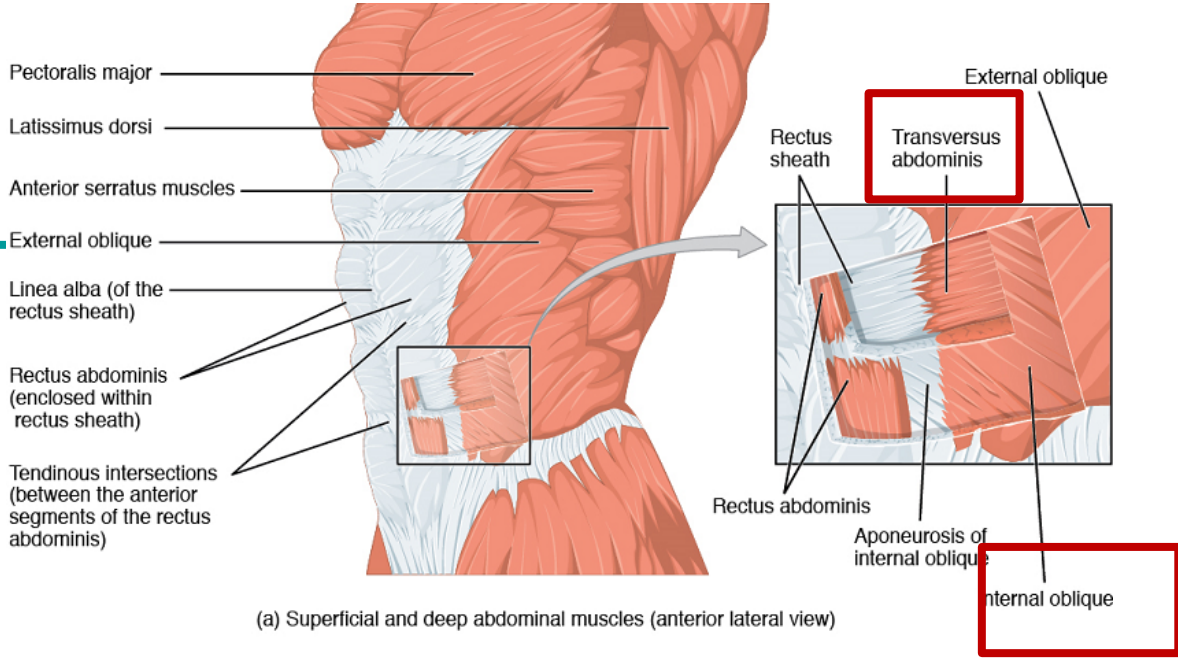
Seven features used in naming muscles

1) Direction/orientation of muscle fibers
2) Location of muscle
3) Relative size of muscle
4) Shape of muscle
5) Number of origins
6) Sites of origins & insertions
7) Action produced by muscle

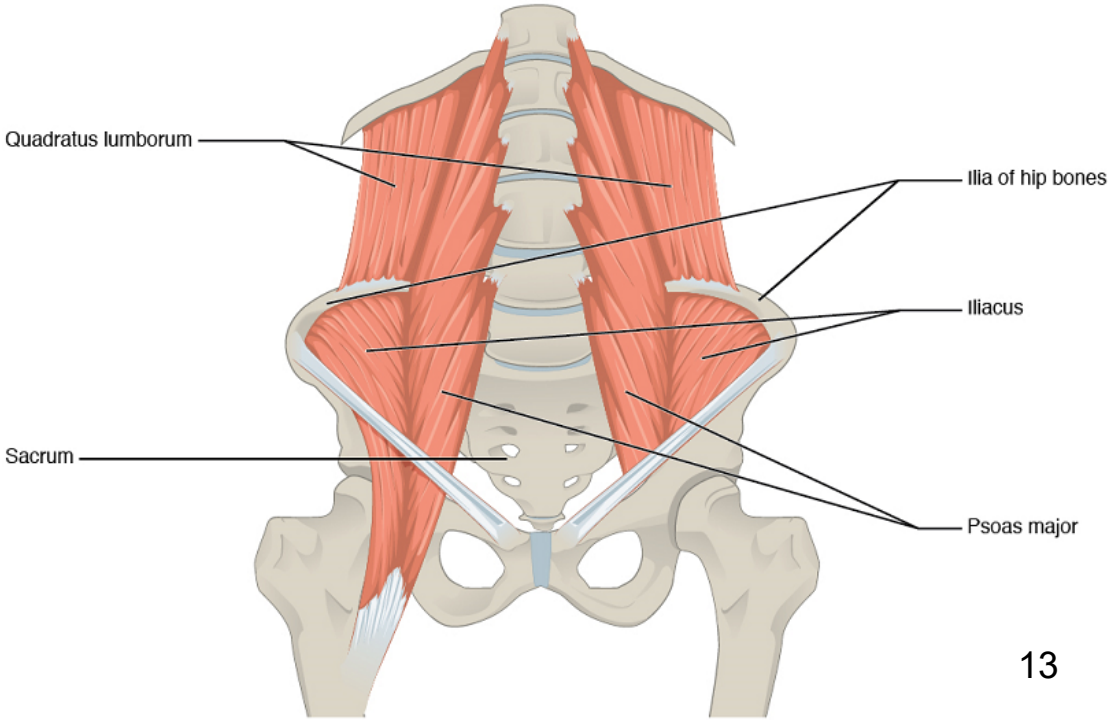
Naming of Muscles

examples

1) Direction /orientation of muscle fibers



(a) Superficial and deep abdominal muscles (anterior lateral view)

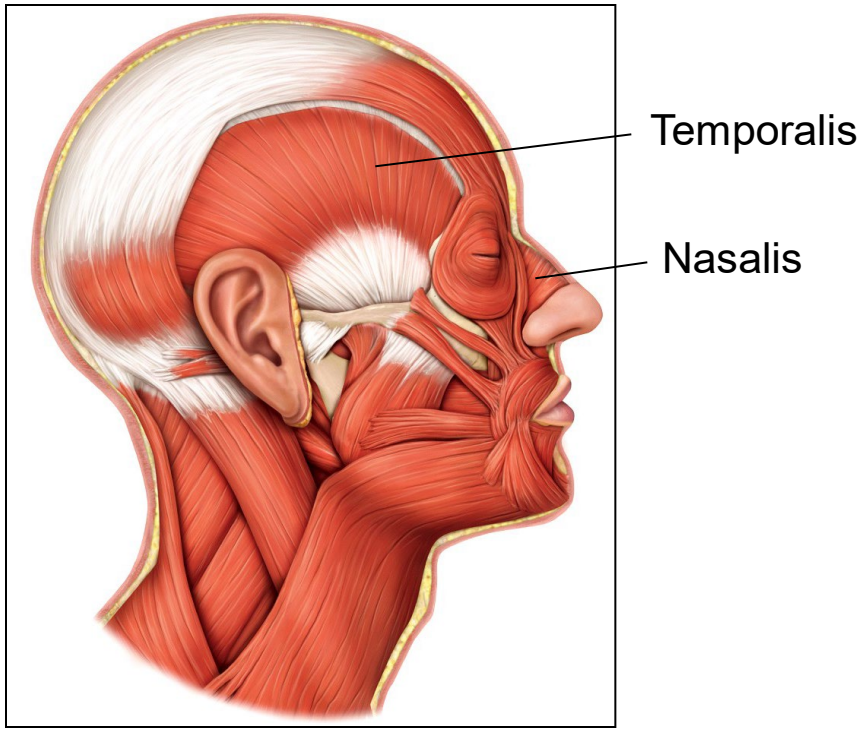


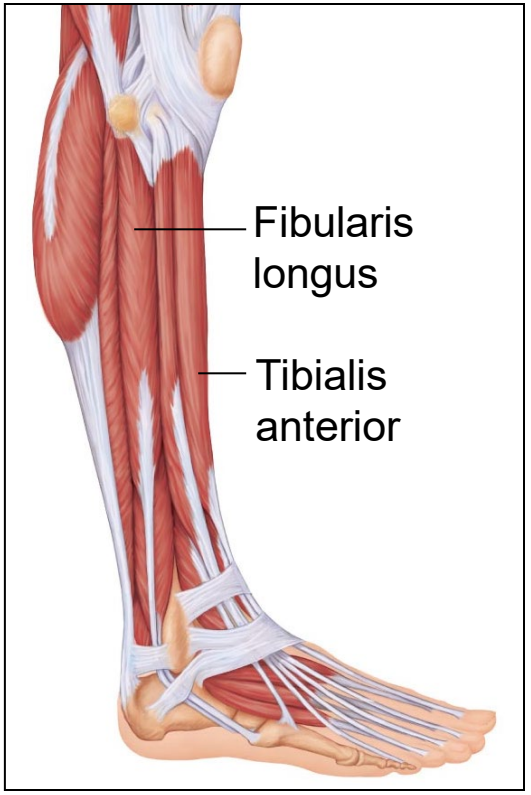
(b) Posterior abdominal muscles (anterior view)

Naming of muscles

examples

2) Location of muscle

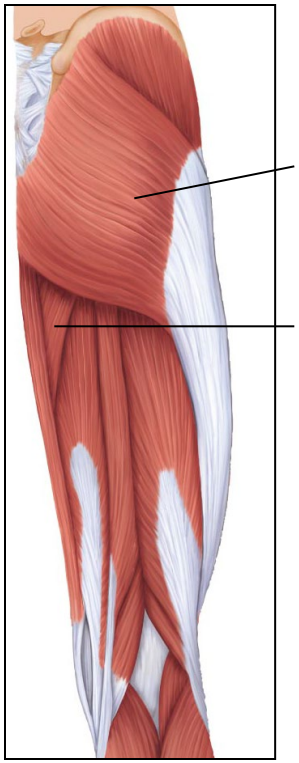


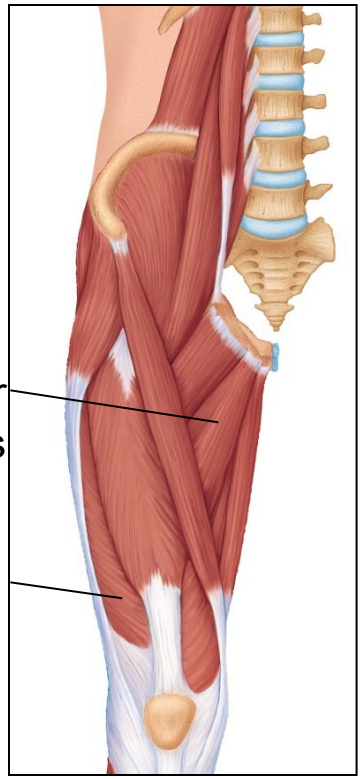


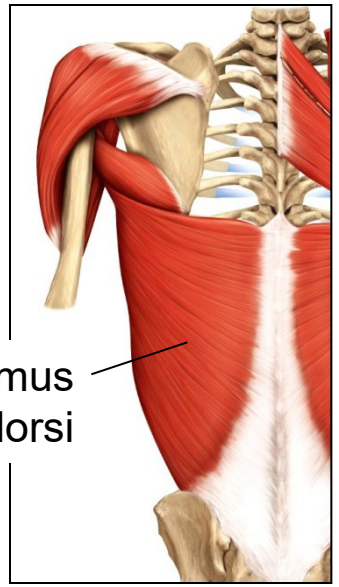
Naming of muscles

examples

3) Relative size of muscle



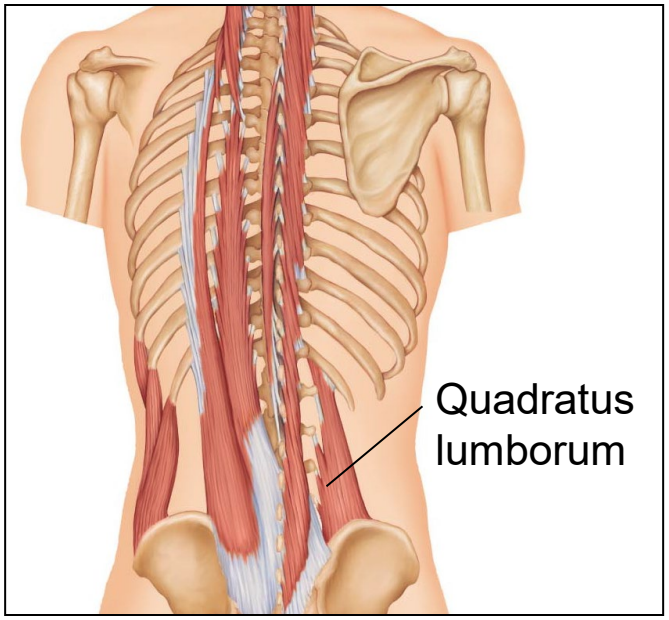


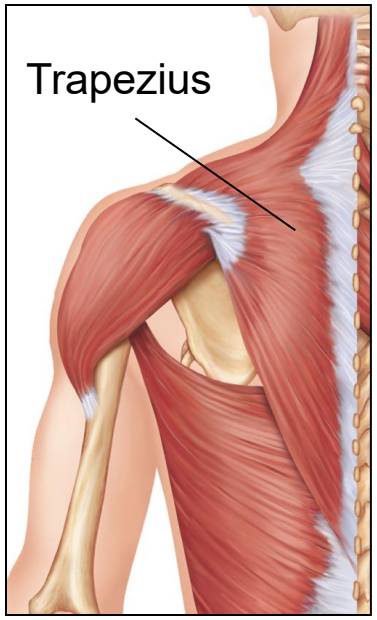


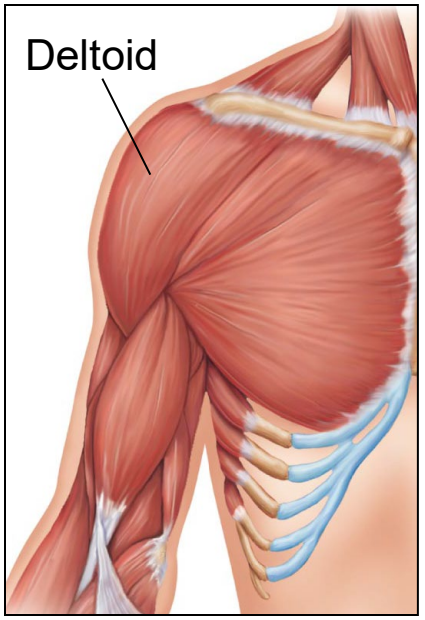
Naming of muscles

examples

4) Shape of muscle





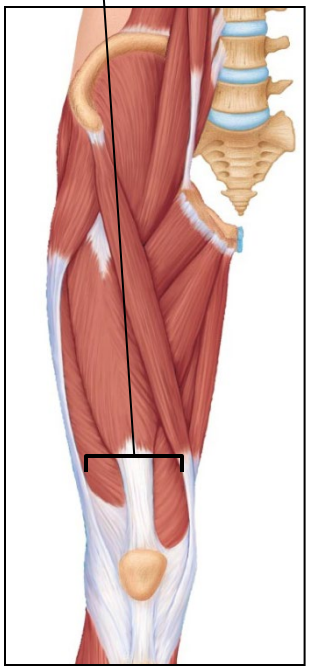


Naming of muscles

examples

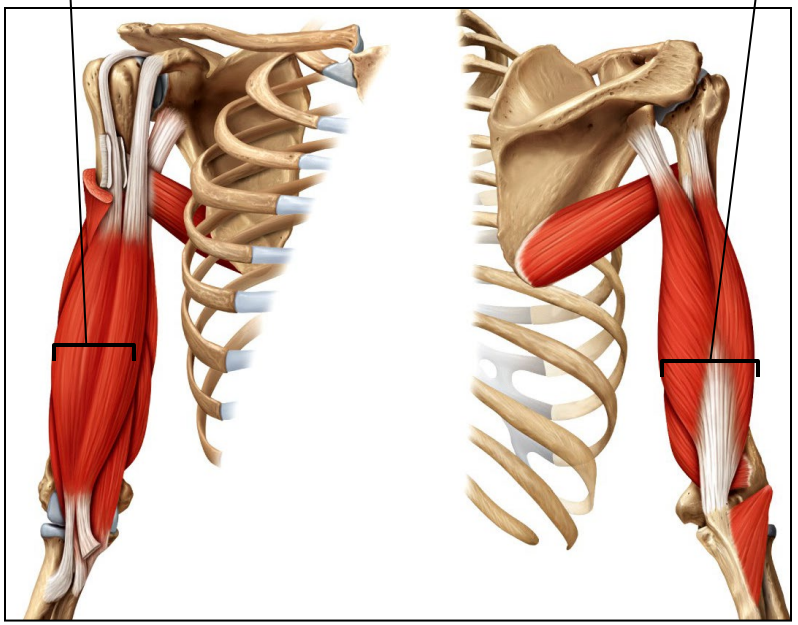
5) Number of origins

Quadriceps femoris



Biceps brachii

Triceps brachii

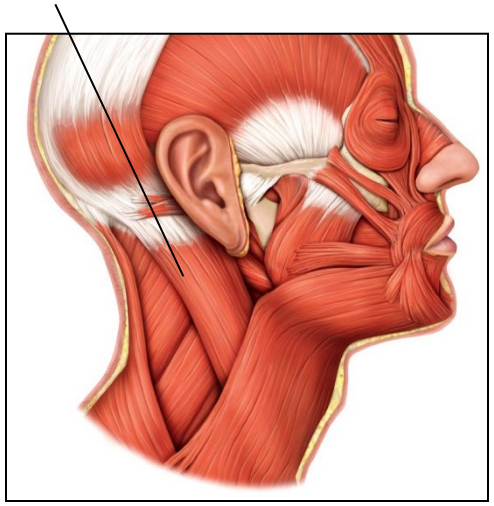


Naming of muscles

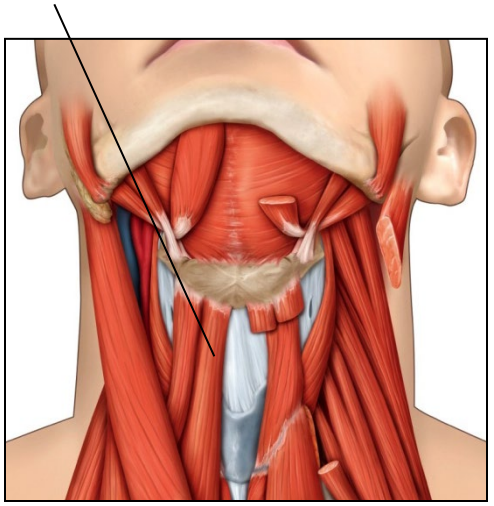
examples

6) Sites of origins & insertions

Sternocleidomastoid



Sternohyoid



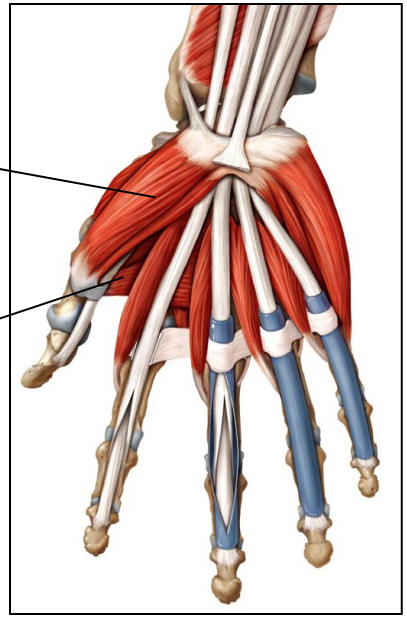
Naming of muscles

examples

7) Action produced by muscle

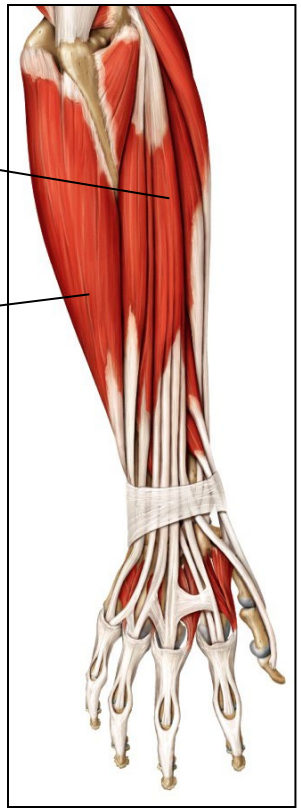
Abductor pollicis brevis

Adductor pollicis



Extensor digitorum

Flexor carpi ulnaris



Types of movement

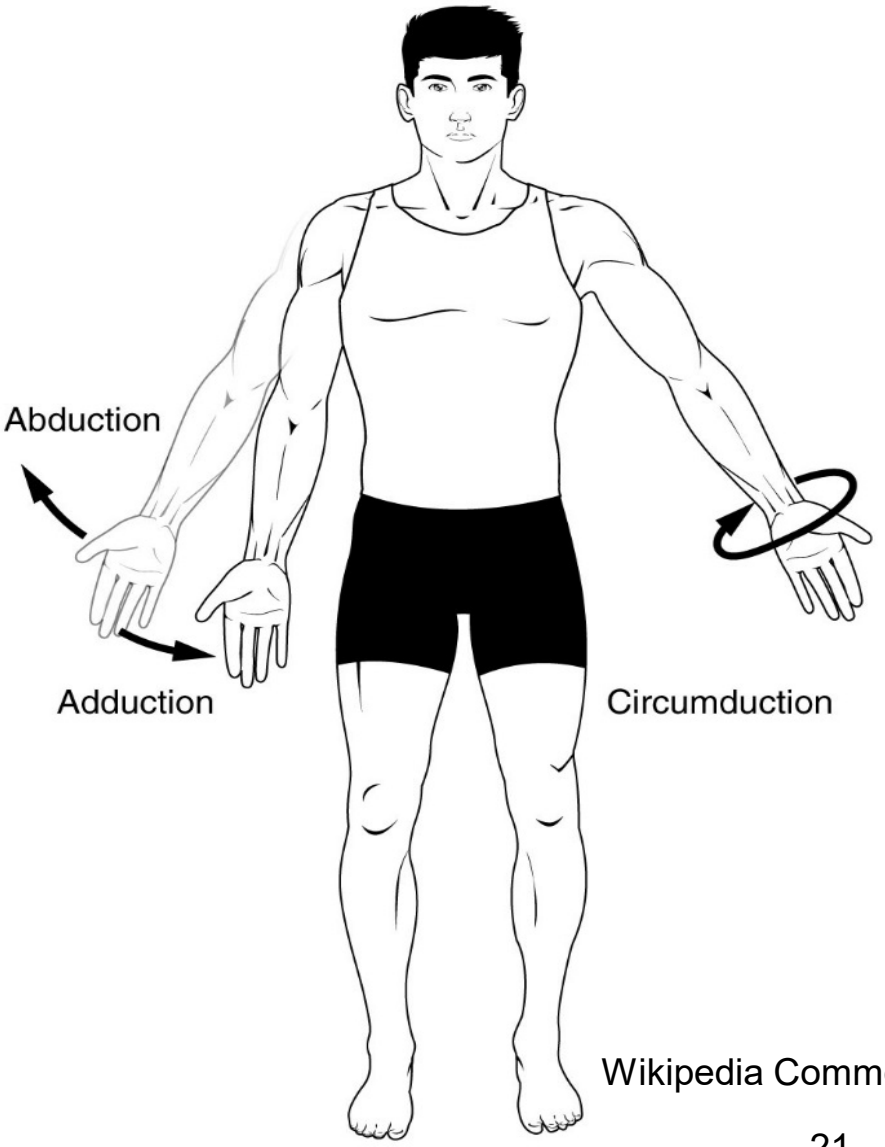
Movements you already know	5 new pairs of opposing movements
- Flexion & Extension - Abduction & Adduction - Rotation - Circumduction	- Elevation & Depression - Plantarflexion & Dorsiflexion - Inversion & Eversion - Supination & Pronation - Protraction & Retraction

Types of muscle movements

Abduction: Bone moves away from midline

Adduction: Bone moves towards midline

Circumduction: Distal end of bone moves in circles



Wikipedia Commons

Types of muscle movements

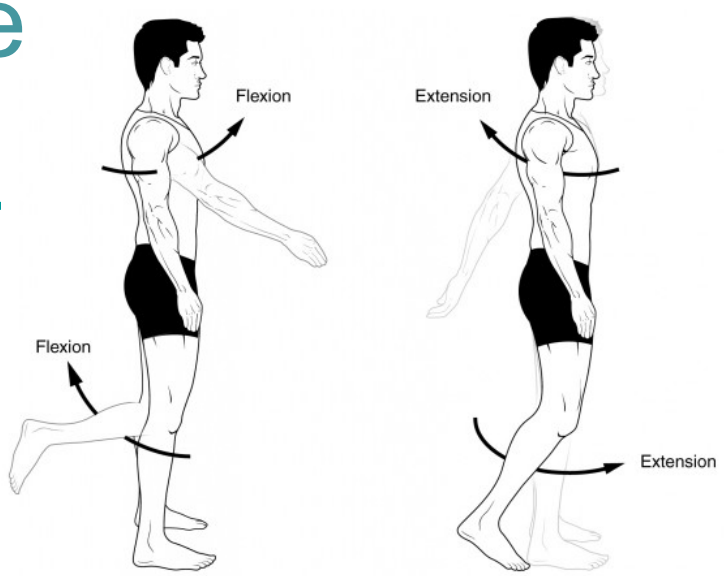
Figure 5

Flexion :

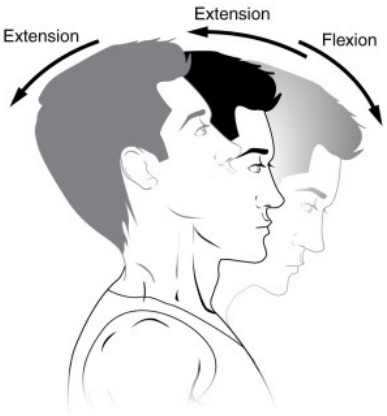
Decreases a joint angle

Extension:

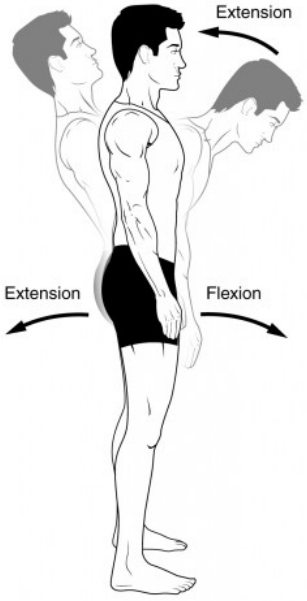
Increases a joint angle



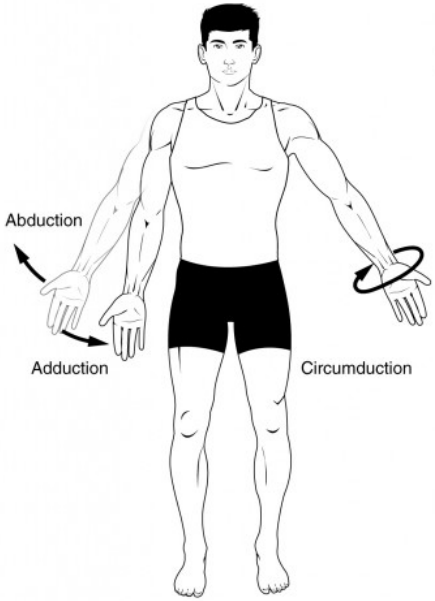
(a) and (b) Angular movements: flexion and extension at the shoulder and knees



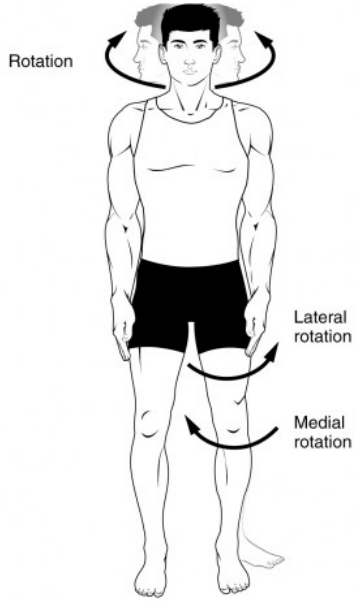
(c) Angular movements: flexion and extension of the neck



(d) Angular movements: flexion and extension of the vertebral column



(e) Angular movements: abduction, adduction, and circumduction of the upper limb at the shoulder

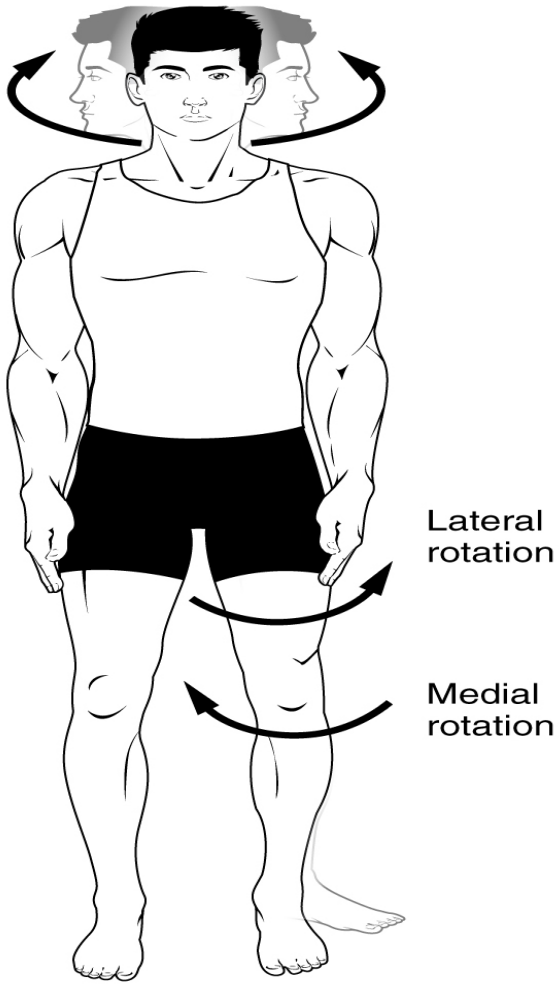


(f) Rotation of the head, neck, and lower limb

Types of muscle movements

Rotation :

Bone moves around its longitudinal axis



f) Rotation of the head, neck, and lower limb

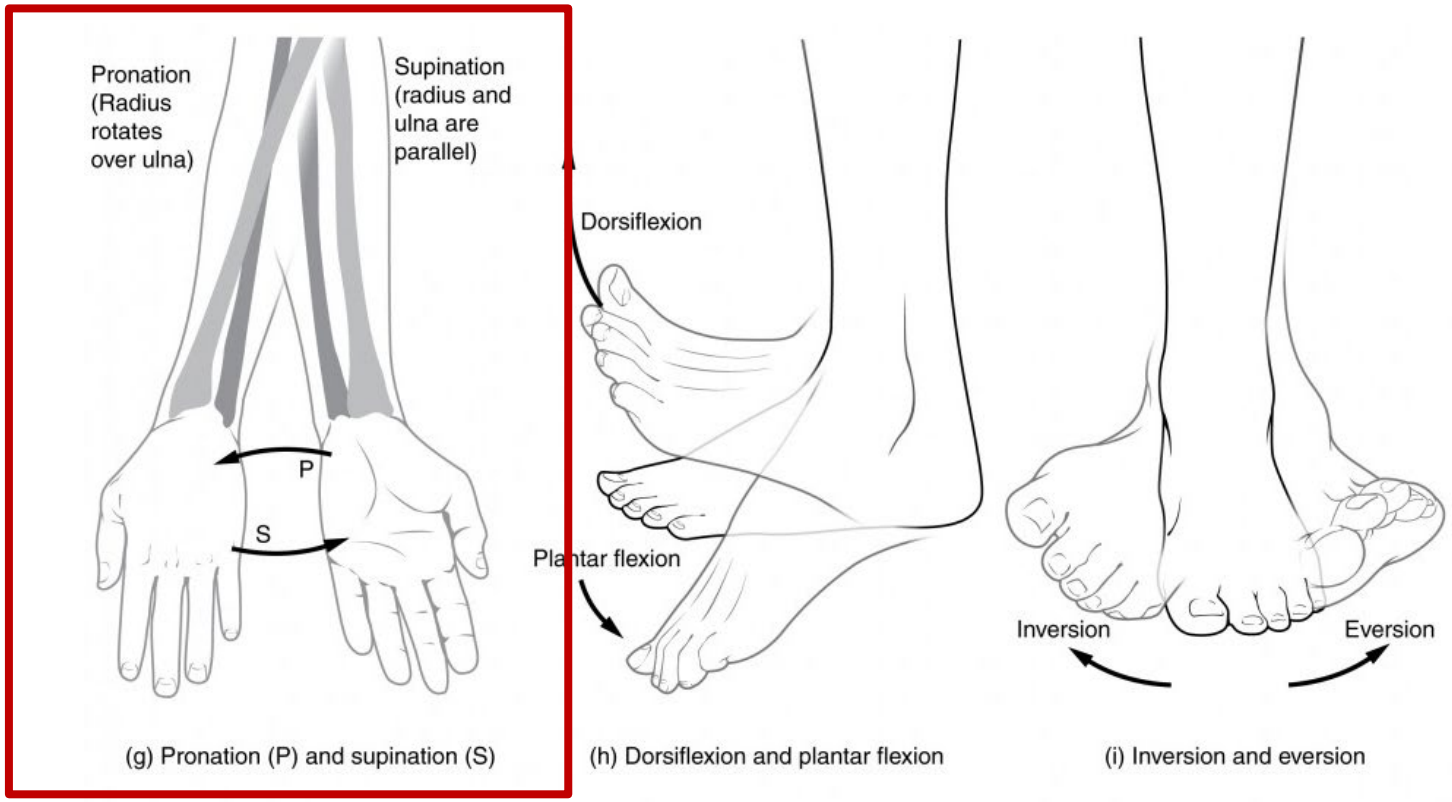
Wikipedia

Types of muscle movements

Supination: Palm of hands turns upwards

Pronation : Palm of hands turns downwards

Figure 6

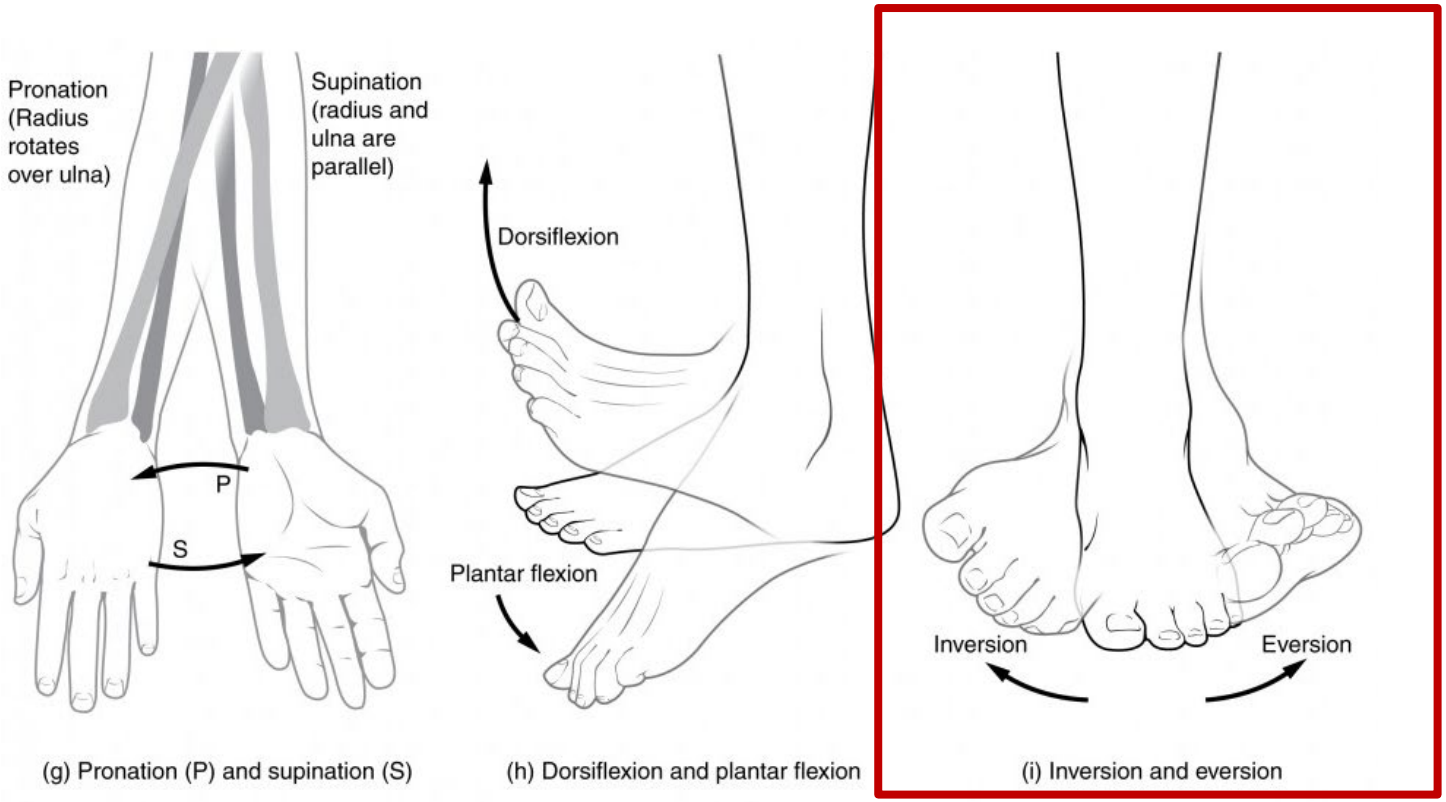


Types of muscle movements

Eversion: Foot moves away from midline

Inversion : Foot moves towards midline

Figure 6



(g) Pronation (P) and supination (S)

(h) Dorsiflexion and plantar flexion

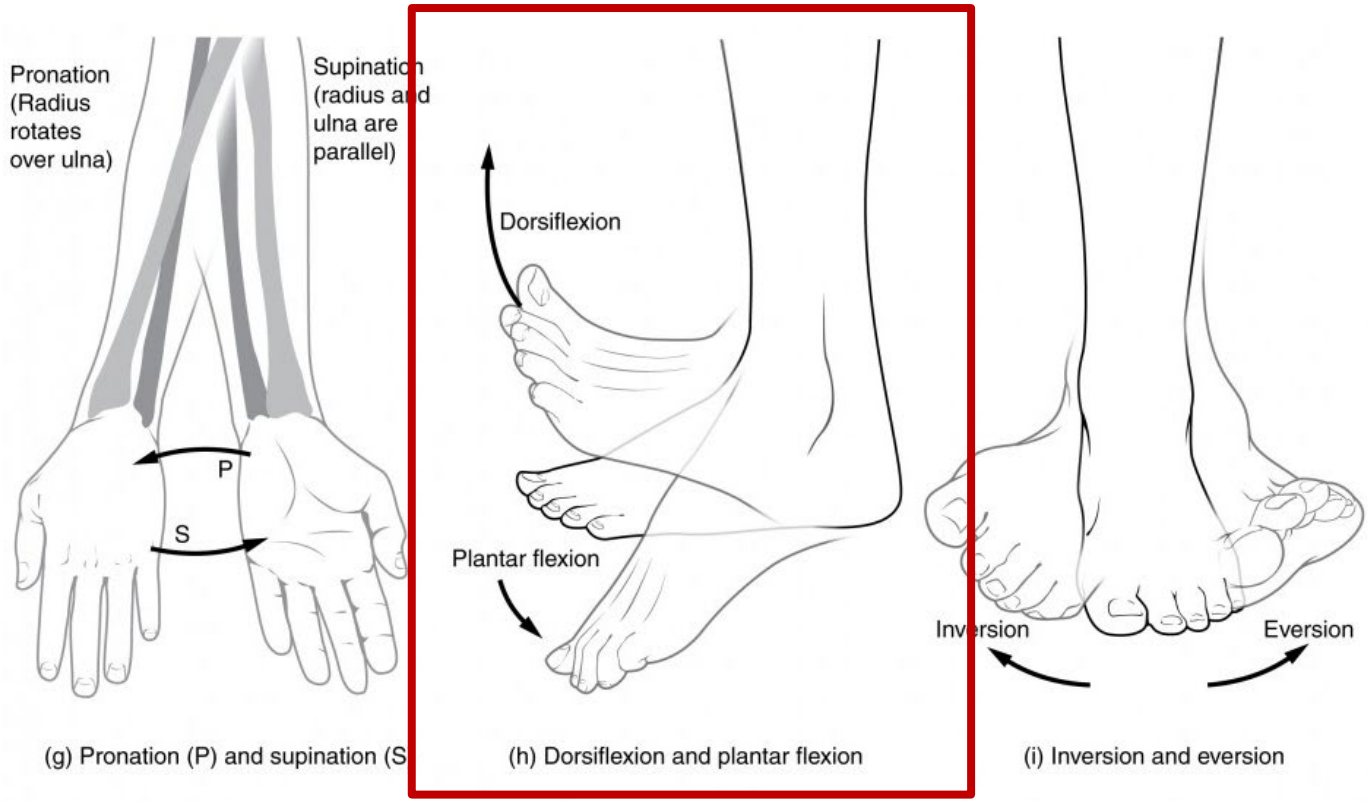
(i) Inversion and eversion

Types of muscle movements

Plantarflexion: Foot extends at ankle

Dorsiflexion : Foot flexes at ankle

Figure 6



Types of muscle movements

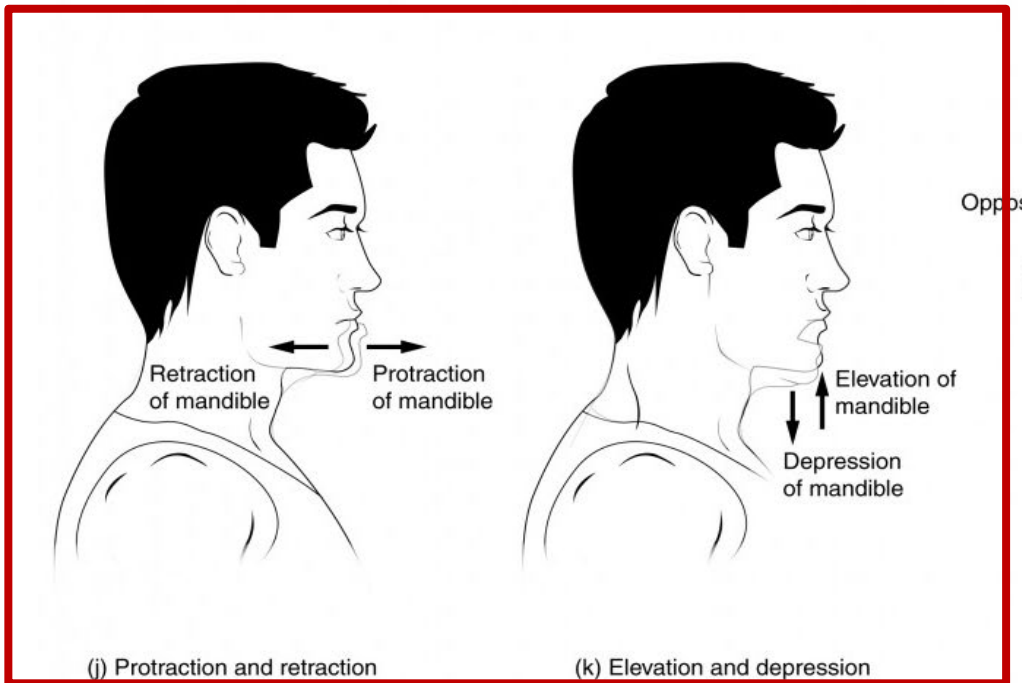
Figure 6

Protraction: Bone moves horizontally towards the front

Retraction: Bone moves horizontally towards the back

Elevation: Bone moves upwards

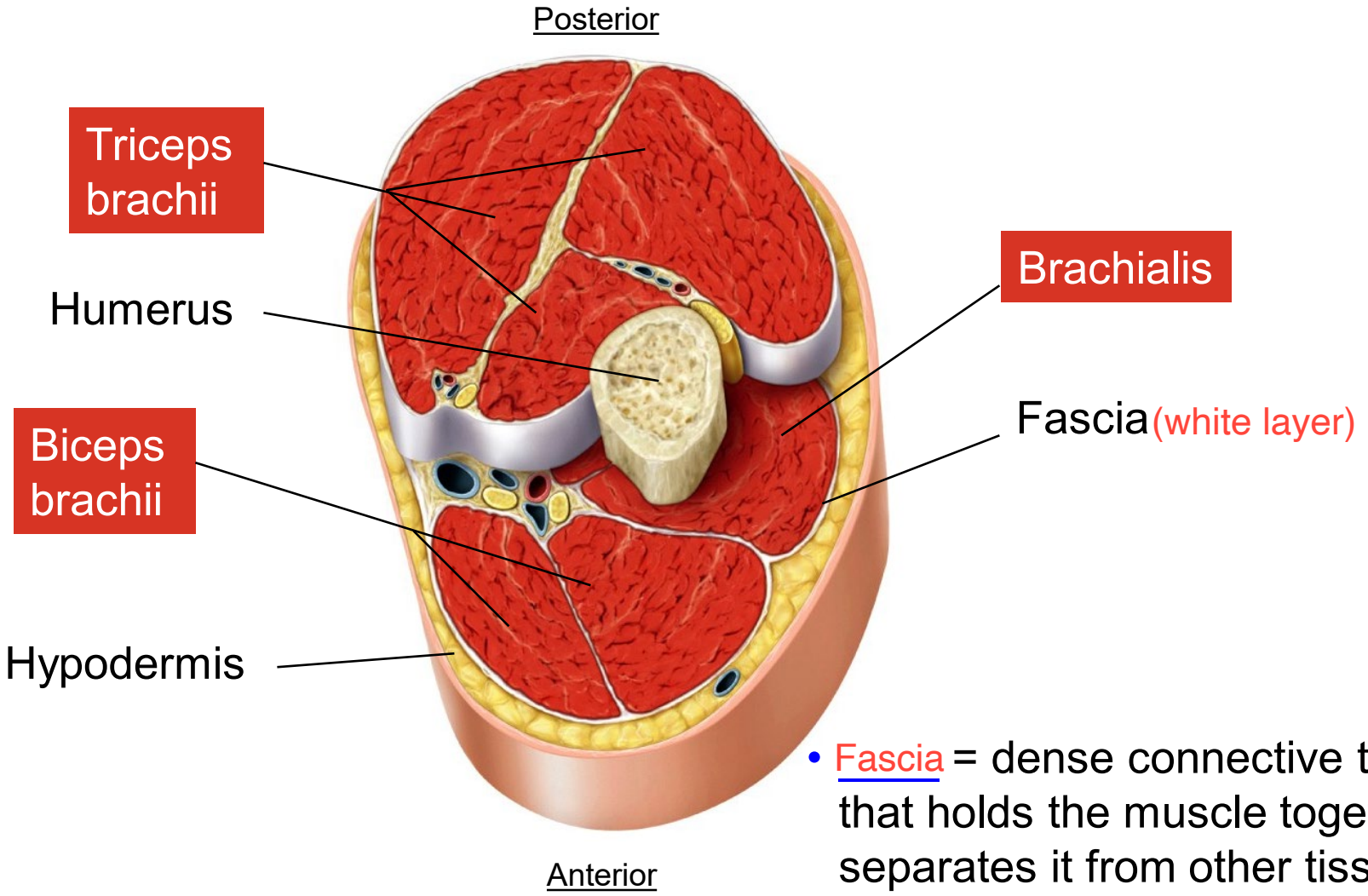
Depression: Bone moves downwards



Skeletal muscles

- Attached to bones via tendons
- Cells = muscle fibers
- Able to contract or relax
- Produce force that causes movement
- Striated

Organization of skeletal muscle



- Fascia = dense connective tissue that holds the muscle together and separates it from other tissues

Muscle organization

Levels of organization

Muscle

↓

Fascicle

↓

Muscle fiber

↓

Myofibril

↓

Myofilament

Fibrous CT layers under Fascia	Other components
Epimysium Perimysium Endomysium	Blood vessels Nerves

Organization of skeletal muscle

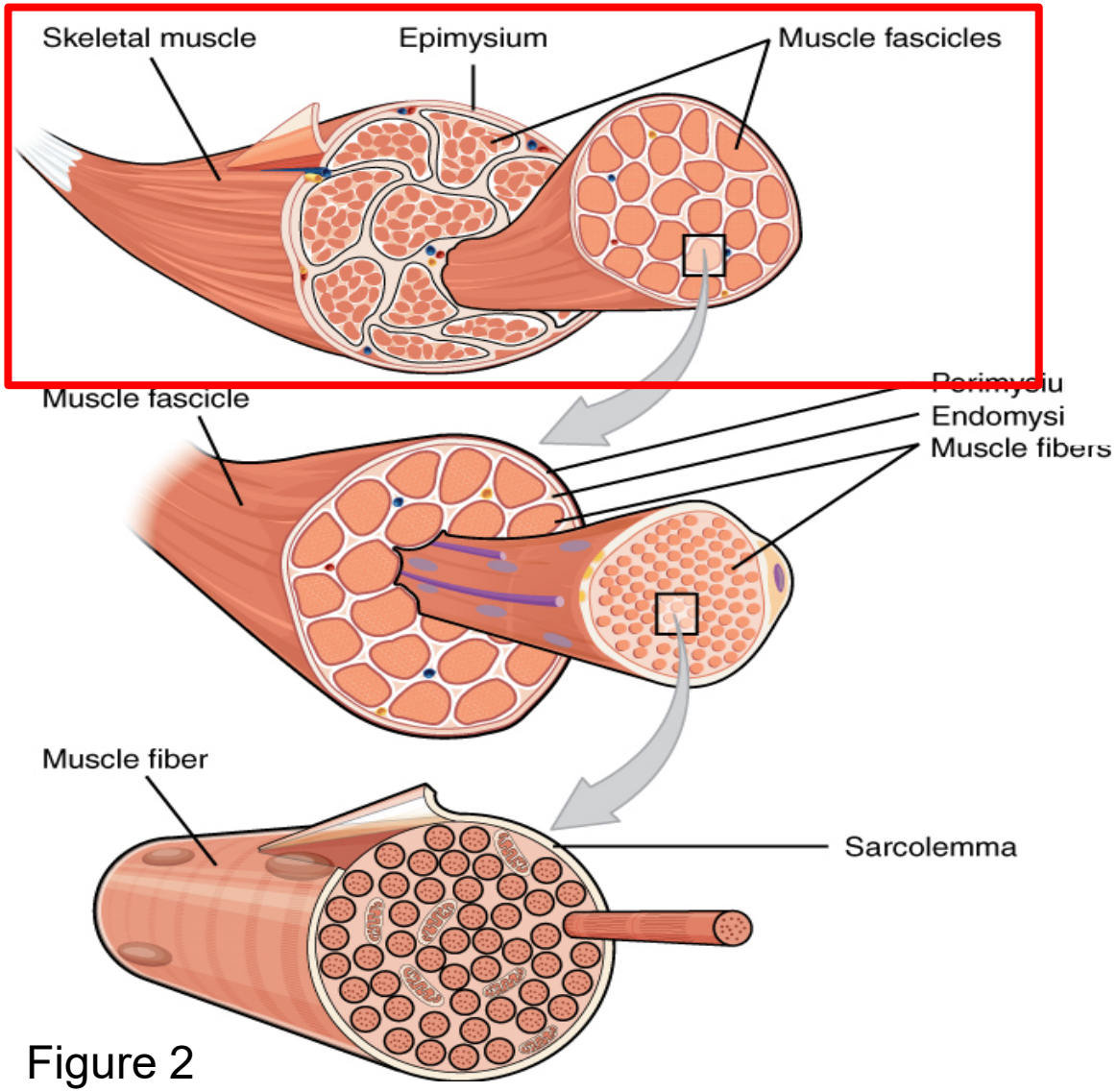


Figure 2

- 1st fibrous CT layer = epimysium
- Covers the entire muscle
- Muscle below the epimysium is composed of fascicles

Organization of skeletal muscle

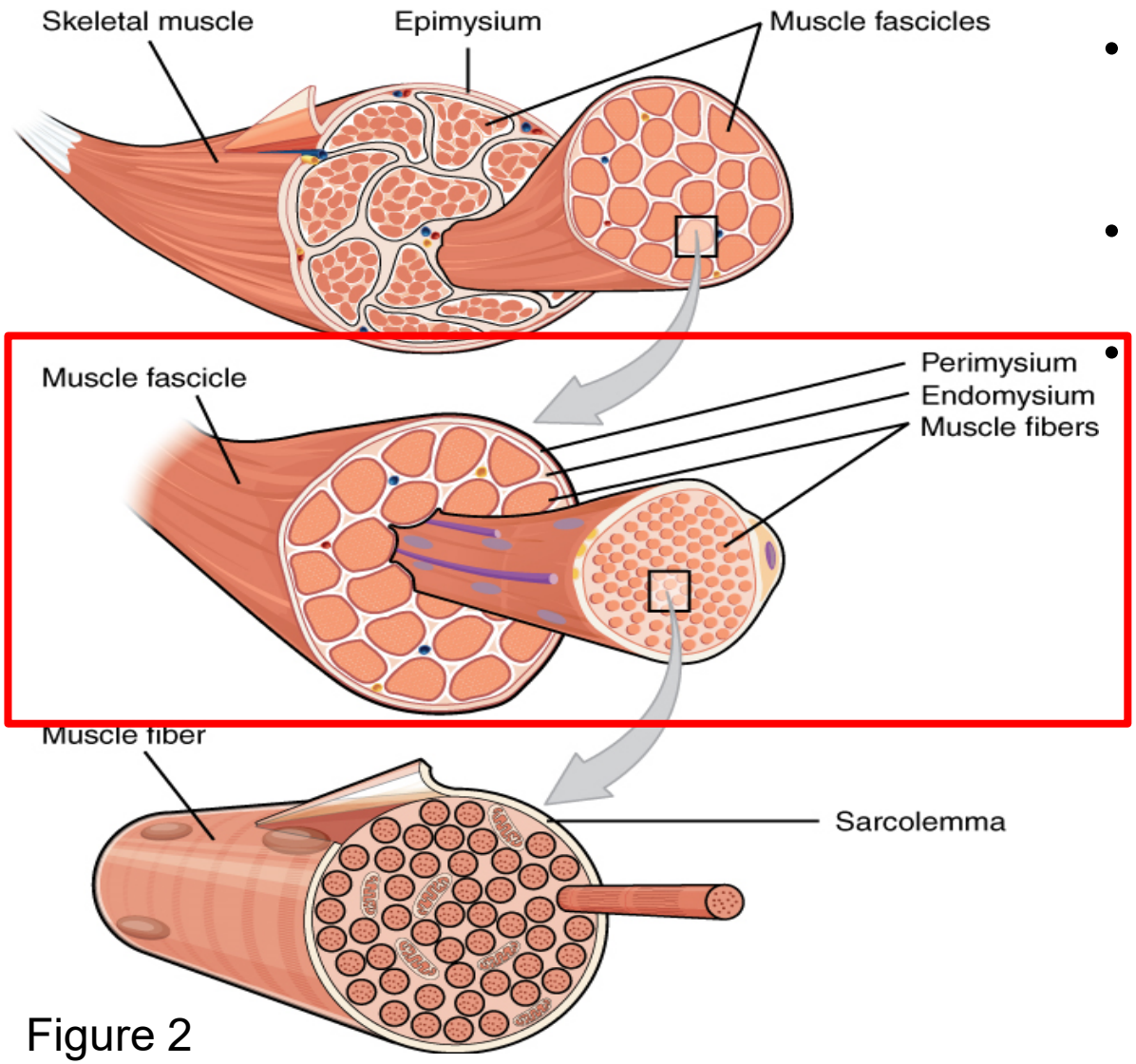
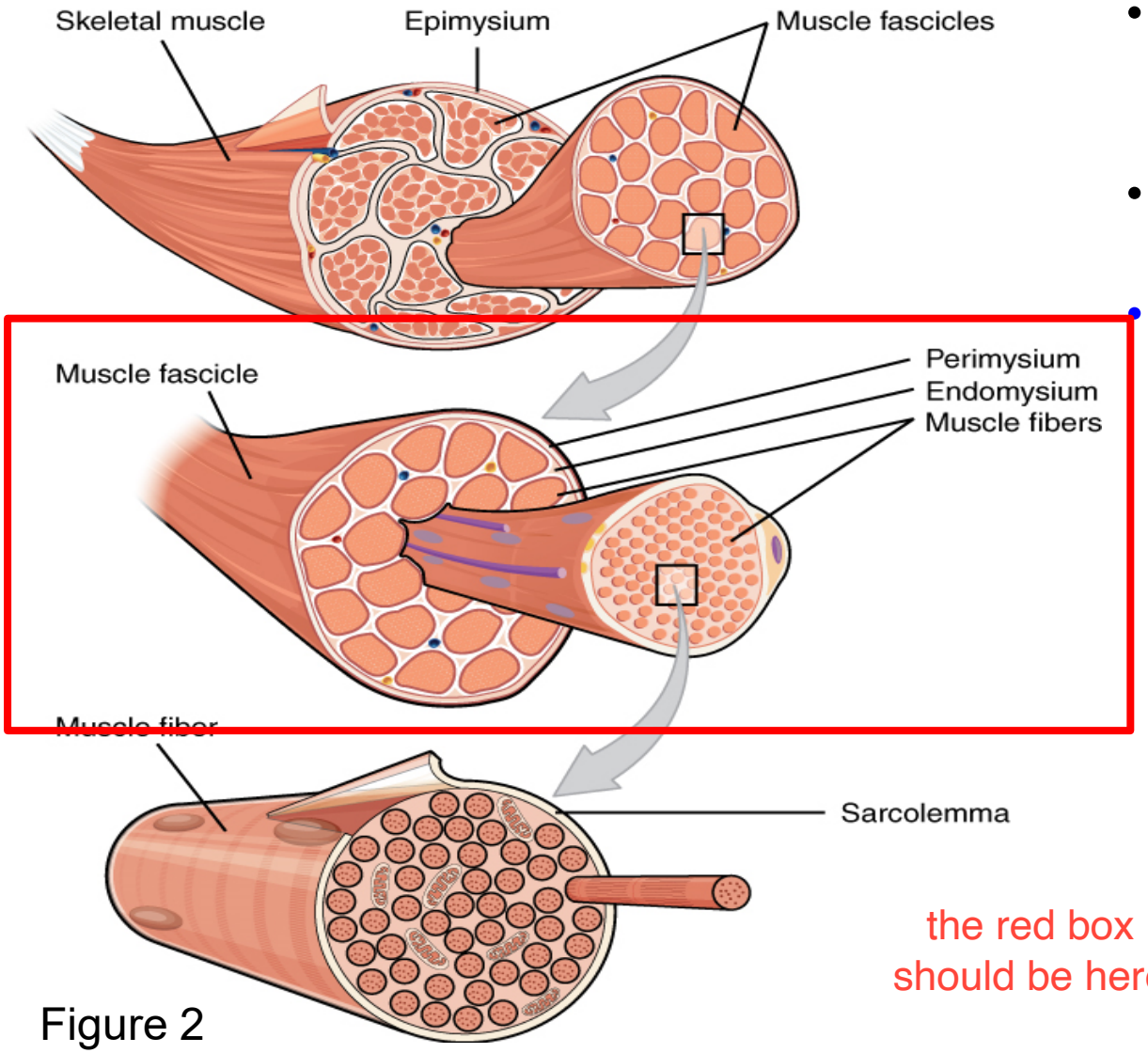


Figure 2

- 2nd fibrous CT layer = perimysium
- Covers each fascicle
- Each fascicle is composed of muscle fibers.

Organization of skeletal muscle



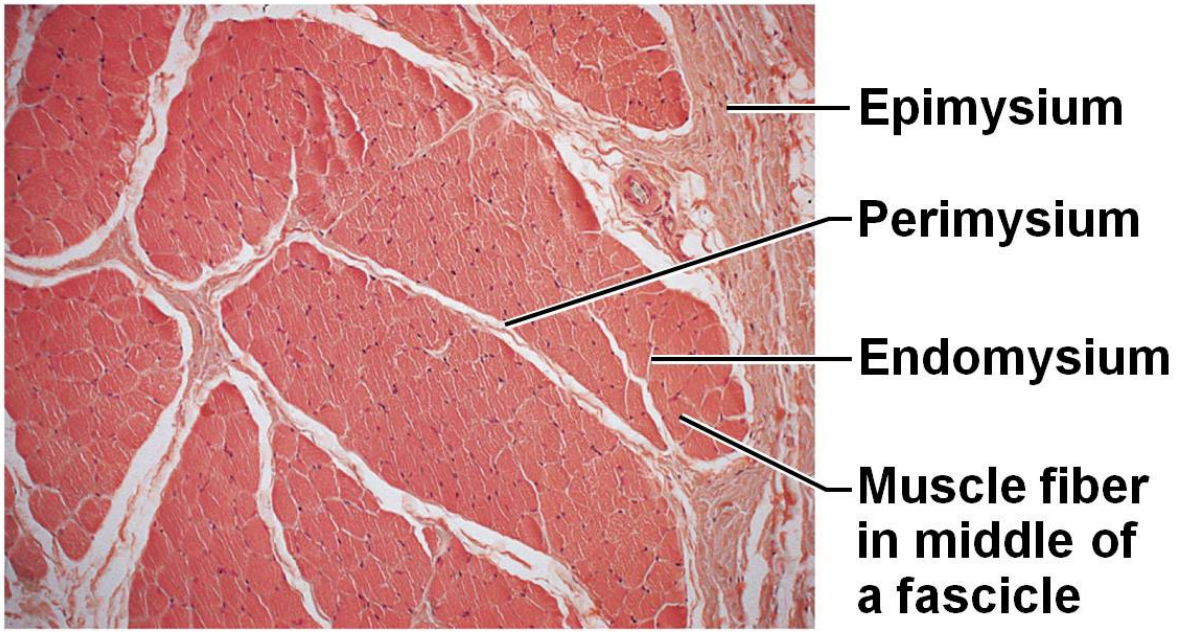
- 3rd fibrous CT layer = endomysium
- Covers each muscle fiber
- Muscle fiber = muscle cell which runs the entire length of the muscle

the red box should be here

Figure 2

Organization of skeletal muscle

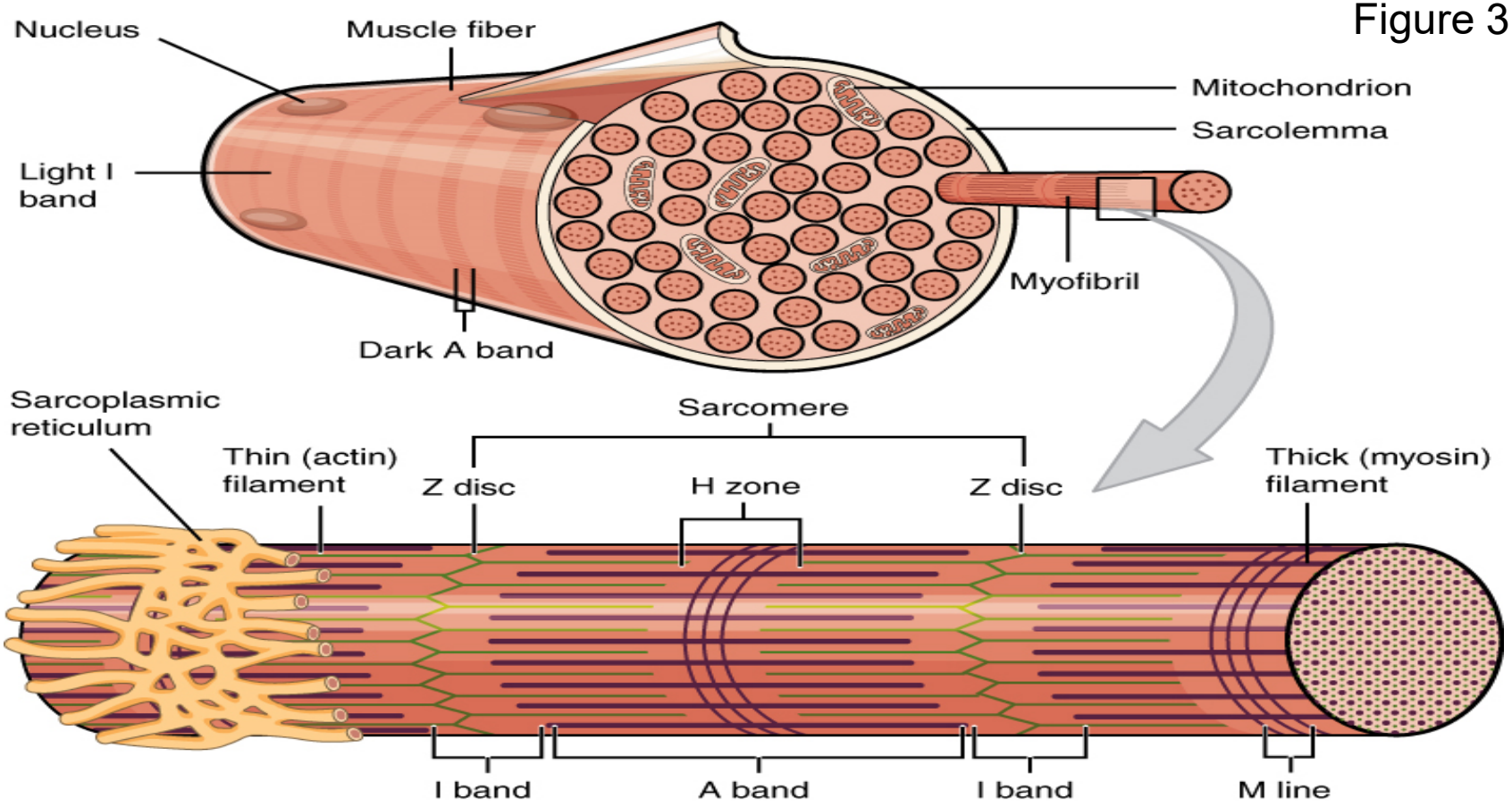
Summary



Layer of Connective Tissue	Muscle Anatomical Level Covered
Fascia	muscle group
Epimysium	muscle
Perimysium	fascicle (= 10 to 100 muscle fibers)
Endomysium	muscle fiber (cell) (= a muscle cell)

The skeletal muscle cell

Figure 3

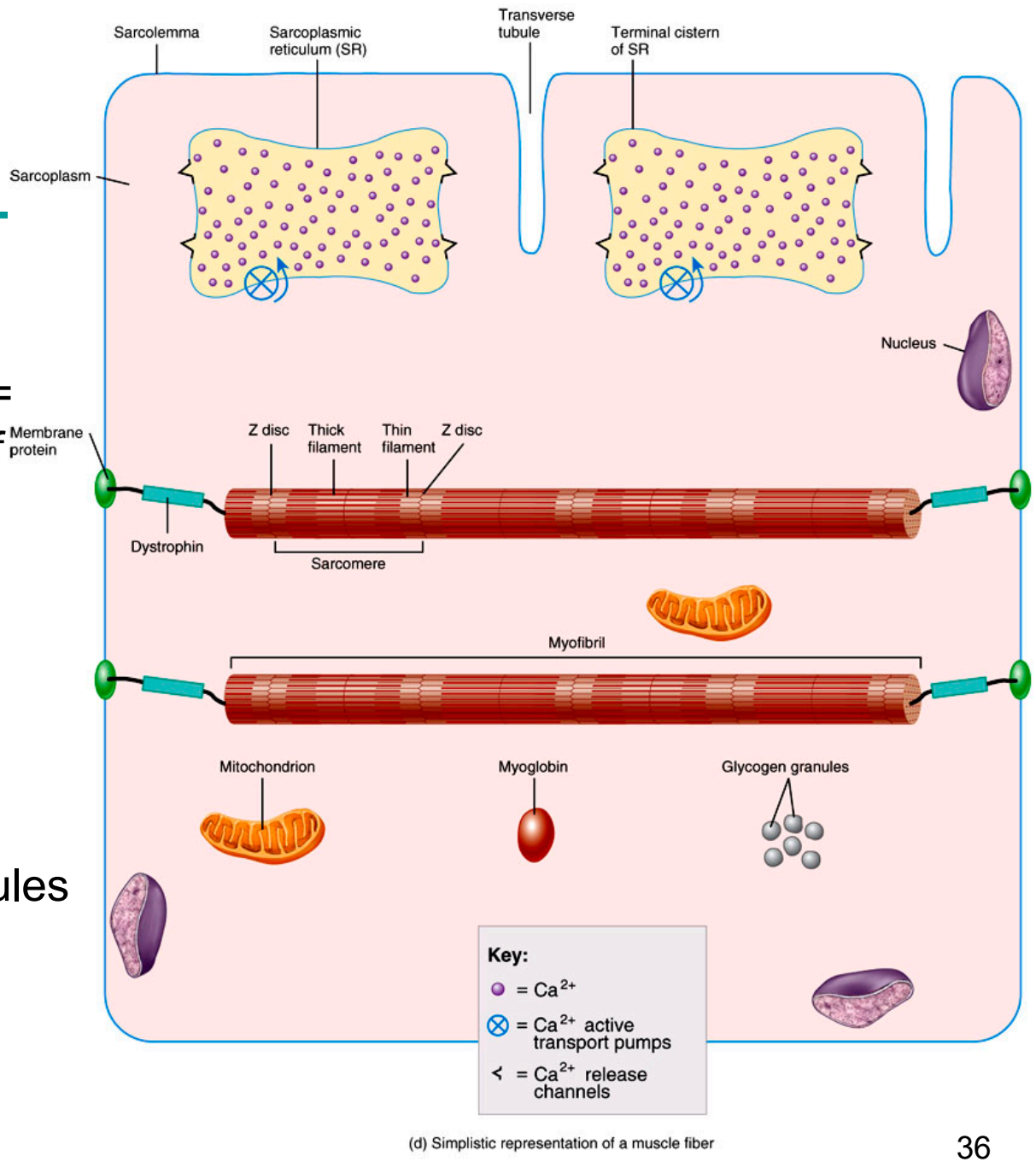


- Myofibrils = run length wise through the muscle cell and are composed of myofilaments
- Sarcolemma = the muscle cell's plasma membrane

The skeletal muscle cell

- Transverse (T) tubules = tunnel like extensions of the sarcolemma that extend into the sarcoplasm; closely associated with the sarcroplasmic reticulum (SR)

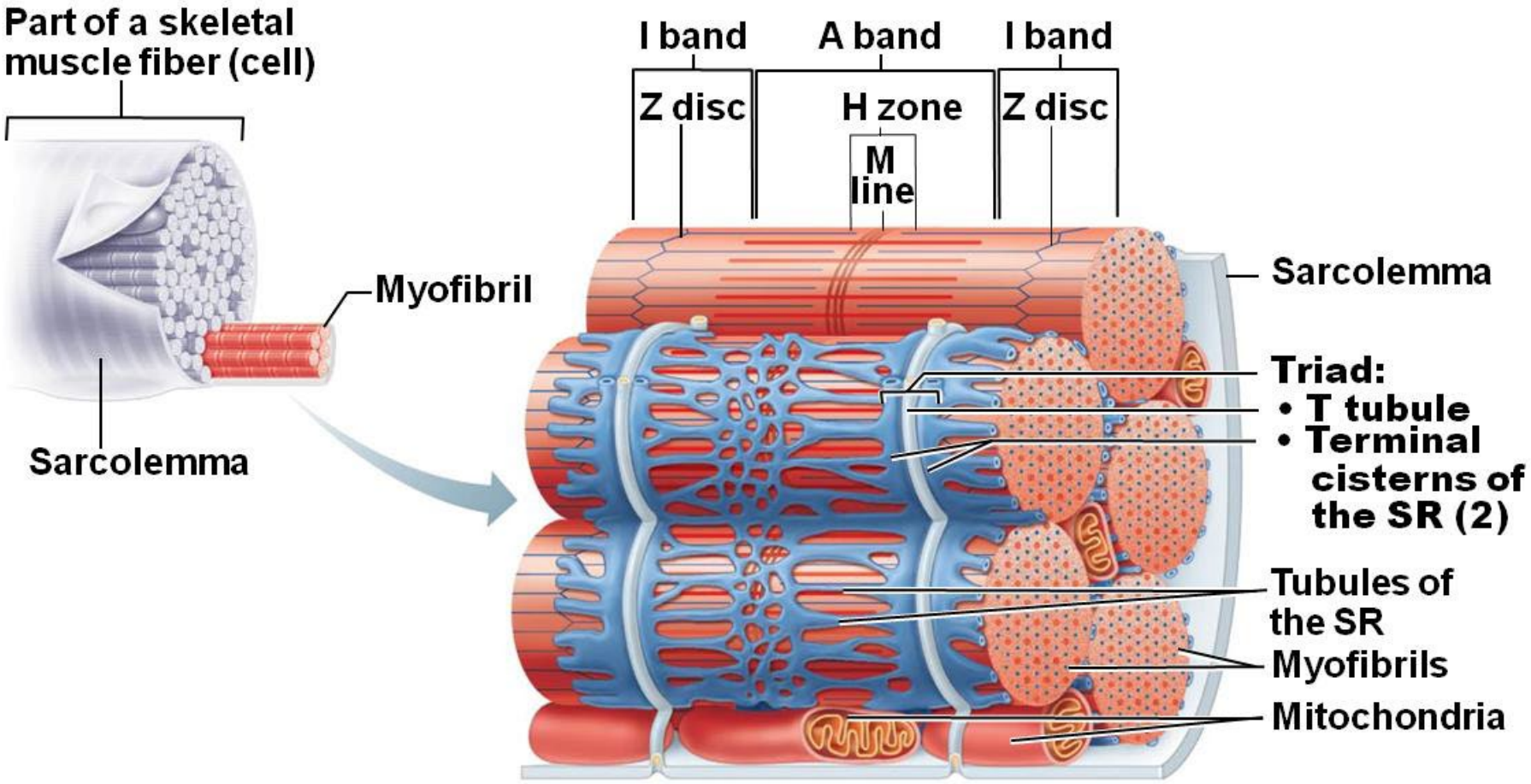
- SR = membranous tubules similar to endoplasmic reticulum



(d) Simplistic representation of a muscle fiber

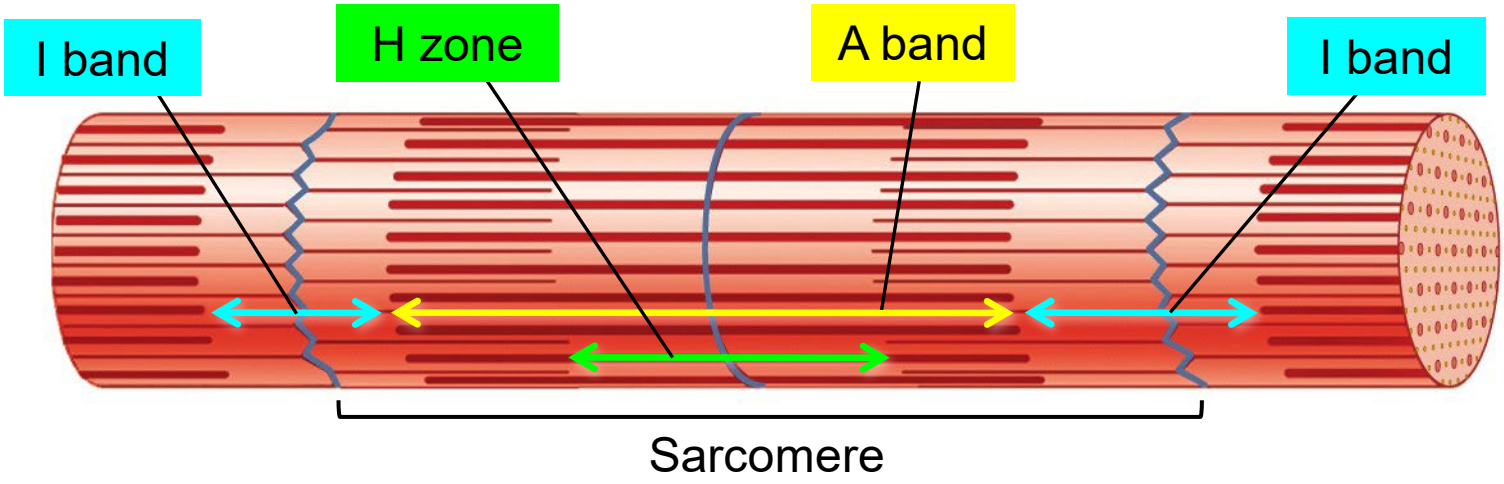
Figure 10.02d Tortora - PAP 12/e

Sarcoplasmic reticulum



Marieb, Figure 9.5

Myofibril structure

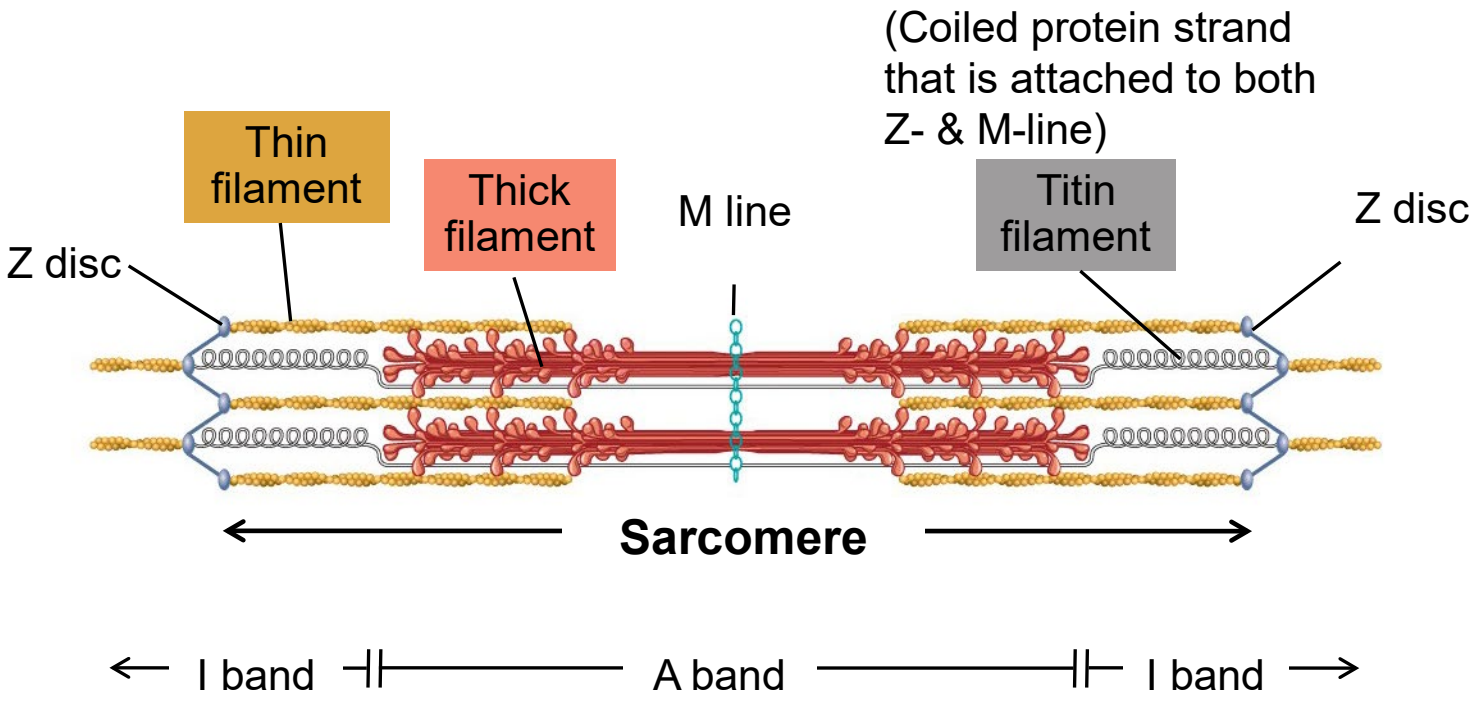


Sarcomere; banded repeating units

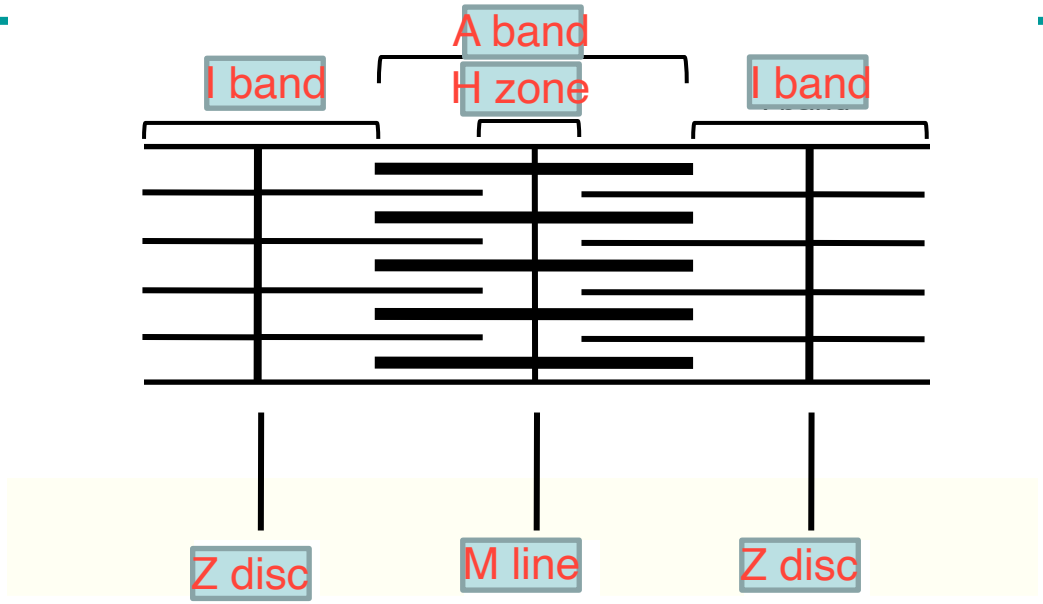
Made up of 3 kinds of **protein**:

1. ***Contractile:*** these generate the contraction force 2 proteins – ***actin*** & ***myosin***
2. ***Regulatory:*** help starting & stopping contraction 2 proteins – ***troponin*** & ***tropomyosin***
3. ***Structural:*** keep contractile proteins aligned & stabilize the myofibril 3 proteins - ***z-line, m-line*** & ***titin filament***

Myofibril structure



The Sarcomere

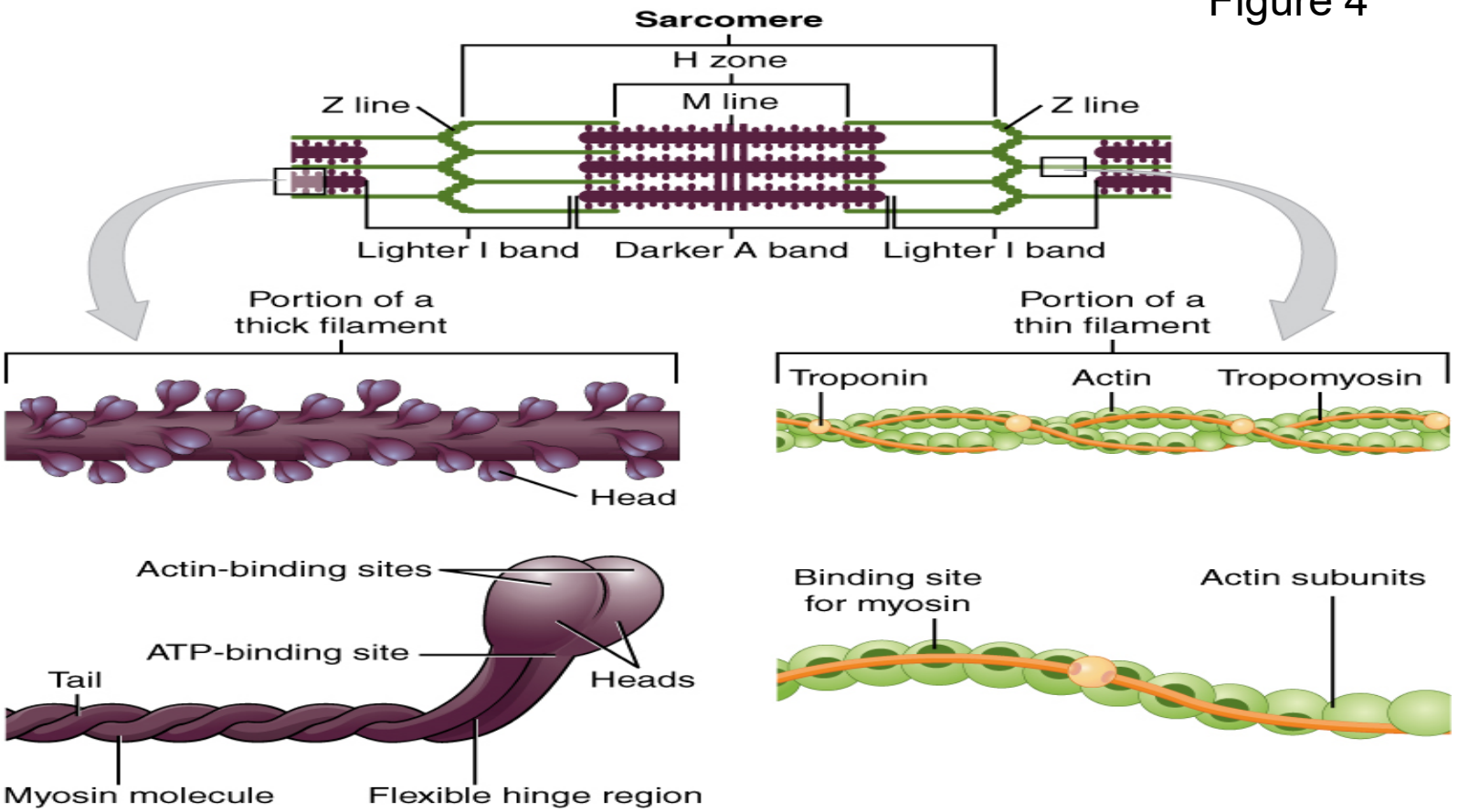


Structure of thick filaments

Myosin

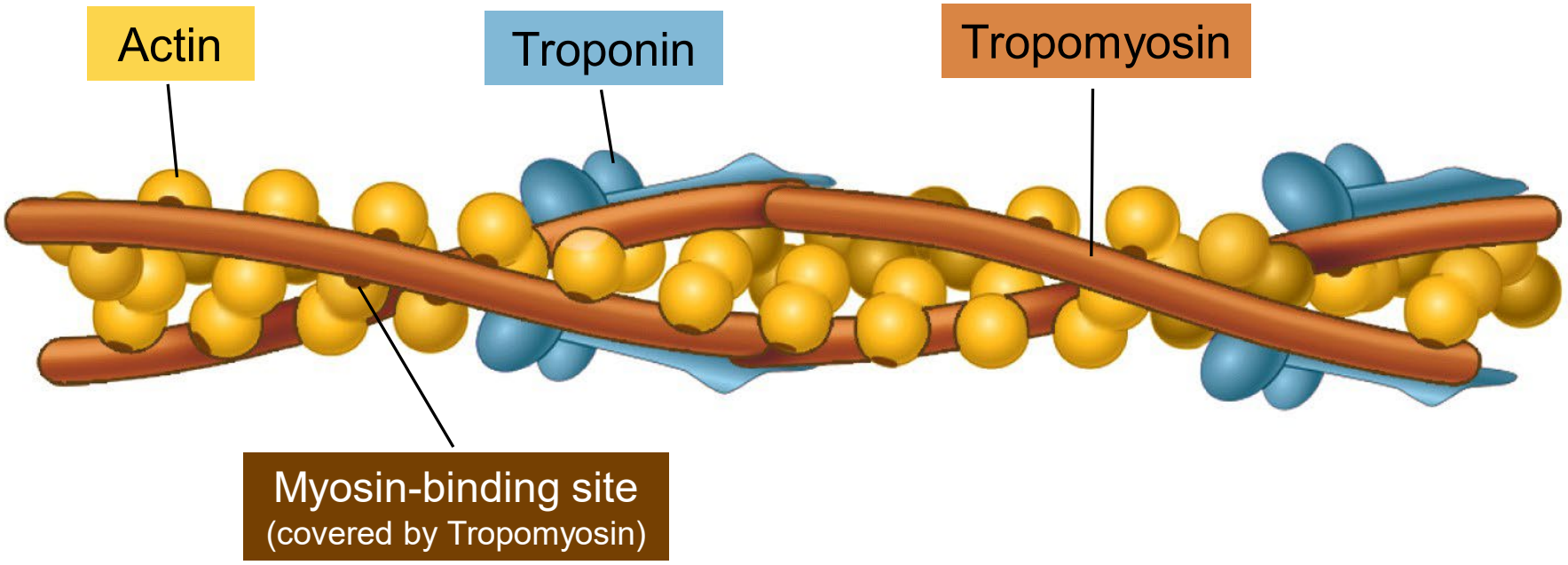
- Myosin is the main components of thick filaments; functions as a motor protein

Figure 4

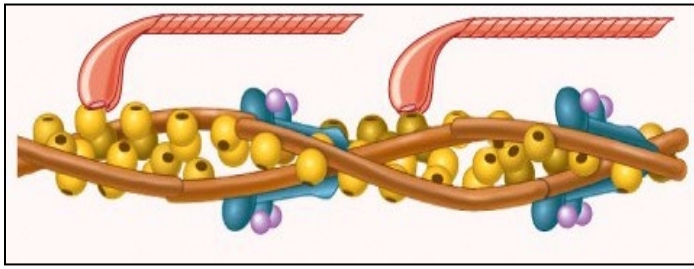


Structure of thin filaments

Actin, Troponin, Tropomyosin



- Actin = contains a myosin binding site where a myosin head can attach.
- Troponin and Tropomyosin = regulatory proteins
- Tropomyosin = blocks the myosin binding site
- Troponin = hold tropomyosin strands in place.



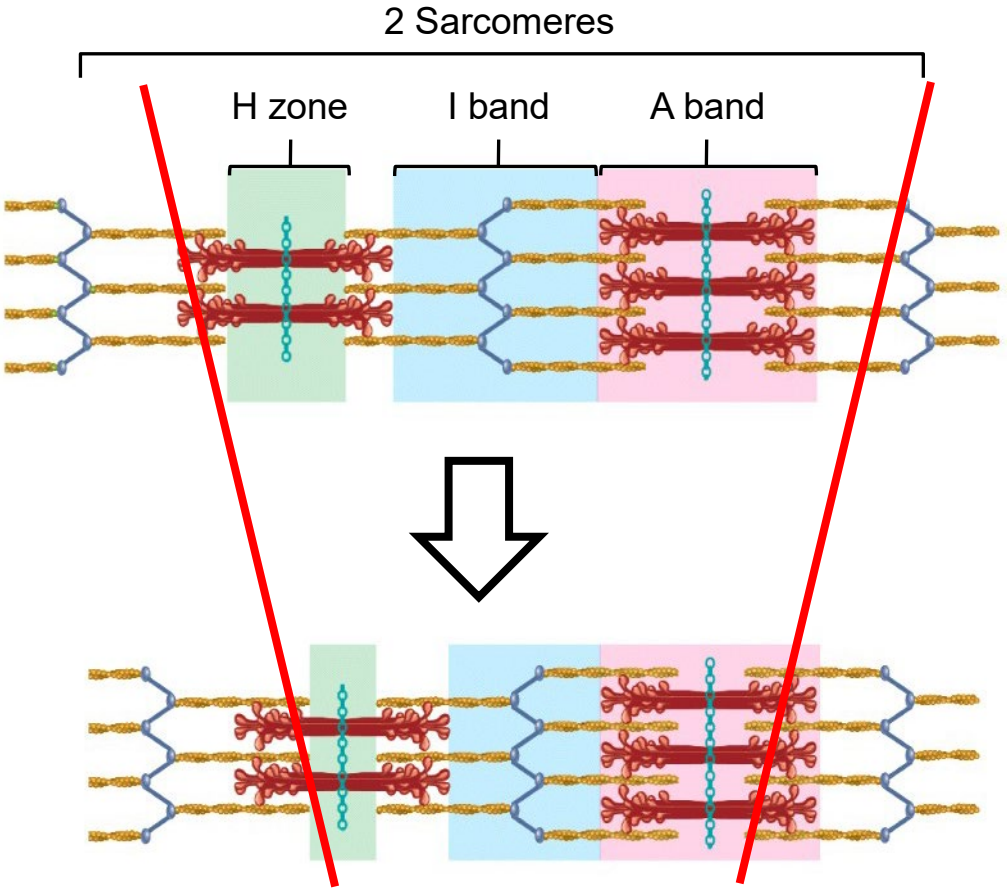
Components of the skeletal muscle cell

Summary

Component	Description
Sarcolemma	Plasma membrane of a skeletal muscle fibre(cell)
Sarcoplasm	Cytoplasm of a muscle cell.
Transverse T tubule	tunnel like extensions of the sarcolemma that extend into the sarcoplasm.
Sarcoplasmic Reticulum	Specialized smooth endoplasmic reticulum, which stores Ca++
Terminal Cistern	Bolbus end of the SR
Triad	1 Transverse T Tubule + 2 Terminal Cisterns
Myofibril	Long, cylindrical organelle that runs parallel within the muscle fibre and contains the sarcomeres.
Sarcomeres	Banded repeating units
Thick Myofilament	Myosin
Thin Myofilament	Actin, tropomyosin, troponin

Muscle contraction

The sliding filament hypothesis



Relaxed muscle

Contracted muscle

Muscular system
Objectives

1. Describe the levels of muscle organization: fascia, fascicles, muscle fibres.
2. Describe the following structures of a muscle cell: sarcolemma, sarcoplasm, nuclei, mitochondria, sarcoplasmic reticulum, myofibrils, myofilaments, sarcomere.
3. Describe the following structures of a sarcomere: Z line, I band, A band, H zone, M line.
4. Describe the basic structure of the thick and thin filaments and their primary protein components.
5. Specify four factors which determine the type of movement accomplished by a muscle.
6. Specify some of the criteria used in the naming of muscles.
7. Describe, using specific examples, 16 types of movements characteristic of skeletal muscle contractions.