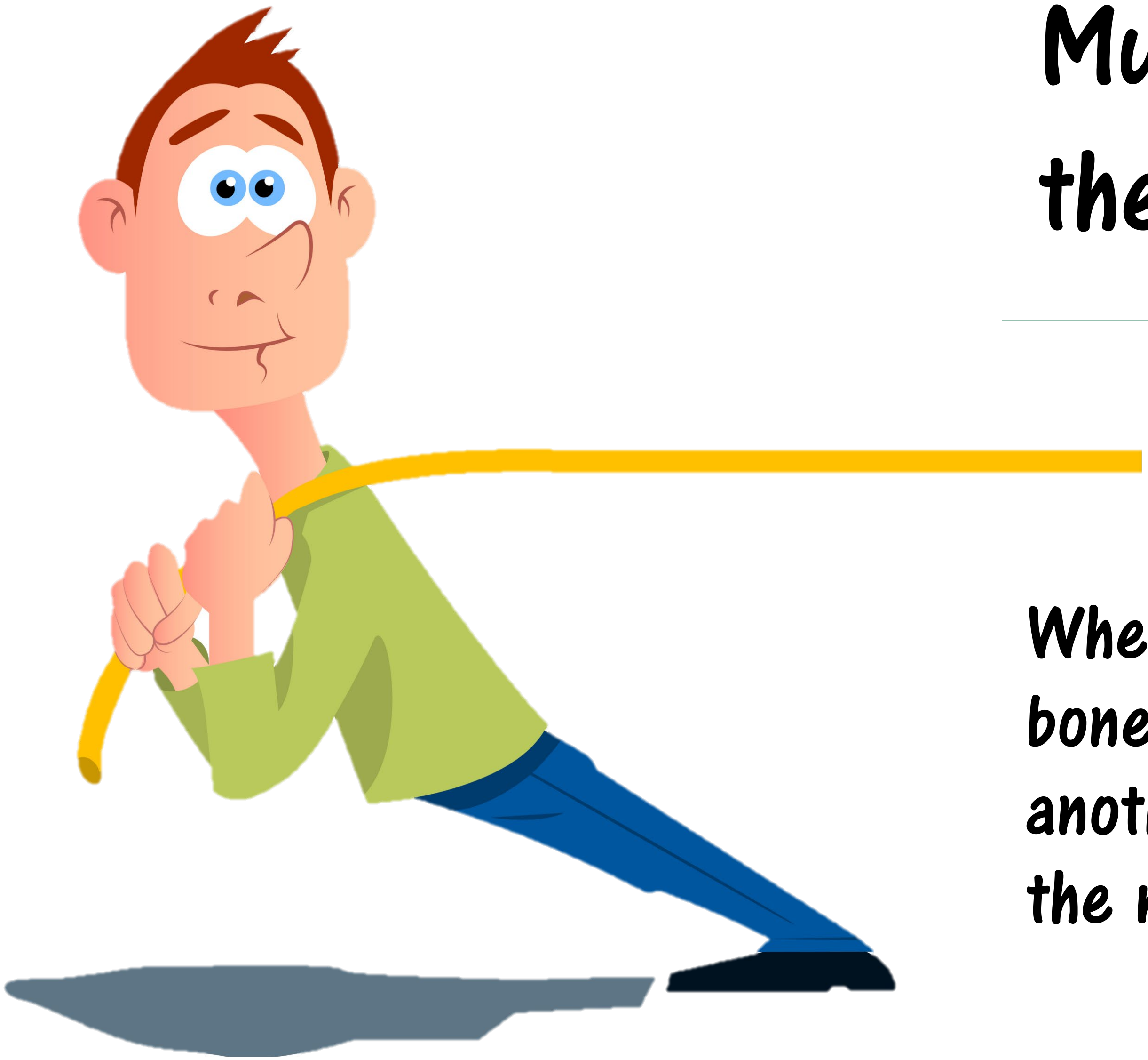
# MUSCLES

By Scientist Cindy

See More at

www.scientistcindy.com



# Muscles always PULL they never PUSH.

When a muscle contracts, it pulls the bones it connects to closer to one another, by decreasing the angle of the movable joint that is spans.

MUSCLES CONTRACT (SHRINK)

# Muscles always PULL they never PUSH.

## Here's proof!

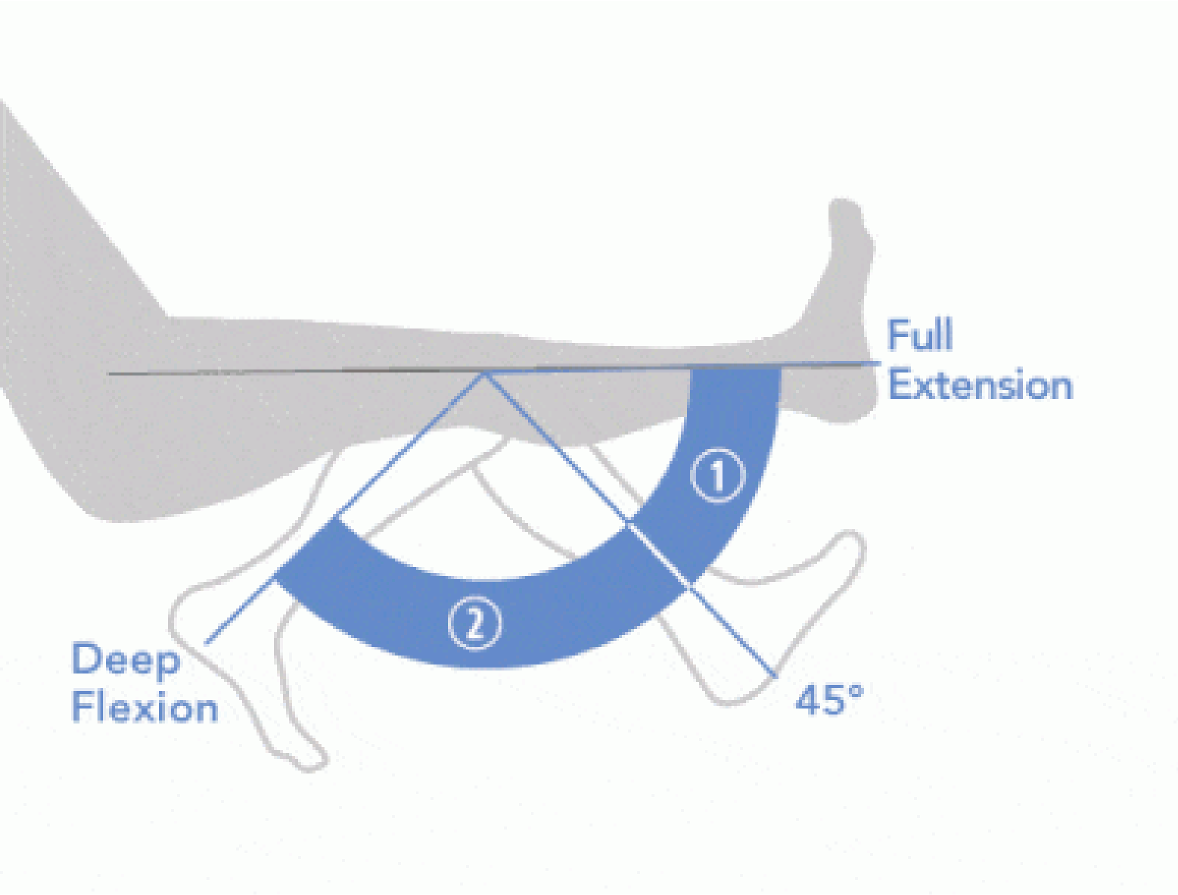
- In this "Muscle Machine", it is the "pulling action" of the biceps muscles that exerts the force that pulls the arm upwards.

- AND…it is the "pulling action" of the triceps muscles that exerts the force that pulls the arm downwards.

# Flexion and Extension

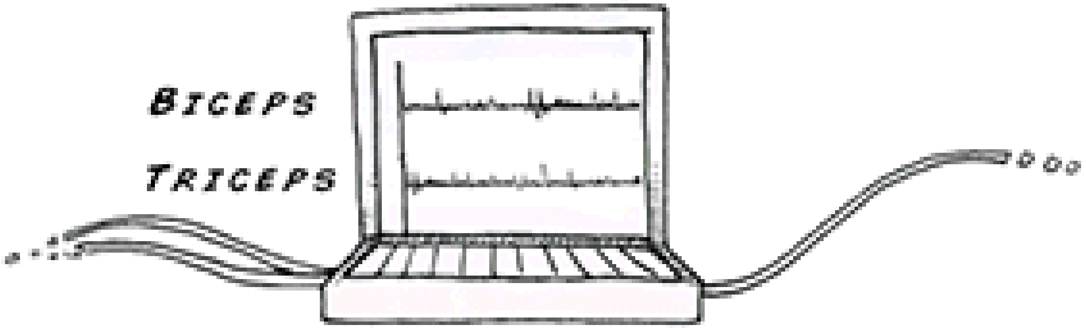
- **Flexion** is the action of decreasing the angle of a joint

- **Extension** is the action of increasing the angle of the joint



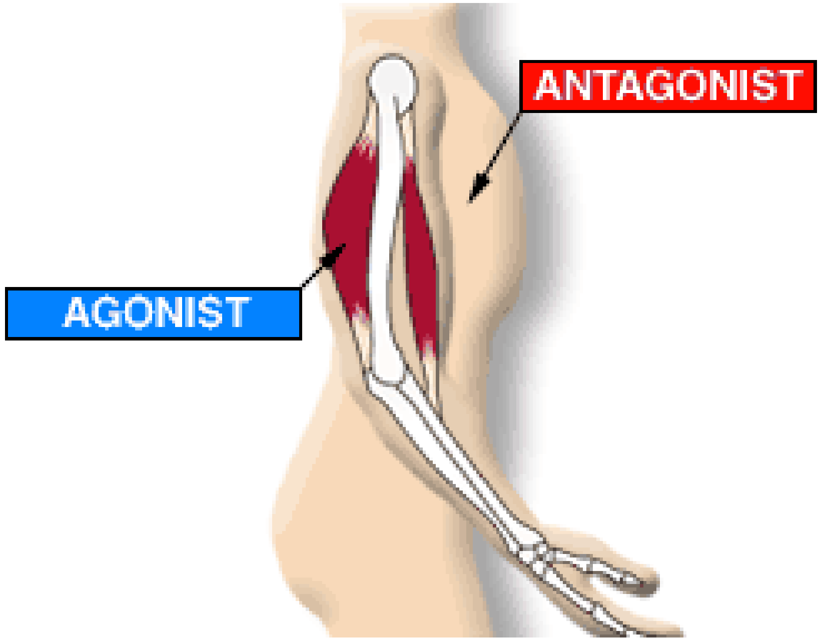
# Agonist / Antagonist

- When you flex your arm at the elbow joint,
  - The biceps muscle are contracting; exerting the force needed to decrease the angle of the elbow joint for flexion.
  - At the same time, the triceps muscle that function to exert force in the opposite direction, must relax, in order to allow for this movement!



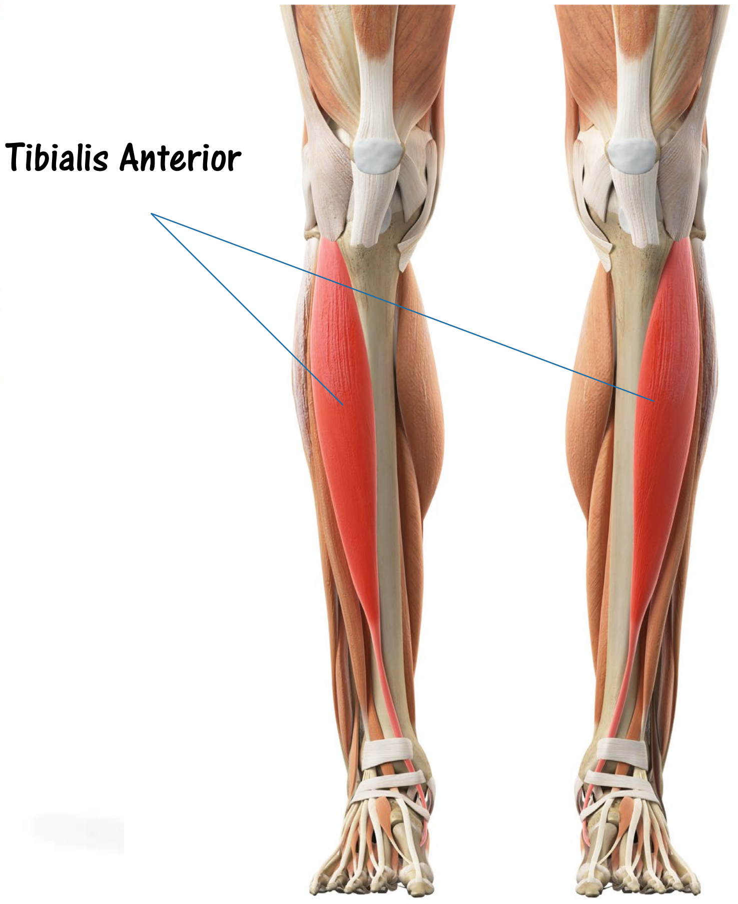
# Agonist / Antagonist

- We call these opposites **agonist** and **antagonist**
- Agonist muscles - muscles that produce movement through contraction
- Antagonist muscles – muscles which(if contracted) function to exert force in the opposite direction to the agonist muscle.



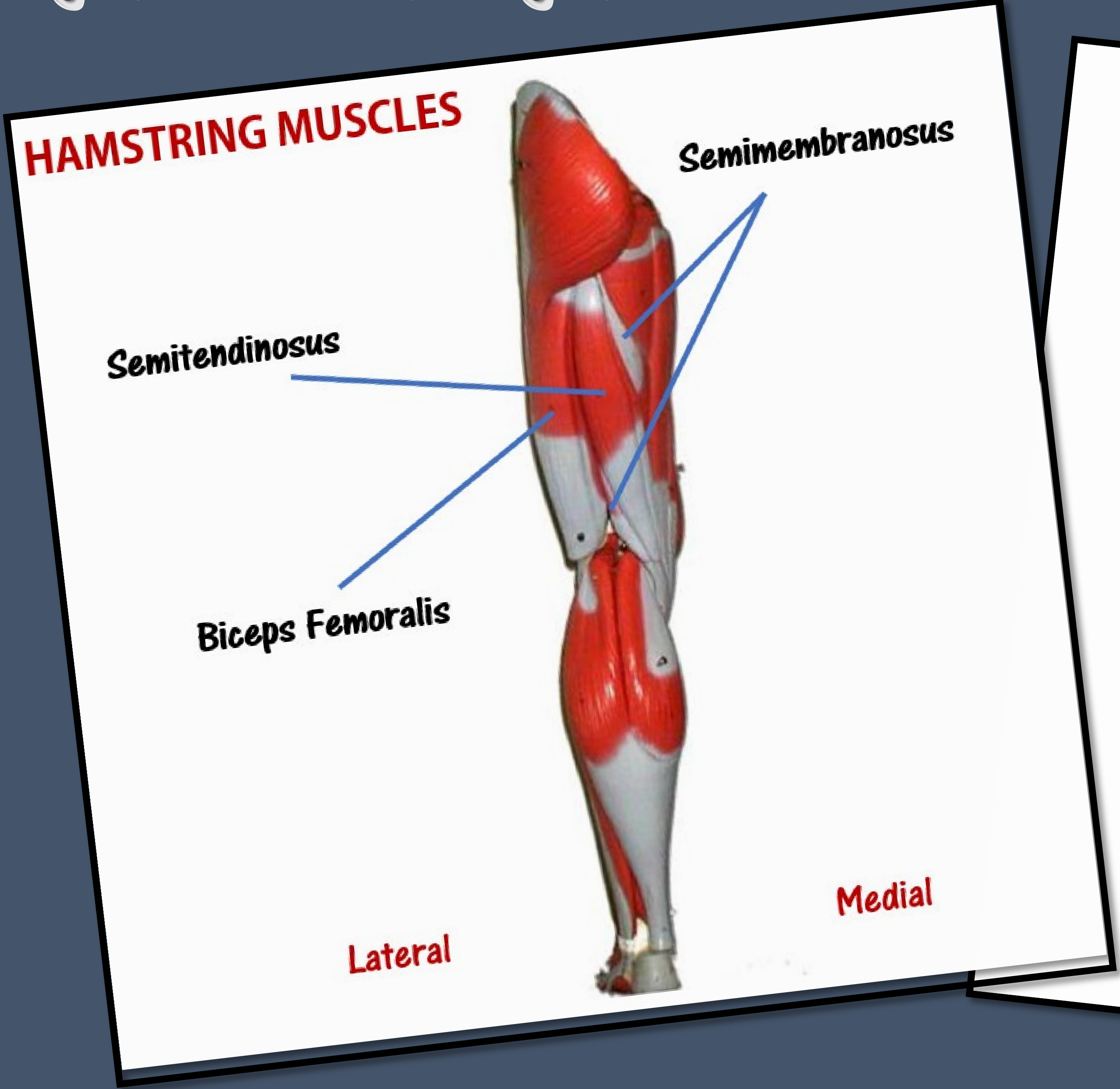
# Agonist / Antagonist

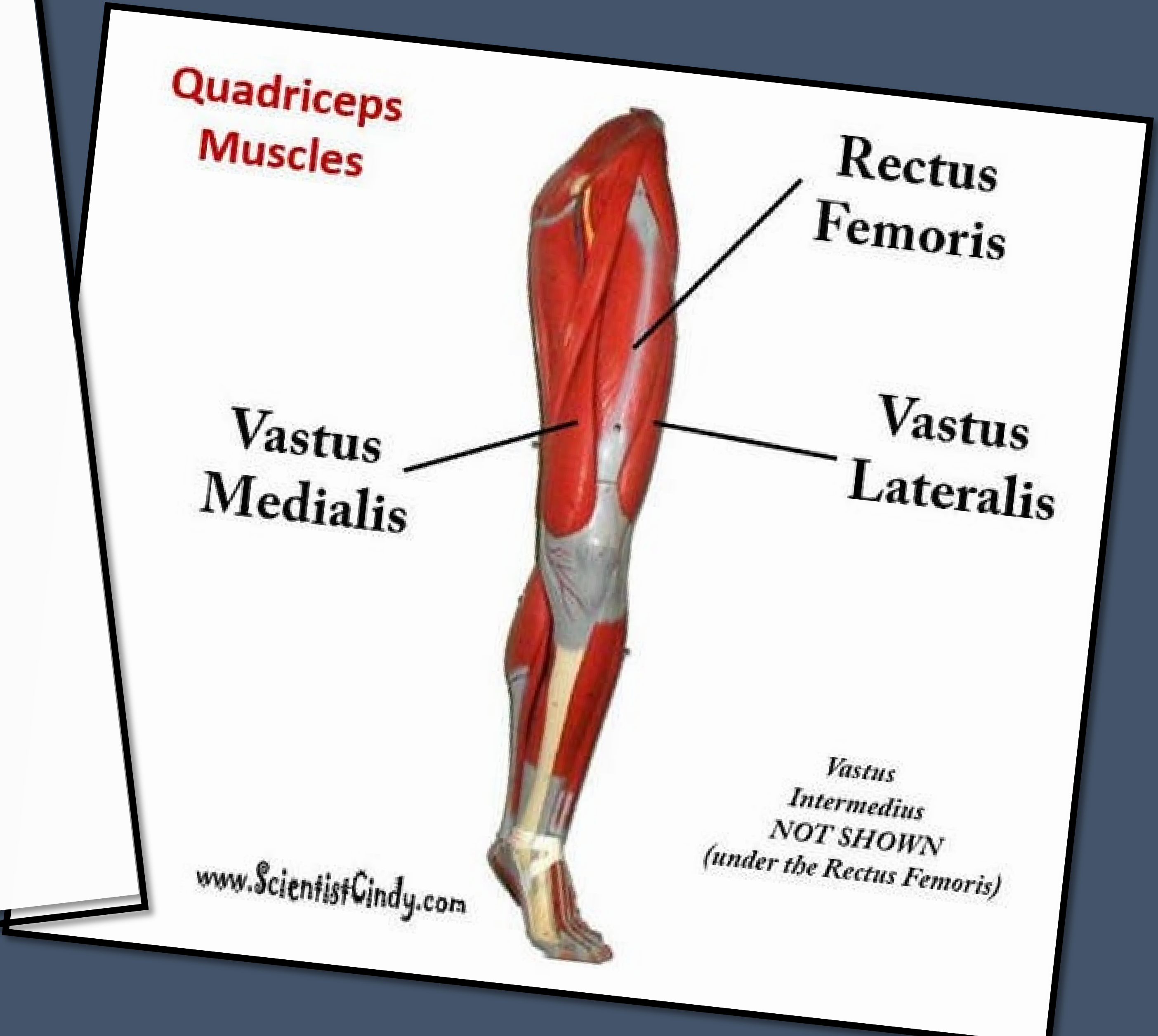
- Another example of an agonist/antagonist pair is the **gastrocnemius muscle** (calf muscle) and the **tibialis anterior.**

# Agonist / Antagonist

- Another example of an agonist/antagonist pair is the **quadriceps** muscles and the **hamstring** muscles.



# Agonist / Antagonist

- Another example of an agonist/antagonist pair is the **quadriceps** muscles and the **hamstring** muscles.

- The quadriceps act as antagonists when you lift your leg up high (hip flexion), because their direction of exerted force (if contracted) would be in a direction that was opposite from the direction of motion.

# Agonist/Antagonist

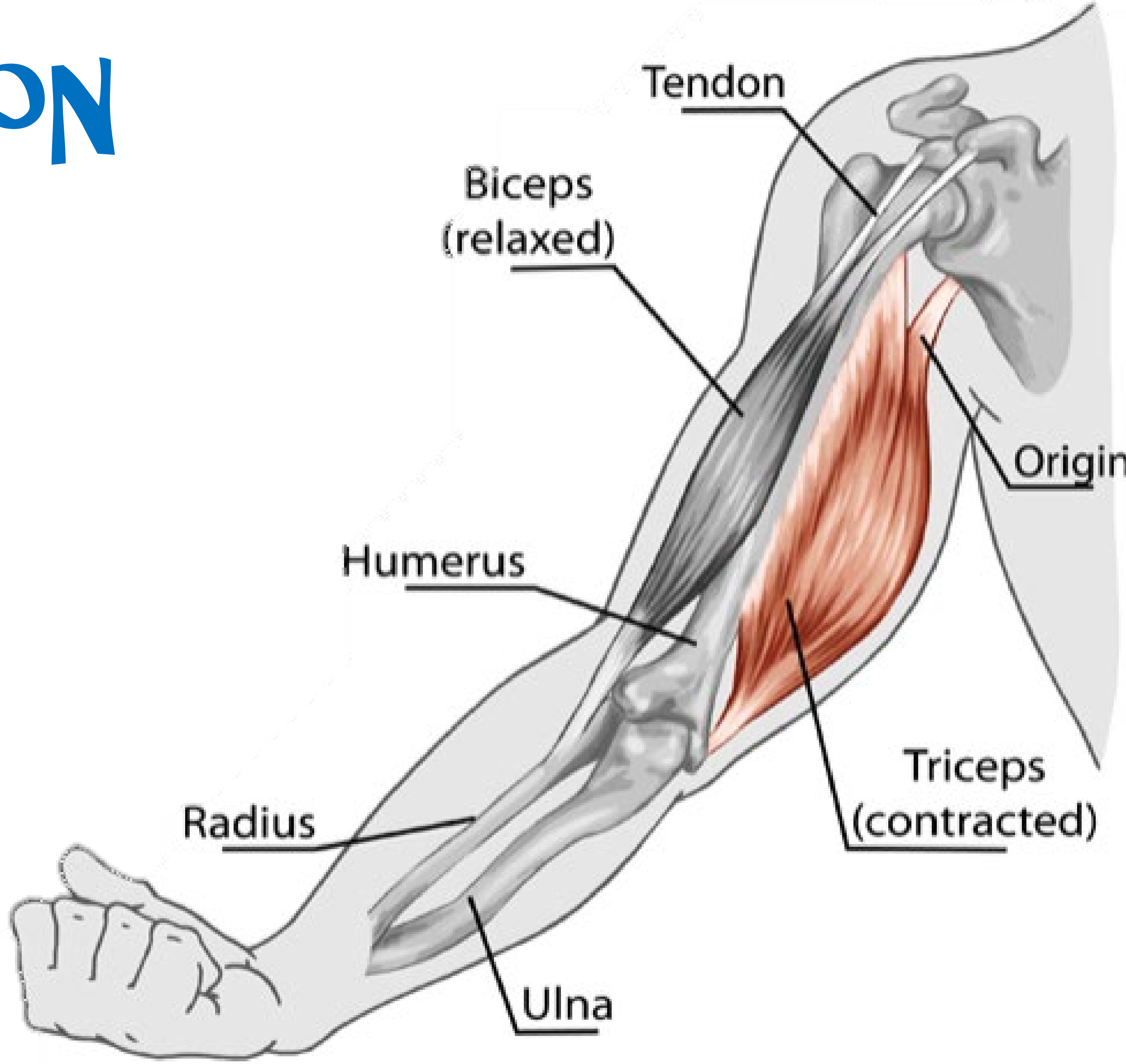
- Sometimes antagonist muscles slow down and control the movement of the agonist partner.

# Agonist/ Antagonist

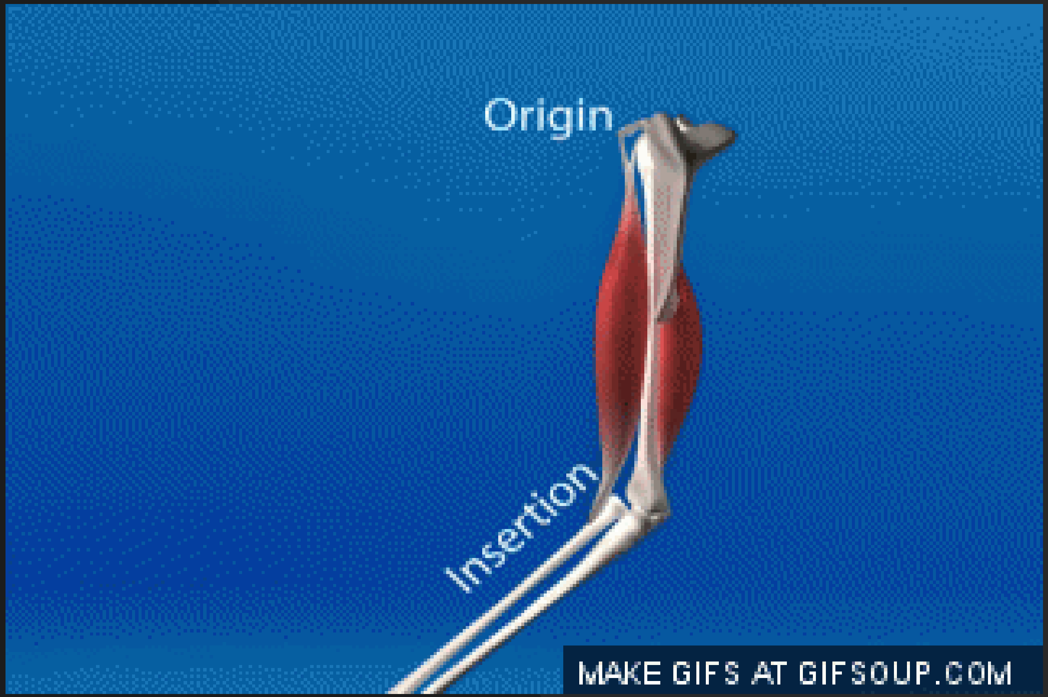
- If you were to flex an agonist and antagonist at the same time, there would be no movement.

# Origin and Insertion

- Skeletal muscles…
    - attach to at least 2 bones,
    - and span one movable joint.
- The way that these muscles attach to the bones of your body, is through TENDONS.

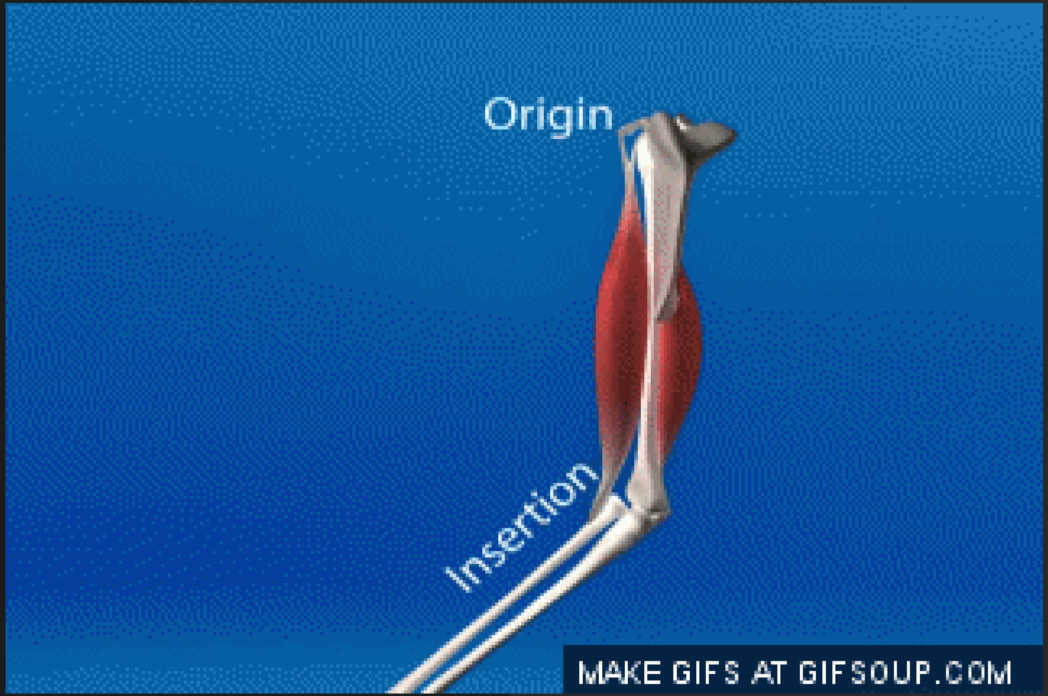


# Origin and Insertion




- It is Important to be Able to Distinguish Between the Origin and the Insertion Point of a Muscle.
- This information will tell us the function of the muscle.
- Remember that structure equals function!

# Origin and Insertion

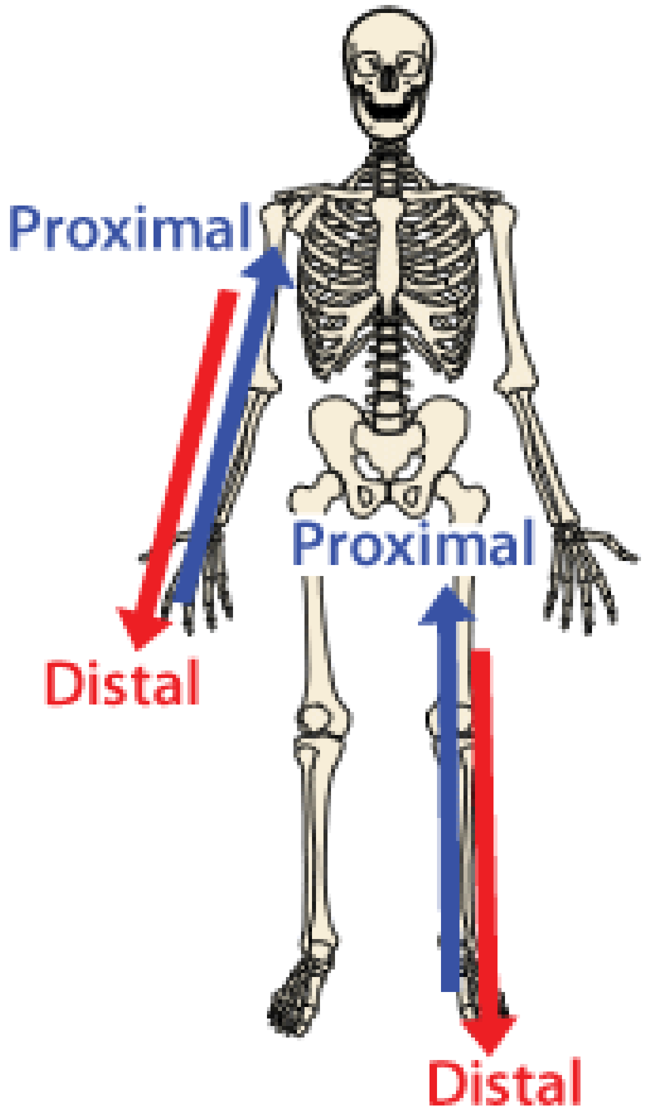



Typically, when we contract a muscle, one of the bones that the muscle attaches to moves a lot, while the other bone(s) that the muscle attaches to remains relatively still or "fixed" in space.

- The **origin** is the attachment site that remains relatively ***"fixed in space"*** during muscle contraction
- The **insertion** is the attachment site that moves quite a bit during muscle contraction.

# Origin and Insertion

- The insertion will usually be the more **distal** (distant from the torso) point of muscle attachment to bone (via the tendon).
- The origin will usually be the more **proximal** (closer to the torso) point of muscle attachment to bone (via the tendon).

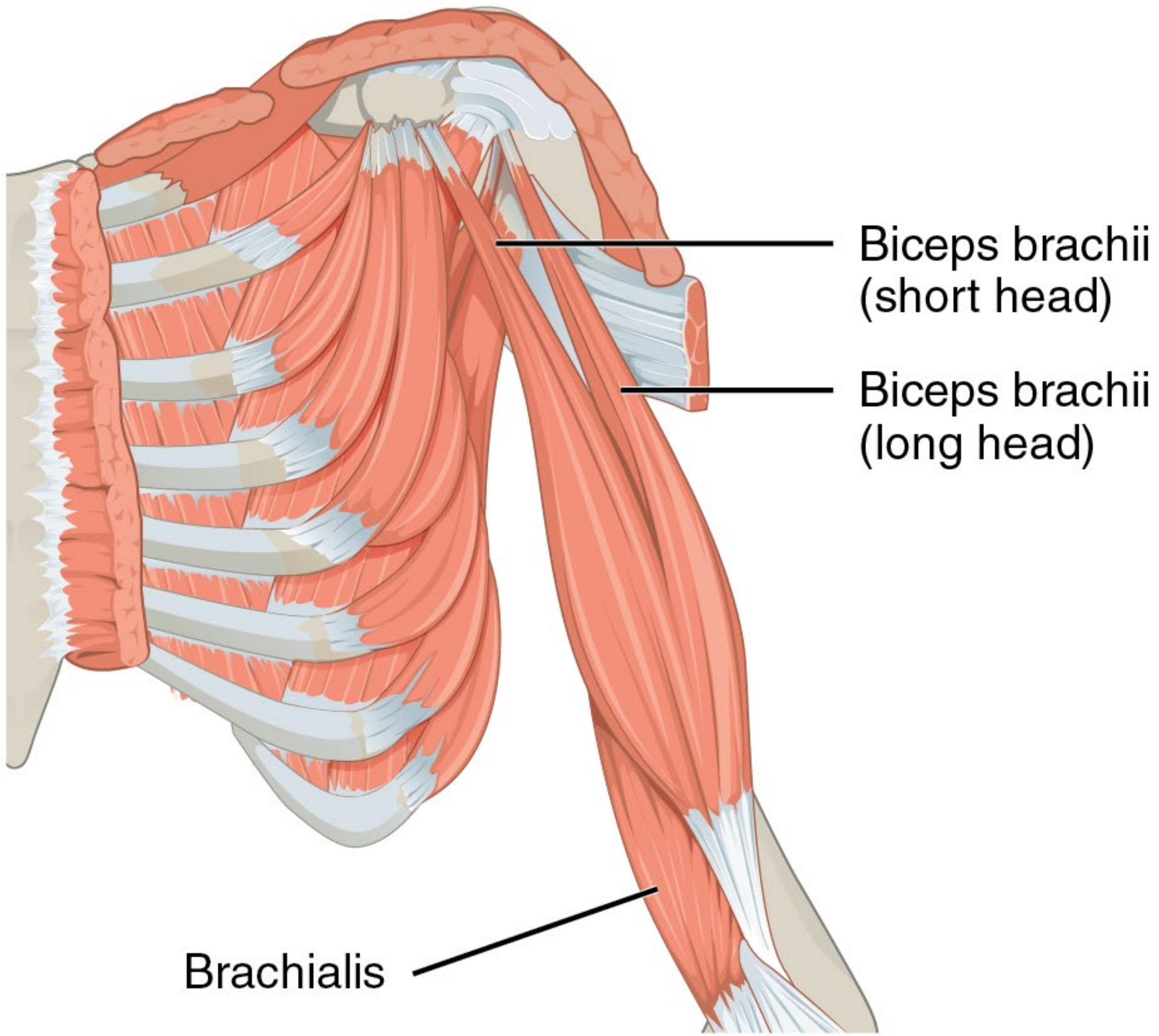


# Muscle Action

- Muscular contraction results in the movement or **action of** the bones attached.
- The action of a muscle is the direct result of the muscle attachments. So, knowing the origin and insertion points, gives us information on the "action" that muscle performs.

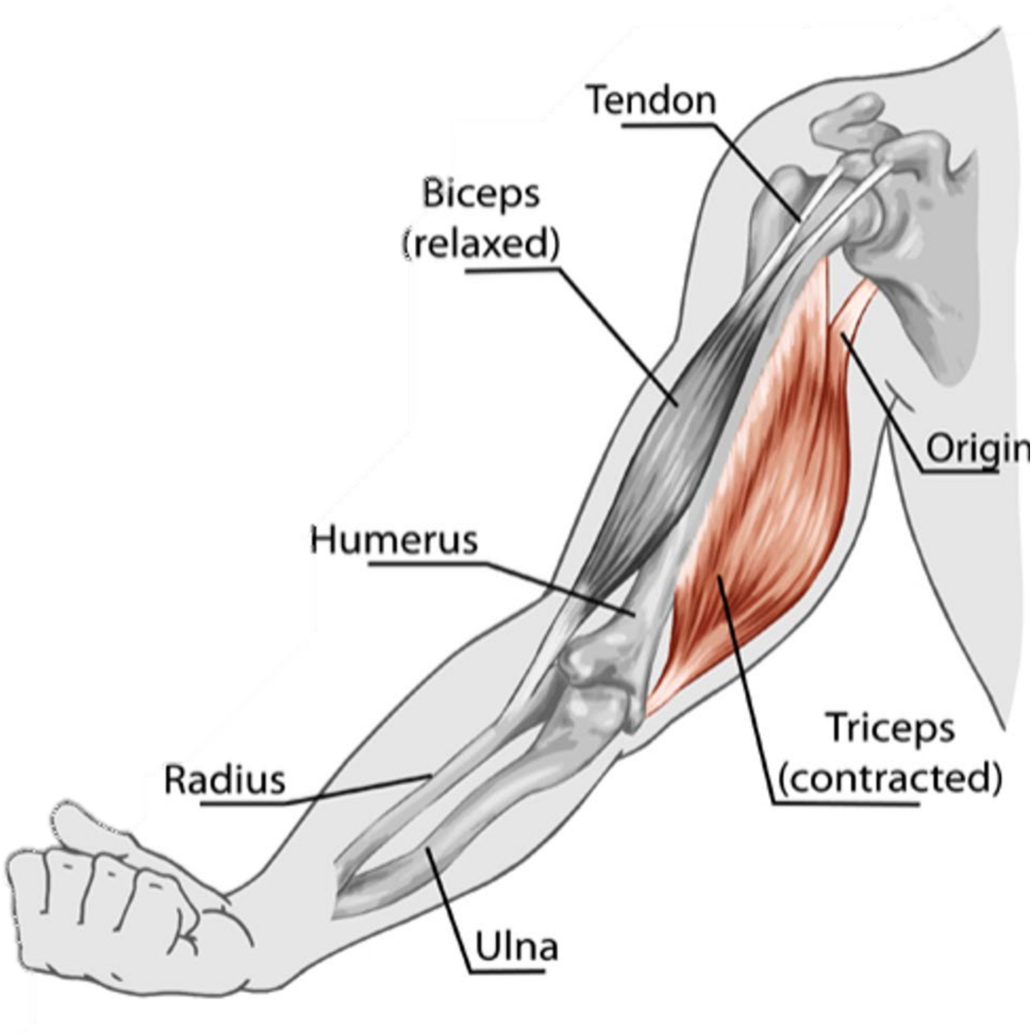
# Muscle Action

- Muscle actions can be described in one of two ways.
  - in terms of the bone or the appendage moved.
    - For example, the biceps brachii performs **flexion of the forearm** as the forearm is moved.
  - Or in terms of the joint, or the **articulation**.
    - For example, that same muscle, the biceps brachii, performs **flexion at the elbow**, in which the elbow is the joint.

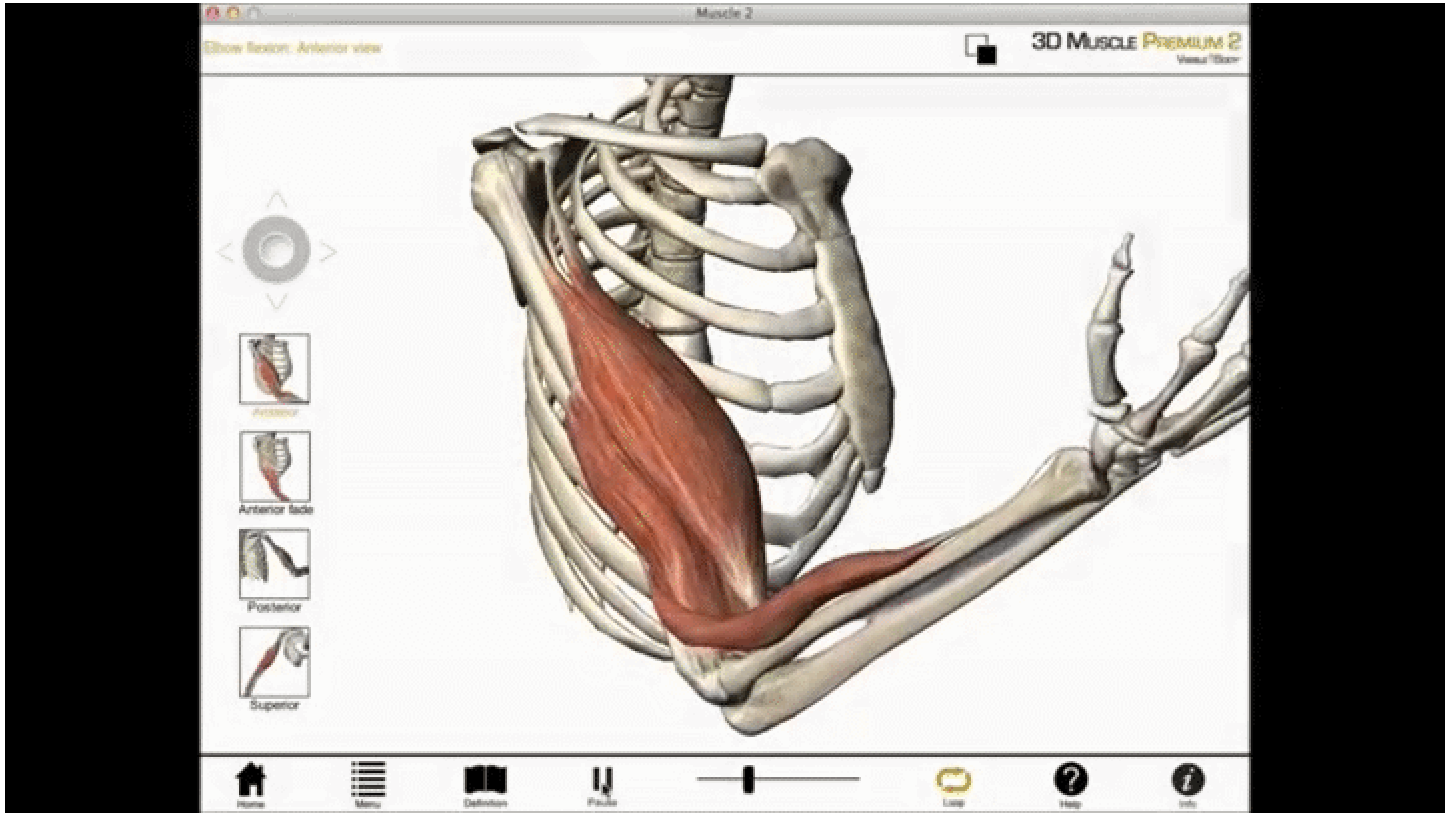


# Muscle Action

- The biceps brachii is the agonist of forearm flexion.
- We can also say that the biceps brachii is the "prime mover" of the forearm.



# Muscle Action

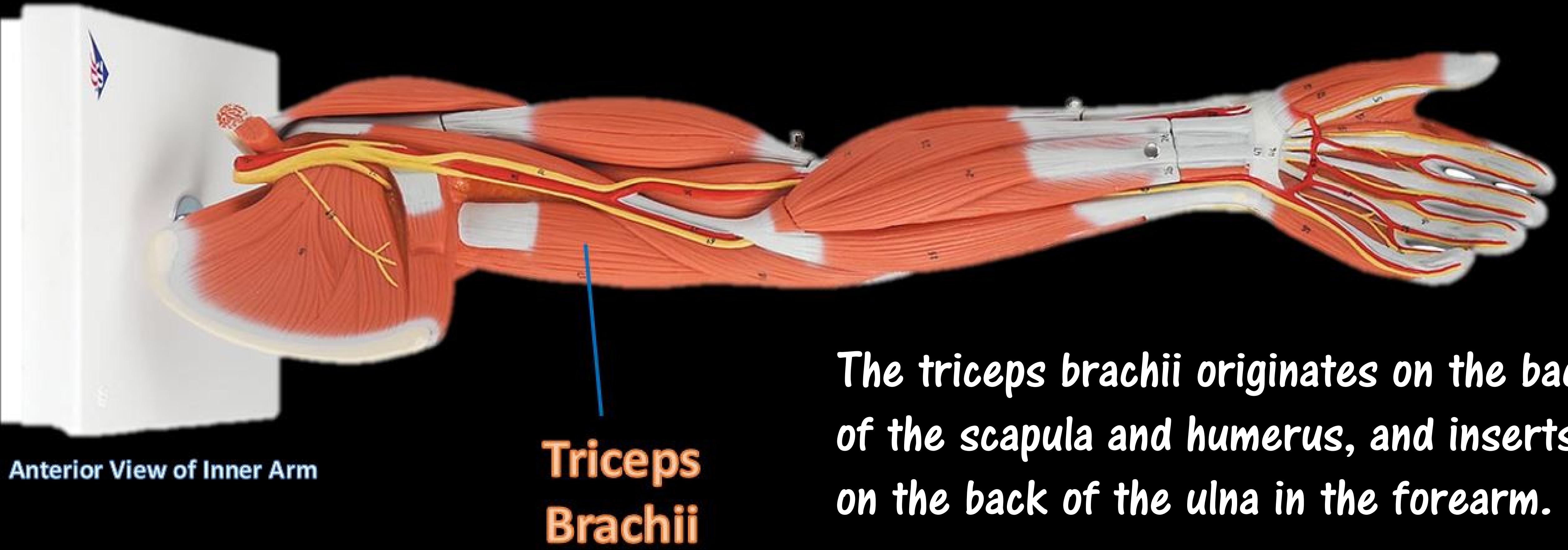



- For example: The biceps brachii originates on the front of the scapula of the shoulder and inserts on the front of the radius in the forearm.

- Due to these attachments, contraction and muscle shortening of the biceps flexes the forearm.

# Muscle Action

- The triceps is the **antagonist**, and its action opposes that of the agonist.




The triceps brachii originates on the back of the scapula and humerus, and inserts on the back of the ulna in the forearm.

# Muscle Action

- Due to these attachments, the triceps is stretched during forearm flexing.
- Stretching the muscle causes the triceps muscle to contract and, thus, slow flexion.
- Antagonist muscles slows and controls the movement.

# Functional groups

**Muscles can be classified into three functional groups:**

Prime Mover or Agonist - A muscle that has the major responsibility for producing a specific movement is a prime mover, or agonist, of that movement.

Antagonist - Muscles that oppose, or reverse, a particular movement are antagonists

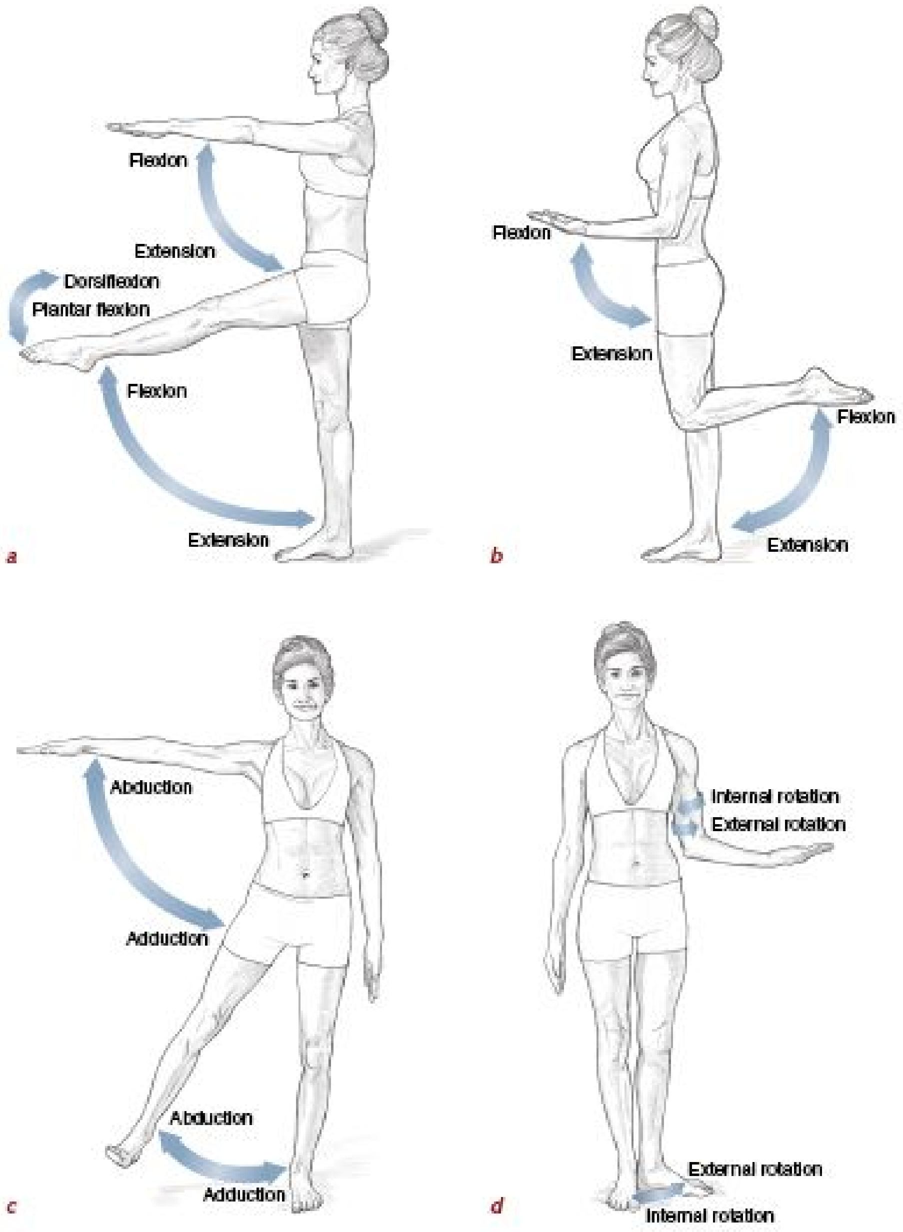
Synergist - Synergists help prime movers or agonists by

- adding additional force to the same movement or
- Inhibiting oppositional movements

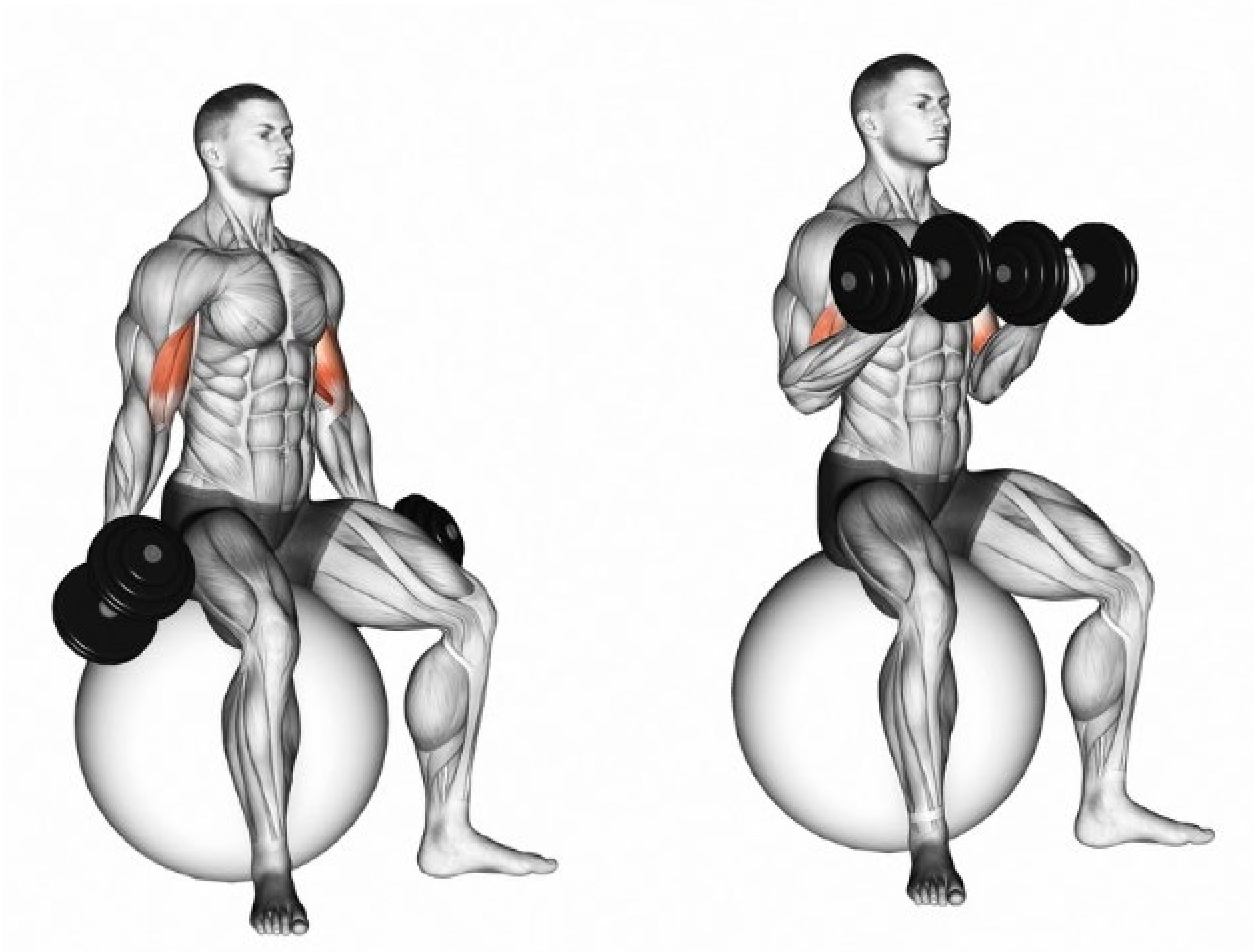
# Muscle action

- Sometimes muscles are named for the movement they produce.
- For example, you may see action words such as
  - Flexor
  - Extensor
  - Adductor

# Muscle Actions



# The action of a Muscle



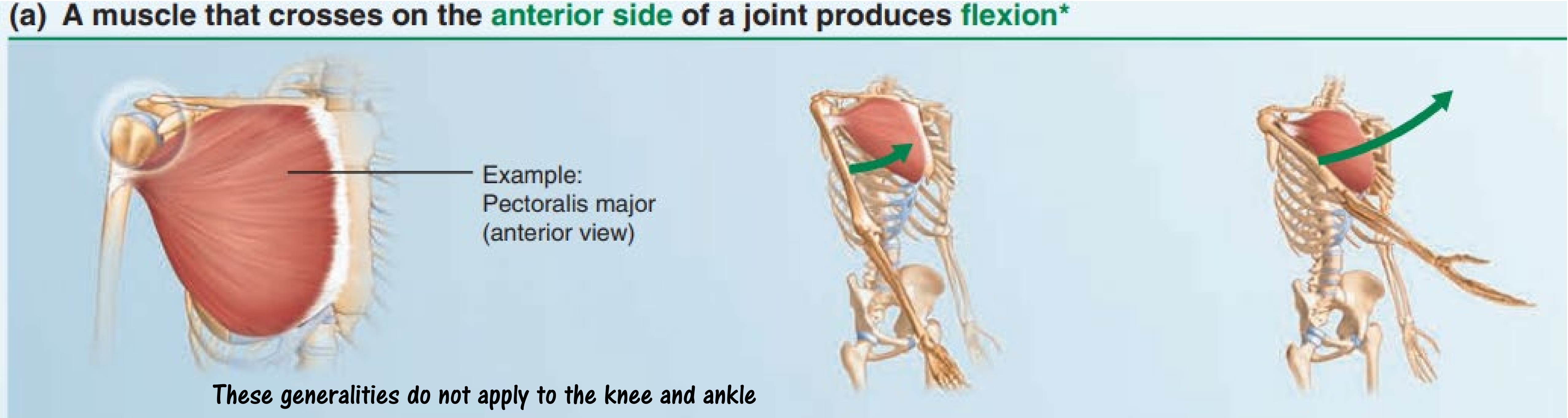
http://ushcgshots.com/media/wysiwyg/image1.jpeg

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the anterior side of a joint produces flexion.

# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the anterior side of a joint produces flexion.

Marieb Human Anatomy & Physiology: Tenth Edition



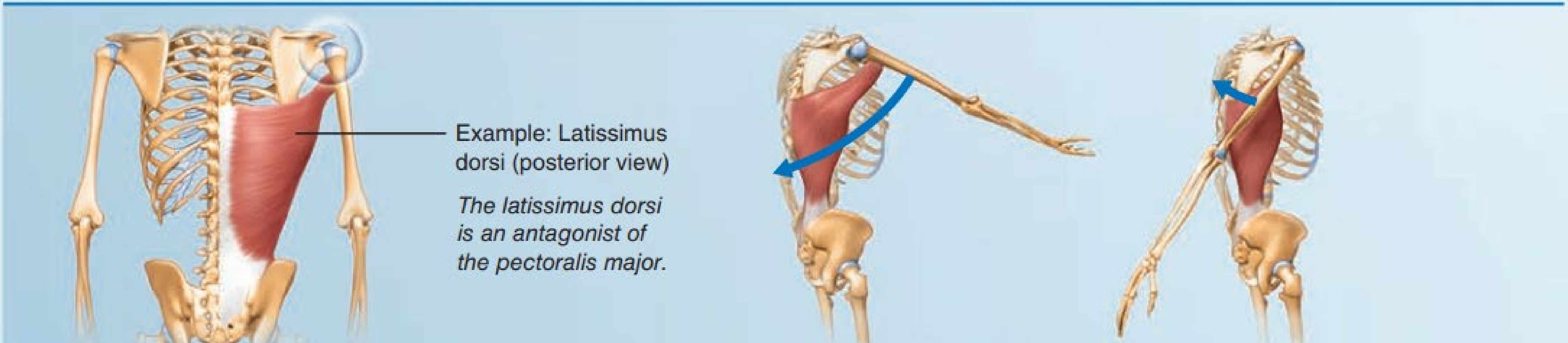

These generalities do not apply to the knee and ankle

# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the posterior side of a joint produces extension.

Marieb Human Anatomy & Physiology: Tenth Edition

(b) A muscle that crosses on the posterior side of a joint produces extension*



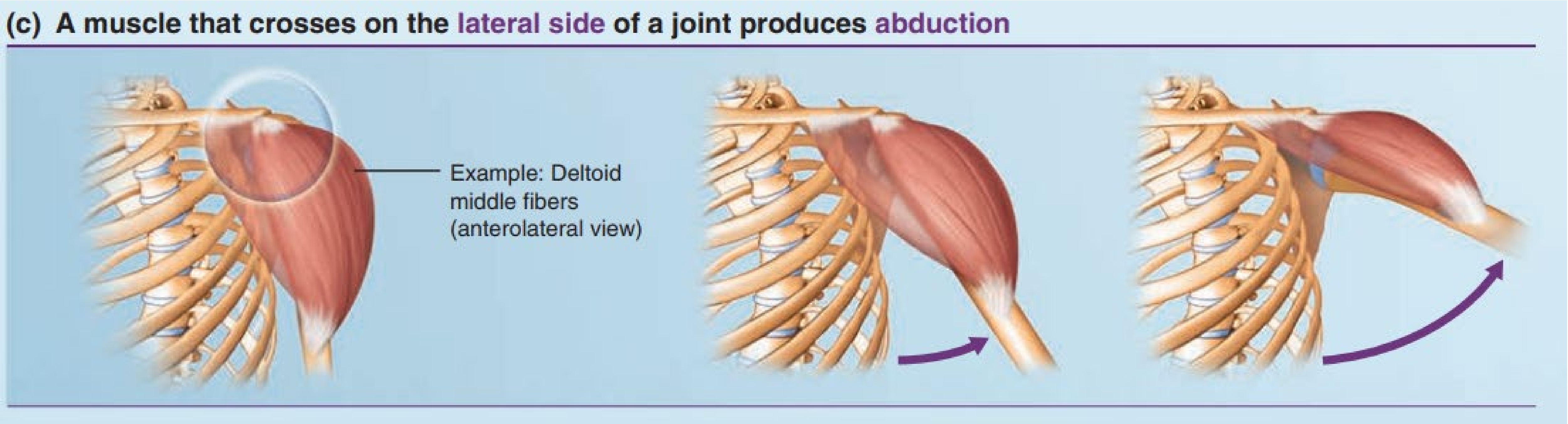

These generalities do not apply to the knee and ankle

# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the lateral side of a joint produces abduction.

These generalities do not apply to the knee and ankle

Marieb Human Anatomy & Physiology: Tenth Edition

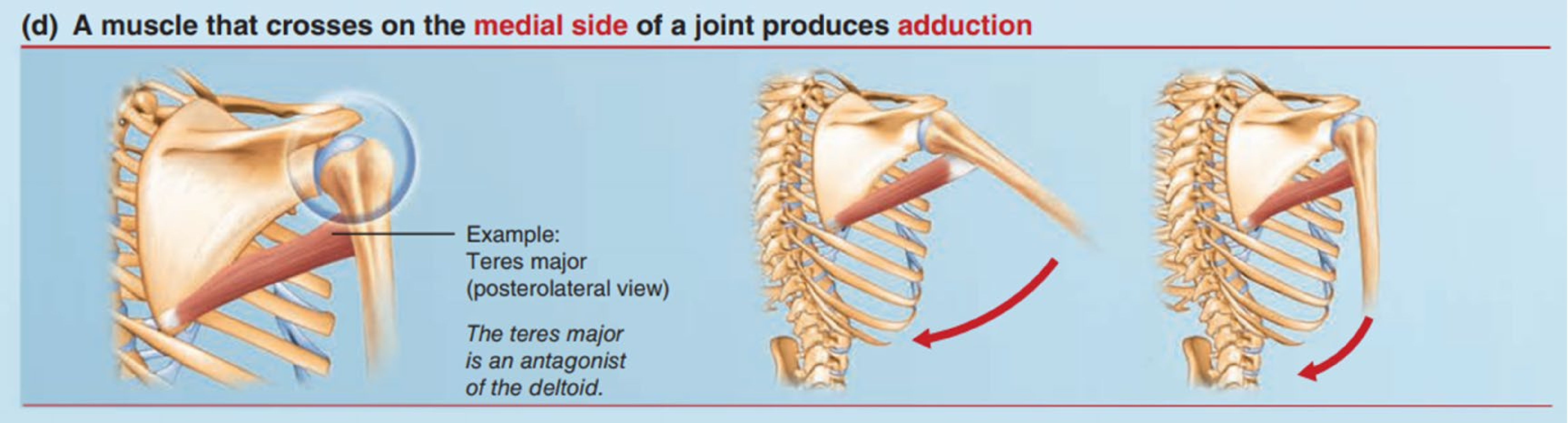


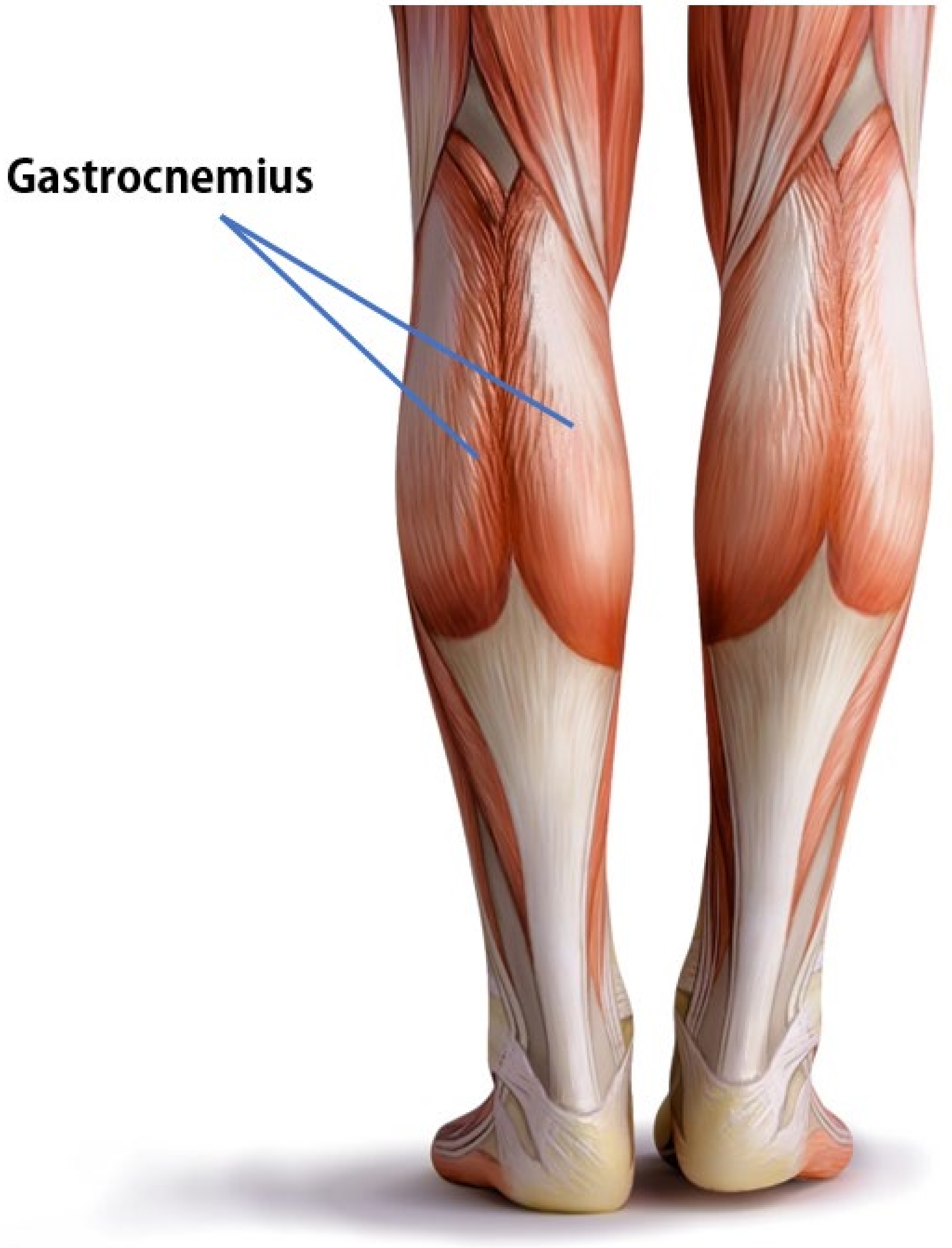
# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the medial side of a joint produces adduction.

These generalities do not apply to the knee and ankle

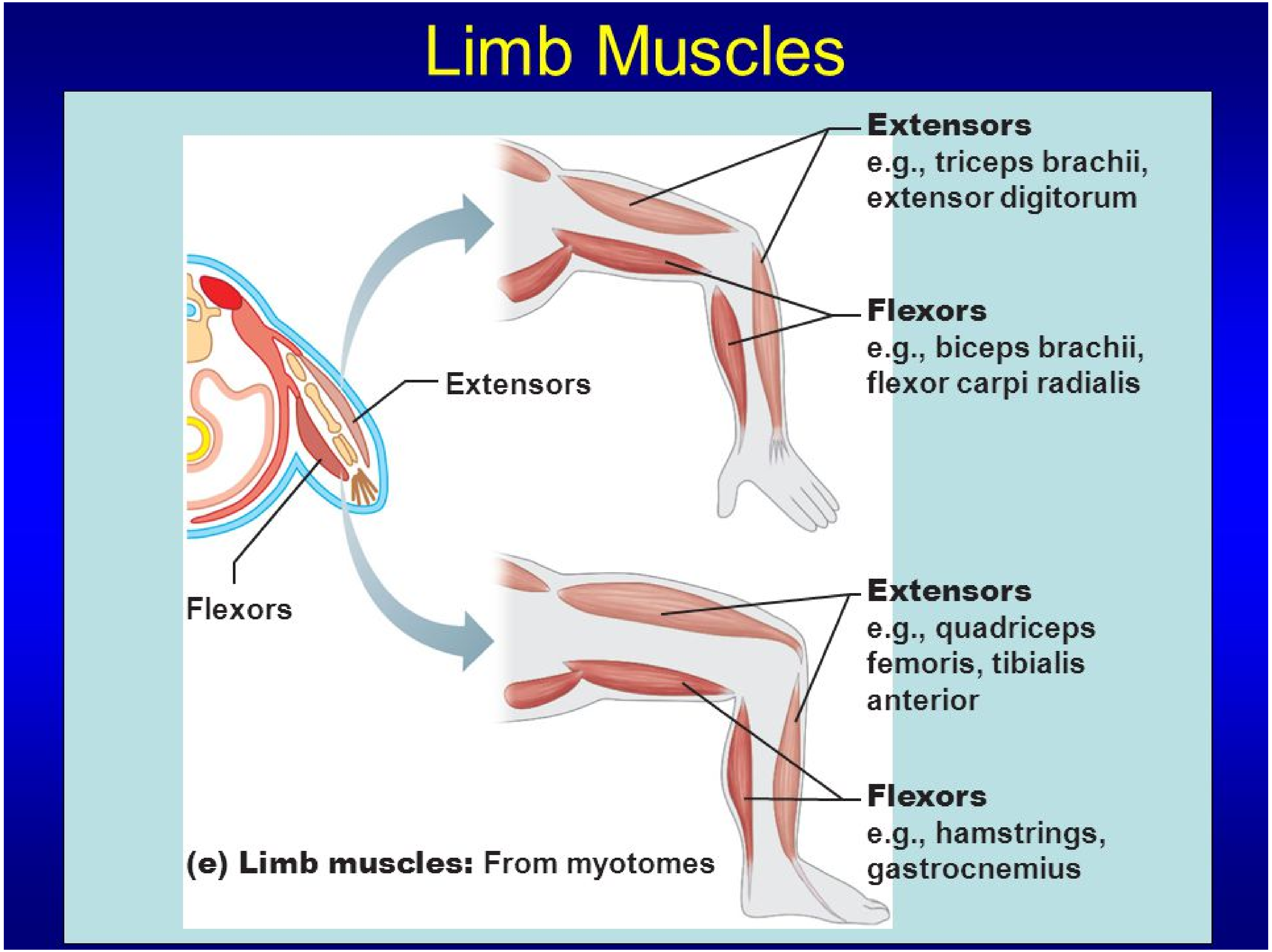
Marieb Human Anatomy & Physiology: Tenth Edition






- These generalities do not apply to the knee and ankle because the lower limb is rotated during development.
- The muscles that cross the knee joint posteriorly produce flexion, and those that cross anteriorly produce extension.

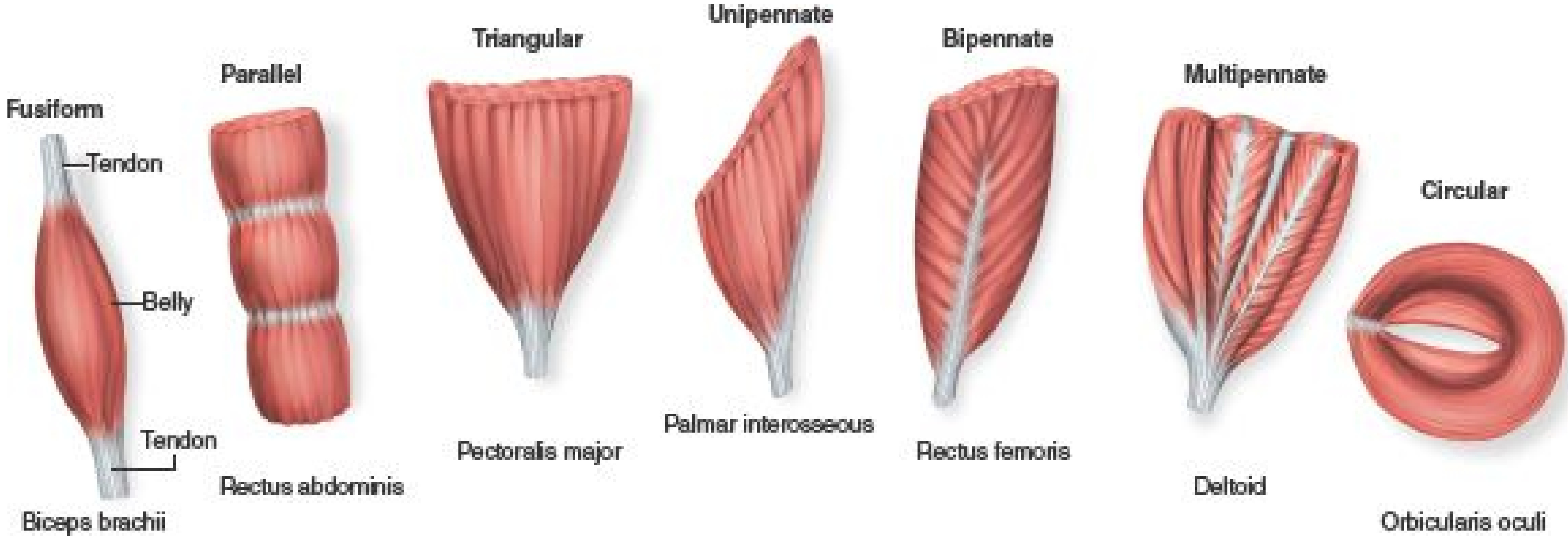
The extensors of the lower leg (or knee) are opposite from the rest of the body!

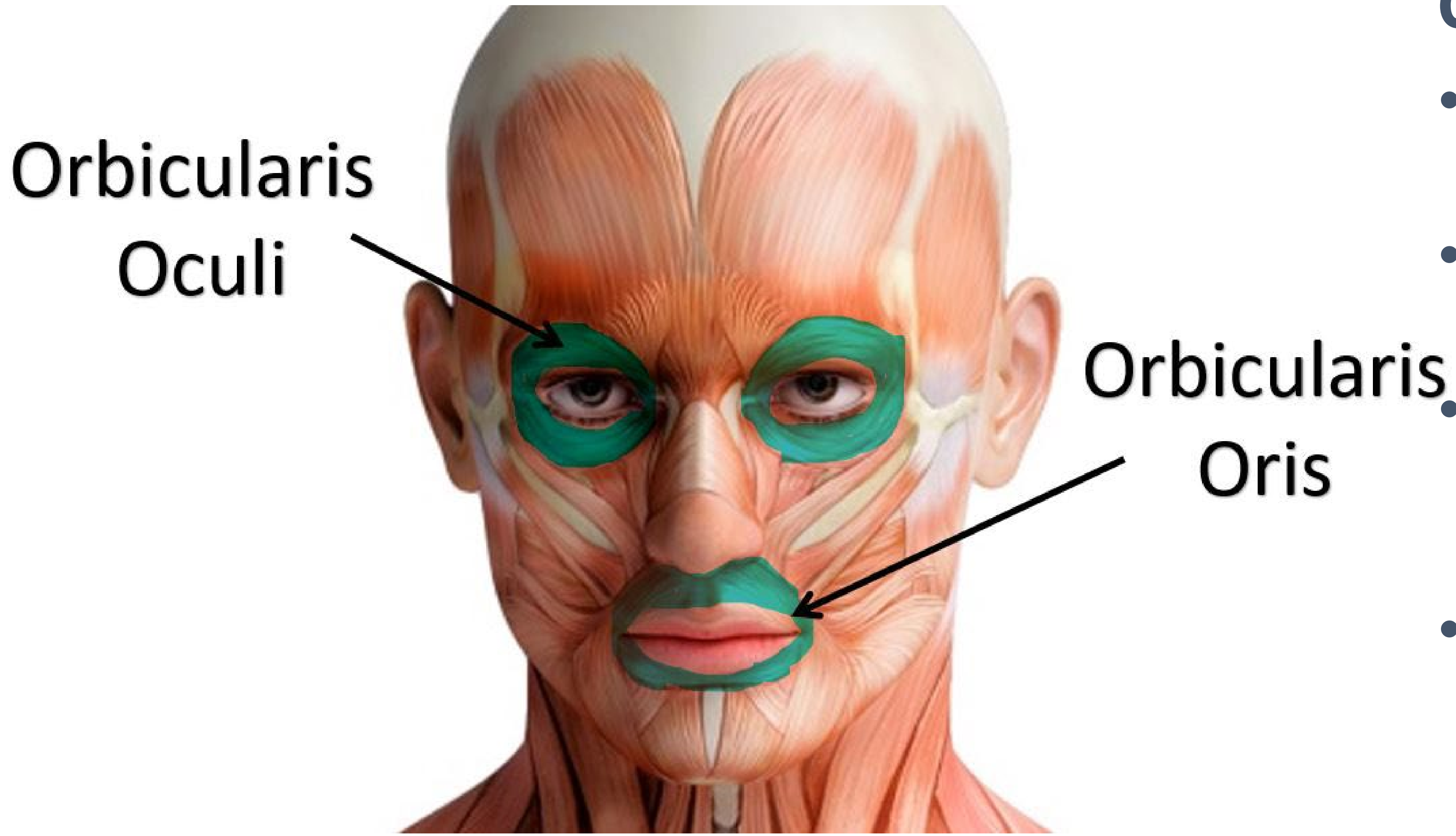



**(e) Limb muscles:** From myotomes

# Fascicle arrangements help determine muscle shape and force.

- Fascicle arrangements vary, resulting in muscles with different morphologies and functions.
- The most common patterns of fascicle arrangement are
  - Circular
  - Convergent
  - Parallel
  - Pennate





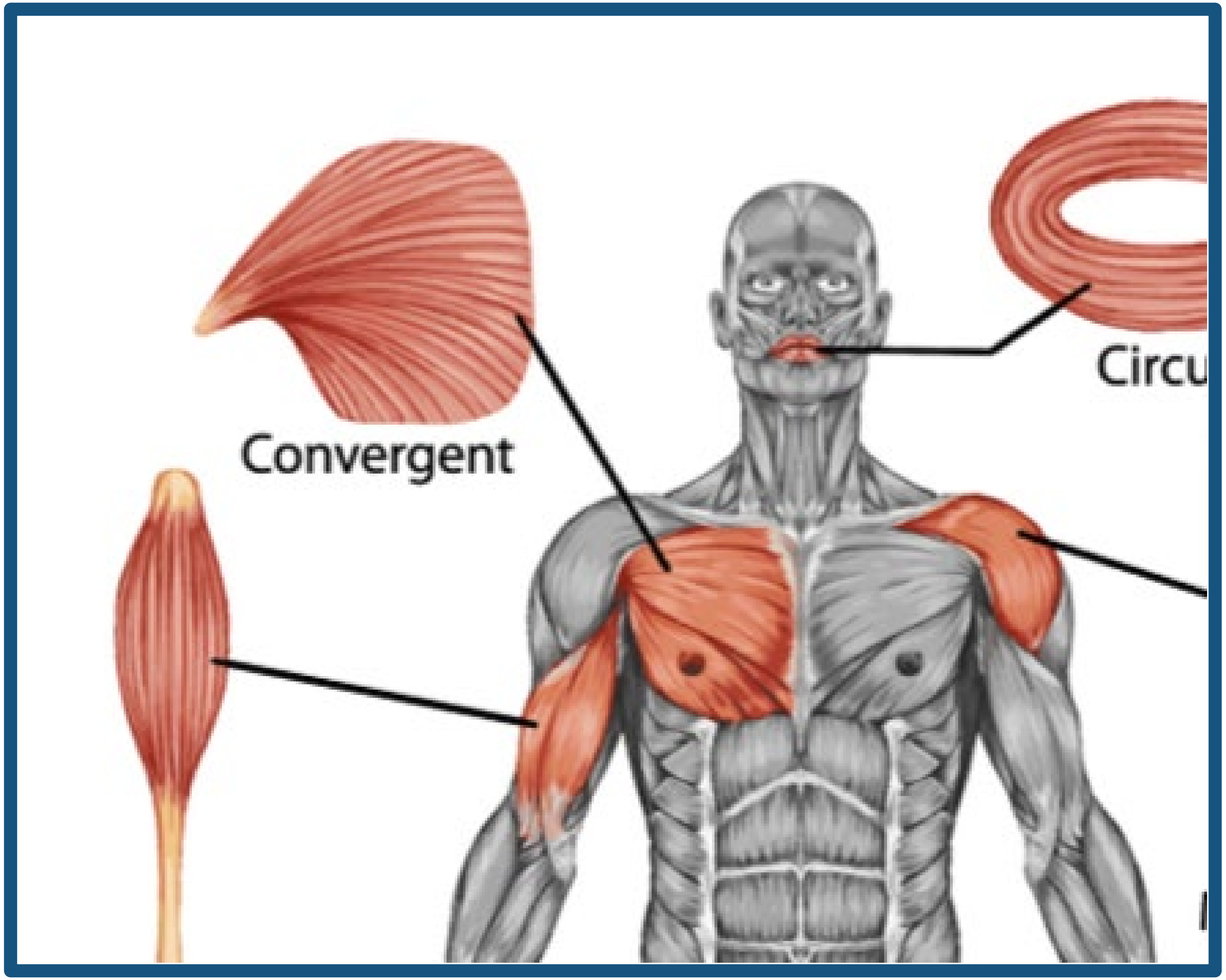

## Circular

- Found At External Body Openings
- When Muscle Contracts, It Closes.
- Known As Sphincters Which Means ("Squeezers").
- Examples Are The Orbicularis Muscles Surrounding The Eyes And The Mouth.

# Fascicle Arrangements

## Convergent

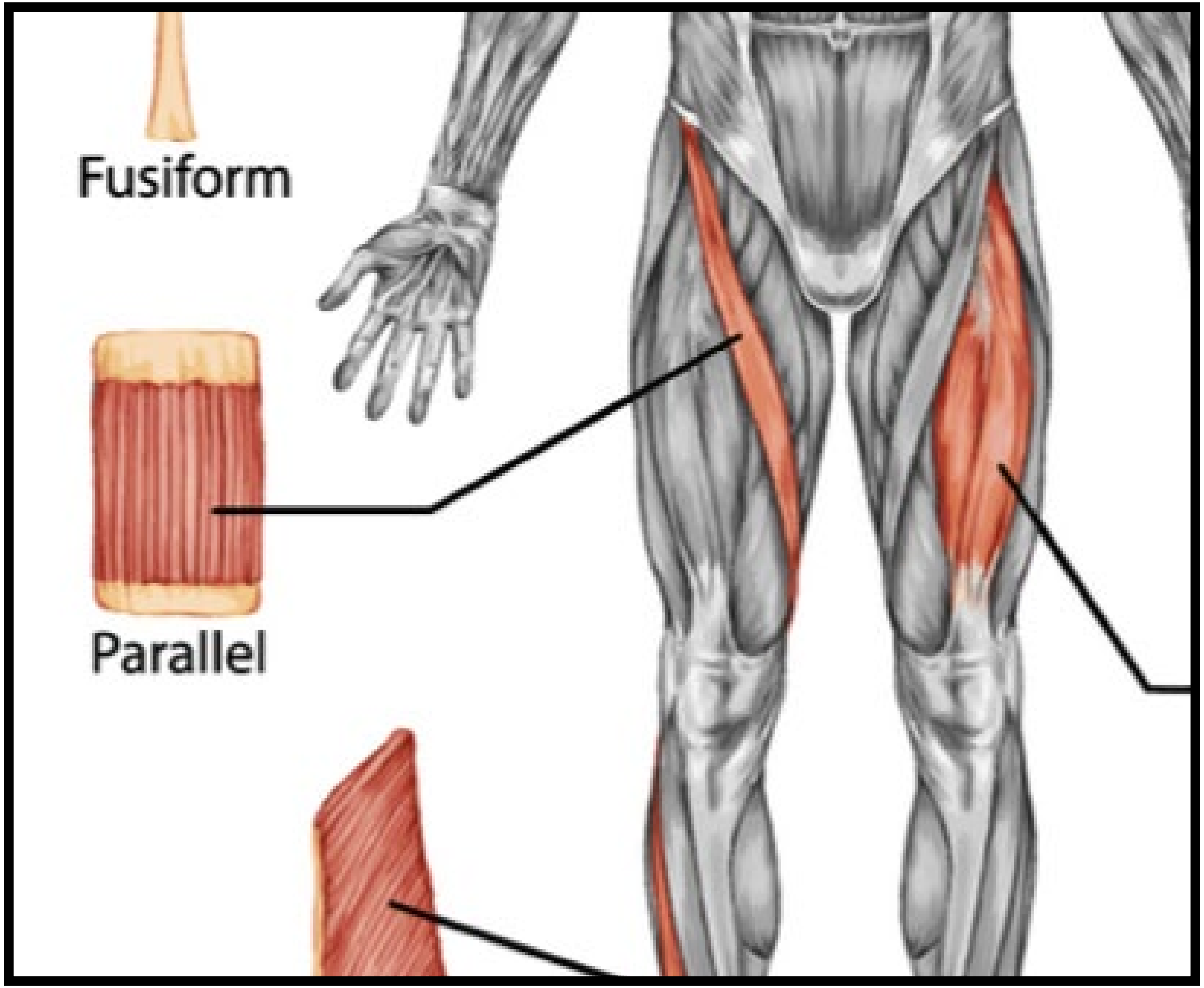
- A convergent muscle has a broad origin, and its fascicles converge toward a single tendon of insertion.
- Such a muscle is triangular or **fan-shaped** like the **pectoralis major muscle** of the anterior thorax.



# Fascicle Arrangements

## Parallel

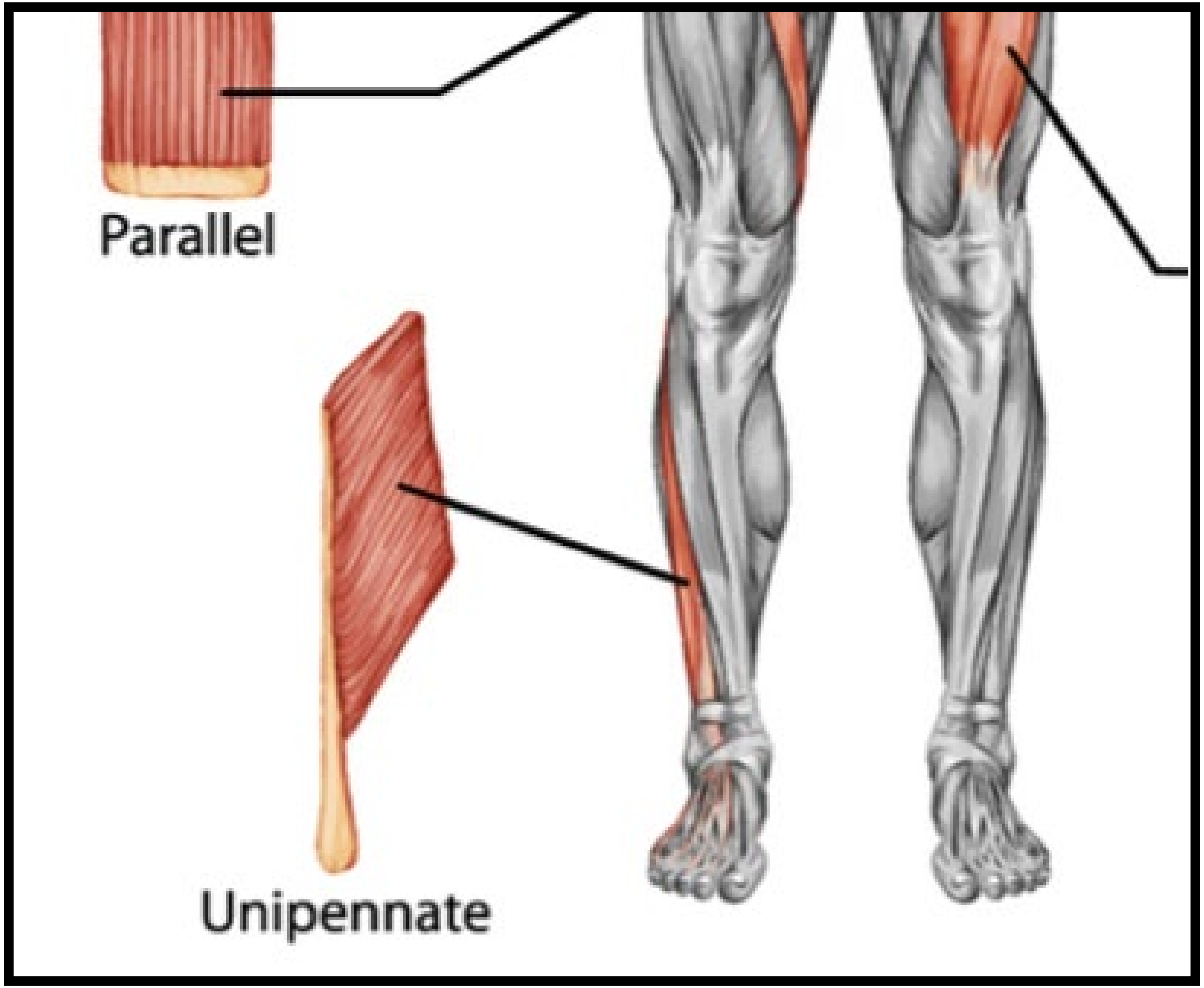
- May be "strap-like"
- Example = sartorius muscle



# Fascicle Arrangements

## Pennate

- Penna means "feather"
- the fascicles are short and they attach obliquely to a central tendon that runs the length of the muscle.

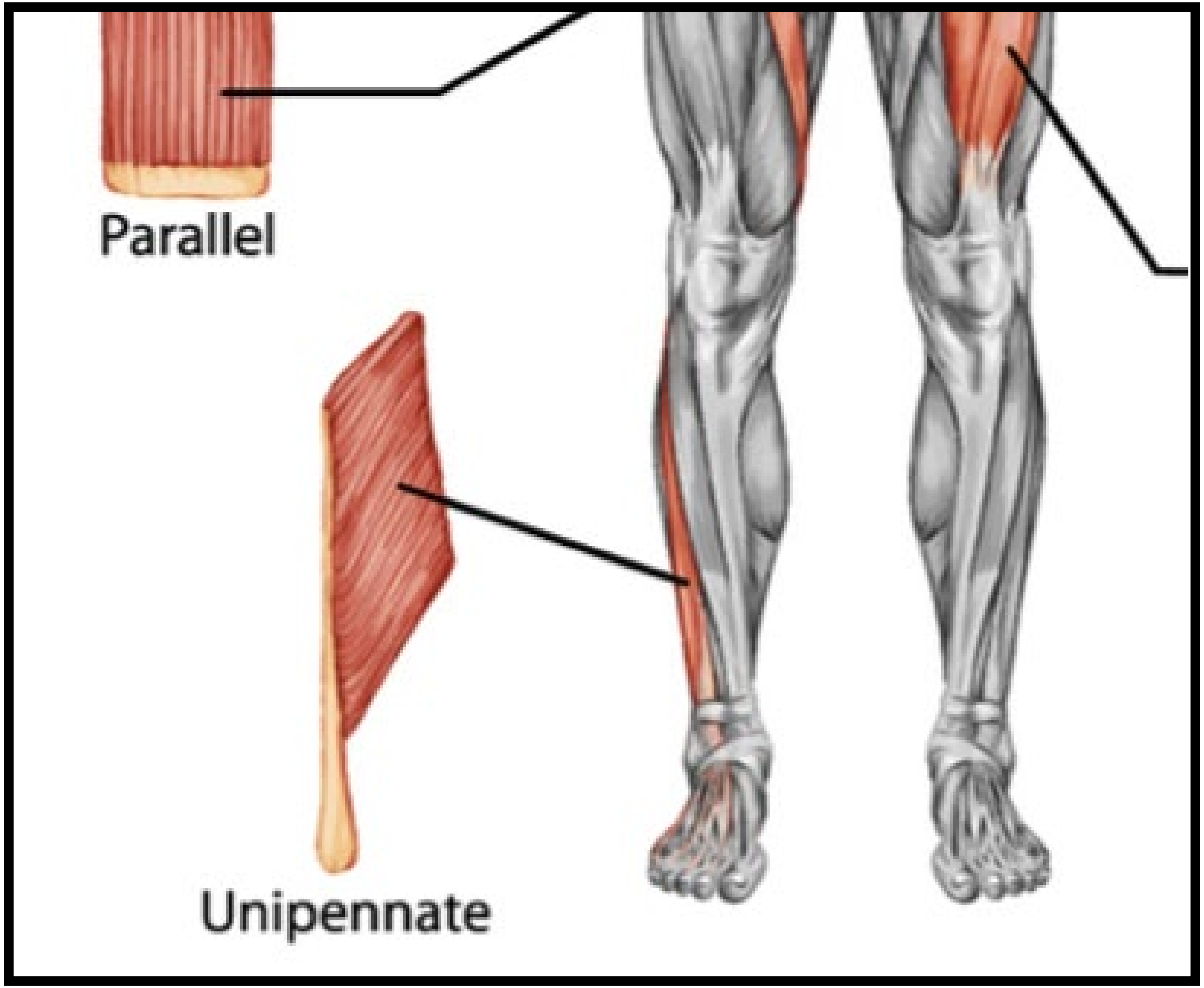


# Fascicle Arrangements

## Pennate

- Pennate muscles come in three forms:

1. Unipennate, in which the fascicles insert into only one side of the tendon, as in the extensor digitorum longus muscle of the leg.

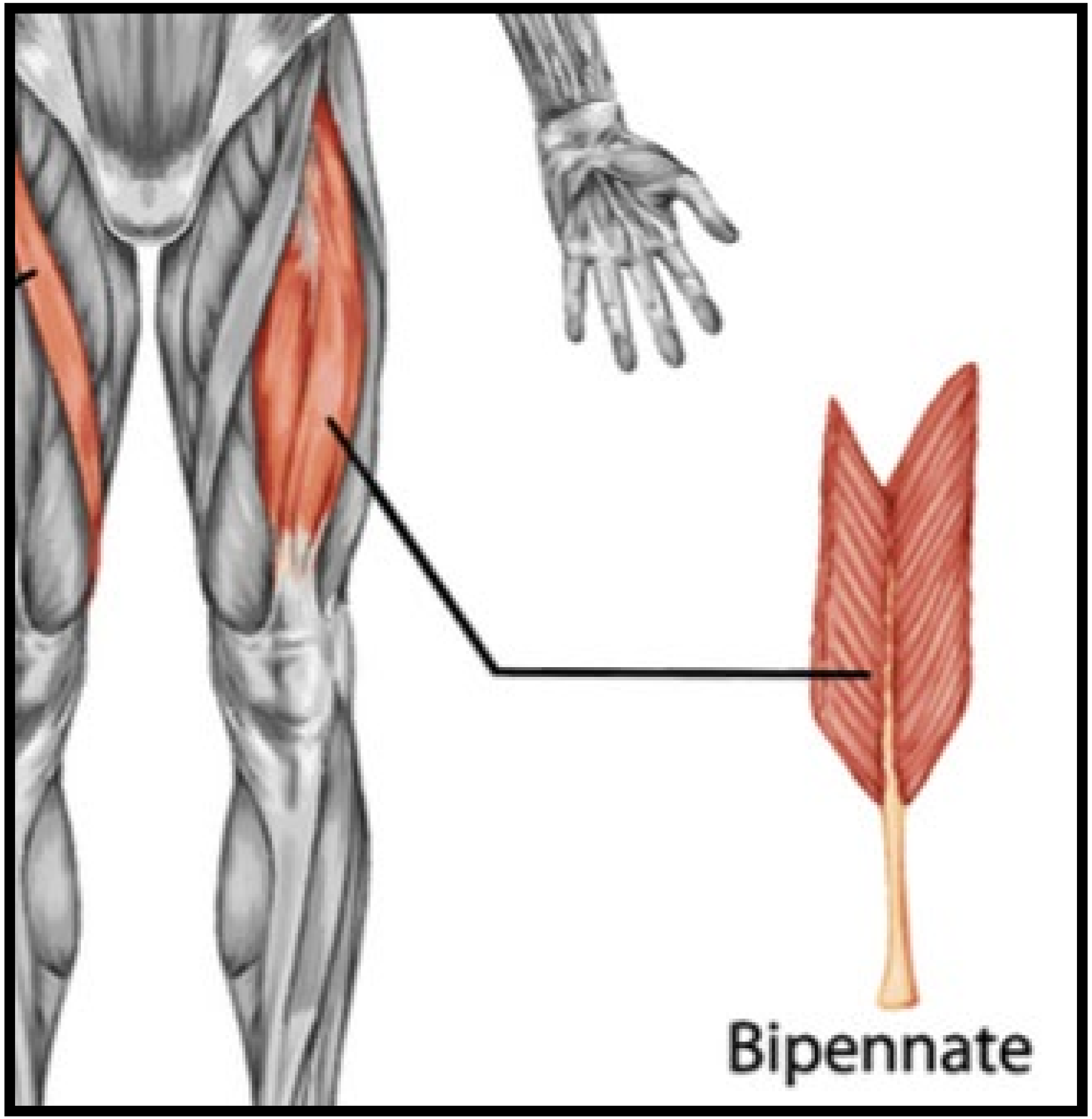


# Fascicle Arrangements

## Pennate

- Pennate muscles come in three forms:

2. Bipennate, in which the fascicles insert into the tendon from opposite sides so the muscle looks like a feather.
   - The rectus femoris of the thigh is bipennate.

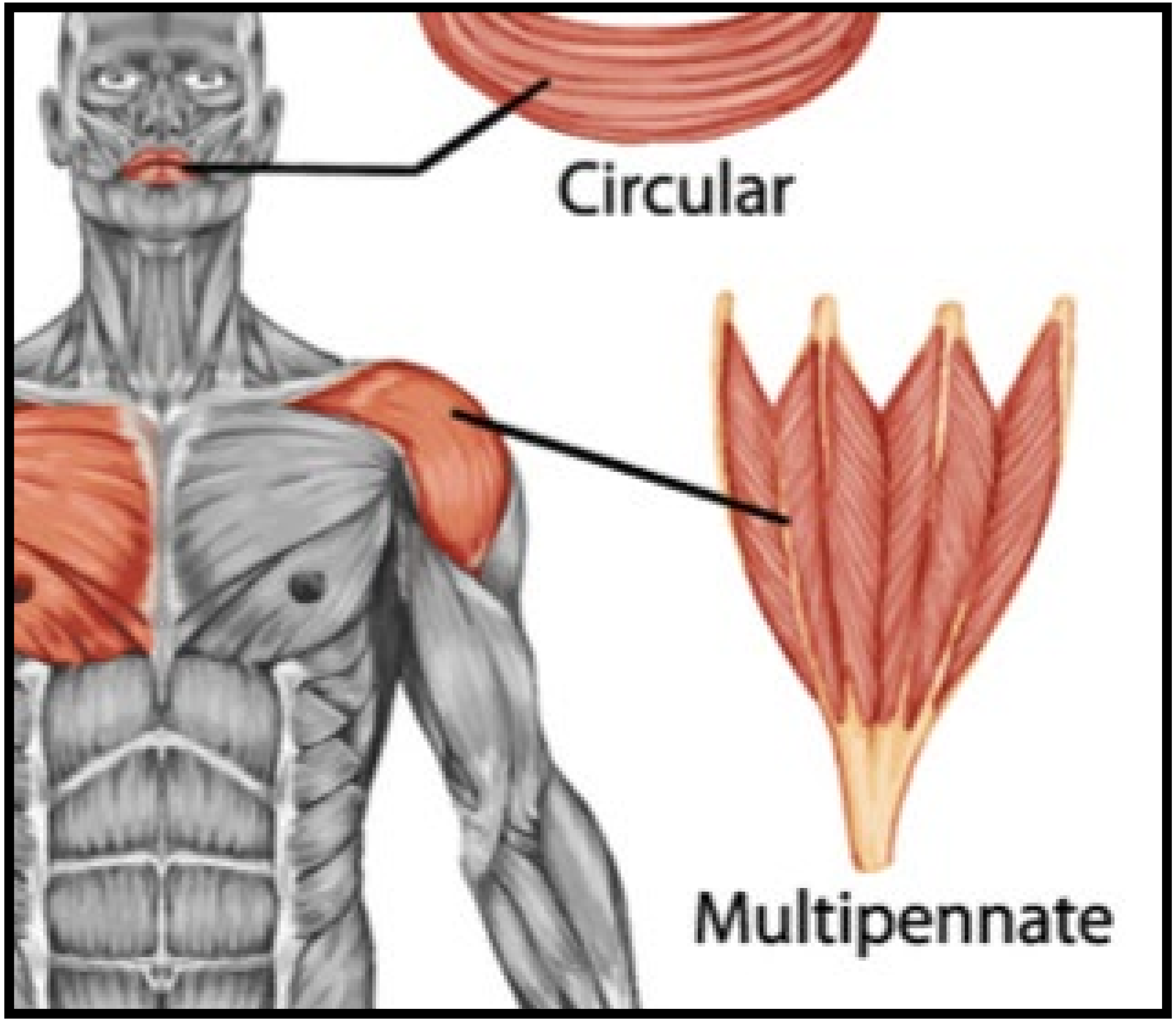


# Fascicle Arrangements

## Pennate

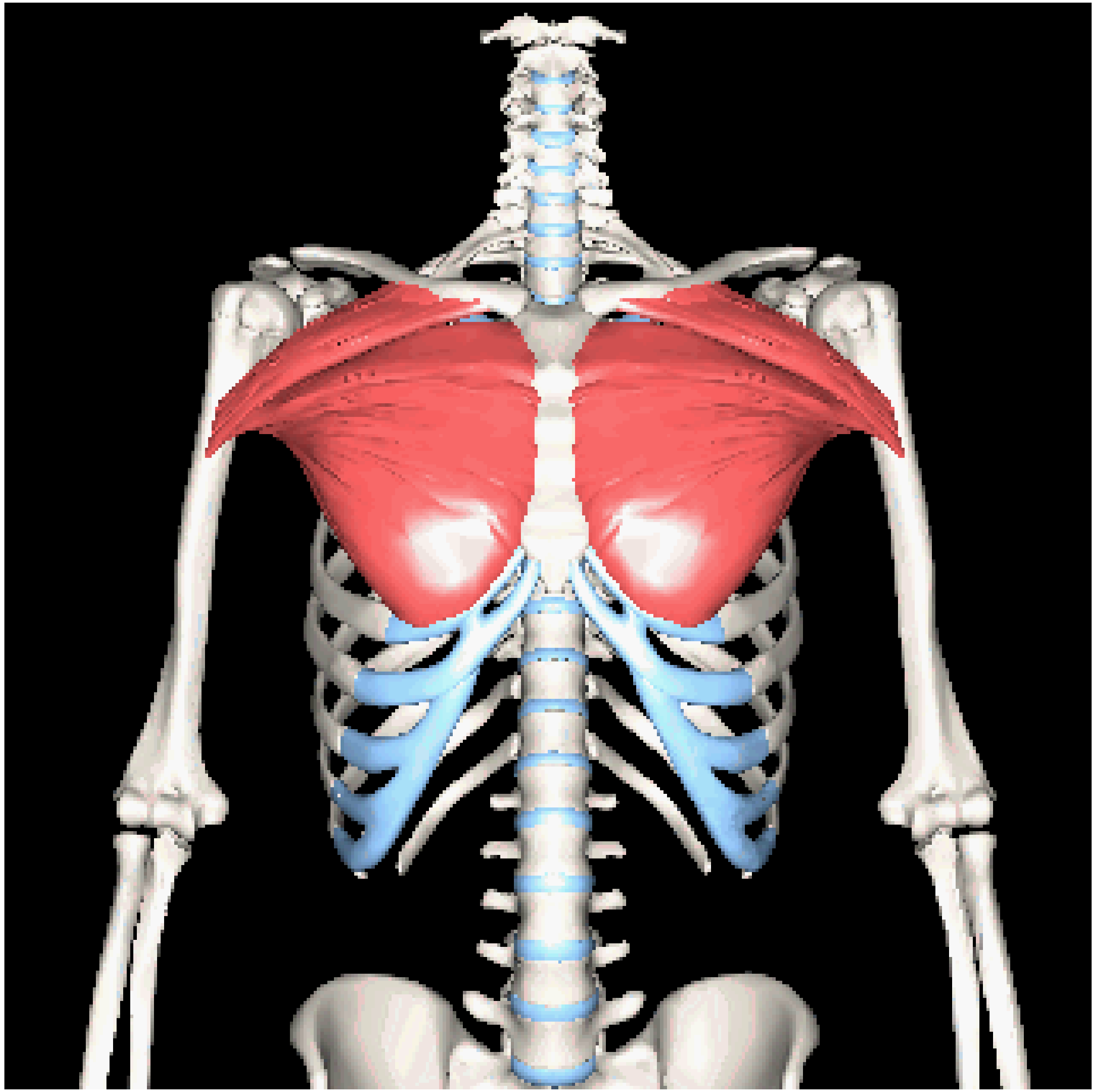
- Pennate muscles come in three forms:

2. Multipennate, which looks like many feathers side by side, with all their quills inserted into one large tendon.
   - The deltoid muscle, which forms the roundness of the shoulder, is multipennate.



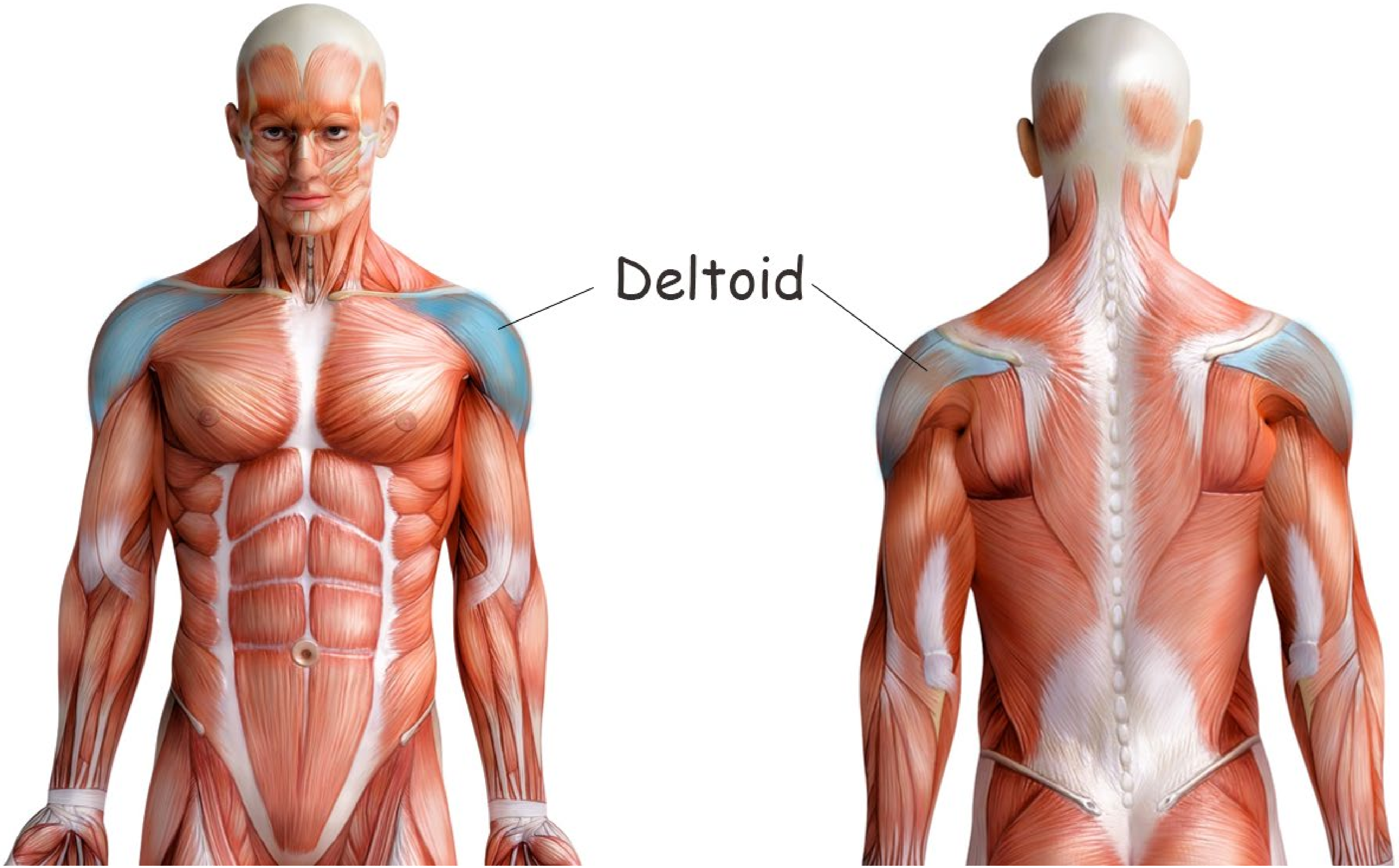
# Pectoralis Major

Adducts and medially rotates arm



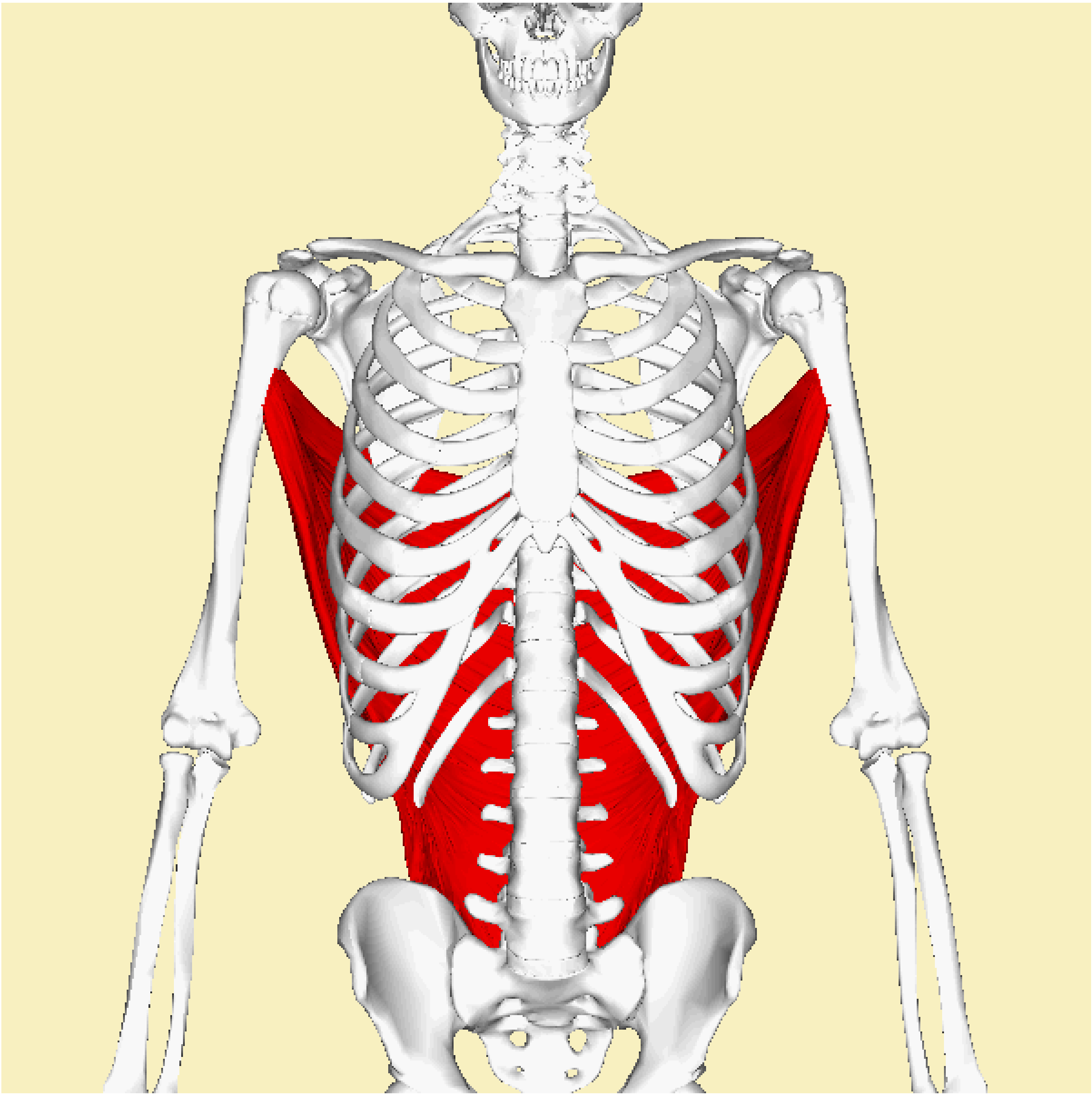
# DELTOID

- Prime mover of arm abduction
- Antagonist of arm adduction



# Latissimus Dorsi

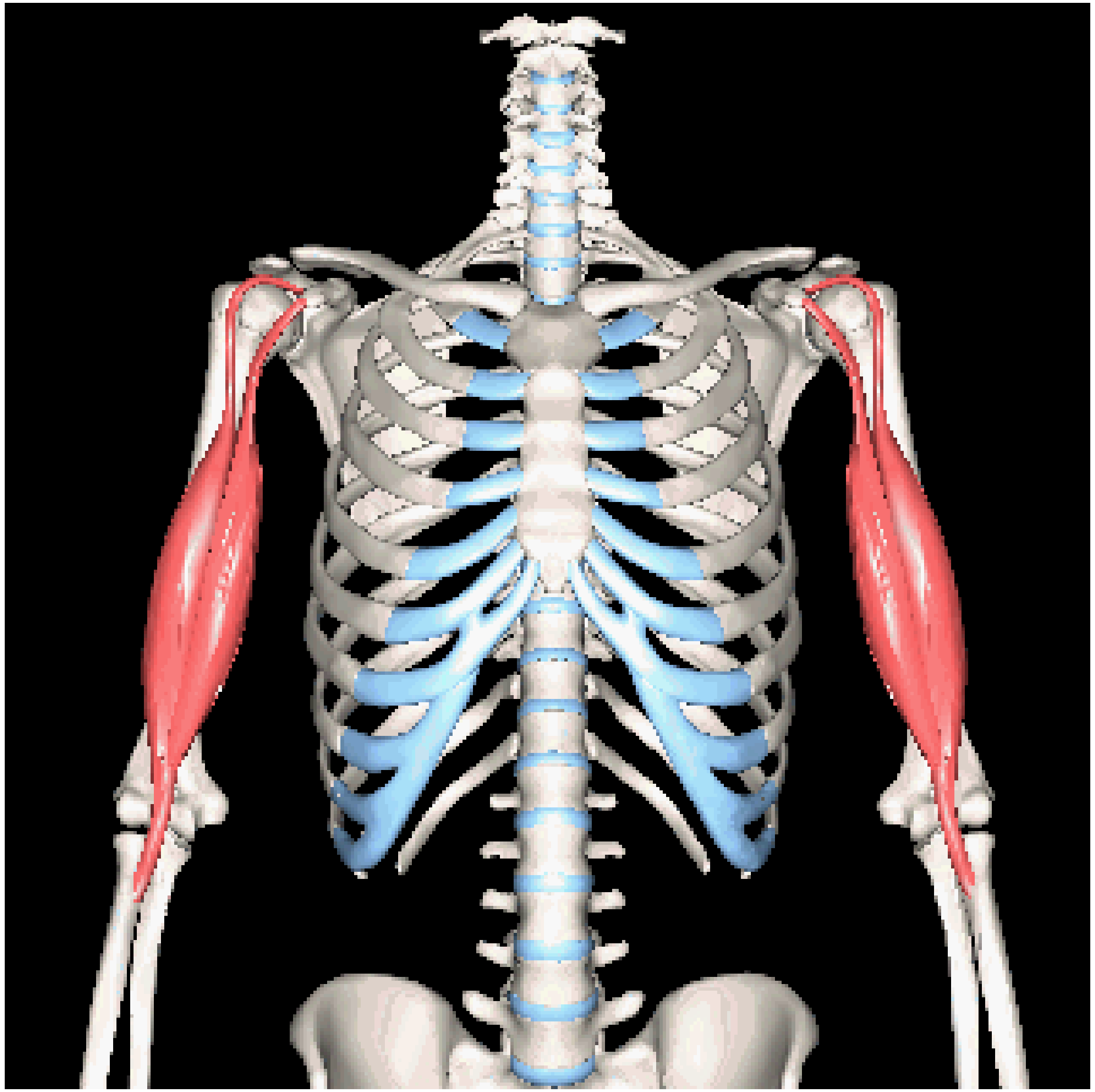
- Prime mover of arm extension
- Antagonist of arm flexion

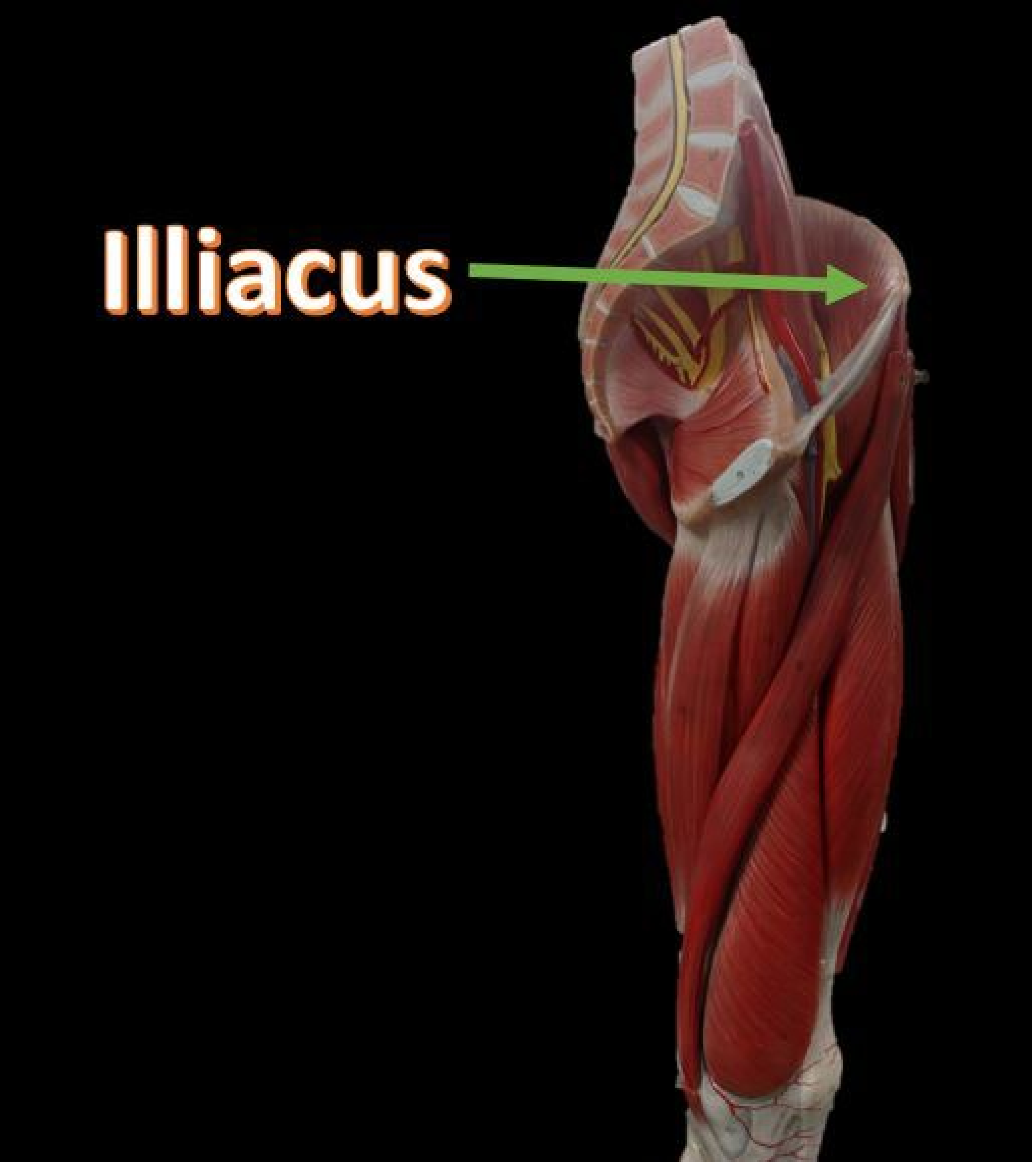


# Biceps brachii

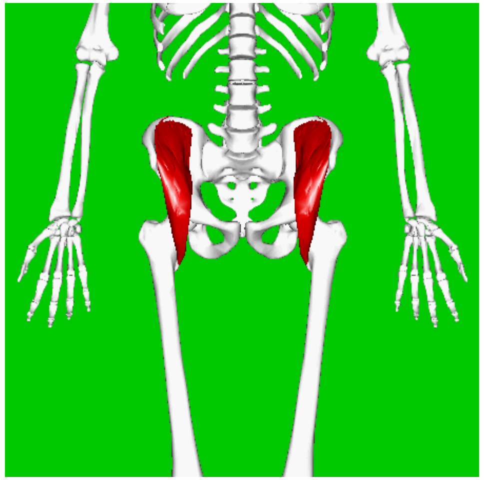
- Prime Mover of Forearm Flexion

- Antagonist of Forearm Extension






www.ScientistCindy.com

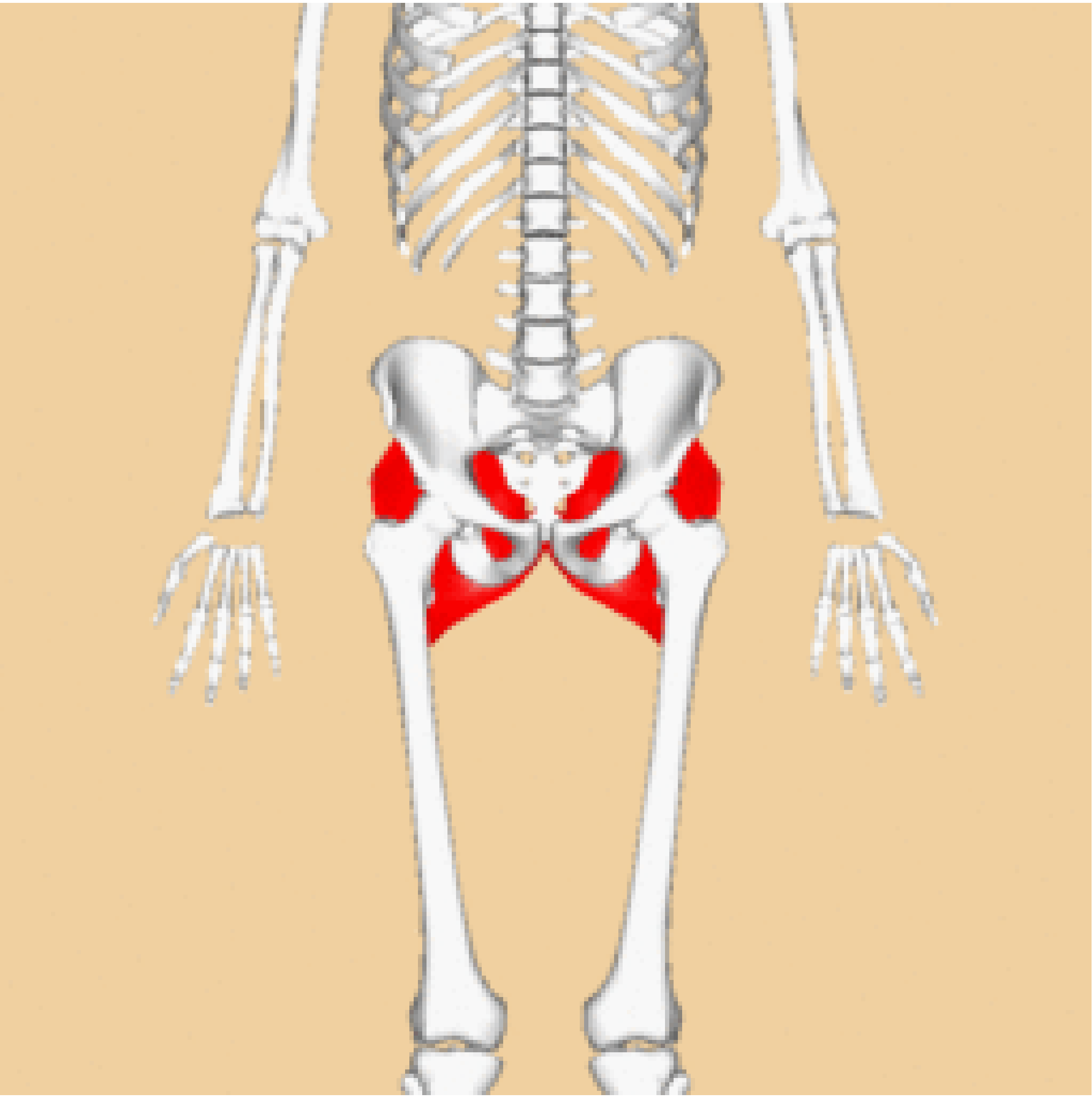


# Iliacus

- Prime Mover for Thigh or Hip Flexion
- Antagonist of Hip Extension

# Gluteus Maximus

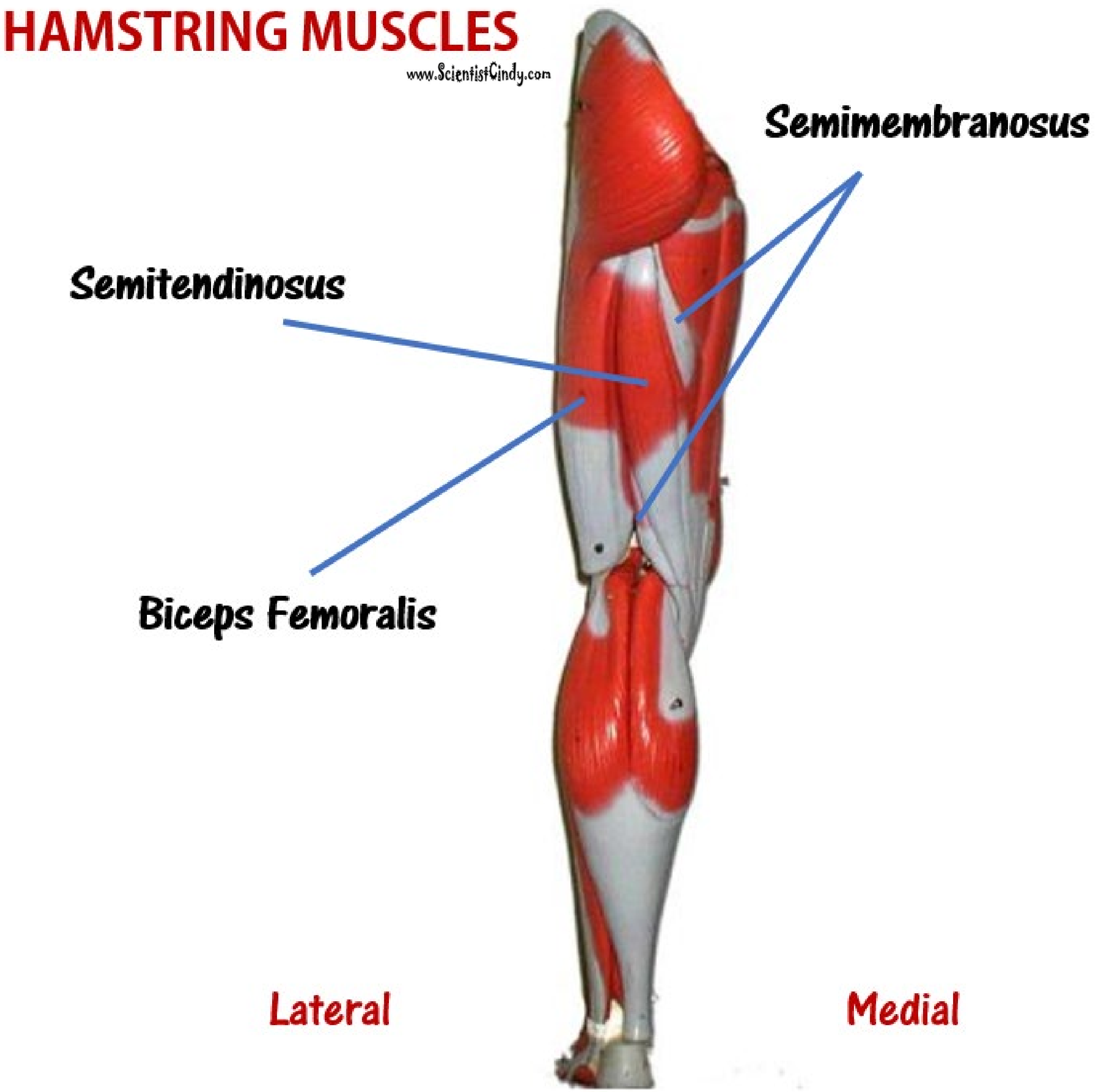
- Prime Mover of Thigh Extension
- Antagonist of Thigh or Hip Flexions



# Hamstrings - Extends thigh

Hamstrings include the…

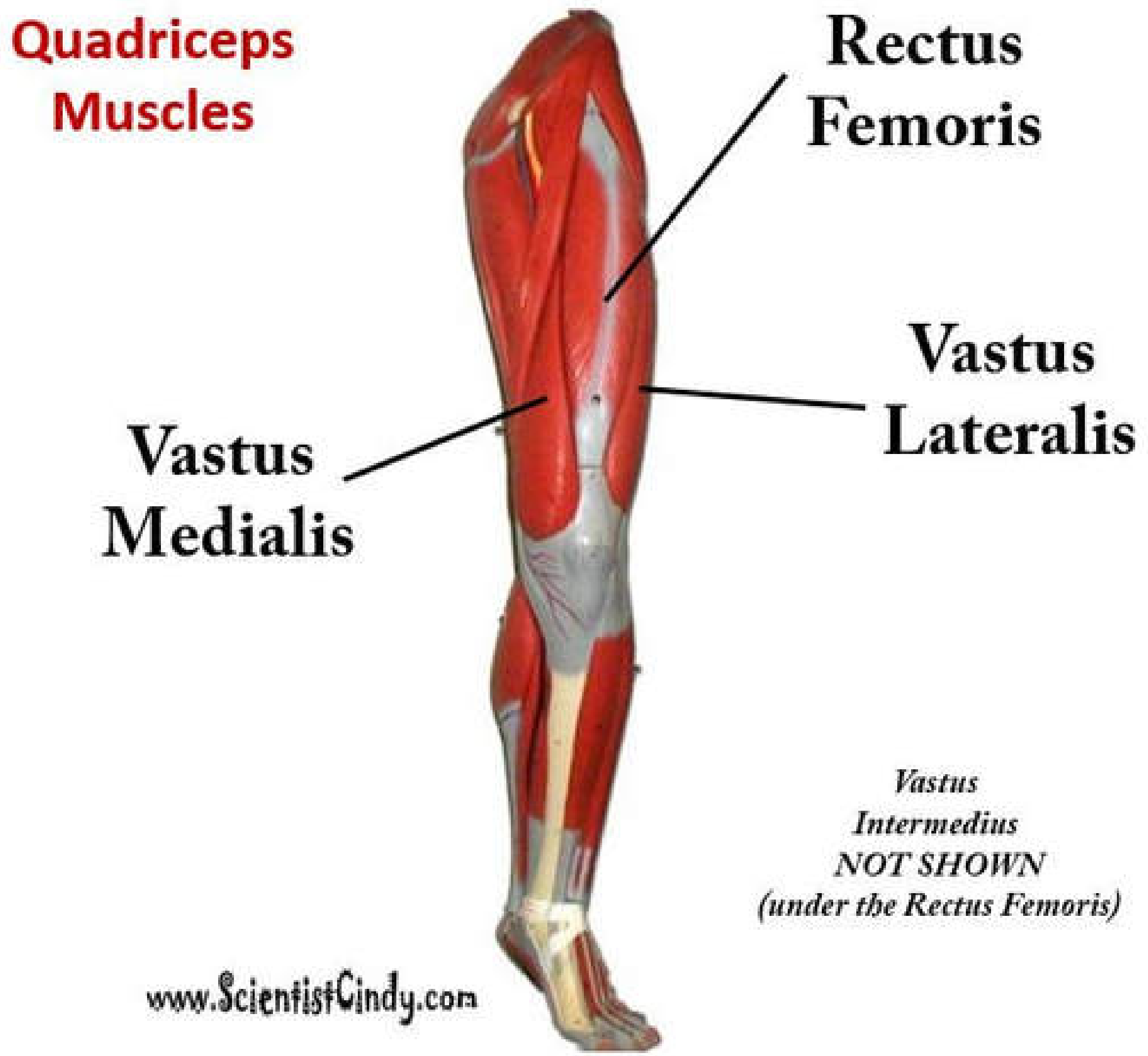
- Biceps femoris
- Semitendinosus
- Semimembranosus



Quadriceps - Flexes thigh

Hamstrings include the...

- Biceps femoris
- Semitendinosus
- Semimembranosus

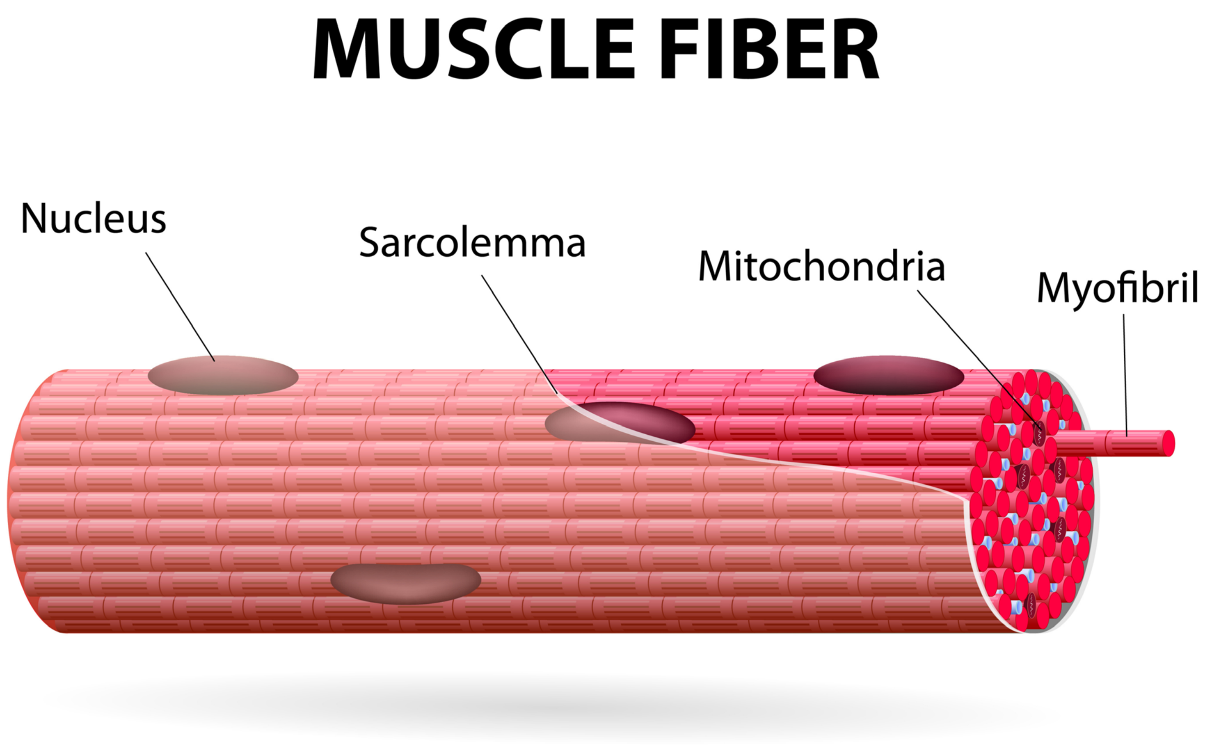


| Action | Prime Mover | Antagonist |
|---|---|---|
| Shoulder/arm flexion | pectoralis major | latissimus dorsi |
| Shoulder/arm extension | latissimus dorsi | pectoralis major |
| Elbow/ forearm flexion | brachialis | triceps brachii |
| Elbow/forearm extension | triceps brachii | biceps brachii |
| shoulder adduction | latissimus dorsi & pectoralis major | deltoid |
| shoulder abduction | deltoid | pectoralis major & latissimus dorsi |
| Hip or thigh flexion | Iliac / iliacus | gluteus maximus |
| hip or thigh extension | gluteus maximus | Iliac / iliacus |
| knee flexion | hamstrings | quadriceps |
| knee extension | quadriceps | hamstrings |

NOW LET'S

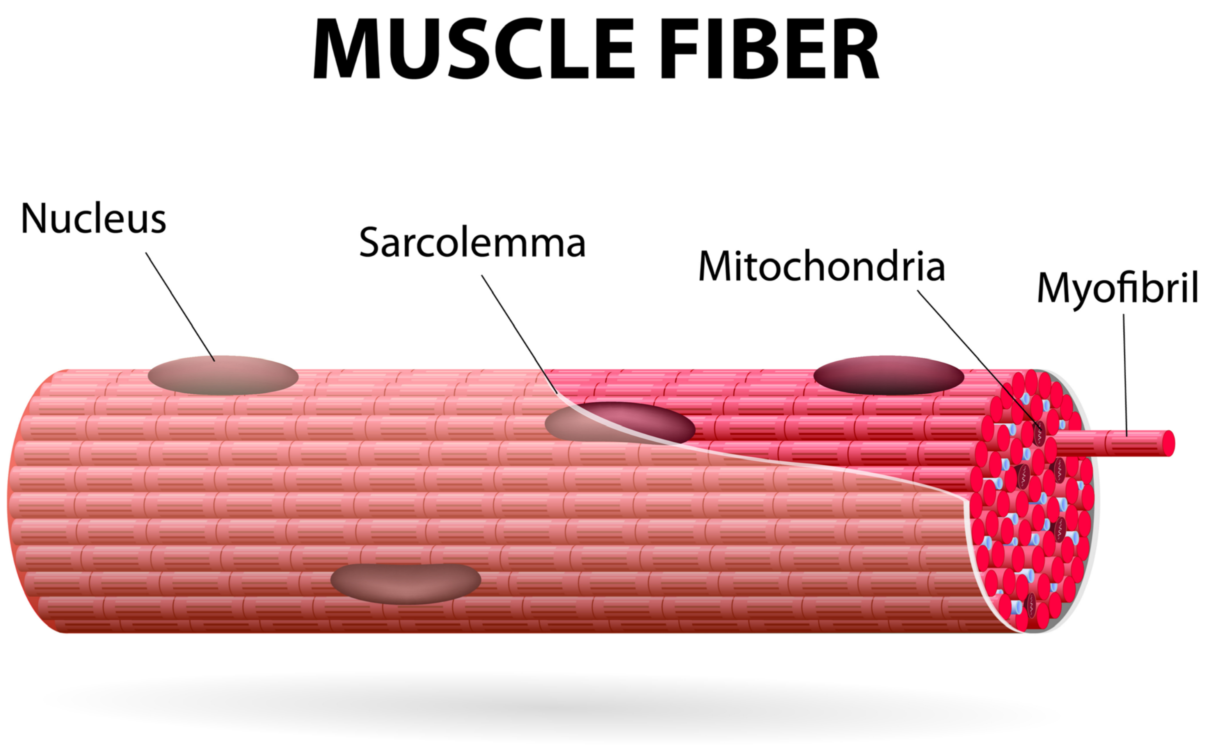
ZOOM

IN!



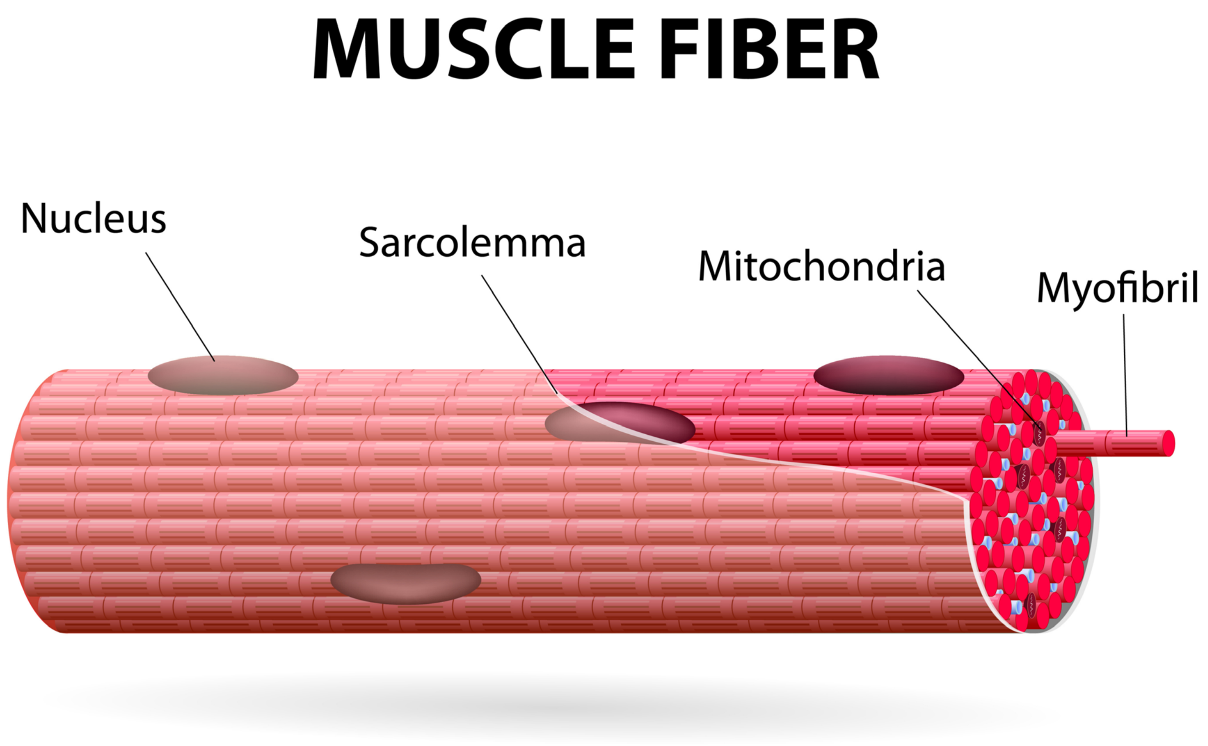

# Properties of Muscle Cells

- Skeletal muscle fibers form through the fusion of many embryonic muscle cells, which helps to explain their rather odd structure.
- Skeletal muscle cells are multinucleated
- They contain numerous mitochondria.




# Properties of Muscle Cells

- Thus, the fluid that fills the lumen of the t-tubule is the extracellular fluid. Within the cytoplasm of the skeletal muscle fiber (myoplasm or sarcoplasm), there are numerous specialized structures, which we need to understand.

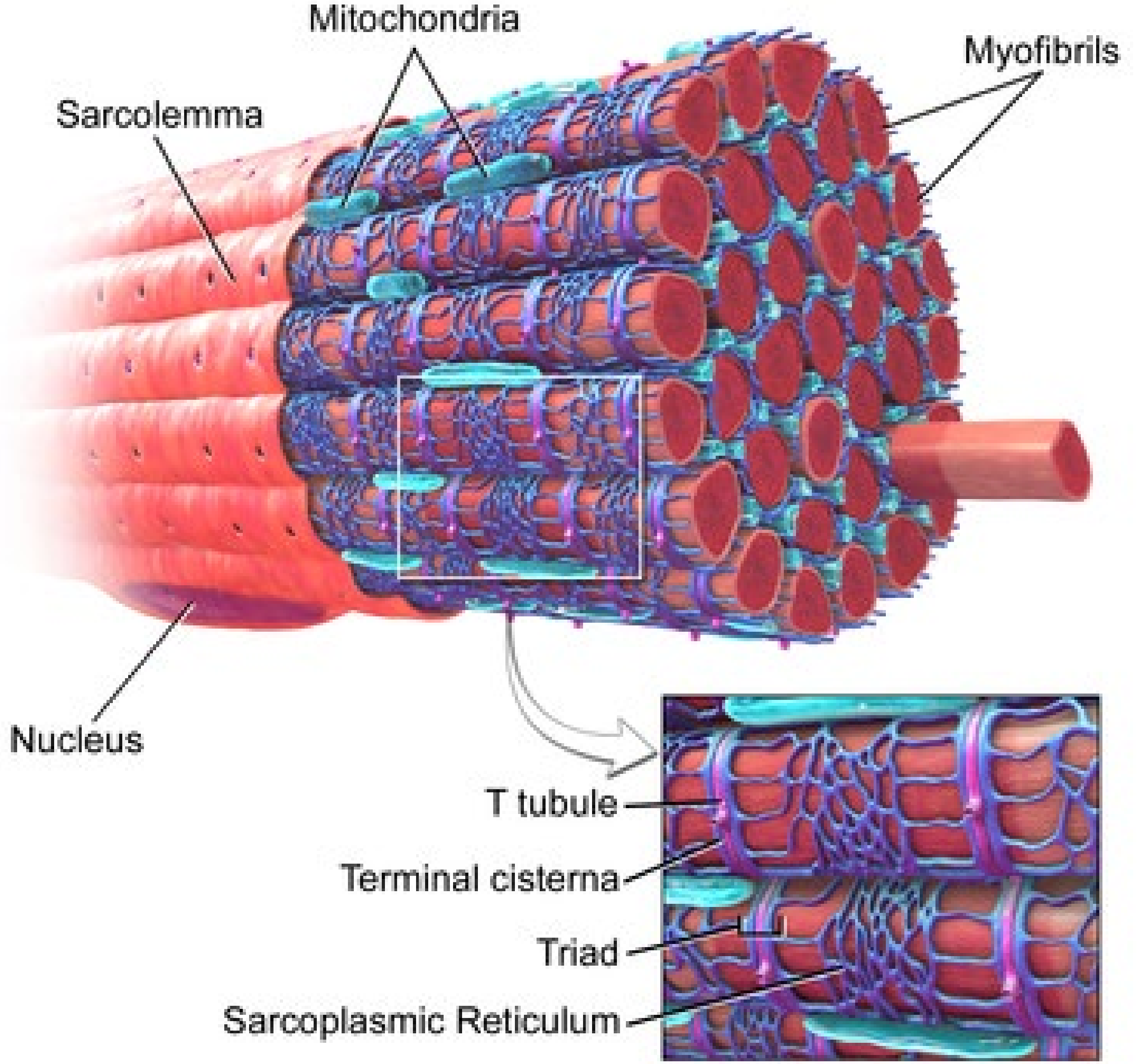



# Properties of Muscle Cells

- A highly specialized endoplasmic reticulum referred to as the sarcoplasmic reticulum is tightly wrapped around individual myofibrils and functions to store a high concentration of Ca2+. Release of Ca2+ from the sarcoplasmic reticulum is responsible for triggering muscular

# Properties of Muscle Cells

- The plasma membrane of skeletal muscle cells has a special name; **the sarcolemma**.
- The sarcolemma is unique, because it continues deep into the muscle cell to form the **"T-tubules" or "transverse tubules"**.

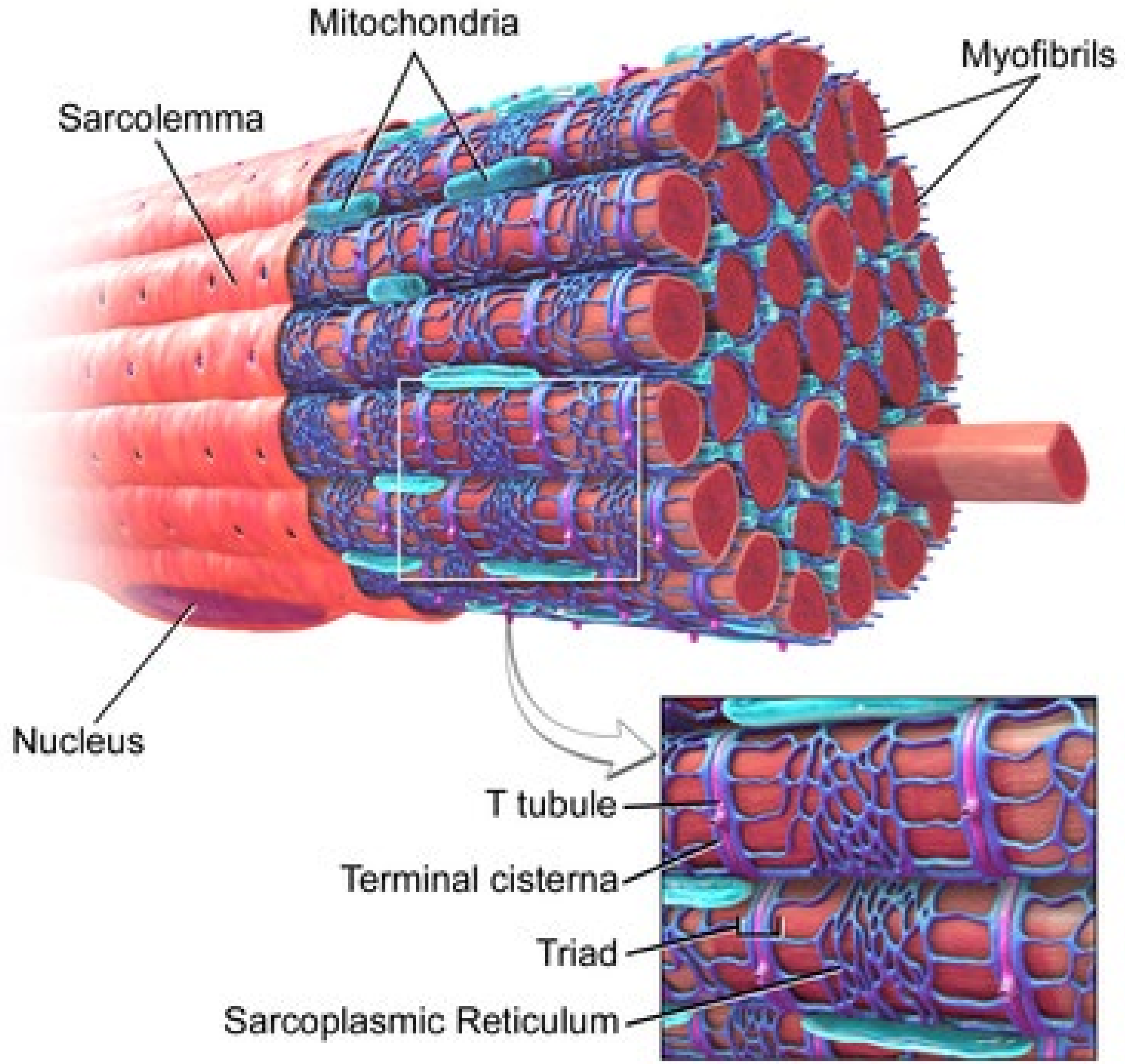



*The t-tubule is continuous with the sarcolemma.*

*IMAGE courtesy of: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436. - Own work*

# Properties of Muscle Cells

- The function of the t-tubules is to allow the muscle action potentials to reach deep into the muscle cell.
- Also the lumen (fluid) of the t-tubule is continuous with the extracellular space.

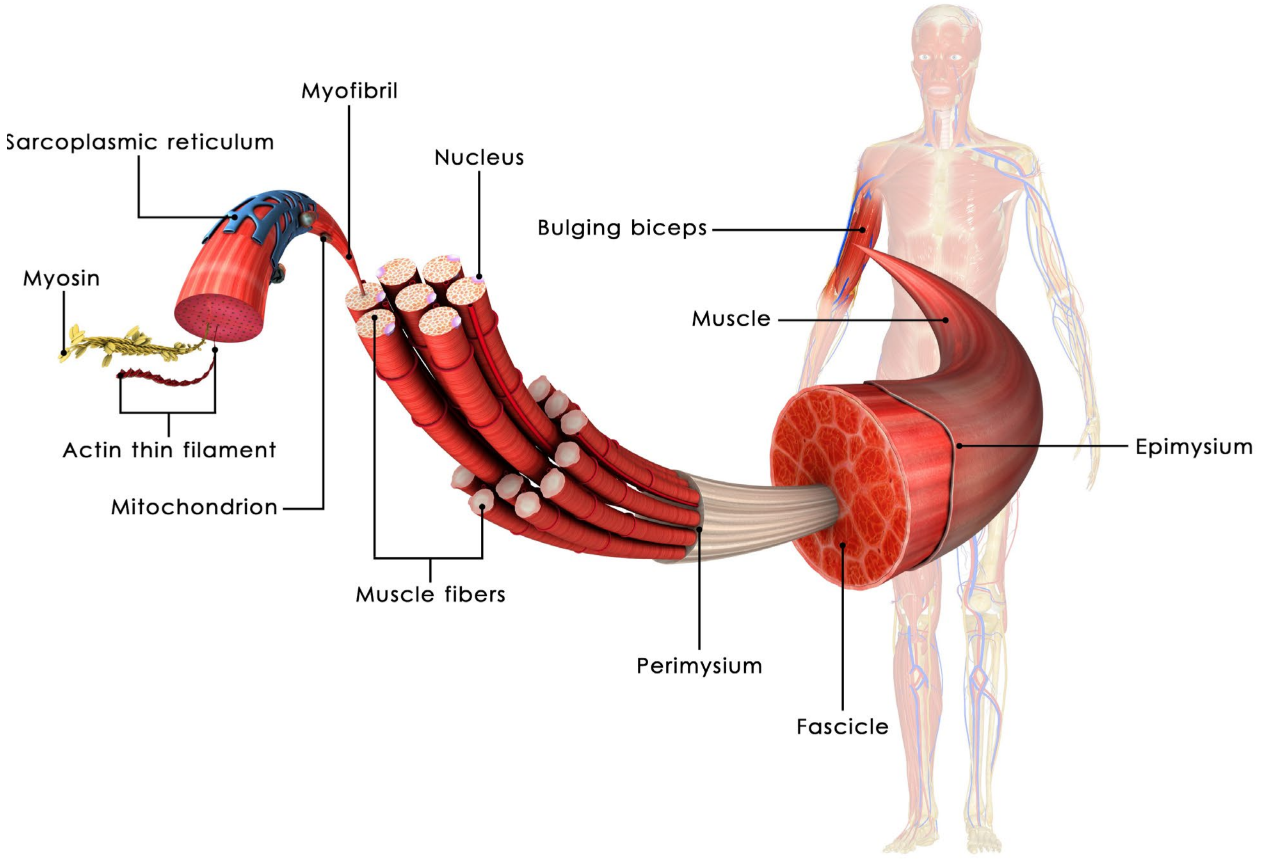



*The t-tubule is continuous with the sarcolemma.*

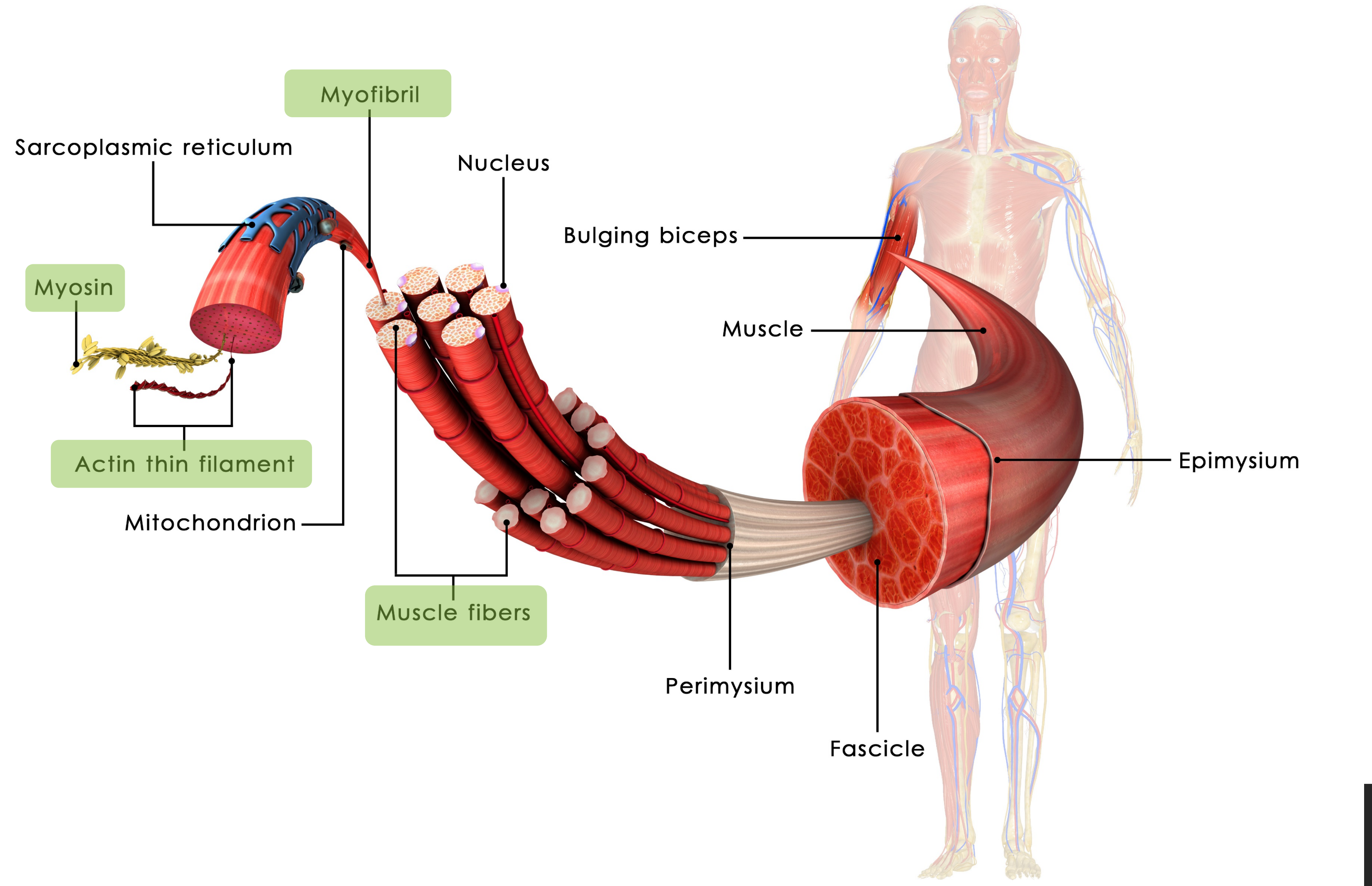
IMAGE courtesy of: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436. - Own work

# The Muscle Cell / Myocyte / Muscle Fiber

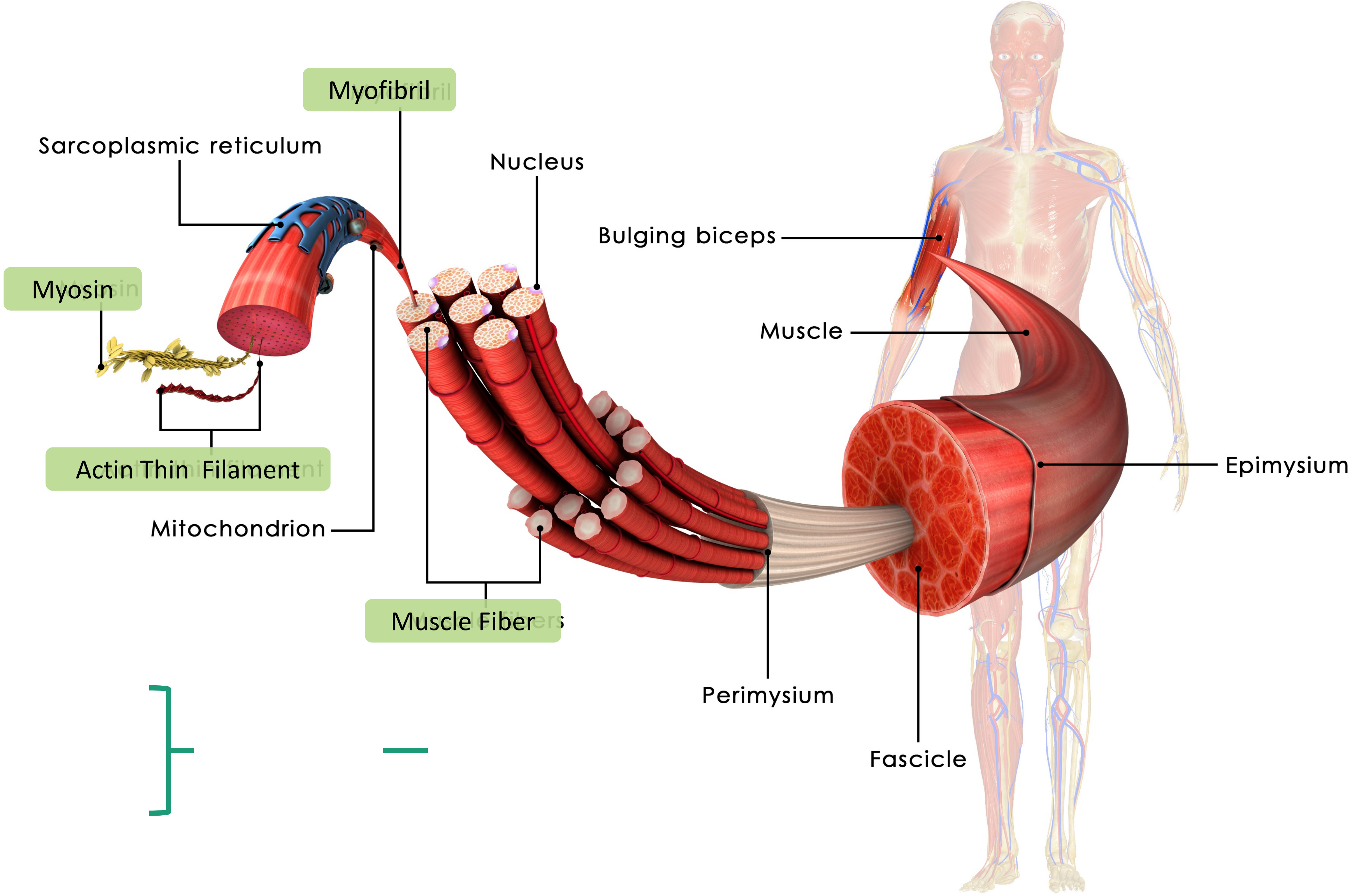
- *A myocyte (also known as a muscle cell or a muscle fiber) is the type of cell found in muscle tissue.*
- *Myocytes are long, tubular cells that develop from myoblasts to form muscles in a process known as myogenesis.*



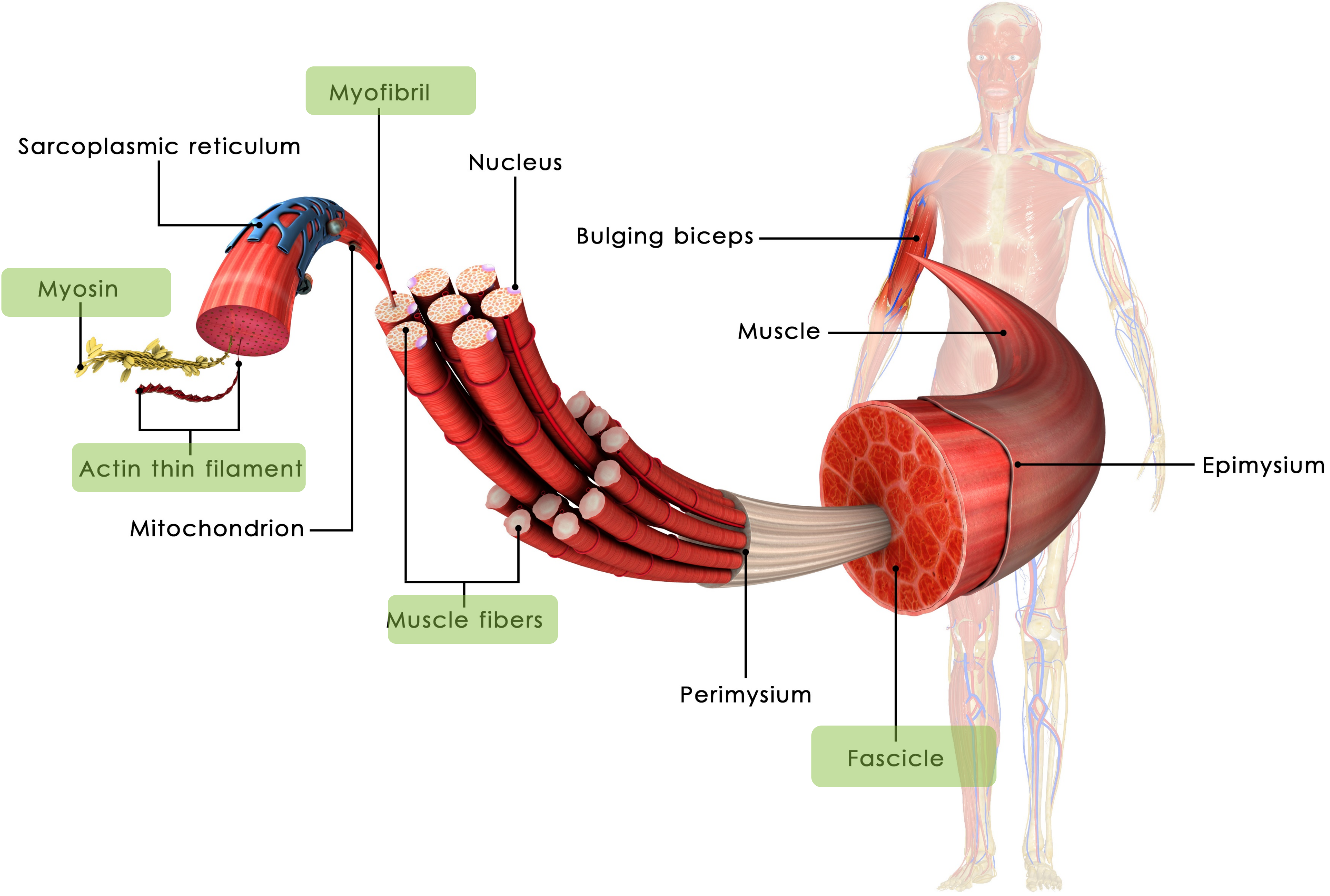
- Fascicles
- Myofibers = muscle fibers = muscle cells
- Myofibrils
- **Myofilaments** (myosin and actin)




# Structure of Muscle Cells (Fibers)

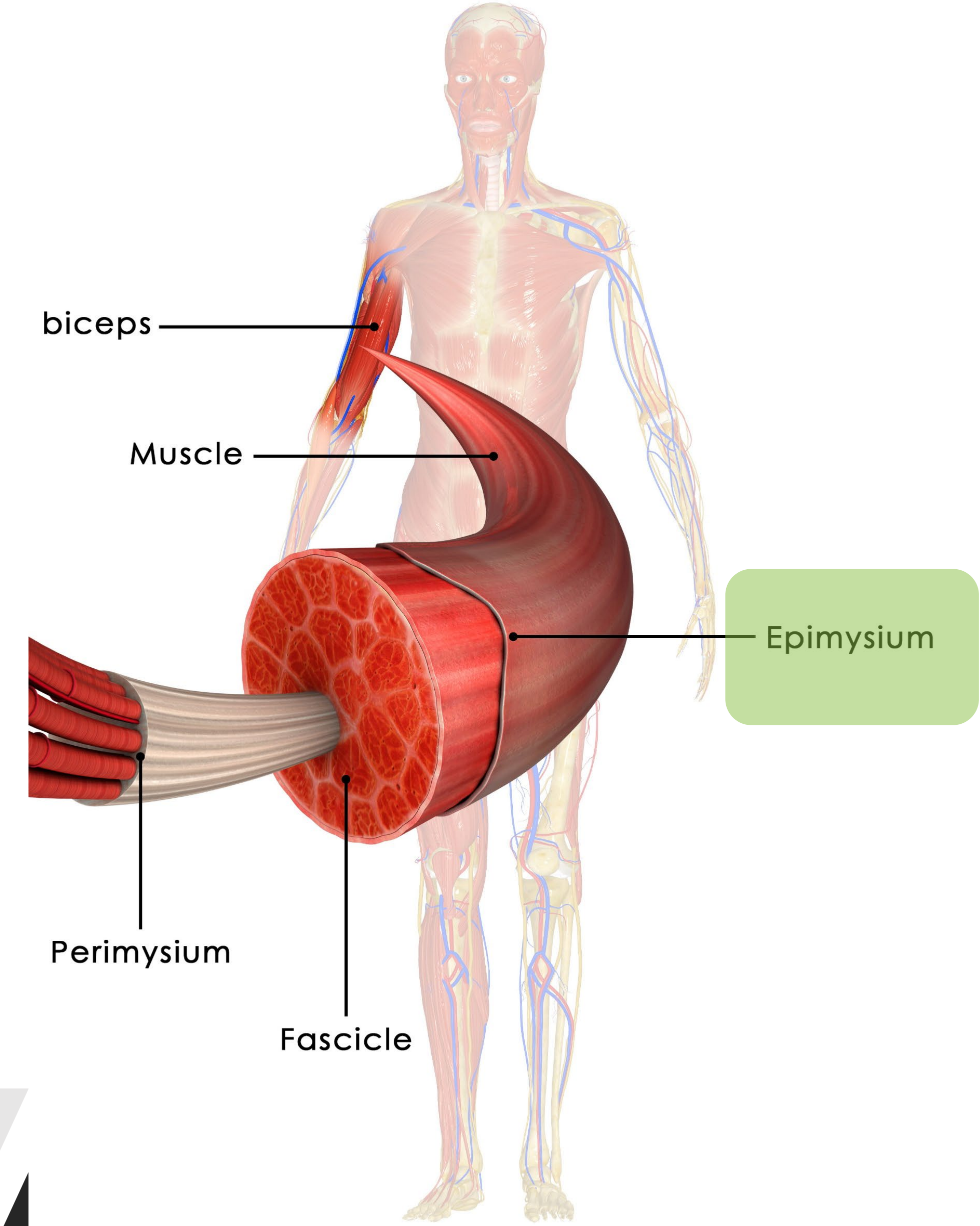

Myofibril
Sarcoplasmic reticulum
Nucleus
Bulging biceps
Myosin
Muscle
Actin Thin Filament
Epimysium
Mitochondrion
Muscle Fiber
Perimysium
Fascicle

- A skeletal muscle (like the biceps shown in the illustration) is a collection of muscle bundles or **fascicles.**
- Each fascicle is made up of a number of muscle cells (or myofibers or muscle fibers).
- Each muscle cell is composed of hundreds to thousands of myofibrils.
- Each myofibril is composed of many myosin filaments and actin thin filaments.



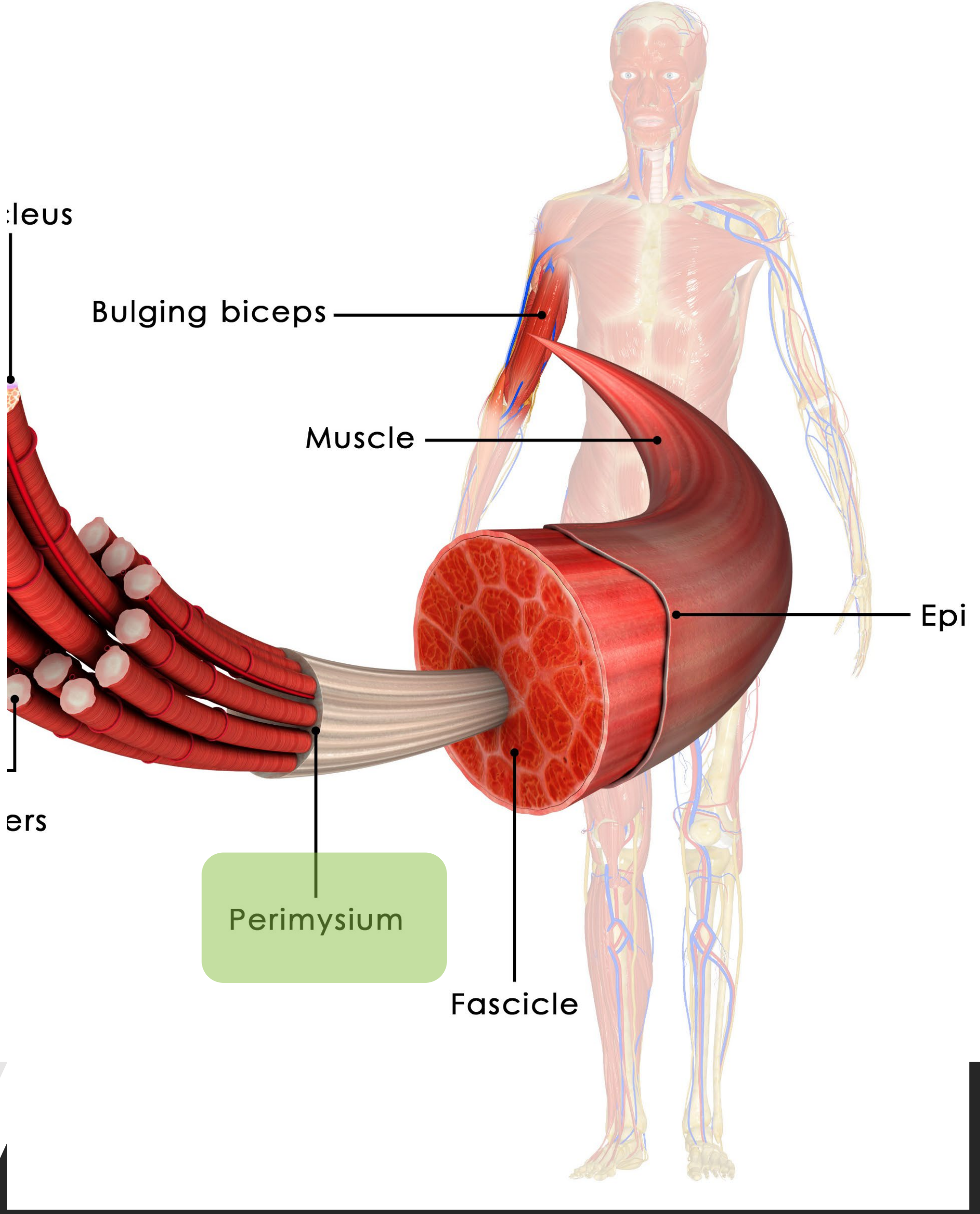

# Structure of Muscle Cells (Fibers)

- ● Epimysium. The epimysium is an “overcoating” that surrounds the whole muscle.



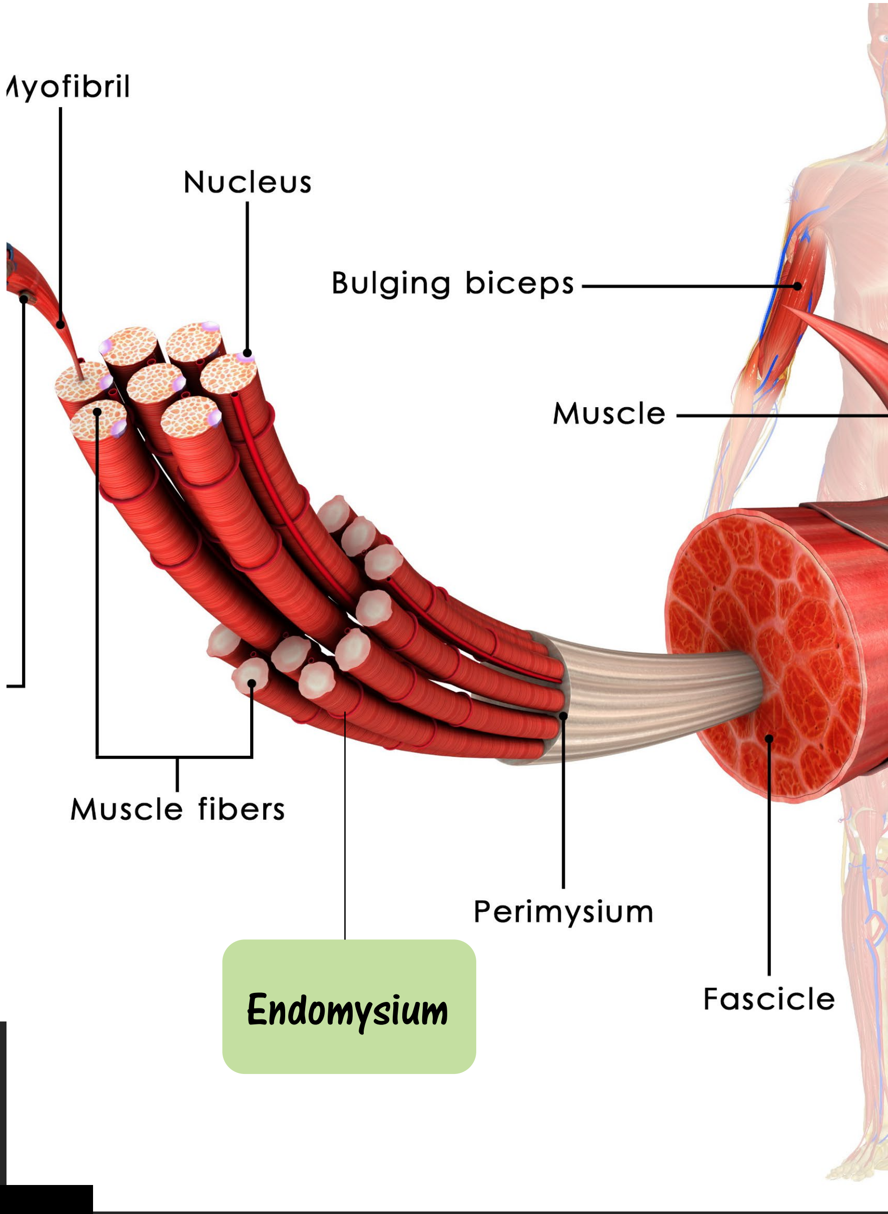

# Structure of Muscle Cells (Fibers)

- Within each skeletal muscle, the muscle fibers are grouped into fascicles that resemble bundles of sticks.
- Surrounding each fascicle is a layer of connective tissue called perimysium.



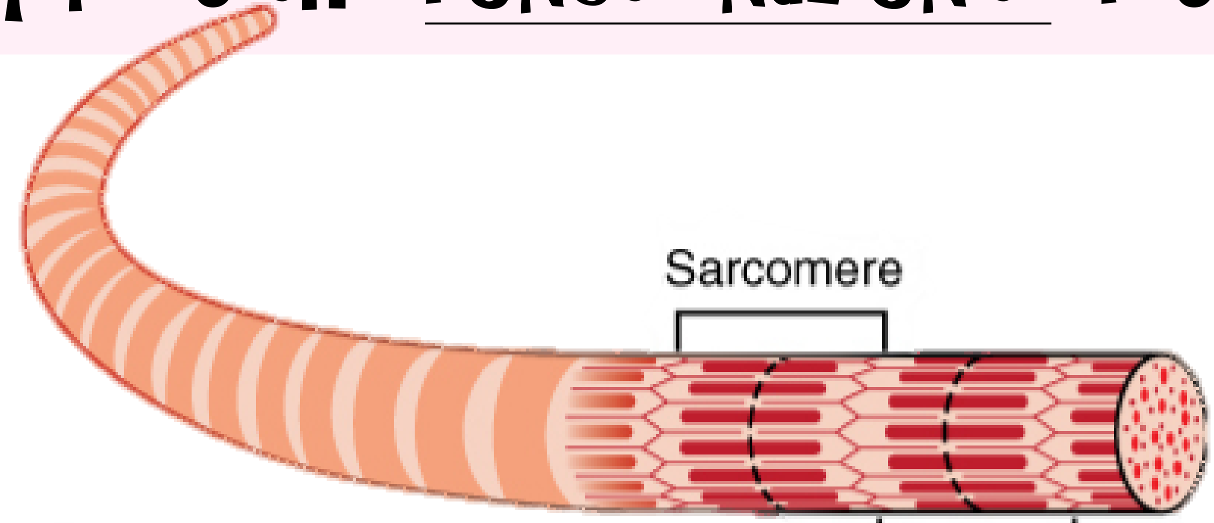

# Structure of Muscle Cells (Fibers)

- Endomysium. The endomysium is a wispy sheath of connective tissue that surrounds each individual muscle fiber.
- It consists of fine areolar connective tissue.




# Structure of Muscle Cells (Fibers)

# The Sarcomere is the Functional Unit of Skeletal Muscle




Muscle fibers are made up of myofibrils.

Those myofibrils are composed of contractile units called SARCOMERES.

Myofibrils are composed of sarcomeres

# PROTEINS OF MUSCLE SARCOMERE

A. Contractile proteins

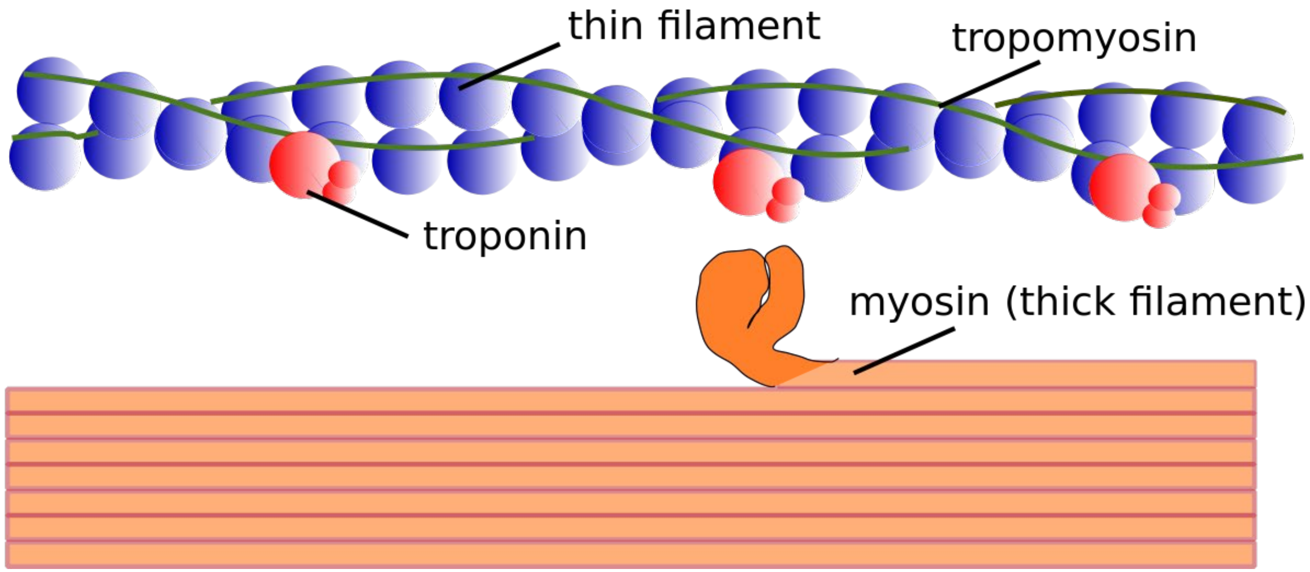
1. Myosin (gives rise to the thick filaments)
2. Actin (gives rise to the thin filaments)

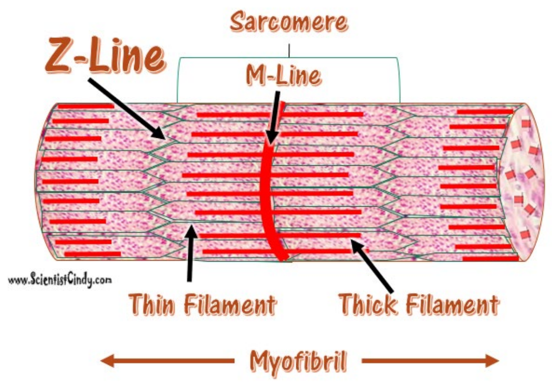
B. Regulatory proteins

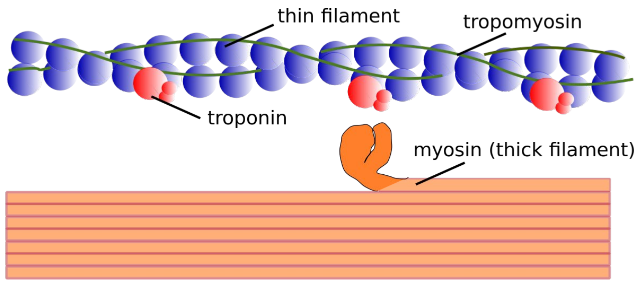
1. Tropomyosin (in the absence of $Ca^{2+}$, it covers the myosin-binding site of actin)
2. Troponin ($Ca^{2+}$ sensor)

# A. Contractile proteins

- Myosin is the protein that makes up the thick filaments of the sarcomere.
- Myosin has a head region and a tail region of the thick filaments






# A. Contractile proteins

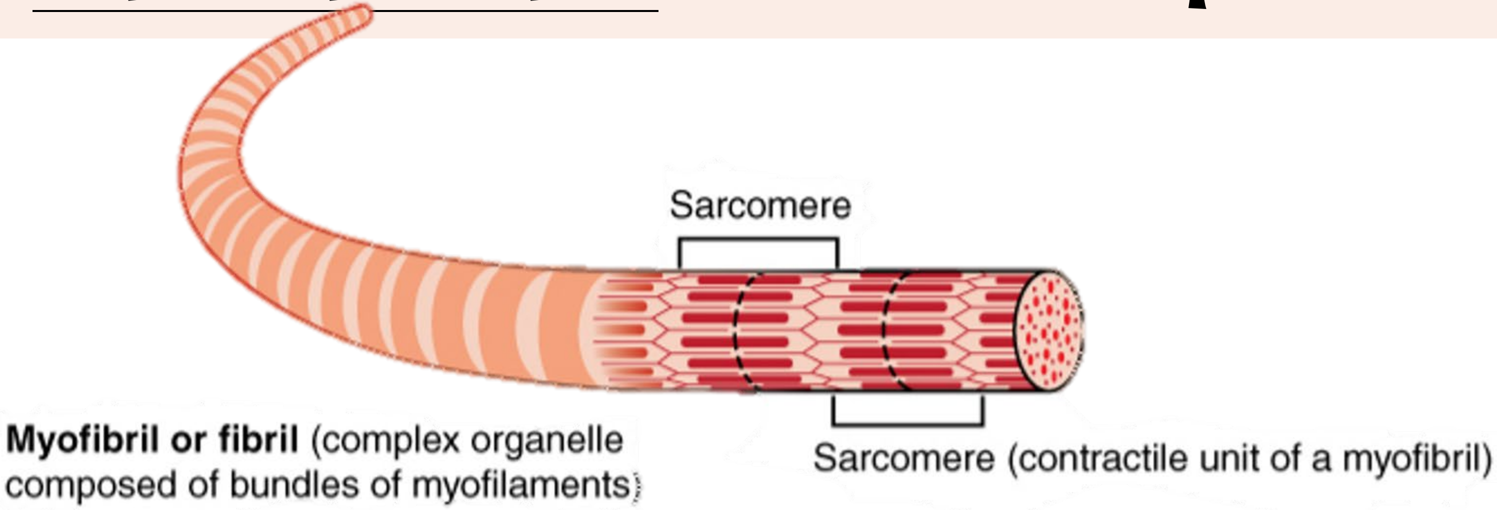
- The myosin head has an actin-binding site that is used to interact with the actin thin filament.
- The myosin head also has an ATP-binding site.

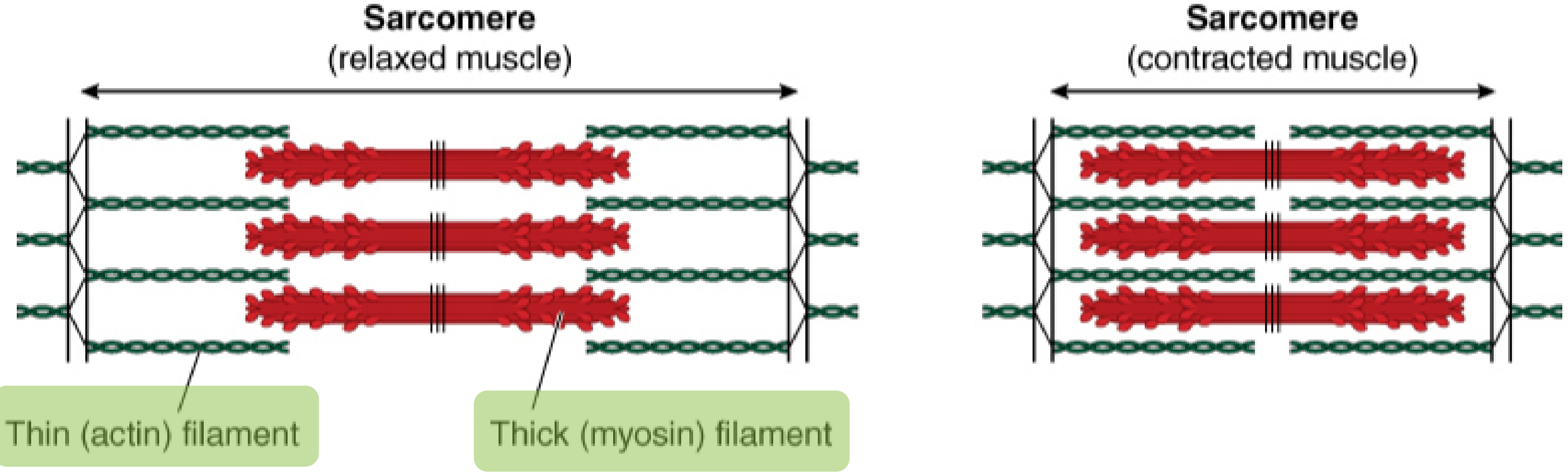
# The Sarcomere is the Functional Unit of Skeletal Muscle

- The sarcomere is the functional unit of skeletal and cardiac muscle.
- The sarcomere contains the myofilaments.

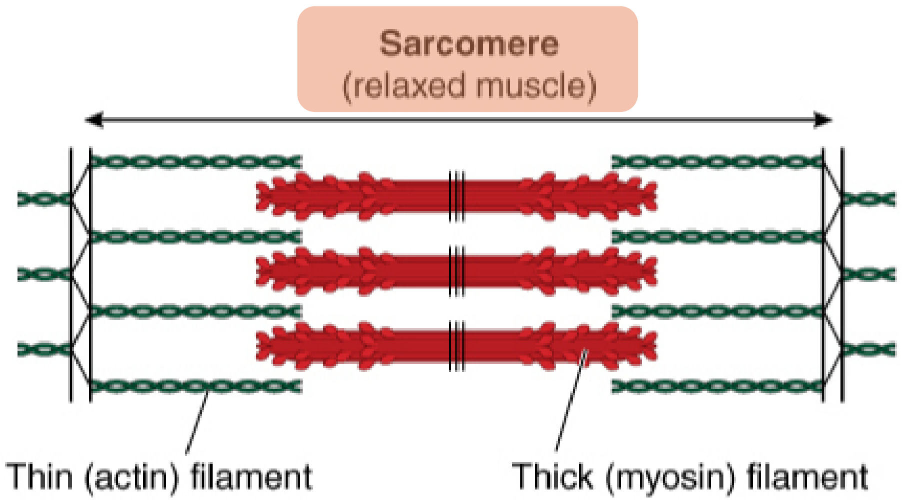
## The Myofilaments Are

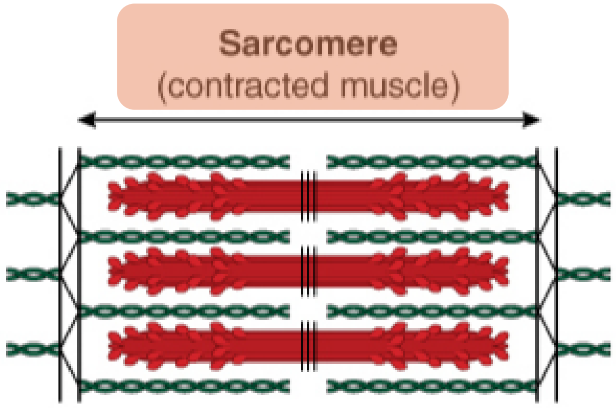
1. the ACTIN (THIN) FILAMENTS
2. the MYOSIN (THICK) FILAMENTS



# The Sarcomere is the Functional Unit of Skeletal Muscle




## During muscle relaxation...

the actin and myosin filaments DO NOT overlap. The sarcomere is lengthened, becoming longer.

## During muscle contraction...

the actin and myosin filaments DO overlap. The sarcomere is contracted, becoming shorter.

## The Myofilaments Are

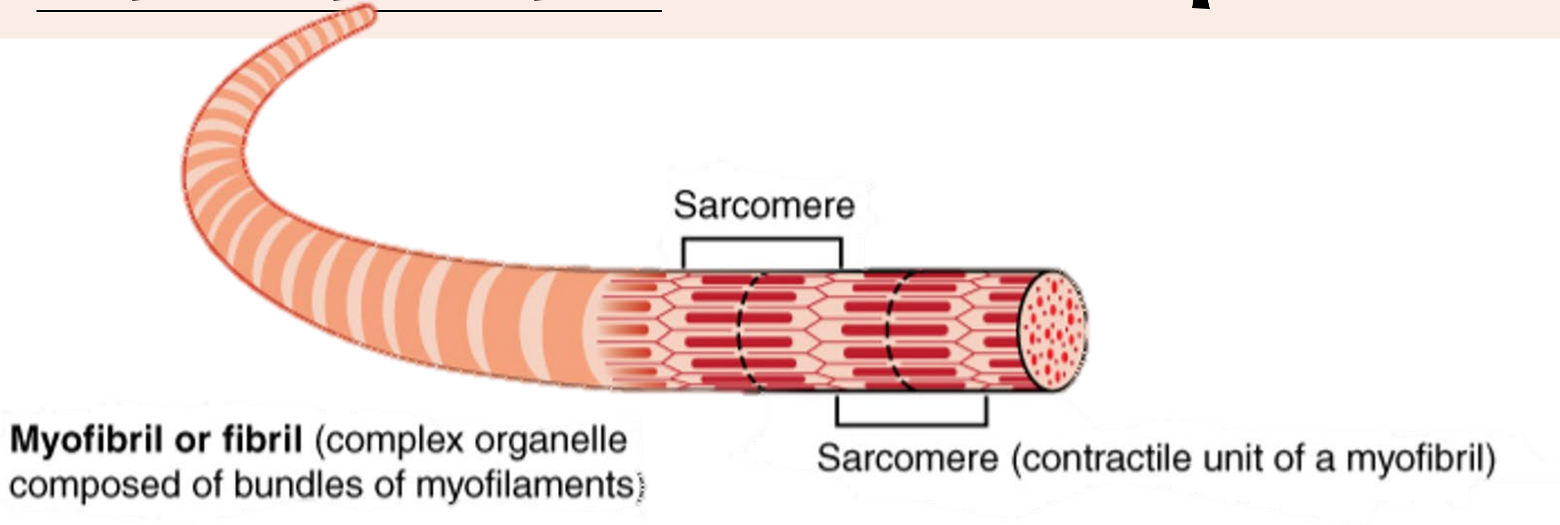
1. the ACTIN (THIN) FILAMENTS
2. the MYOSIN (THICK) FILAMENTS

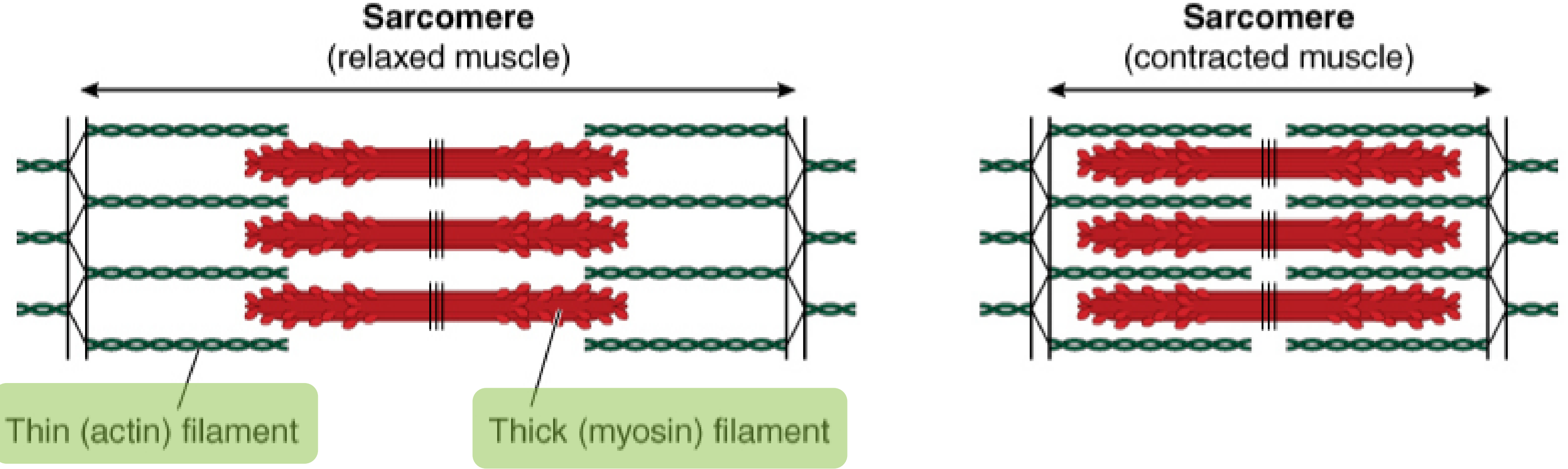
The SAROMERES perform the contractile behavior of the muscle fibers.

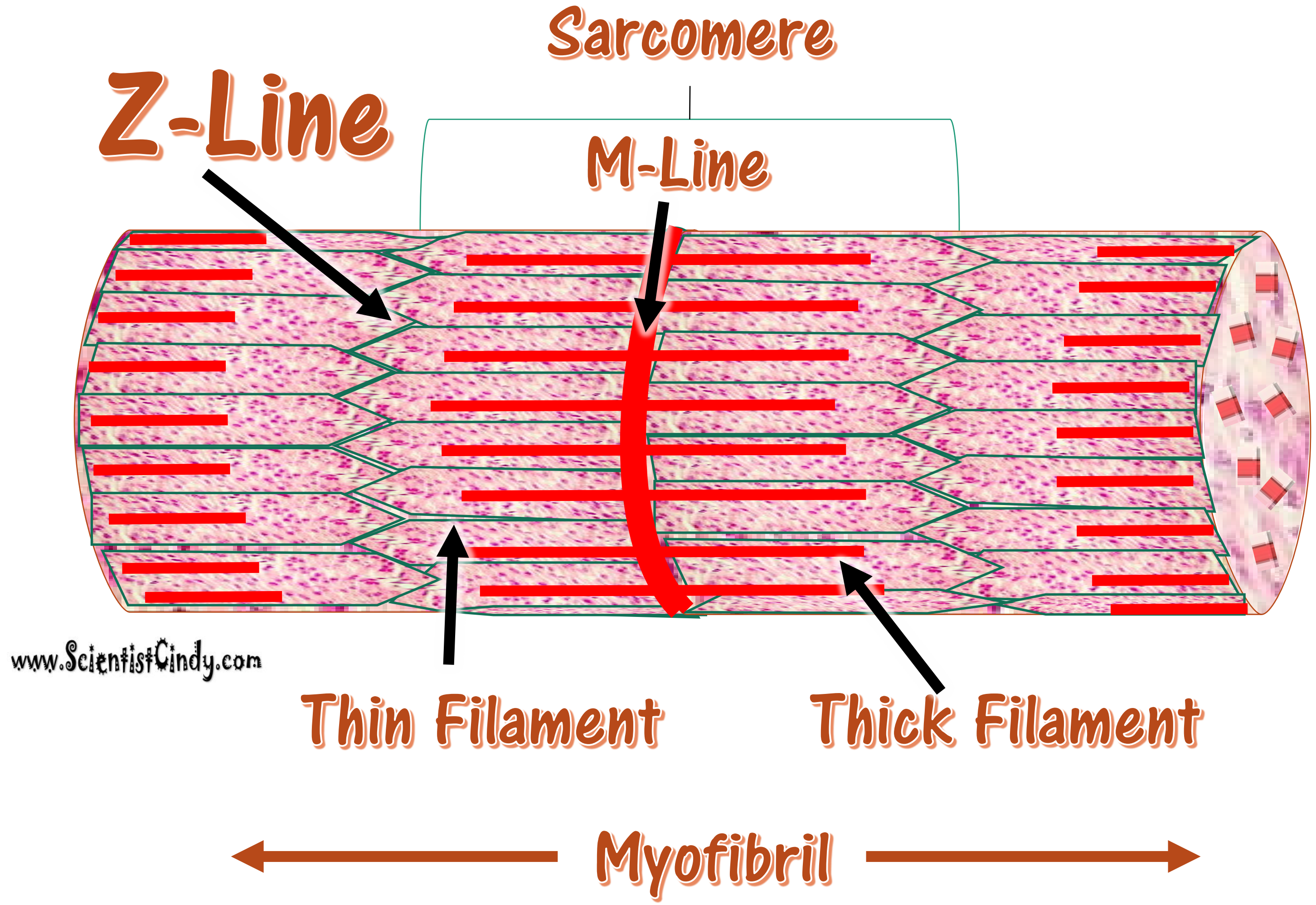
# The Sarcomere is the Functional Unit of Skeletal Muscle

The sarcomere contains contractile proteins

1. • Myosin (gives rise to the thick filaments)
2. • Actin (gives rise to the thin filaments)





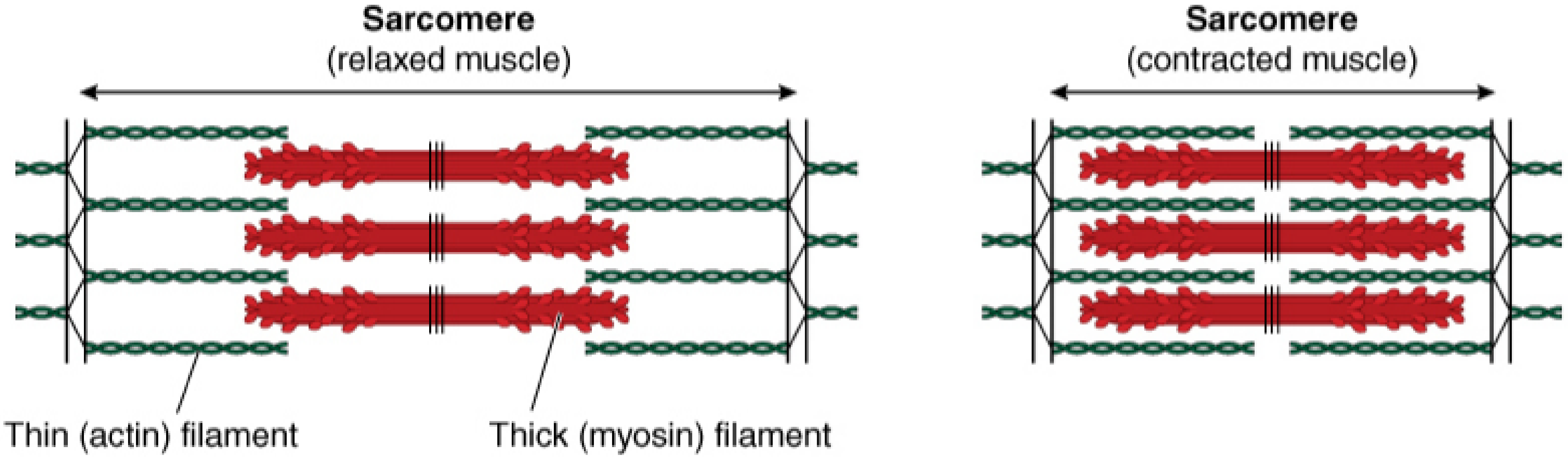

The Actin thin filaments are attached to the Z lines.

- Myosin thick filaments overlap with the thin filaments in the middle of a sarcomere.
- Myosin pulls the thin filaments towards the M-Line on each side, shortening the sarcomere and causing contraction.

# Cross-Bridge Cycle/ Muscle Contraction

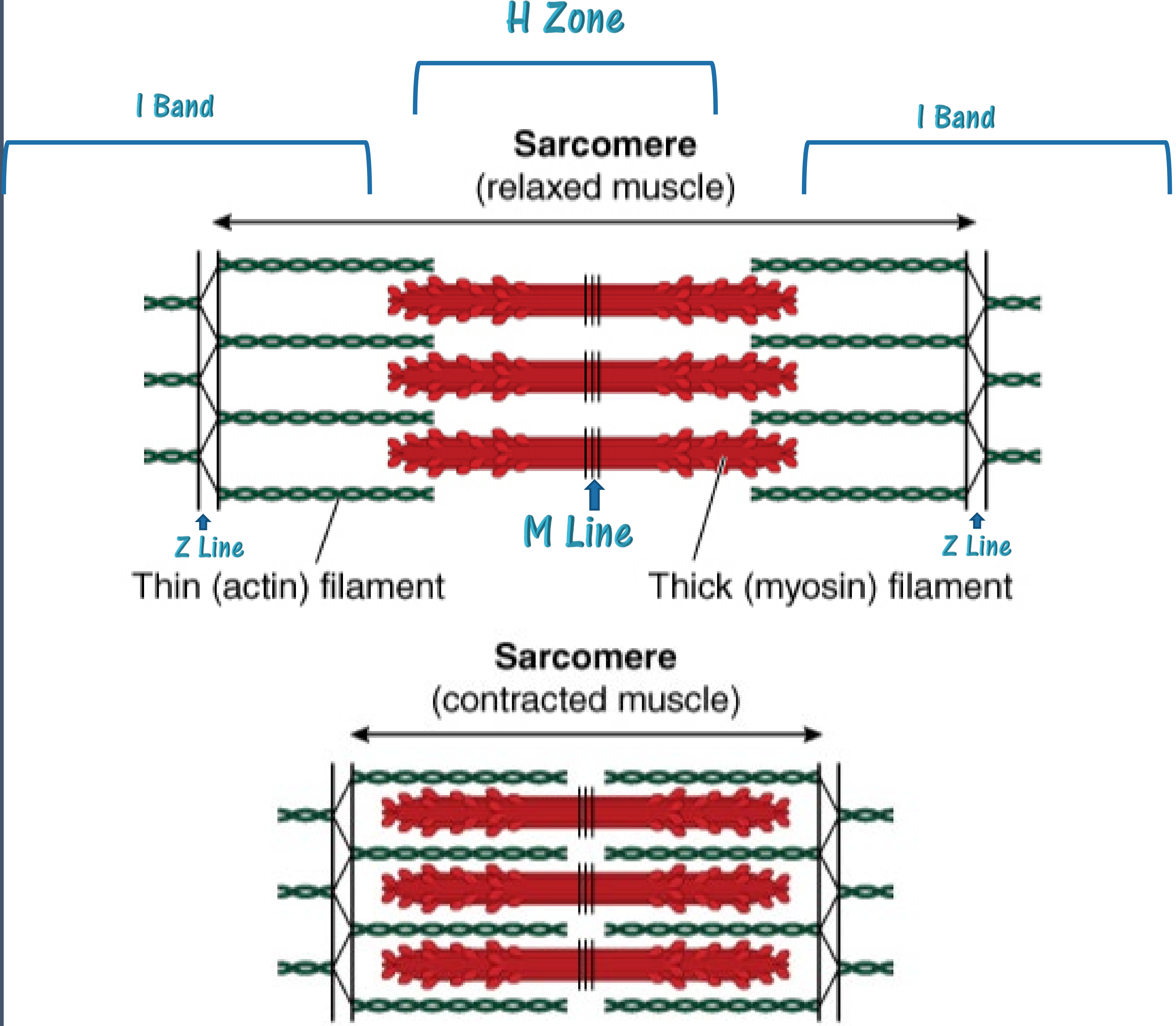
# Sliding Filament Model of Contraction

- Muscle contraction is an energy-requiring event (requires ATP) that involves the movement of the thin filaments over the thick filaments.



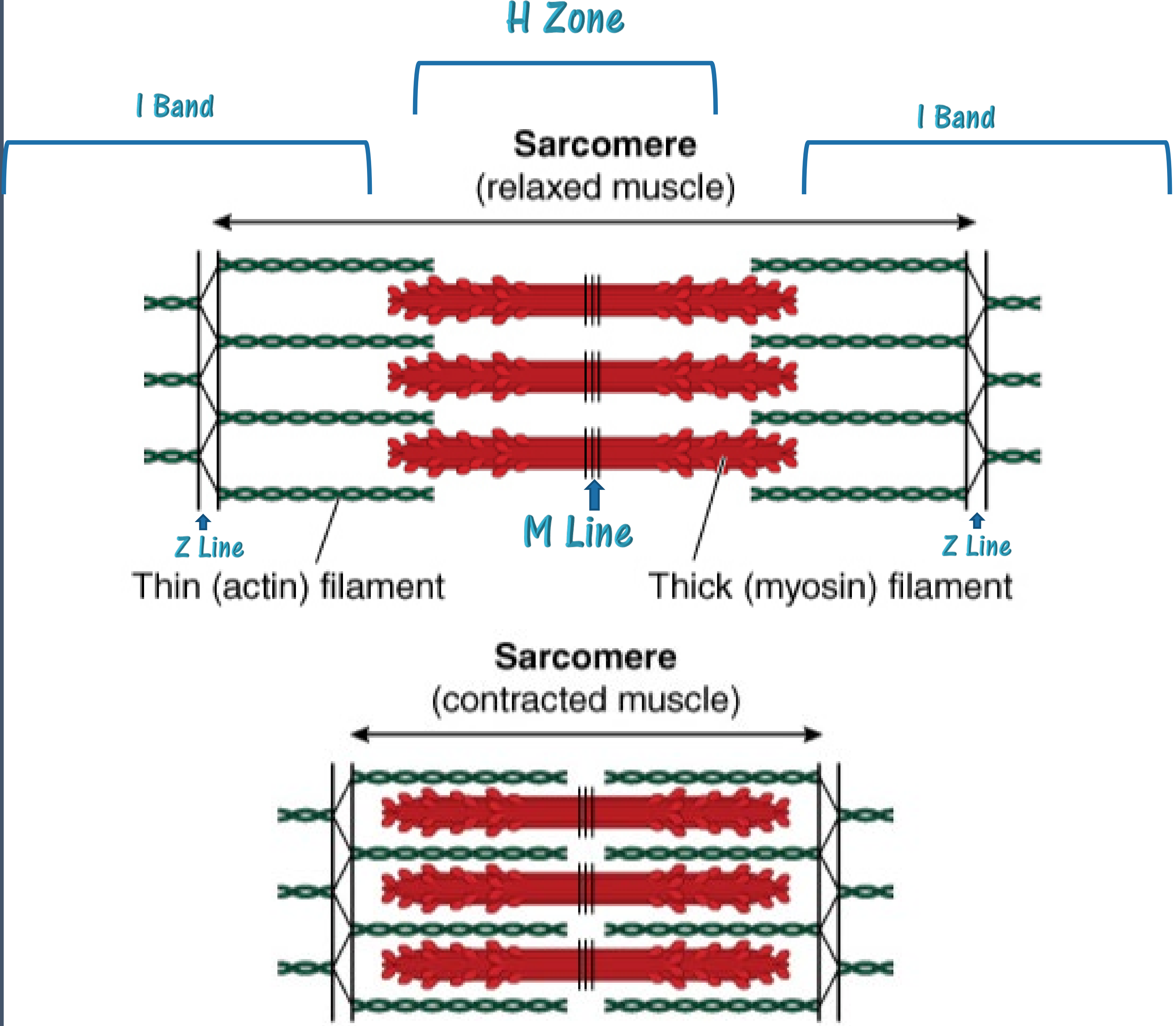
In a relaxed muscle fiber, the thin and thick filaments overlap only at the ends of the A band.

The Sliding Filament Model of contraction states that during contraction, the thin filaments slide past the thick ones so that the actin and myosin filaments overlap to a greater degree.



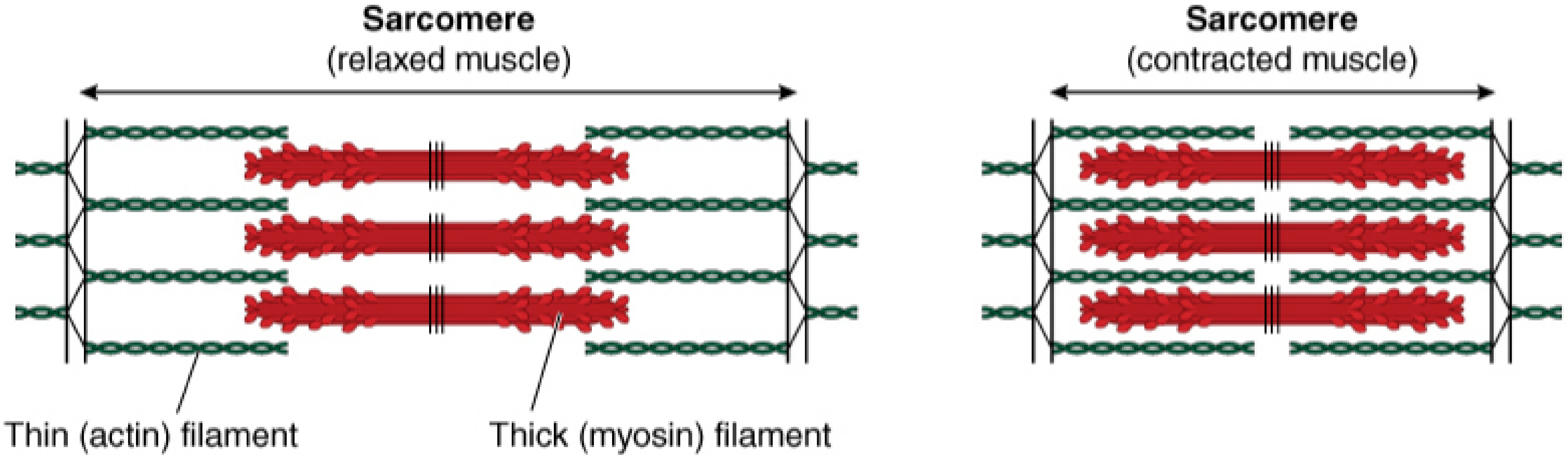
# The Following Occurs in the Sarcomere When the Muscle Shortens:

- The I bands shorten.
- The distance between successive Z discs shortens.
- The H zones disappear.
- The contiguous A bands move closer together, but their length does not change.



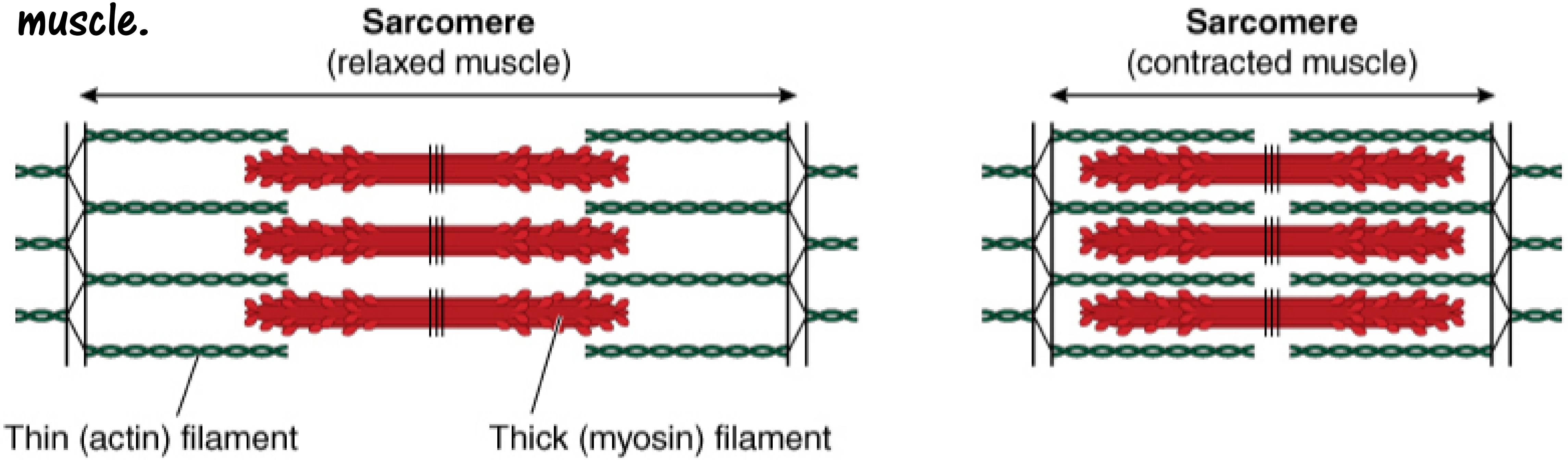
# IV. Sliding Filament Model of Contraction

- This shortening brings the Z disks of a sarcomere closer together. During muscle contraction, the size of the A band remains the same, but the I band and the H zone become shorter as the thin filaments slide past the thick filaments.

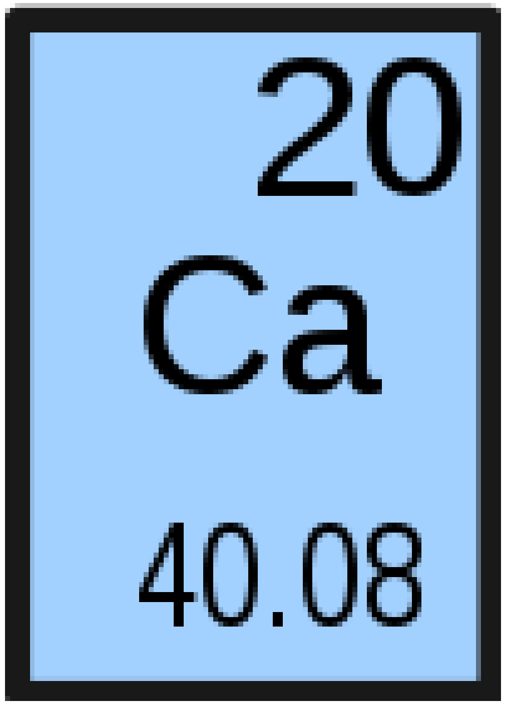


# IV. Sliding Filament Model of Contraction

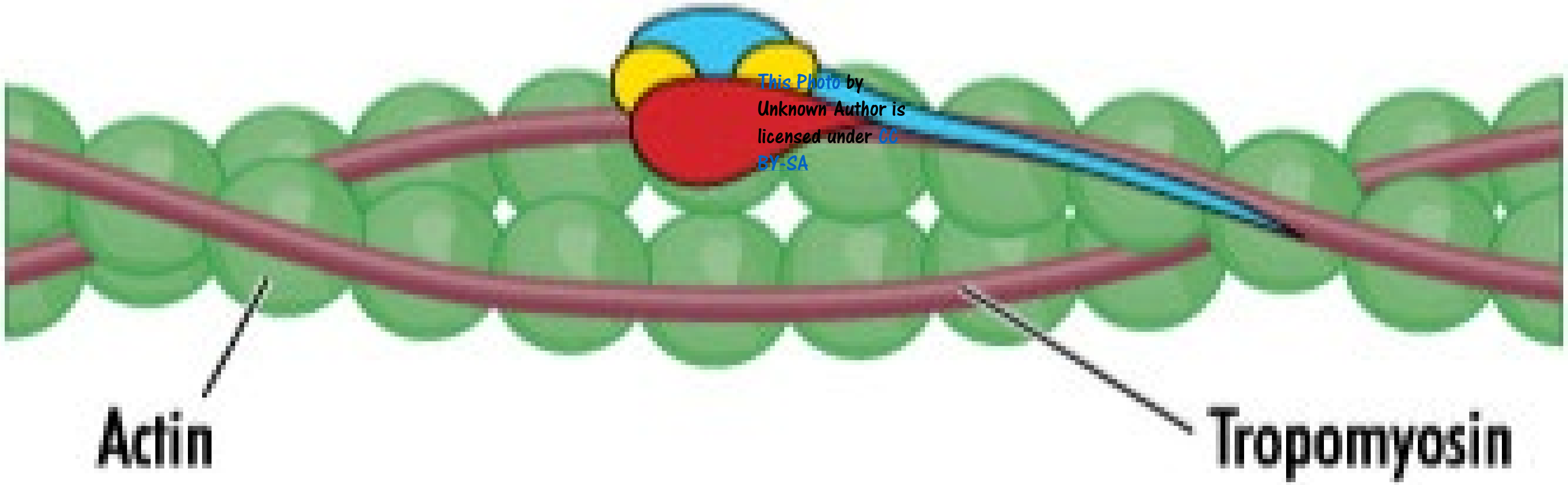
- A very important point to consider is that the tension generated in a muscle is directly proportional to the overlap between the thick and thin filaments.
- This extent of the overlap, of course, is a function of the number of myosin head groups that interact with actin molecules.
- Thus, the greater the overlap, the larger the tension that is developed by the muscle.



# Tropomyosin



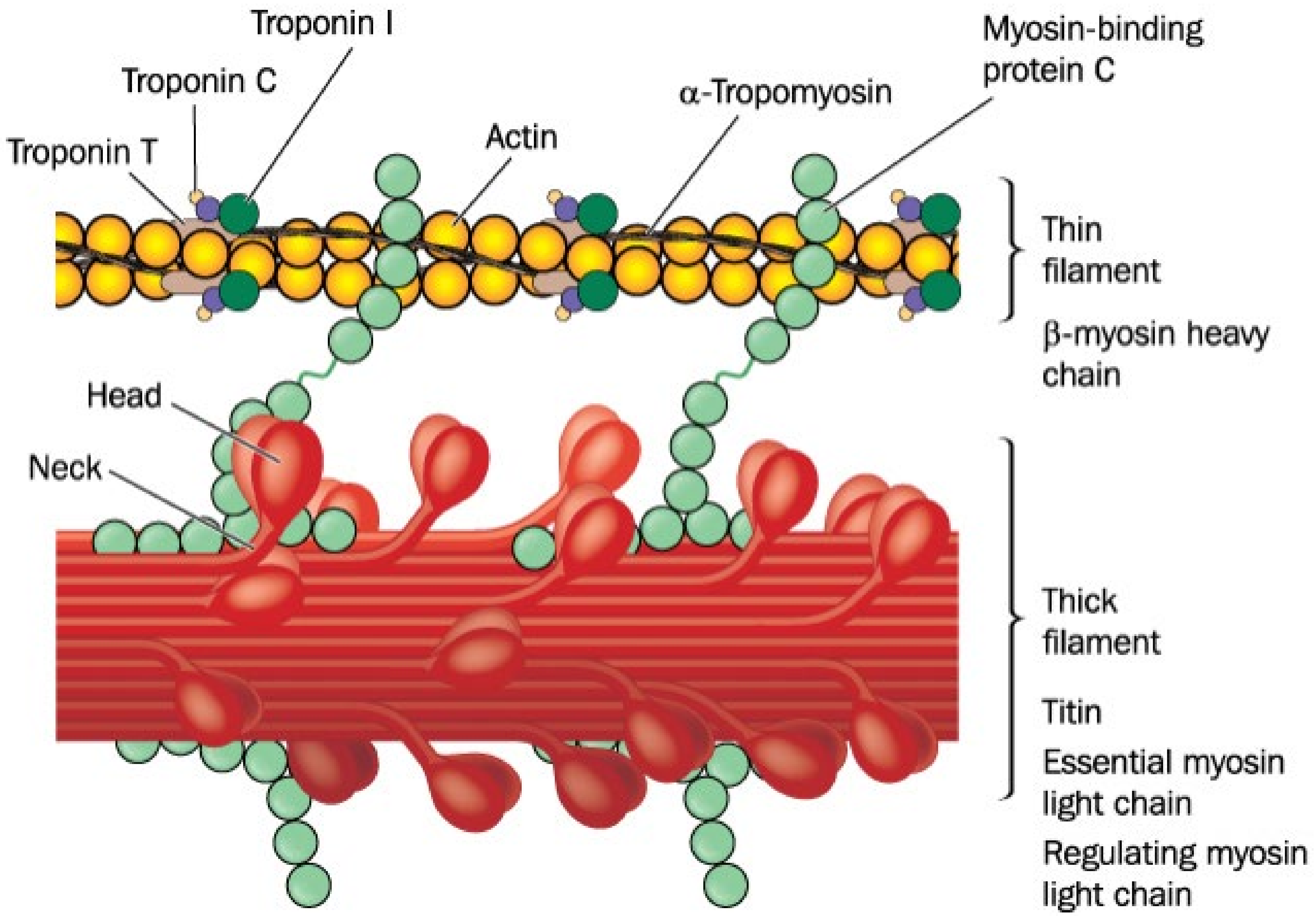

- As long as calcium is available, the cross-bridge can form, and the muscle contracts.



# The Sarcomere is the Functional Unit of Skeletal Muscle

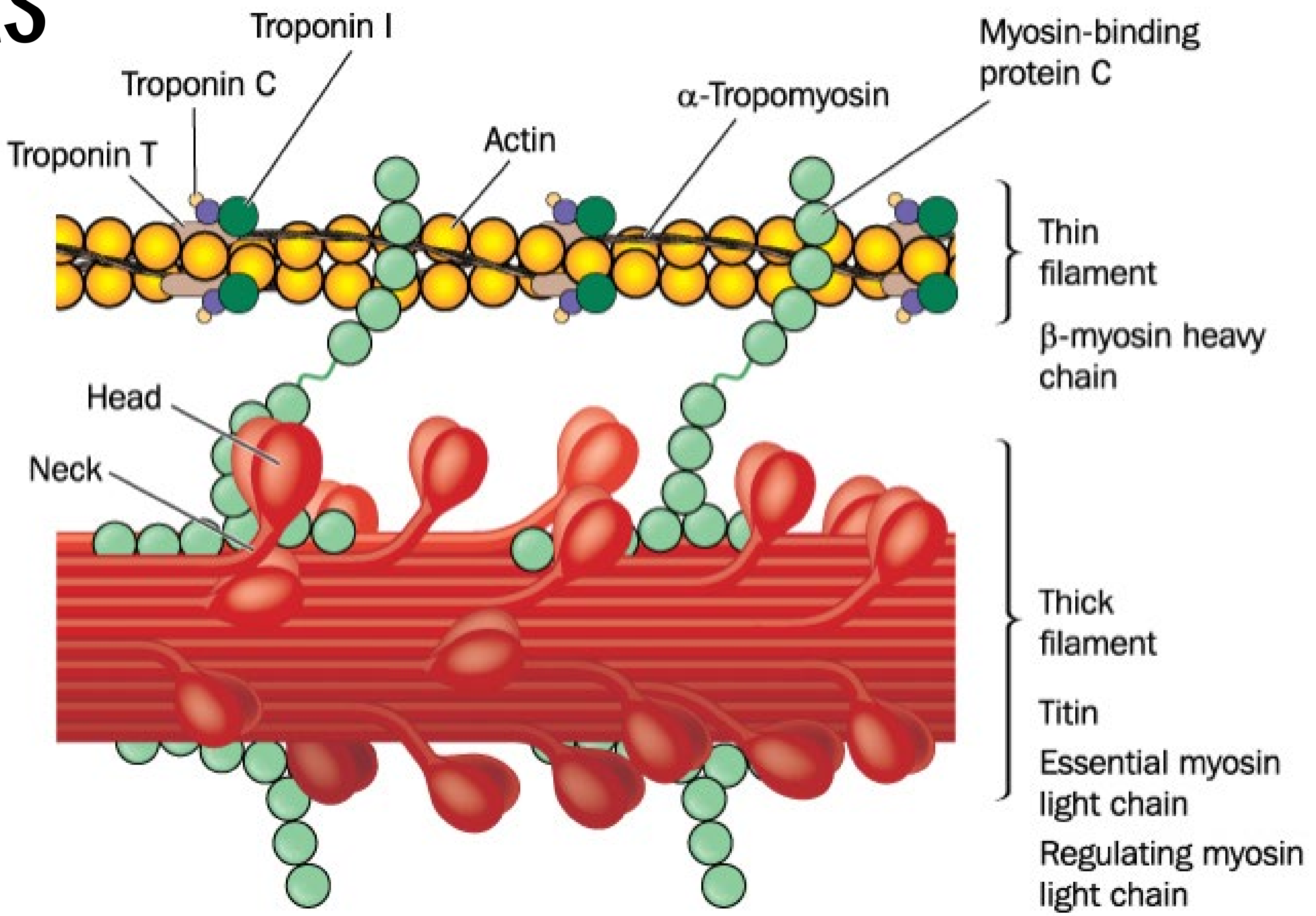
The sarcomere also contains

1. Regulatory proteins
   a. Tropomyosin (in the absence of Ca2+, it covers the myosin-binding site of actin)
   b. Troponin (Ca2+ sensor)



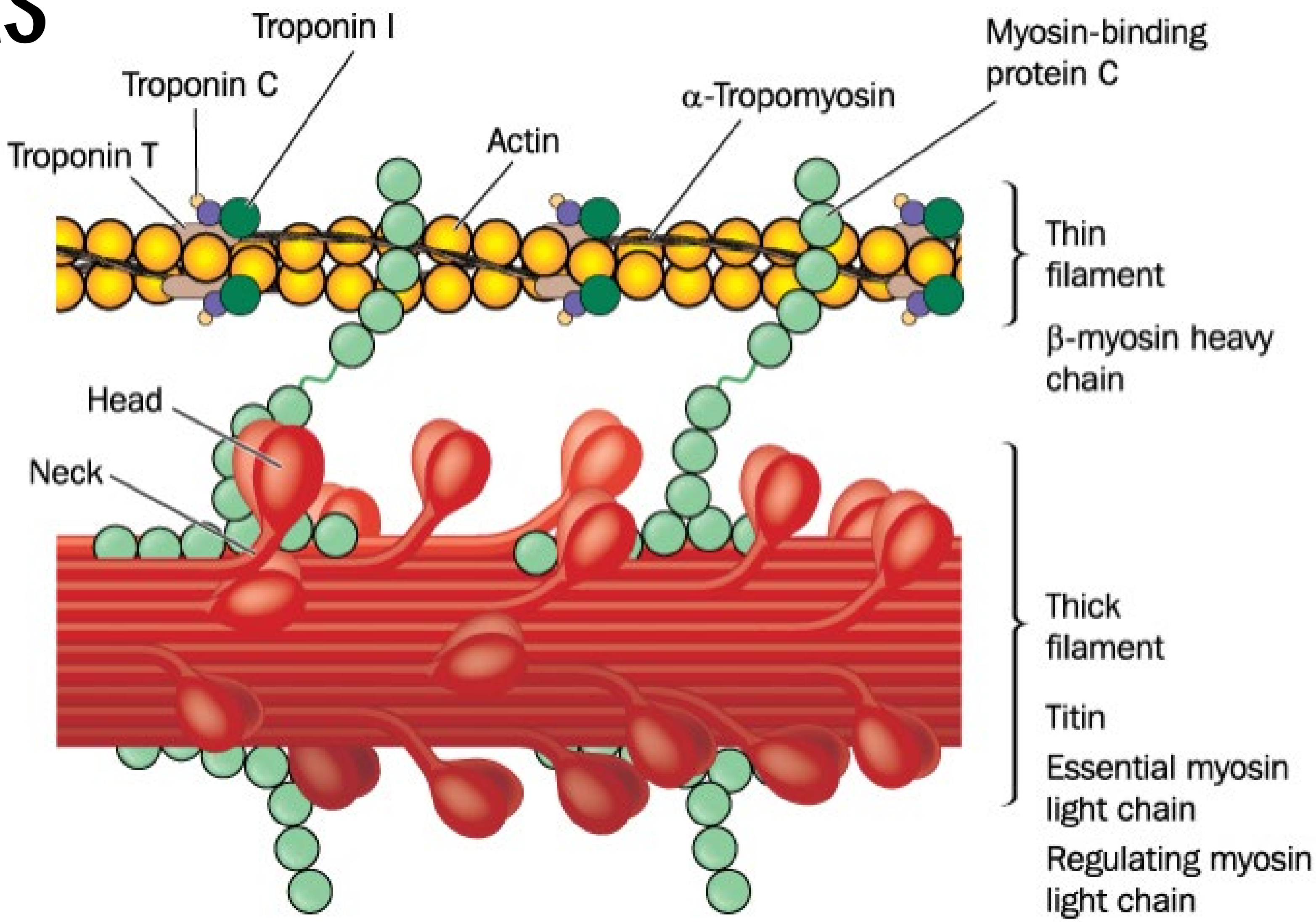
# Regulatory proteins

- Two regulatory proteins closely interact with actin.
- A regulatory protein called tropomyosin normally lies over the binding sites and prevents the interaction of the myosin head group with actin.



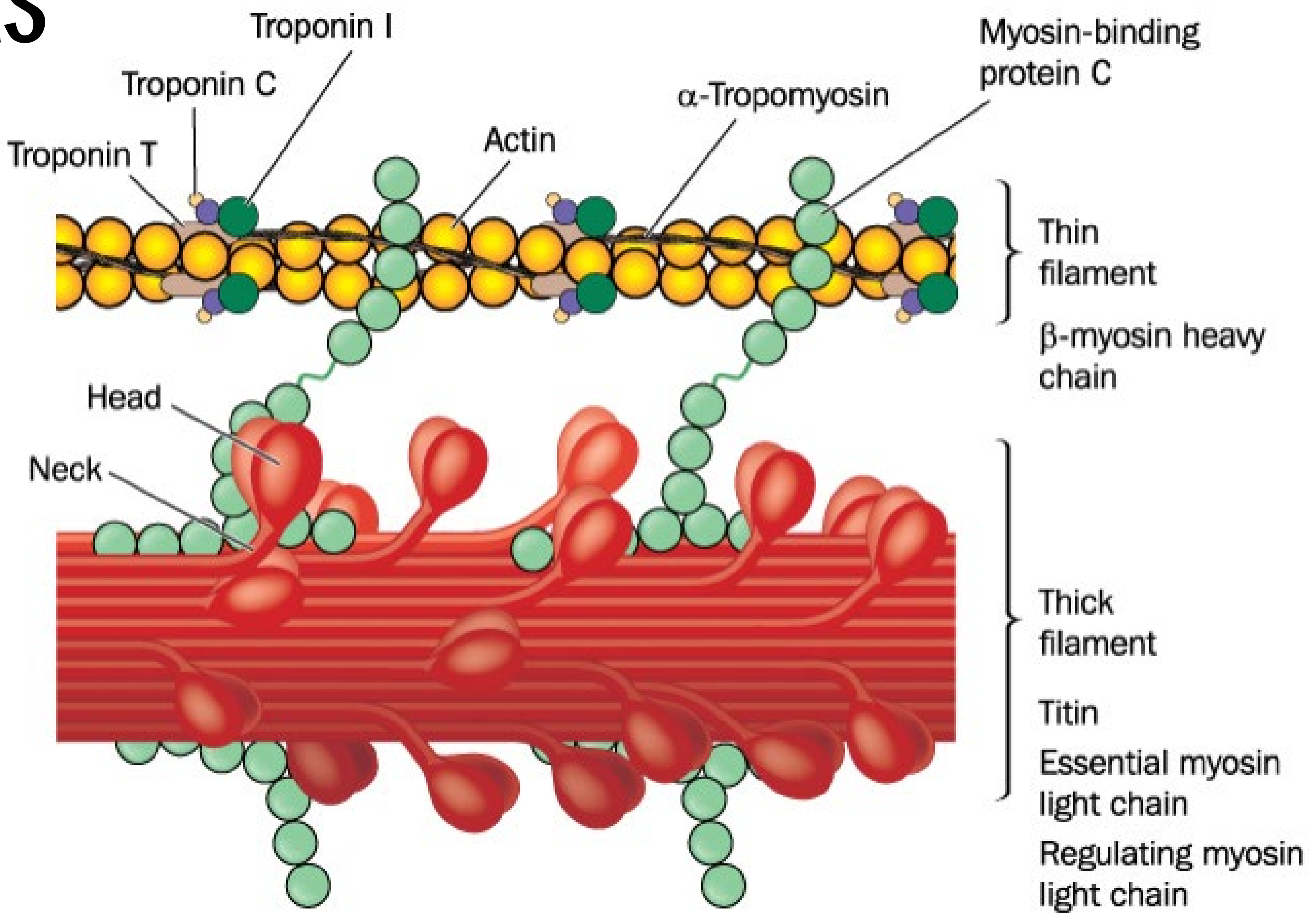
# Regulatory proteins

- When the myoplasmic Ca2+ concentration is low at its resting level, tropomyosin covers the myosin binding site of ctin.
- Tropomyosin also closely interacts with troponin, which is a Ca2+ sensor.



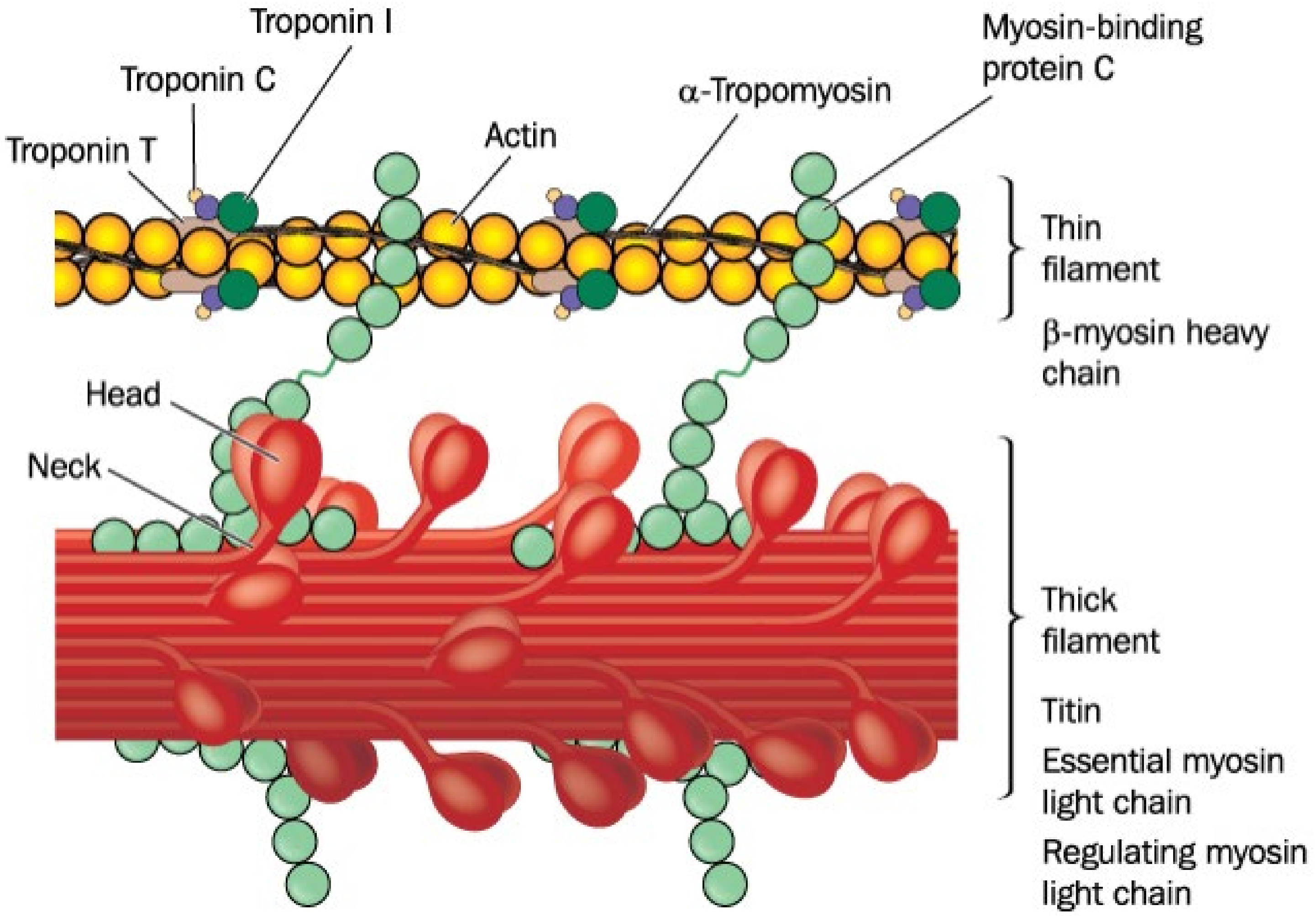
# Regulatory proteins

- Binding of Ca2+ to troponin moves the troponin-
- tropomyosin complex out of the way exposing the myosin binding site. This allows the myosin head to interact with G-actin



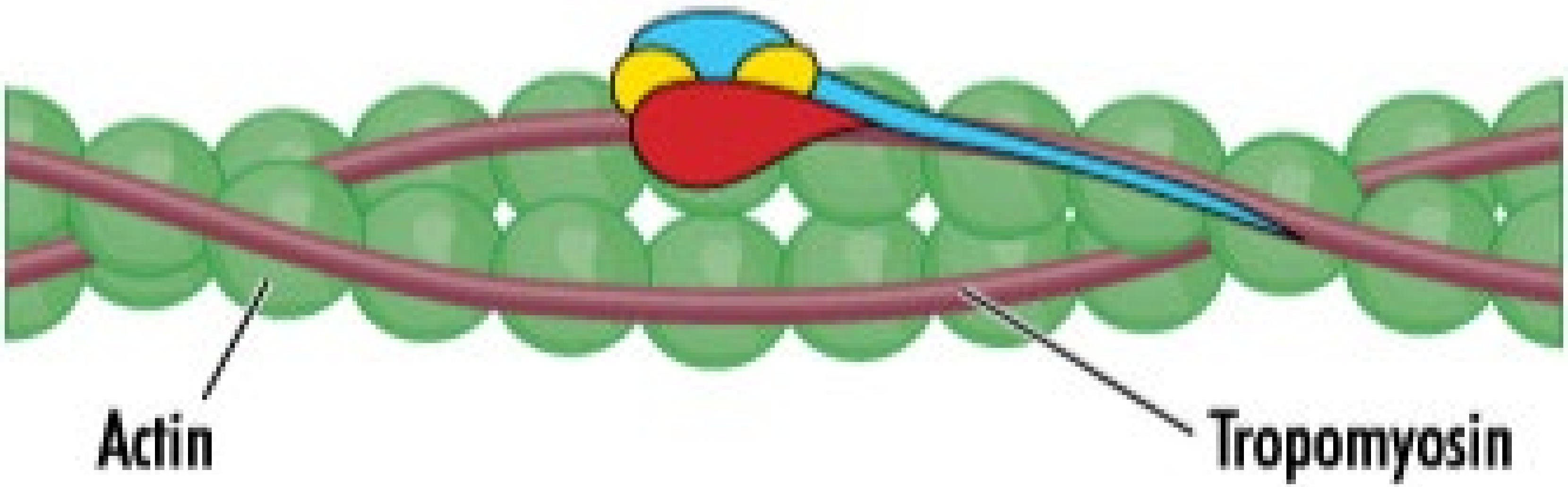
# Cross-Bridge Cycling

- Actin is the protein that makes up the thin filaments of the sarcomere.
- The actin units have myosin binding sites.
- Thus, myosin is able to bind to the myosin binding site of on actin.
- It can do this because the myosin head has an actin binding site on it!



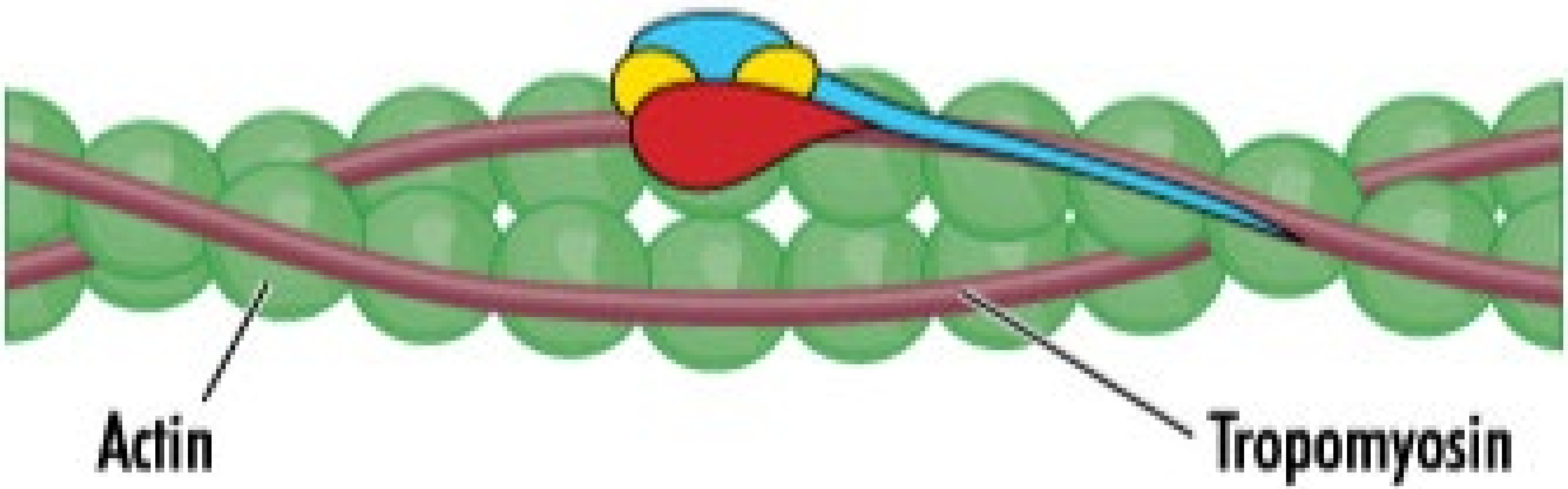
# Tropomyosin

- **Tropomyosin** covers the myosin binding sites and prevents cross-bridge formation when a muscle is relaxed.



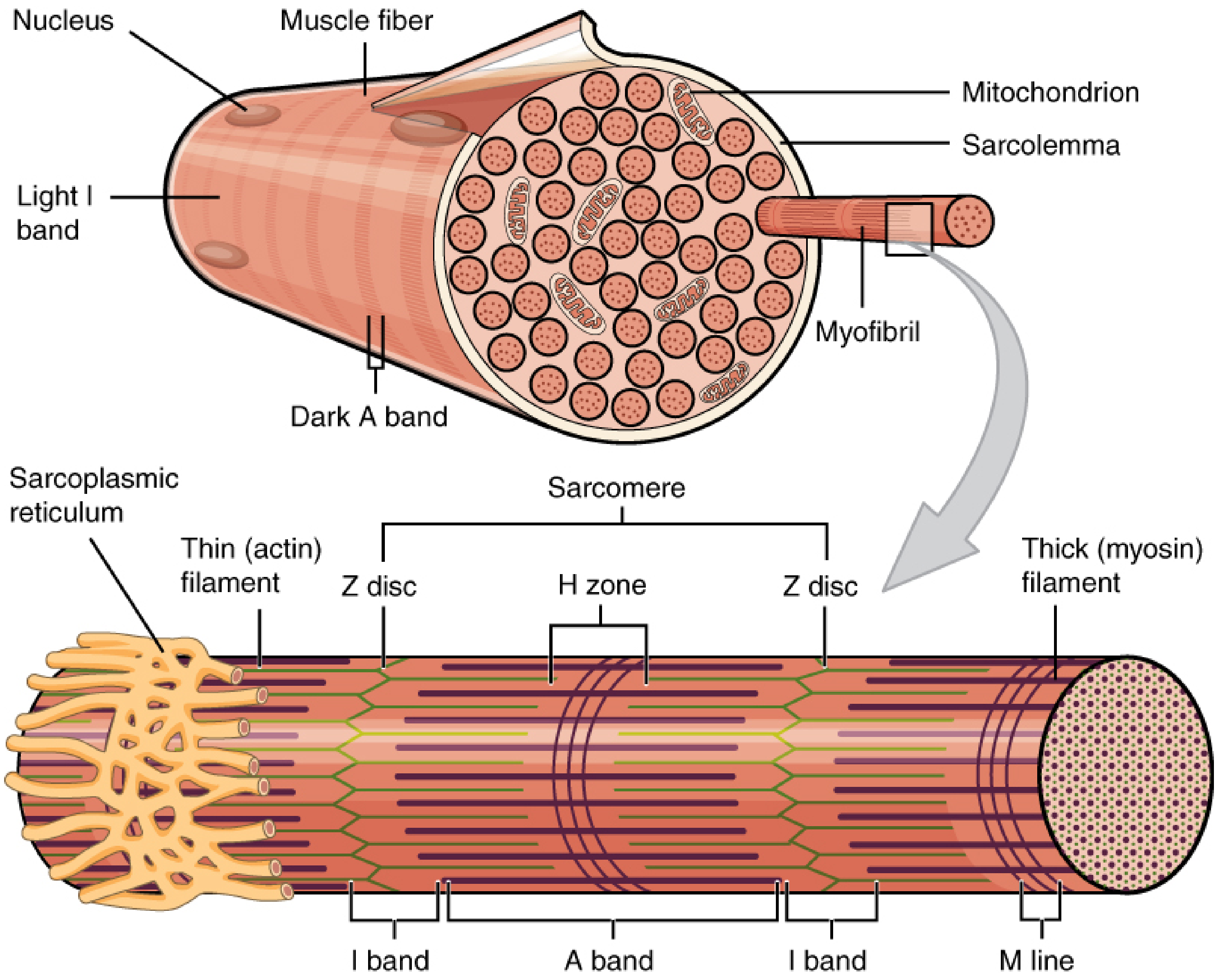
# Tropomyosin

- When the muscle receives enough stimulation from the nervous system to initiate contraction, **calcium** is released from the sarcoplasmic reticulum.
- Calcium binds to tropomyosin and moves it away from the myosin binding sites, allowing cross-bridge formation and muscular contraction.



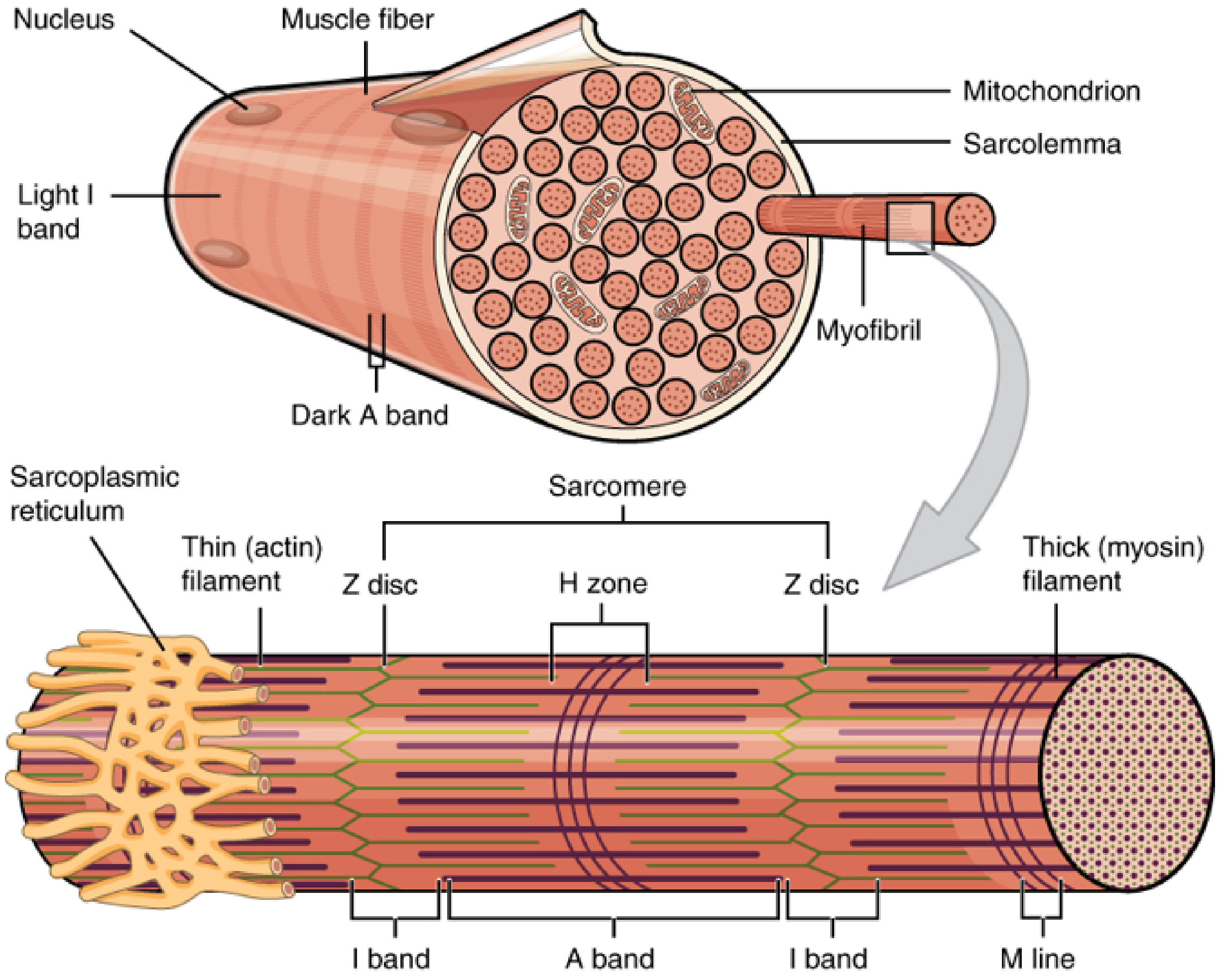
**Overall, as a muscle cell shortens, all of the following occur:**

- The I bands shorten.
- The distance between successive Z discs shortens.
- The H zones disappear.
- The contiguous A bands move closer together, but their length does not change.



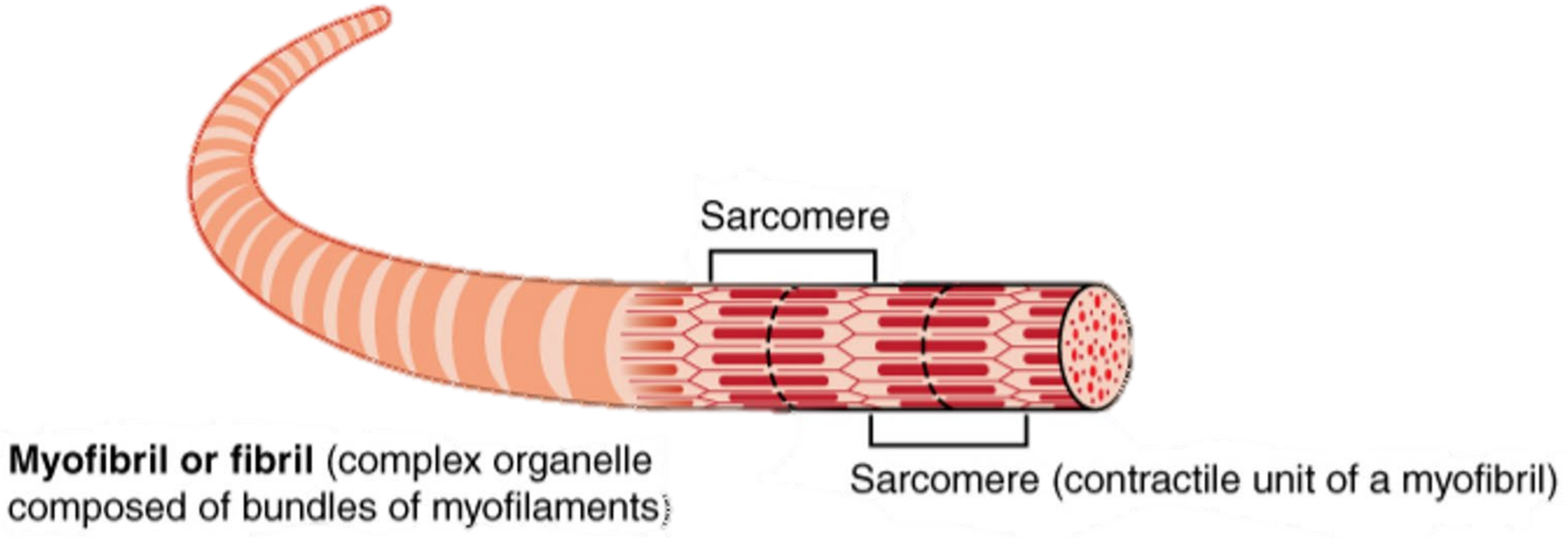
# Sliding Filament Model of Contraction

- As the thin filaments are connected to the Z disks, and as muscle contraction brings about movement of the thin filaments over the thick filaments and towards the center of the sarcomere (the M line), a shortening of the sarcomere takes place.



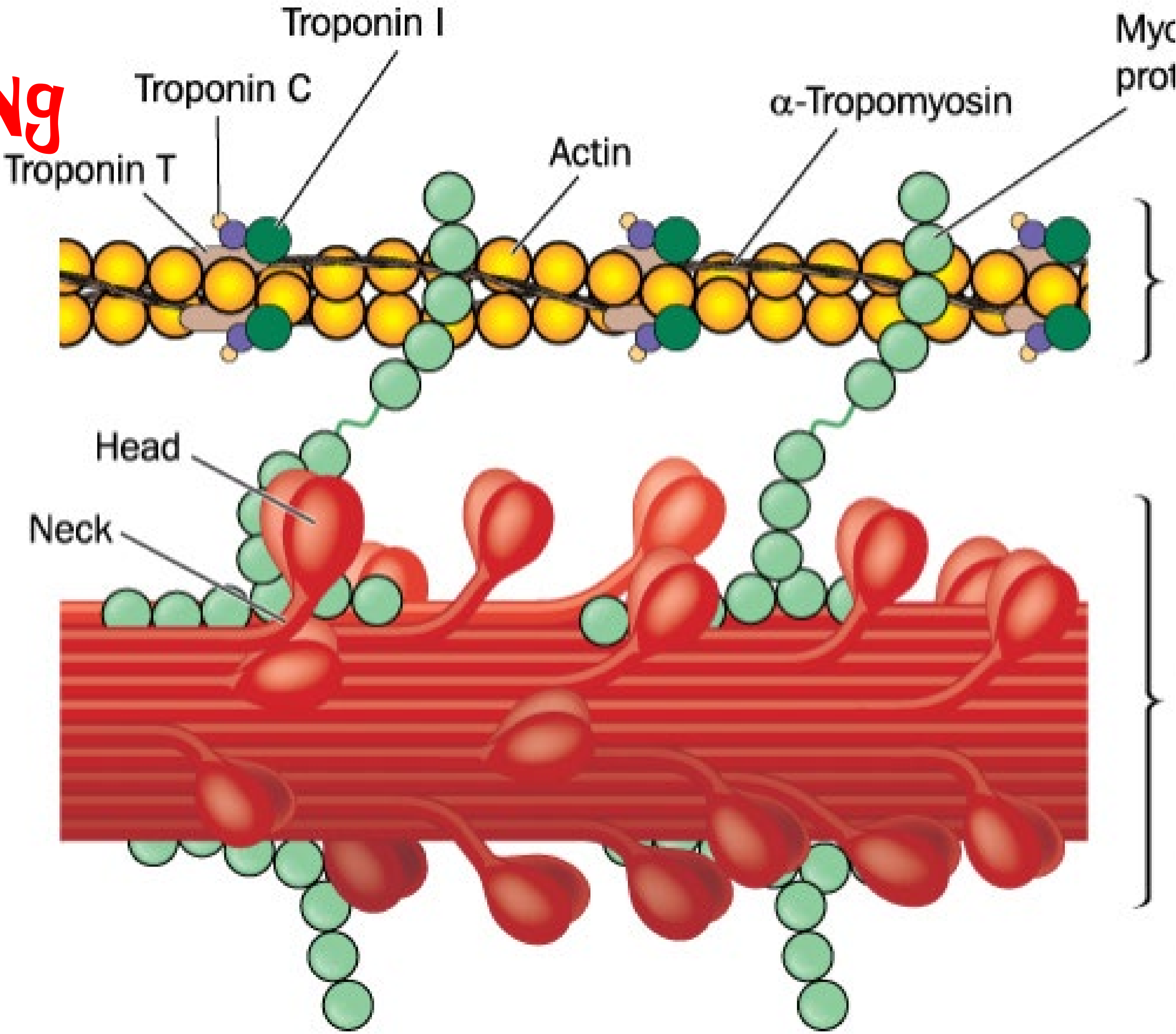
# Cross-Bridge Cycle/ Muscle Contraction

- *Sarcomere Shortening*
- *The sarcomere is the functional unit of striated muscle. Let's look at the cross-bridge within the context of a single sarcomere to understand how contraction occurs.*



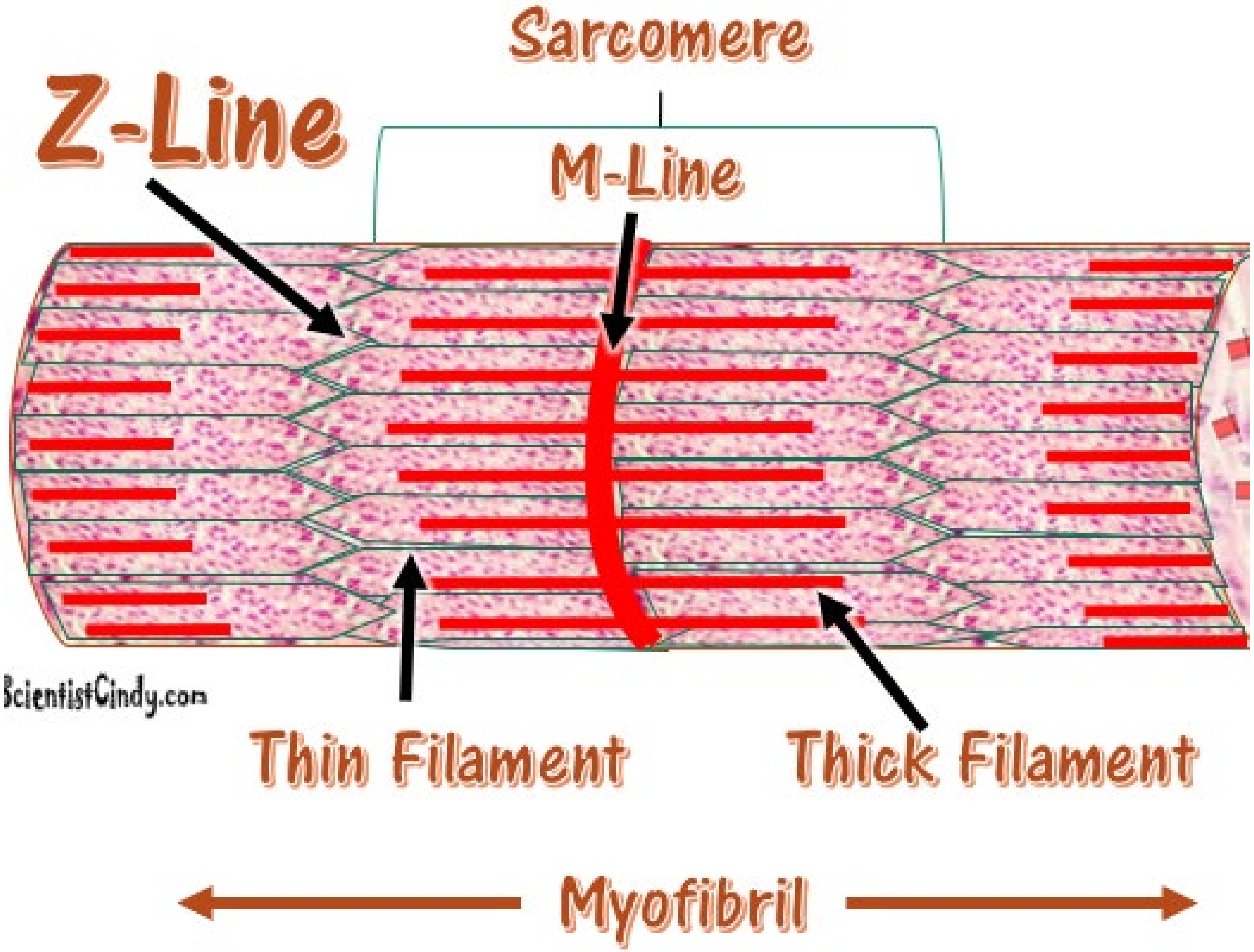
# Cross-Bridge Cycling

- In order for the muscle to contract…
- the actin and the myosin molecules of the thin and thick filaments have to interact with one another.
- When the actin and myosin interact, they are said to be connected by cross-bridges.
- The cross-bridges refer to the myosin head groups that interact with a myosin-binding site on actin.



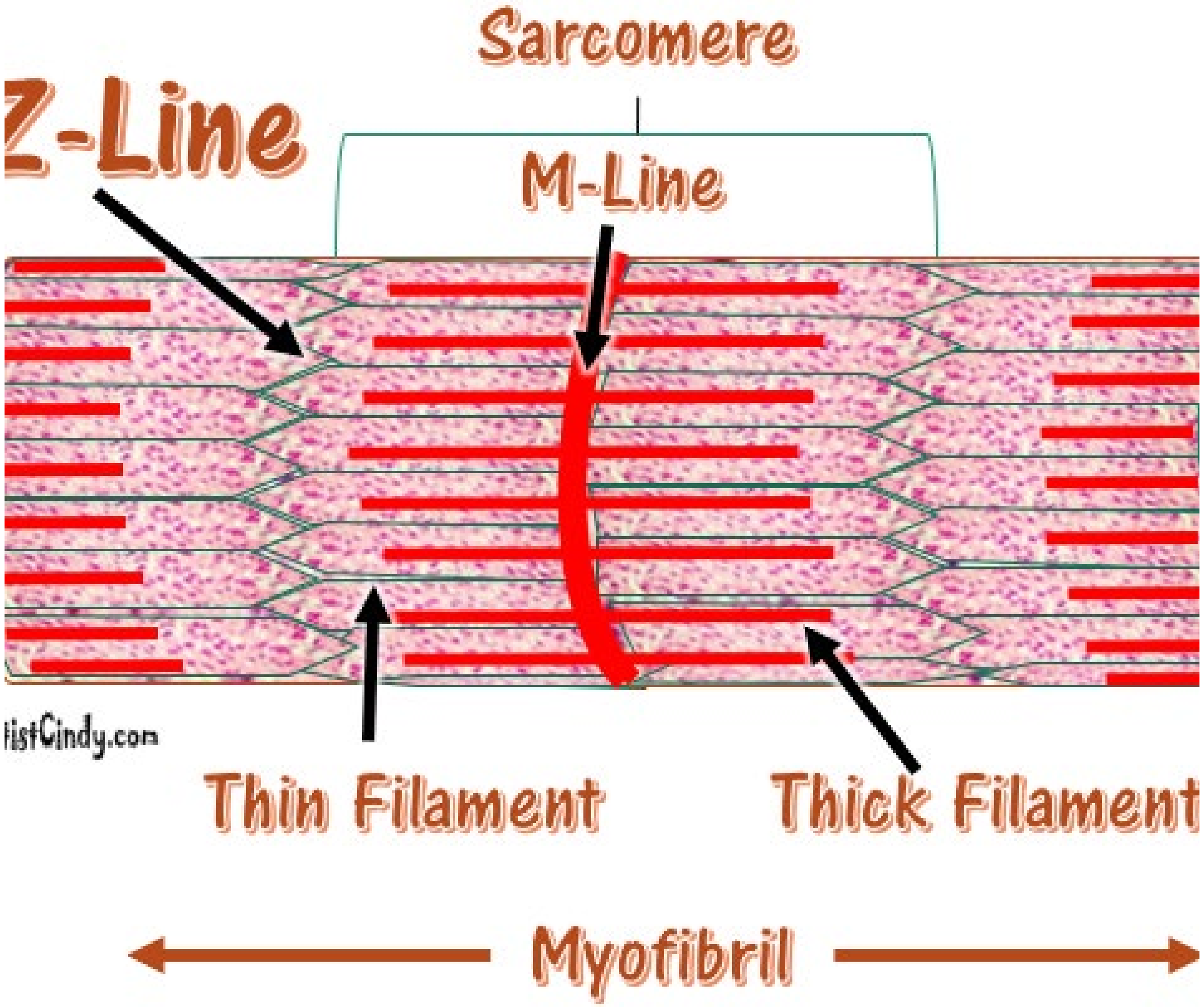
# Z disks or Z Line

- Two adjacent Z disks along the myofibril mark the boundaries of a single sarcomere.
- The Z disks are the attachment sites for the thin filaments.
- Therefore, from each Z disk, thin filaments extend to two neighboring sarcomeres.



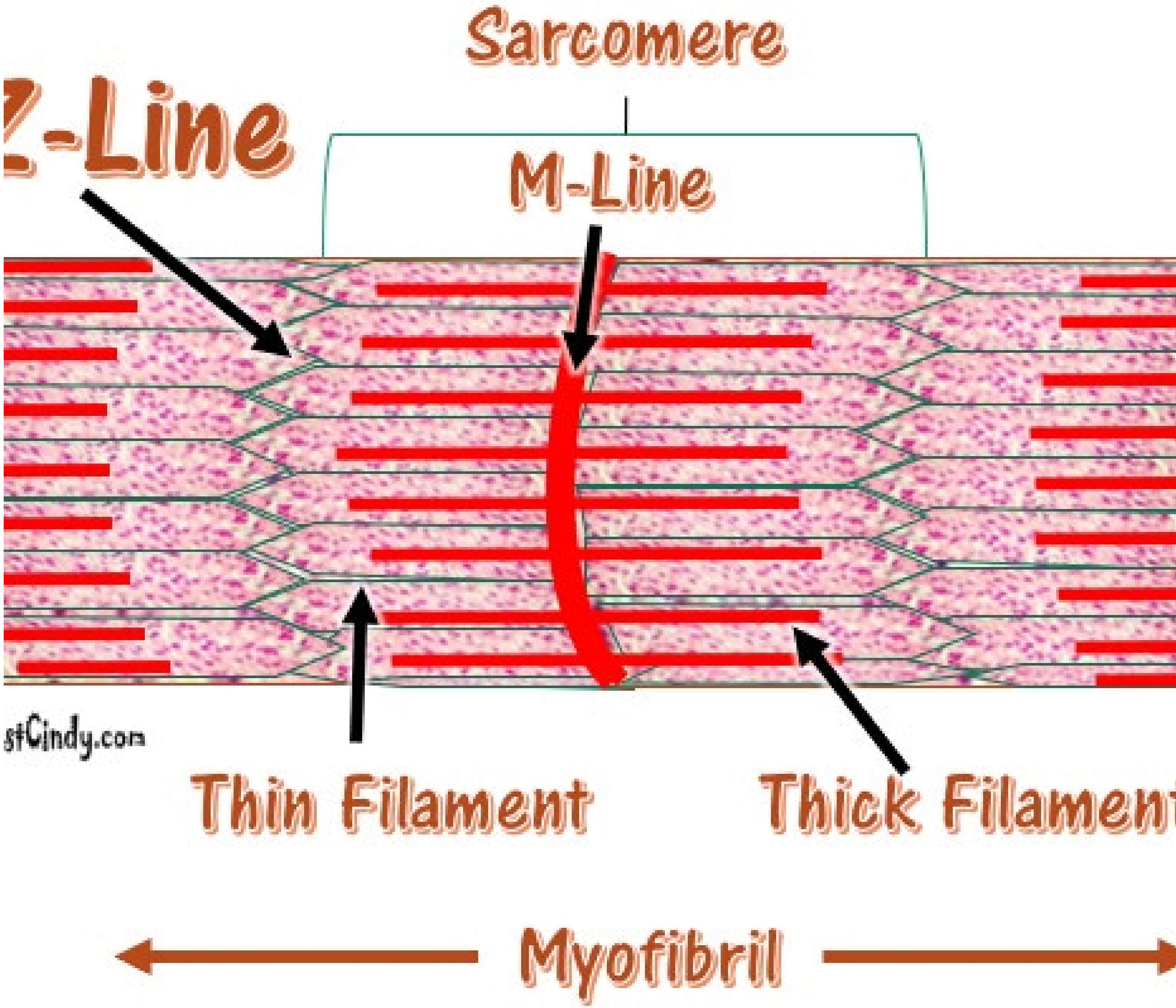
# Z disks or Z line

- When a muscle fiber contracts, the Z disks of a sarcomere move closer together. Thus, the sarcomere shortens as the muscle contracts.



# M Line

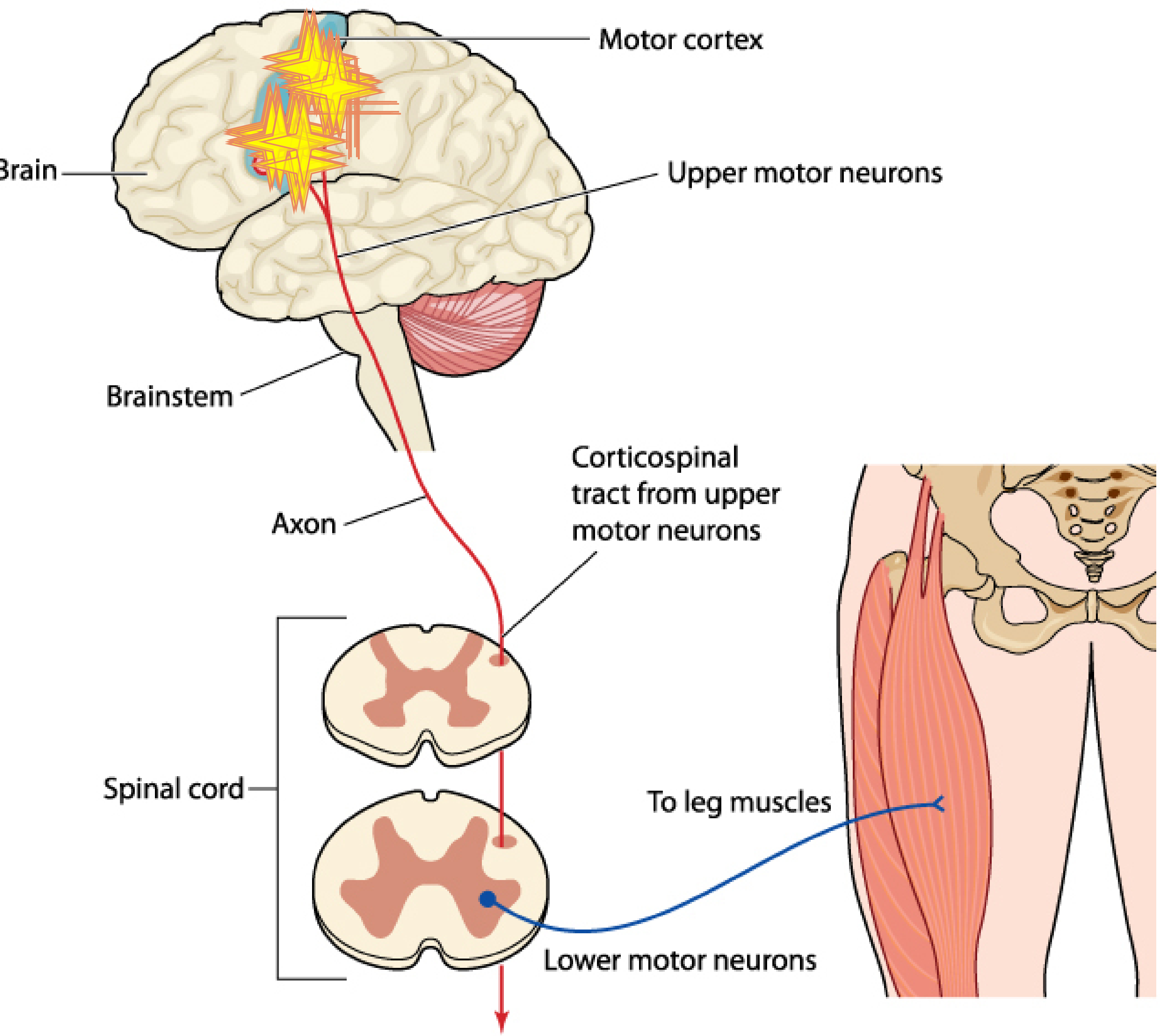
- The M line is the attachment site for the thick filaments.
- The M line is in the middle of the A band and, thus, it is in the middle of the sarcomere.



# Events That Lead to Muscle Fiber contraction

Muscle fiber contraction requires the following steps:

1. Membrane Depolarization / Fiber Activation: The fiber must be activated or stimulated by a nerve (motor neuron)so that the membrane/sarcolemma becomes depolarized (the membrane potential becomes less negative due to an influx of positively charged sodium ions).
2. Action Potential Generation: The change in membrane potential must be strong enough to generate an action potential in the sarcolemma.
3. Action Potential Propagation: Once the action potential is initiated, it will be propagated along the sarcolemma.
4. Calcium Release: Calcium is released from the sarcoplasmic reticulum.



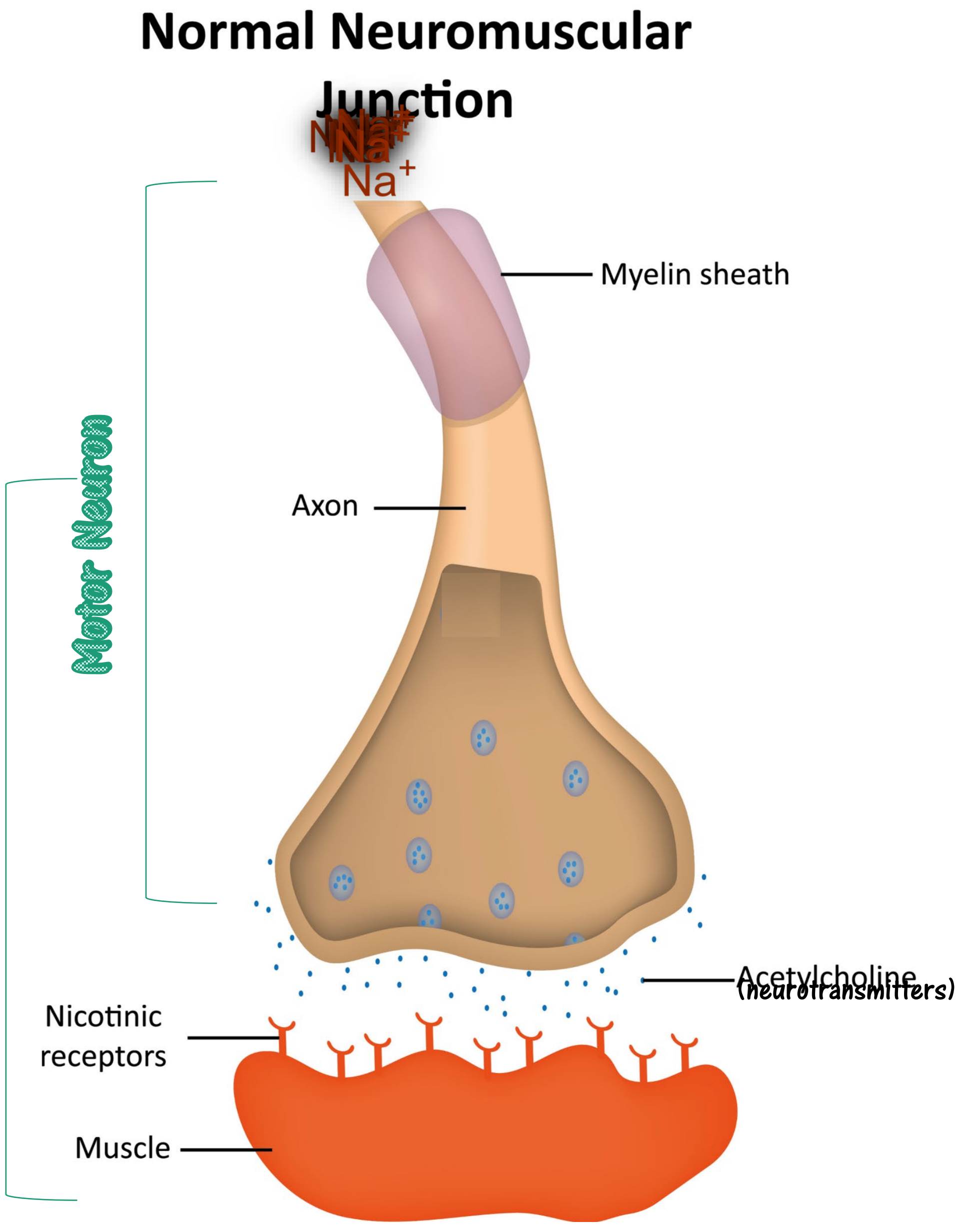

# Excitation-Contraction Coupling

**How do muscles contract?**

- The whole process really begins with the command from the central nervous system.
- The decision to make a conscious movement is made in the brain.
- The command to move is sent from the brain's motor cortex and travels down the spinal cord, to the motor nerve (directly or indirectly).
- The signal initiating movement of the muscle travels from the central nervous system to the motor nerve (motor neuron).

# Excitation-Contraction Coupling

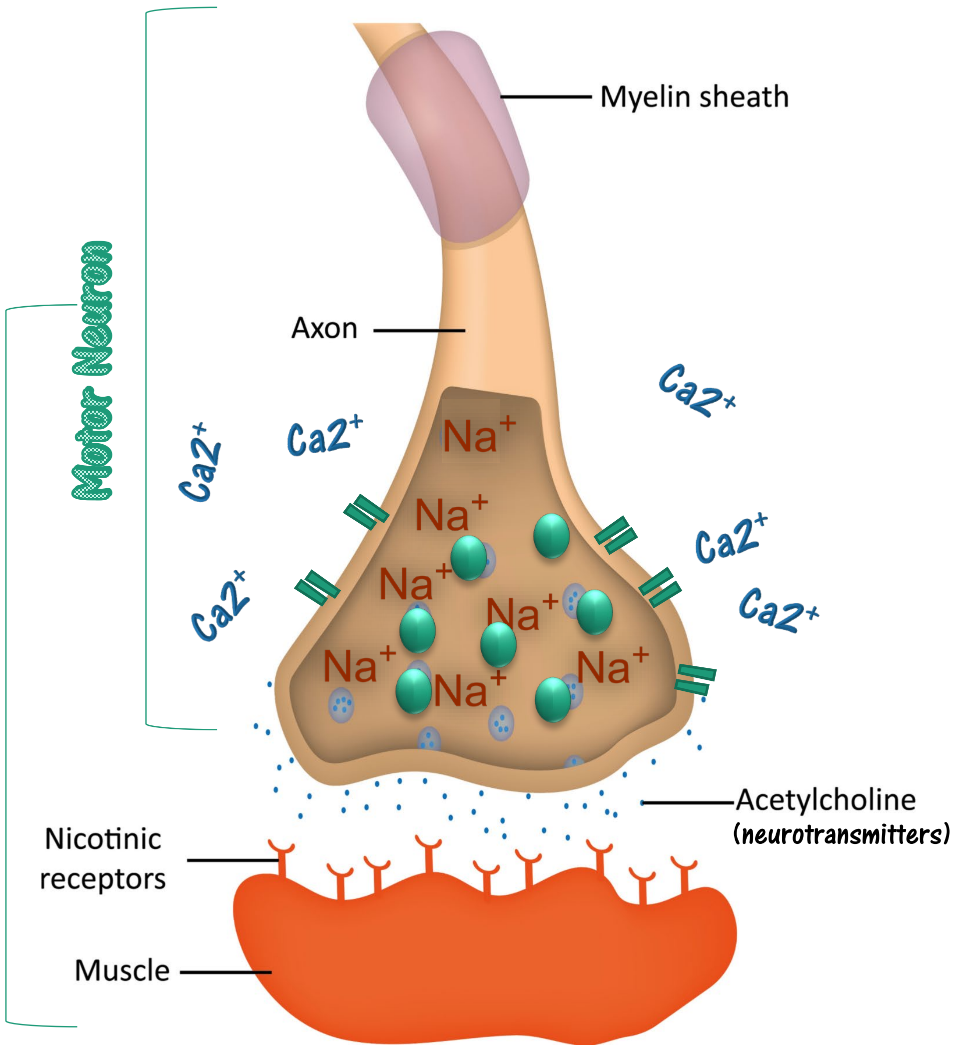
- The signal reaches the terminal end (called the axon terminal) of the motor neuron causing the release of the neurotransmitter, acetylcholine.



# Excitation-Contraction Coupling

- The signal reaches the terminal end (called the axon terminal) causing calcium channels to open.
- The influx of calcium in the axon terminal causes the release of the neurotransmitter, acetylcholine.

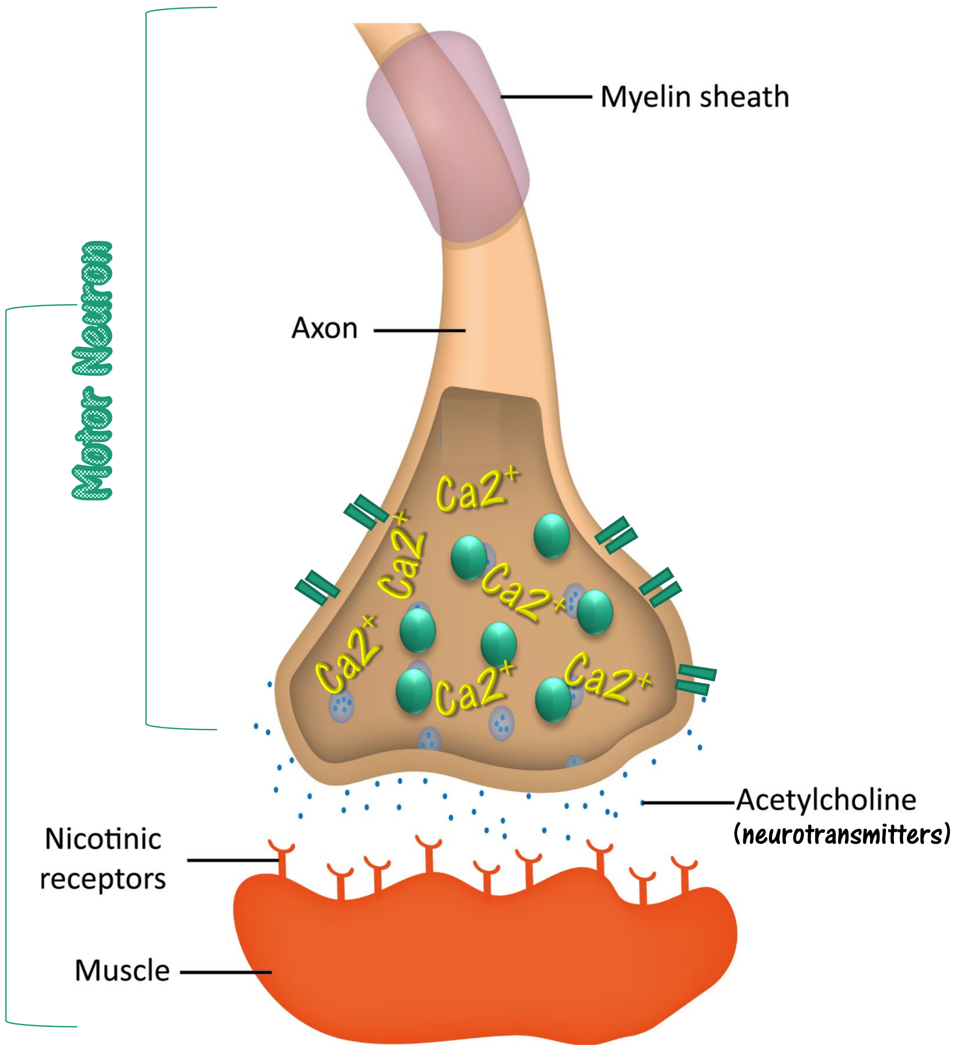
**Normal Neuromuscular Junction**



# Excitation-Contraction Coupling

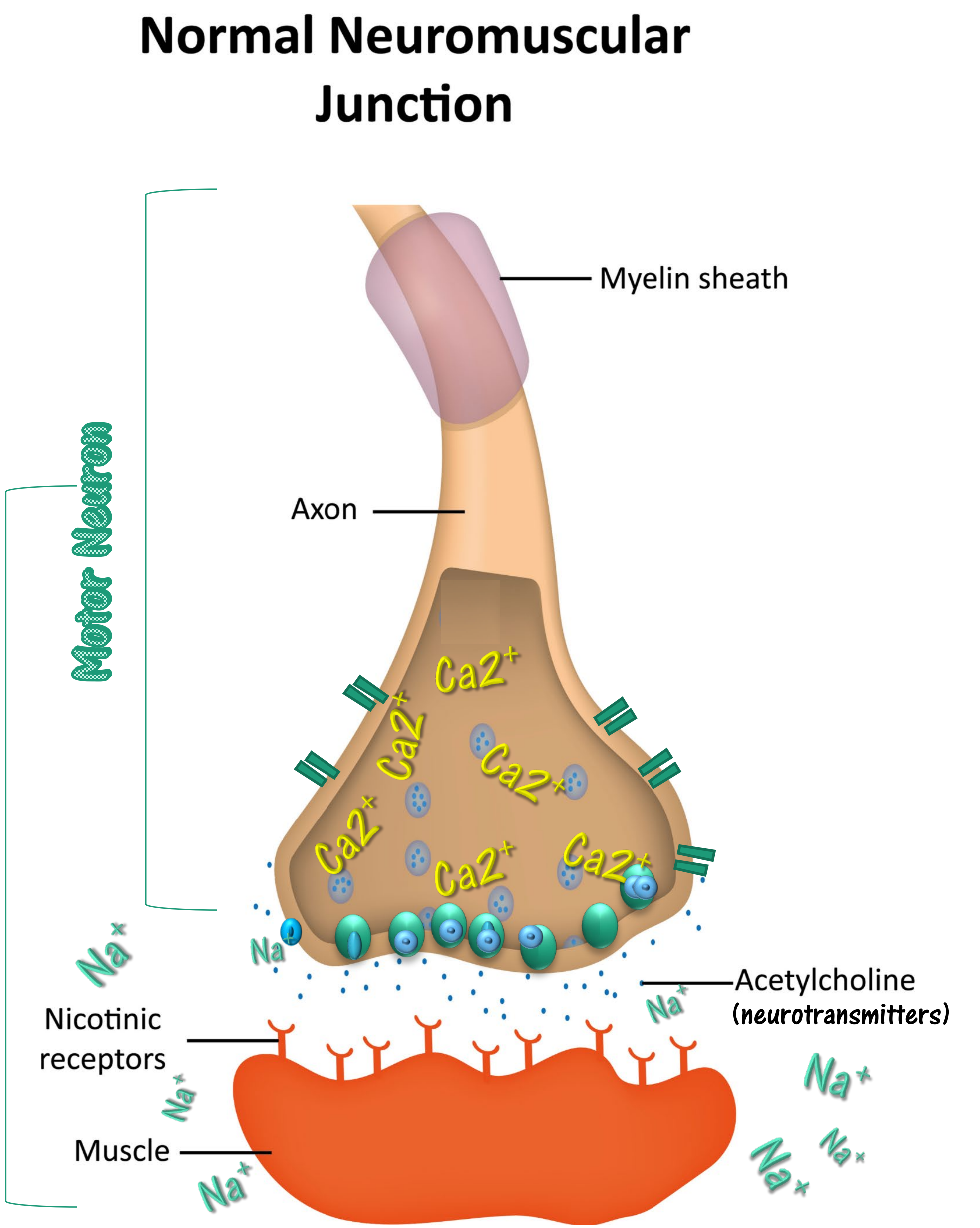
- The signal reaches the terminal end (called the axon terminal) causing calcium channels to open.
- The influx of calcium in the axon terminal causes the release of the neurotransmitter, acetylcholine.

**Normal Neuromuscular Junction**



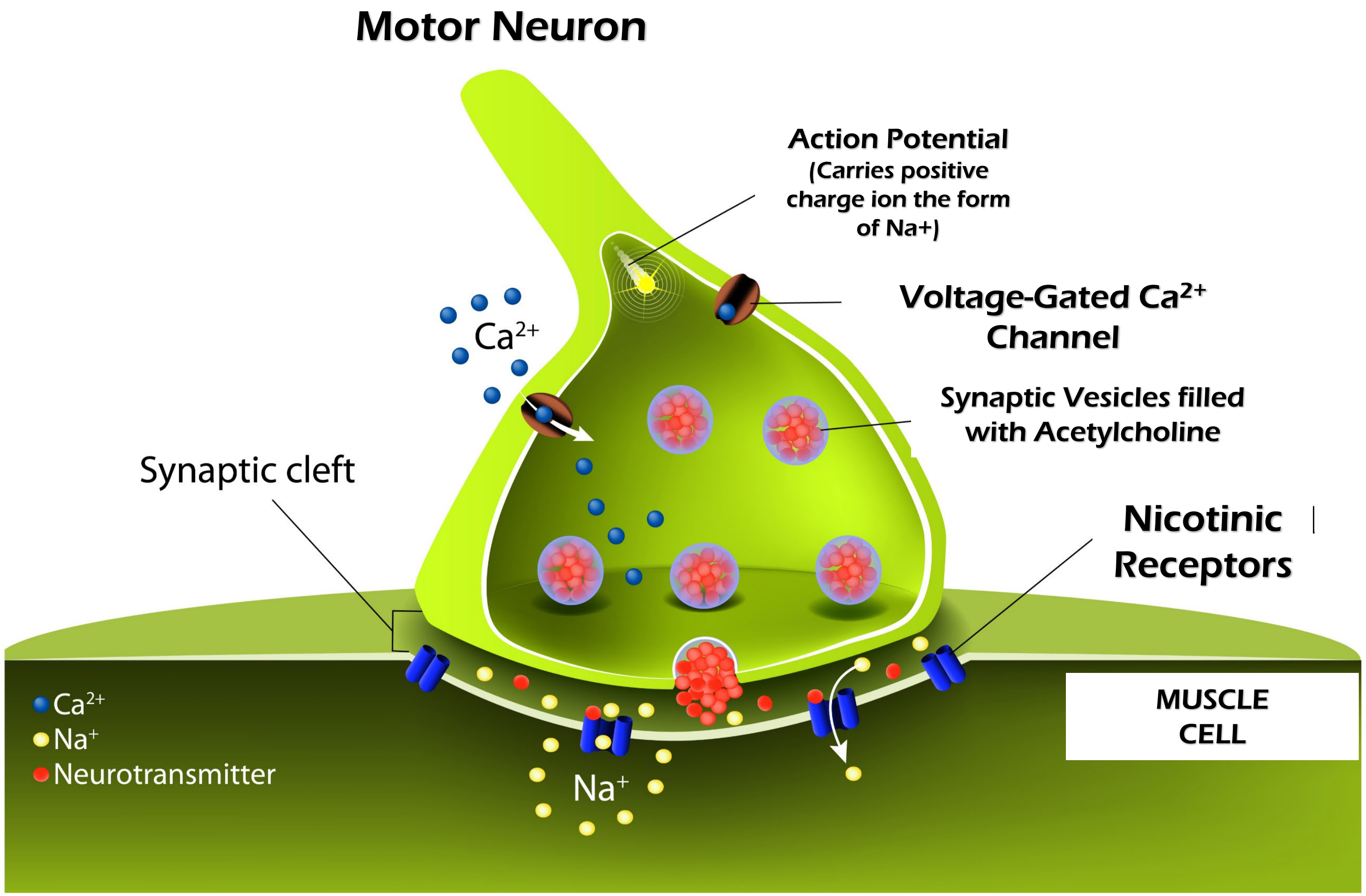
# Excitation-Contraction Coupling

- Acetylcholine diffuses passively across the synaptic cleft and transiently binds to post- synaptic (nicotinic) receptors.
- This binding causes the receptors to open, allowing an influx of sodium ions into the muscle fiber.



- Acetylcholine diffuses passively across the synaptic cleft and transiently binds to post- synaptic (nicotinic) receptors.
- This binding causes the receptors to open, allowing an influx of sodium ions into the muscle fiber.

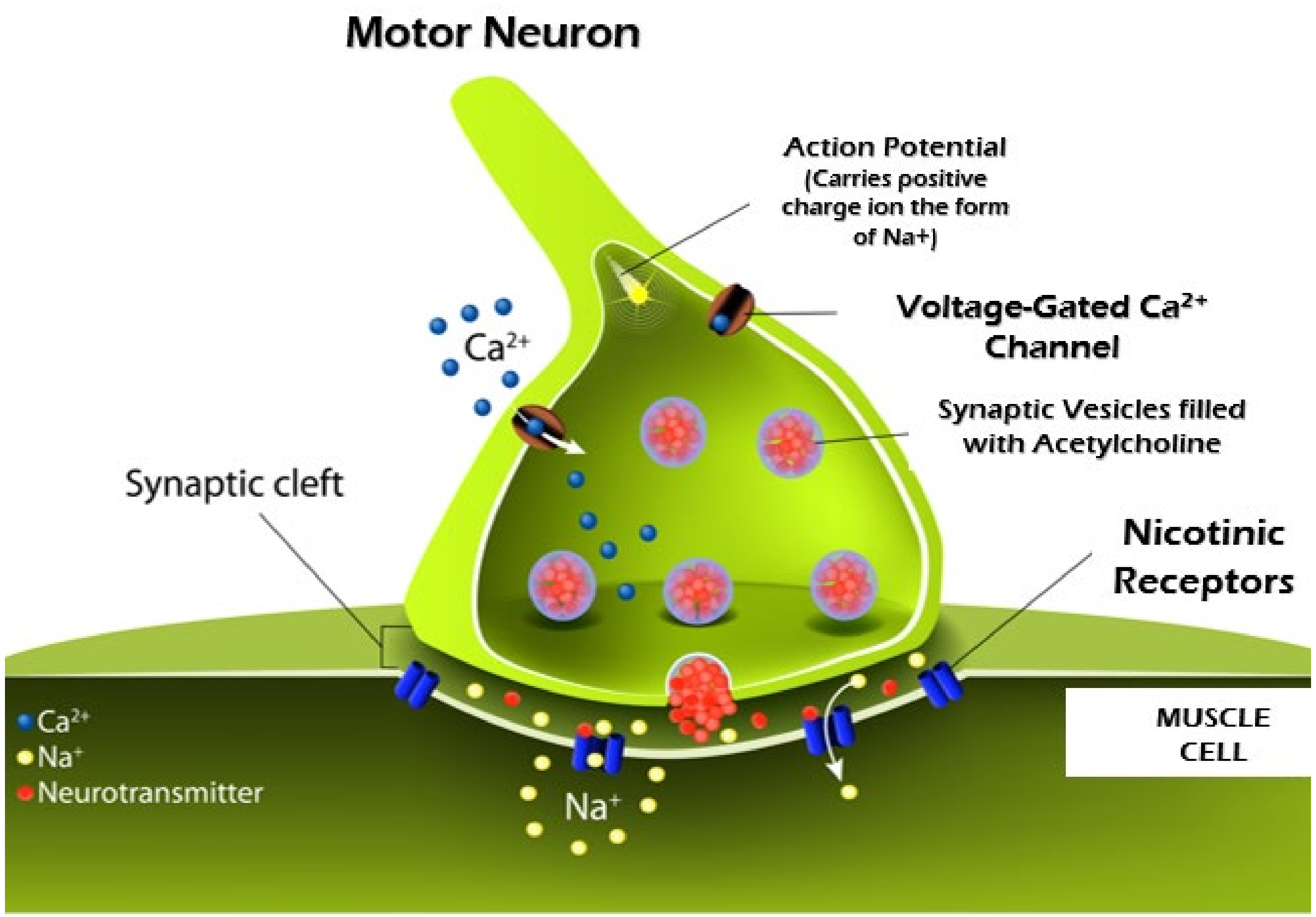
# Neuromuscular Junction



# Events That Lead to Muscle Fiber contraction

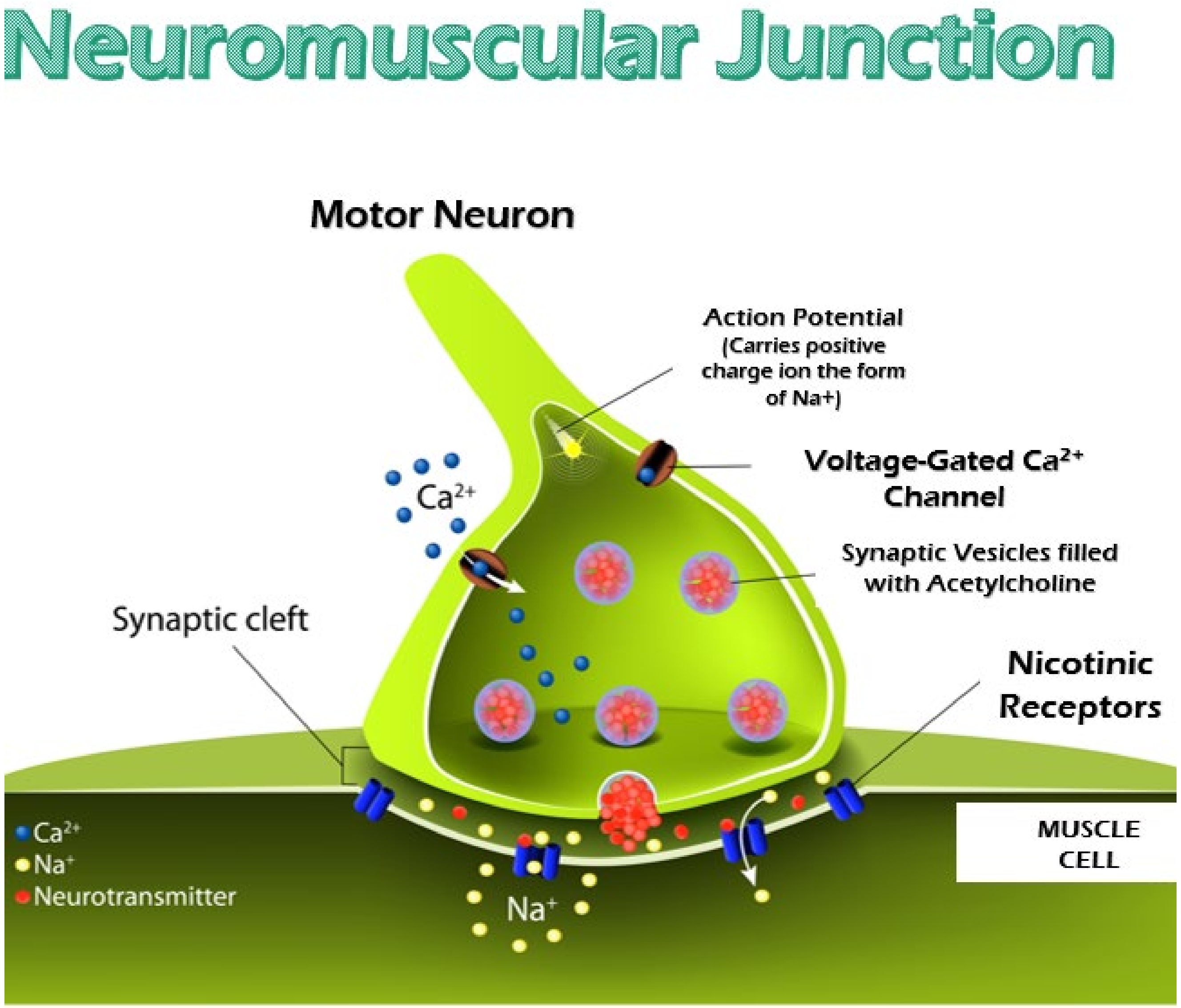
1. Action potential arrives at axon terminal of the motor neuron at neuromuscular junction
2. Acetylcholine (Ach) is released
3. Ach binds to receptors on the sarcolemma

## Neuromuscular Junction



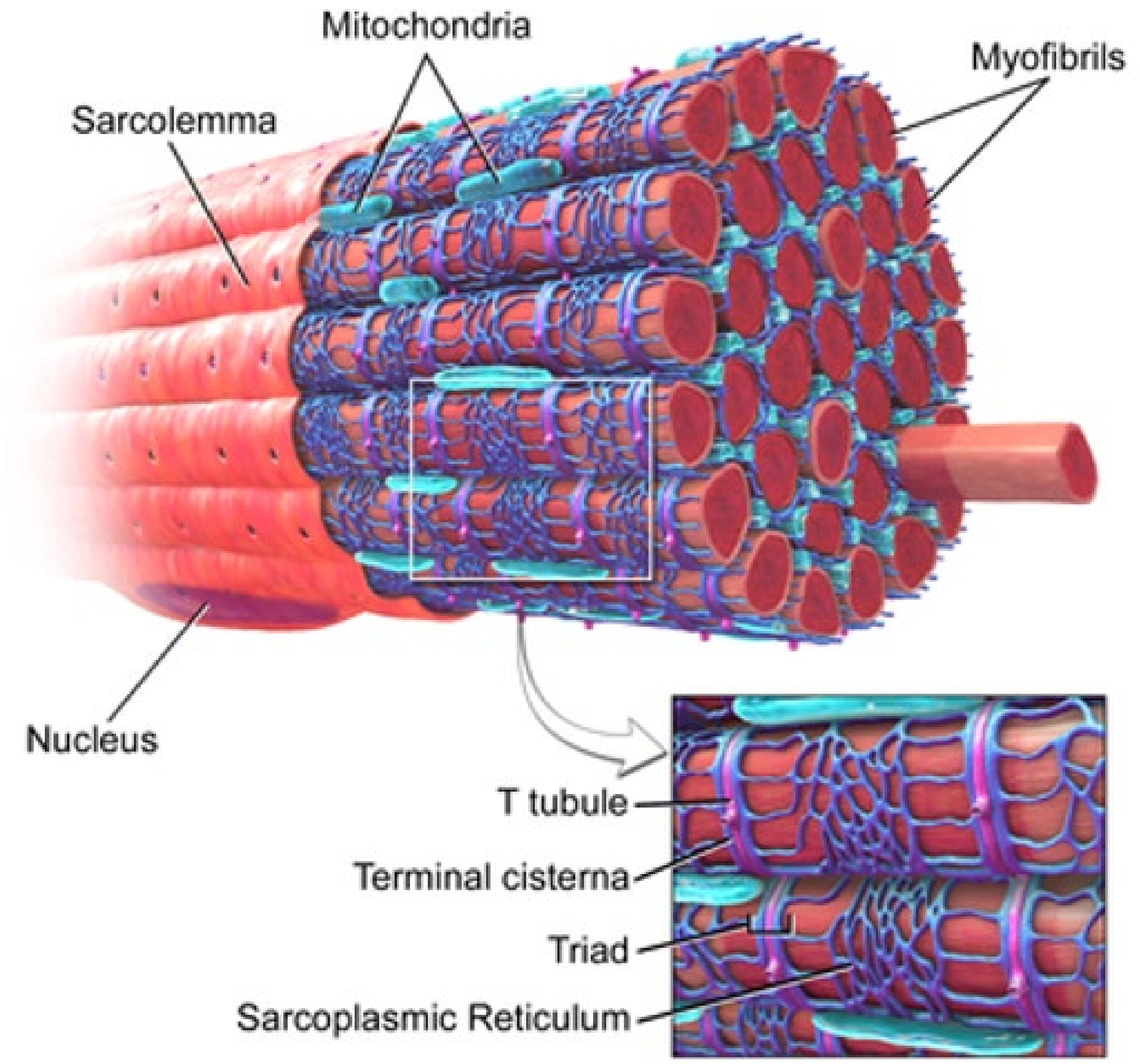
# Events That Lead to Muscle Fiber contraction

4. Ion permeability of sarcolemma changes
5. Local change in membrane voltage (depolarization) occurs
6. Local depolarization (end plate potential) ignites AP in sarcolemma



# Events That Lead to Muscle Fiber contraction

7. AP travels across the entire sarcolemma
8. AP travels along T tubules
9. SR releases Ca2+



# Events That Lead to Muscle Fiber contraction

10. Ca2+ binds to troponin which exposes the myosin-binding sites on actin

**Troponin** changes conformation when it binds calcium, and that moves the tropomyosin away from the myosin binding sites, allowing cross-bridge formation and muscular contraction.

10. Myosin heads bind to actin; contraction begins

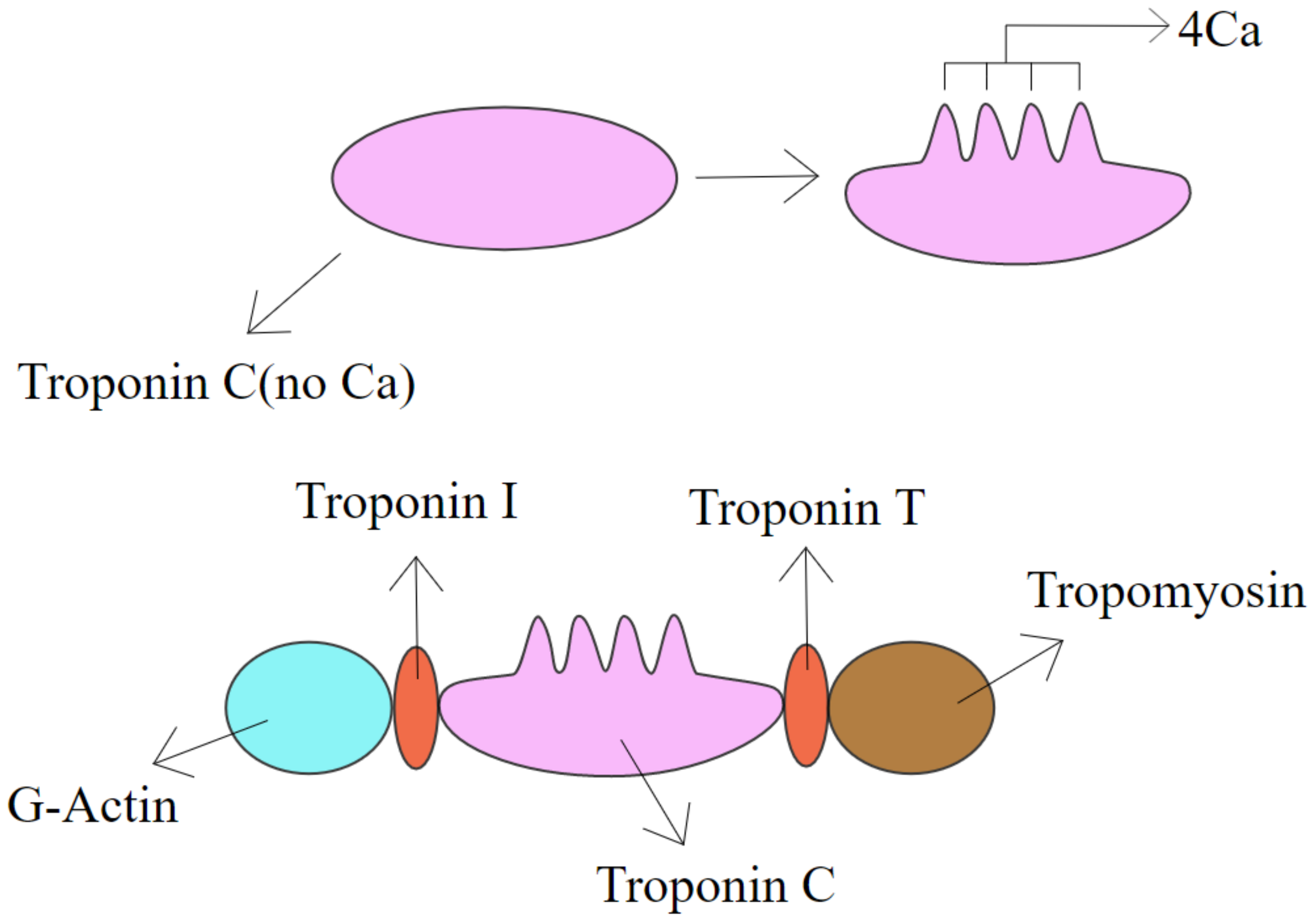


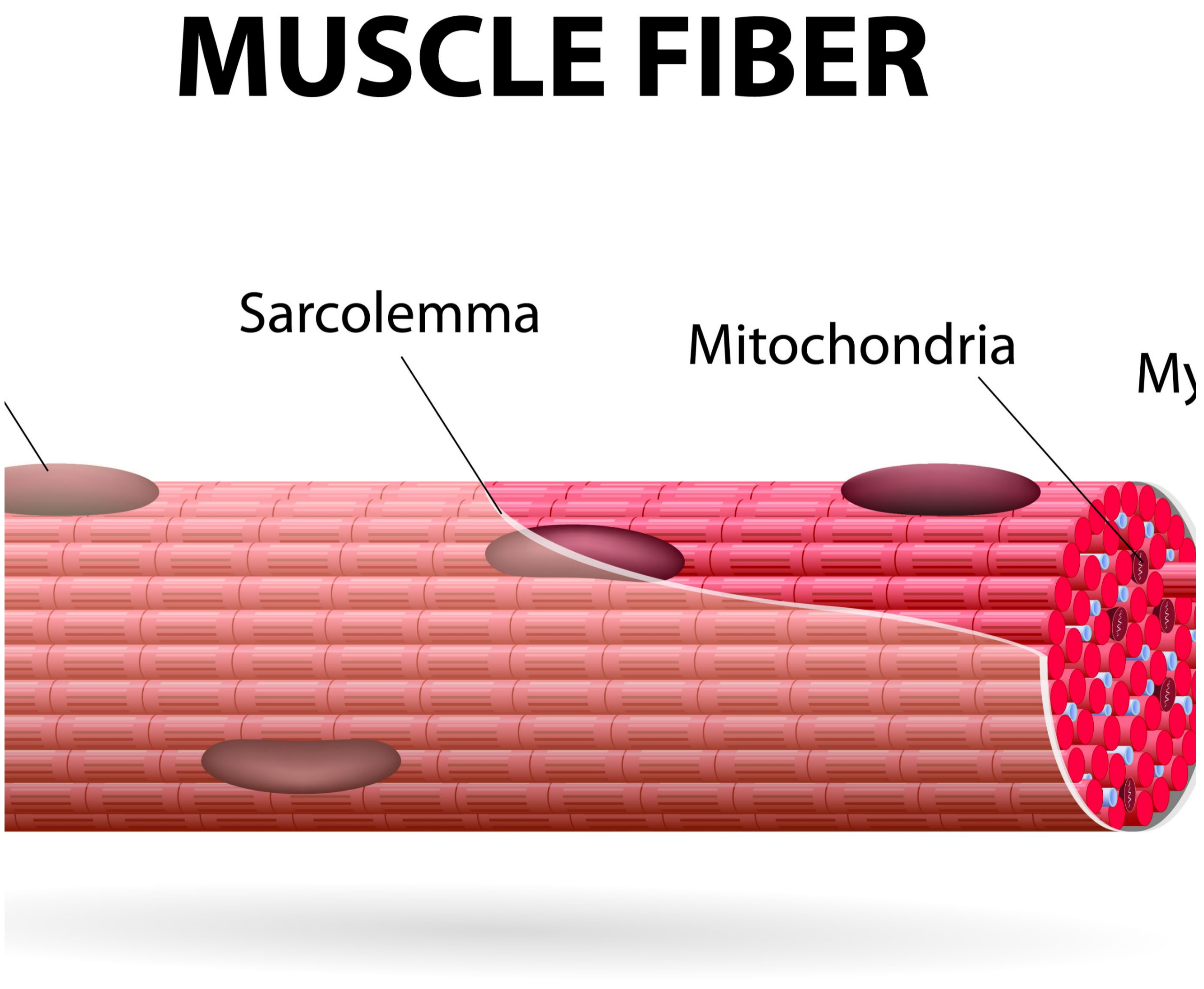

IMAGE COURTESY OF: By Arcadian (Troponino.jpg) [https://commons.wikimedia.org/wiki/File%3ATroponino.svg], via Wikimedia Commons

# Events That Lead to Muscle Fiber Contraction

12. Binding of myosin cross-bridges to the binding sites on G-actin molecules.
13. Power stroke of the cross-bridges and movement of the thin filaments over the thick filaments.
14. Continued cross-bridge cycling for as long as ATP is present and Ca2+ concentrations remain high in the myoplasm.
15. Muscle shortening and/or tension development.

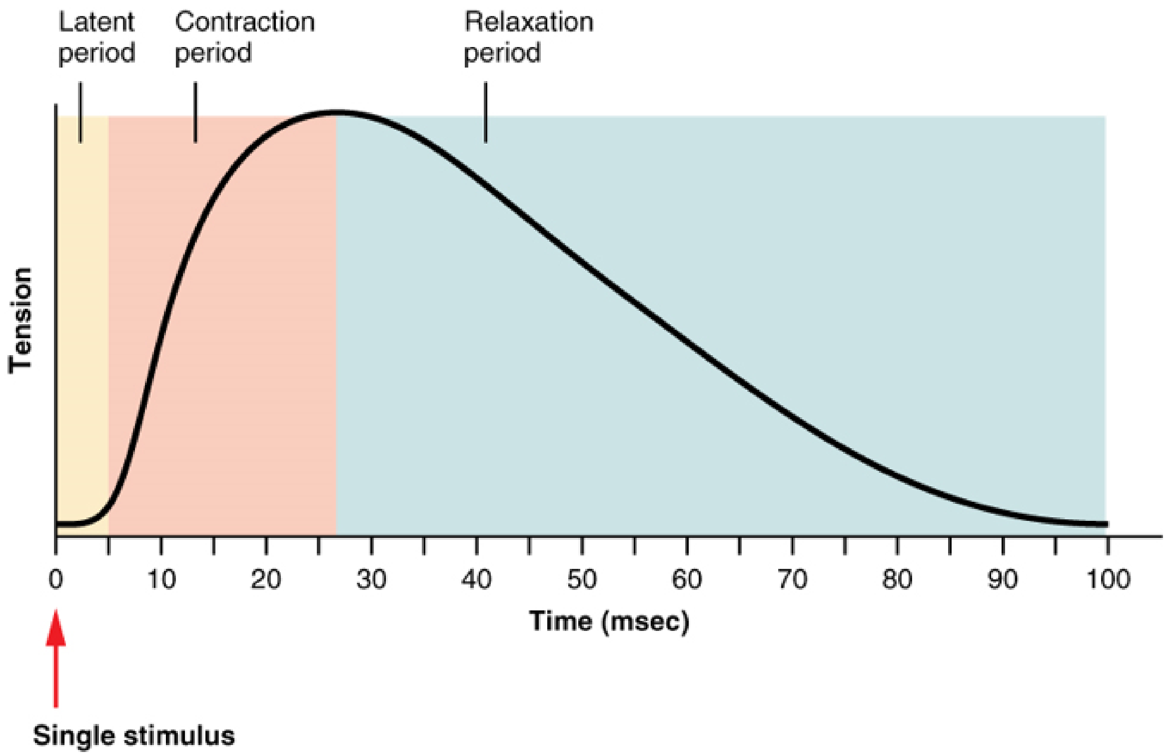
# Twitch

- A single **muscle twitch**, which is a single contraction in response to a brief threshold stimulation.
- **Threshold stimulation:** the smallest amount of stimulation that result in sarcomere shortening.



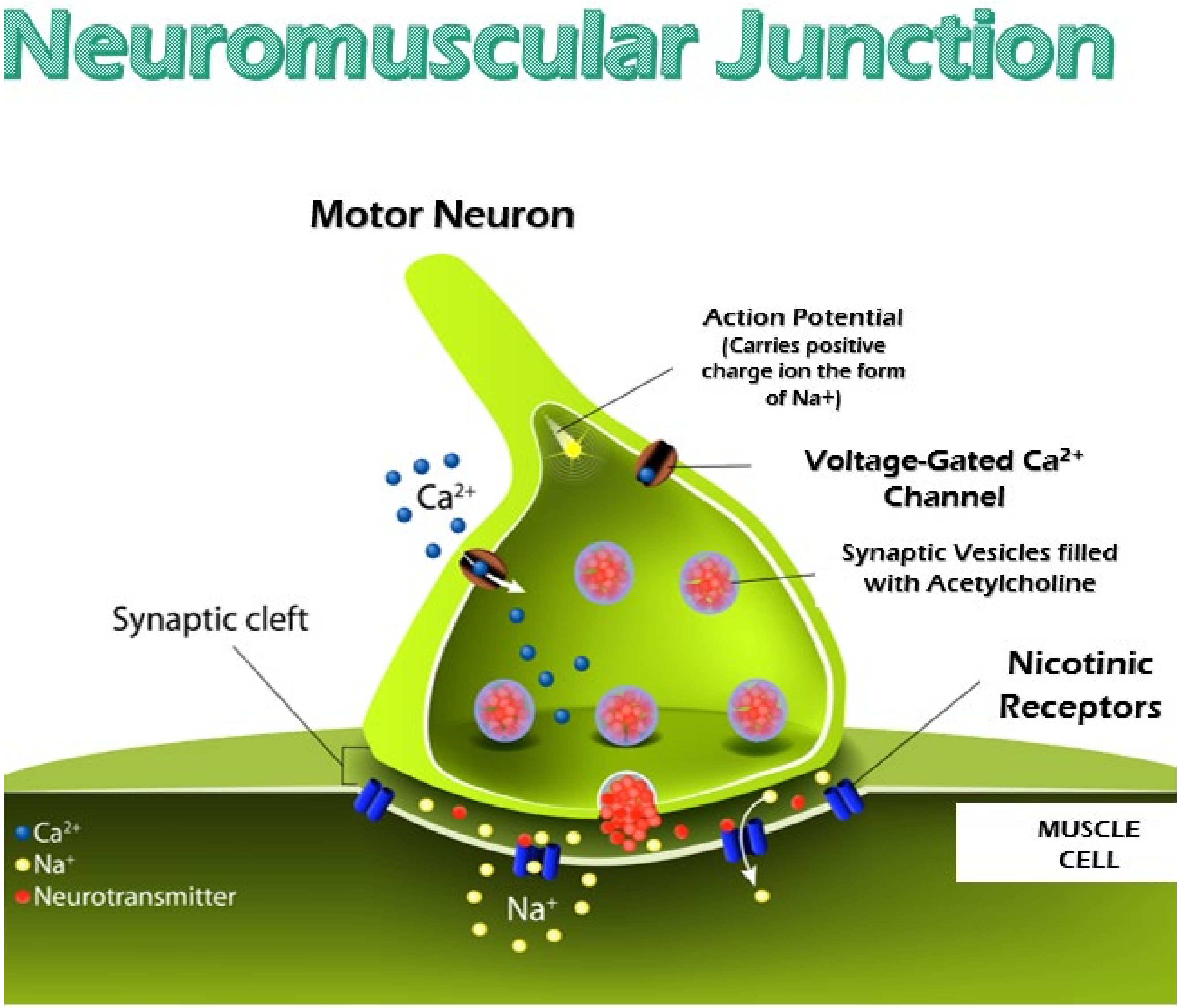
# Twitch response

- A threshold stimulation is the smallest amount of stimulation that will actually result in a contraction.
- If we administer a single threshold stimulus in a lab, we get a single muscle twitch in response.
- We can measure this with a Myogram.



# The Muscle Twitch

- A muscle twitch is the minimum muscle response to a single action potential generated by a motor neuron.
- Excitatory input from the motor neuron must reach a minimum threshold (minimum level) to trigger the flood of calcium from the sarcoplasmic reticulum, in order for any muscular repose to occur.



# The Muscle Twitch

- Every twitch has three distinct phases

1. Latent period. This is the lag time due to the time needed for the action potential to spread through the sarcolemma and T-tubules and trigger calcium release from the sarcoplasmic reticulum. No tension in muscle, no force is generated yet.

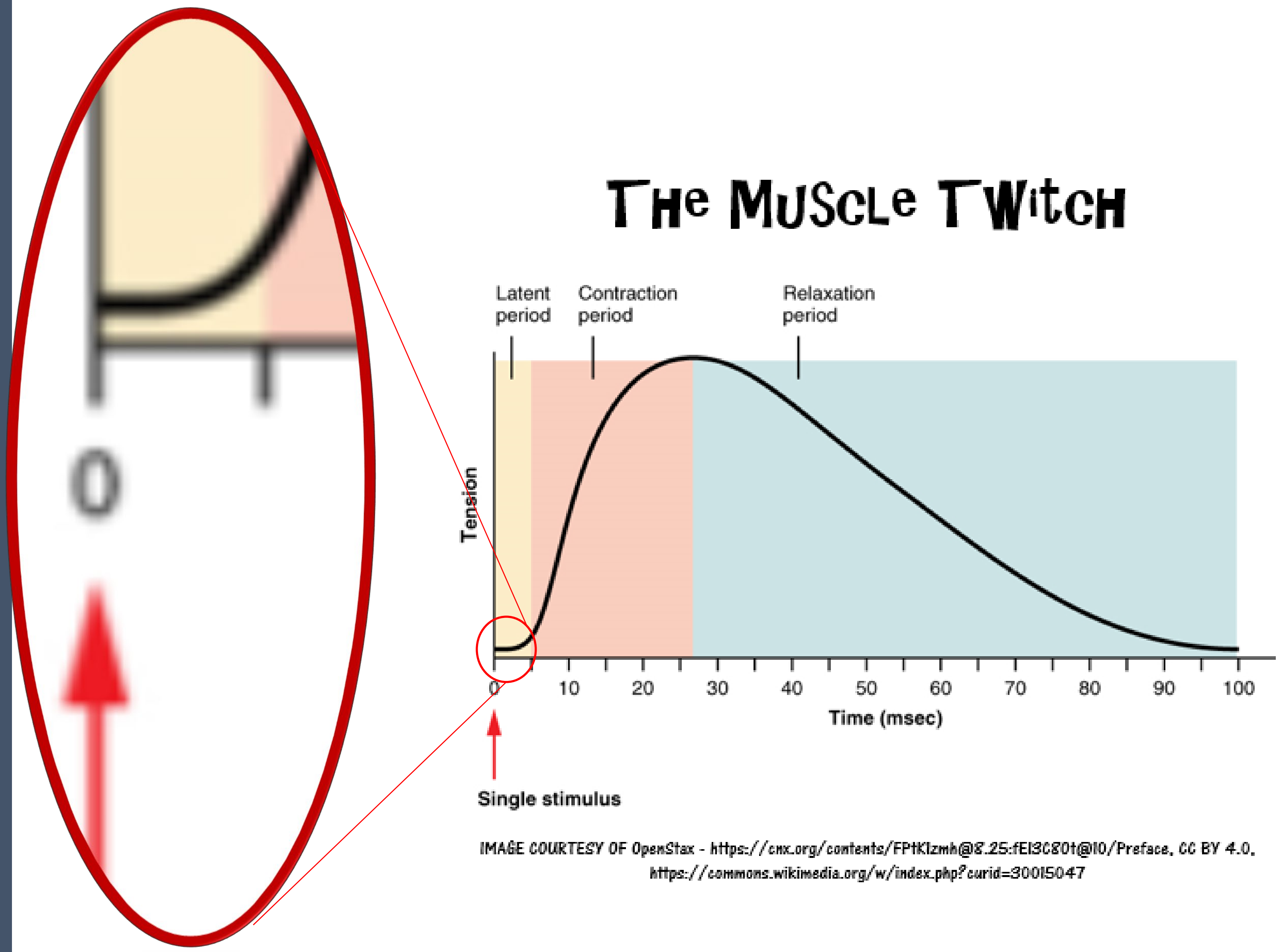


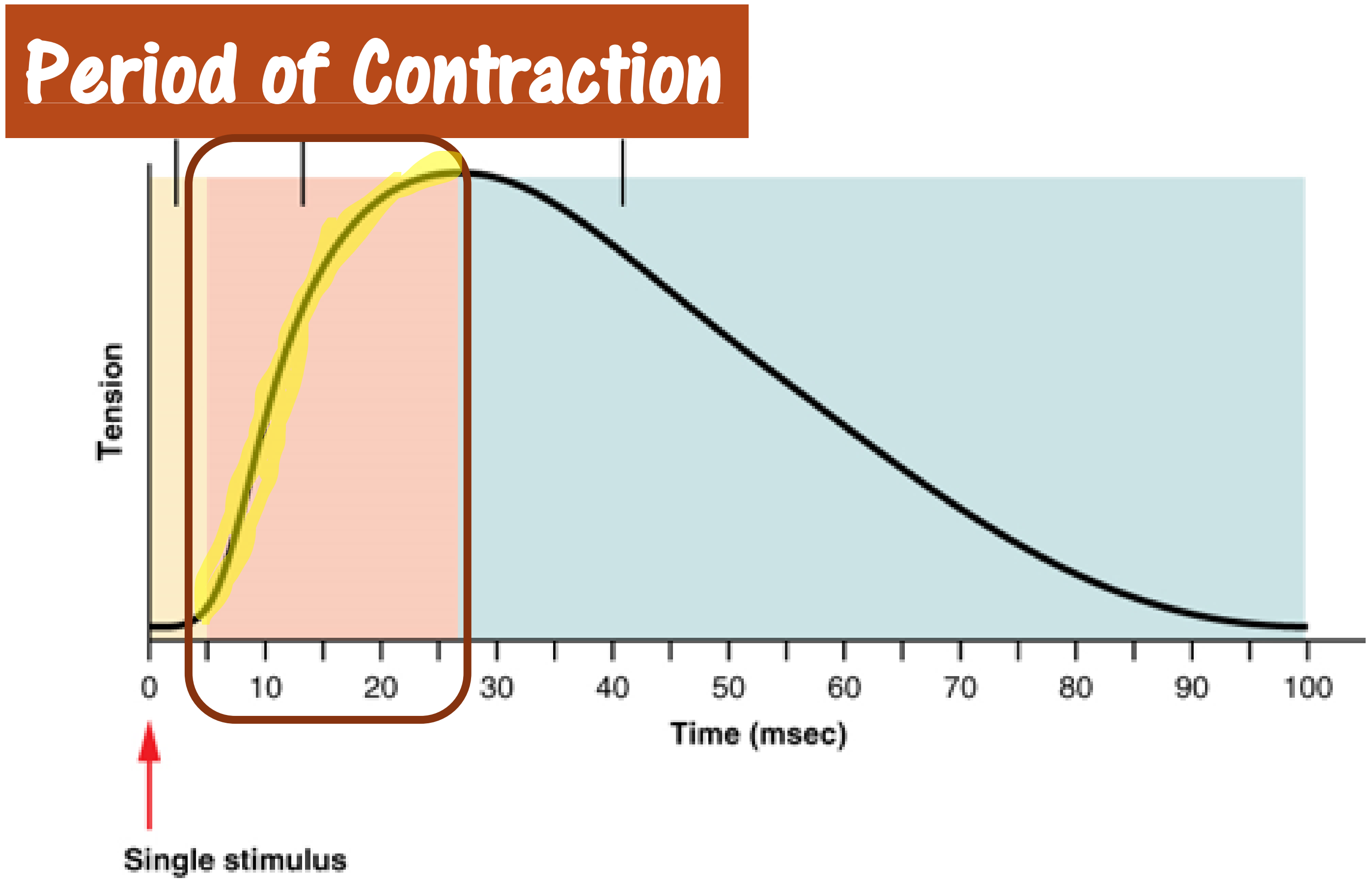

IMAGE COURTESY OF OpenStax - https://cnx.org/contents/FPtK1zmh@8.25:fEI3C8Ot@10/Preface, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=30015047

# The Muscle Twitch

2. Period of contraction.

- Cross bridges are forming.
- The muscle tenses.
    - If the tension becomes great enough to overcome the resistance of the load, the muscle shortens.

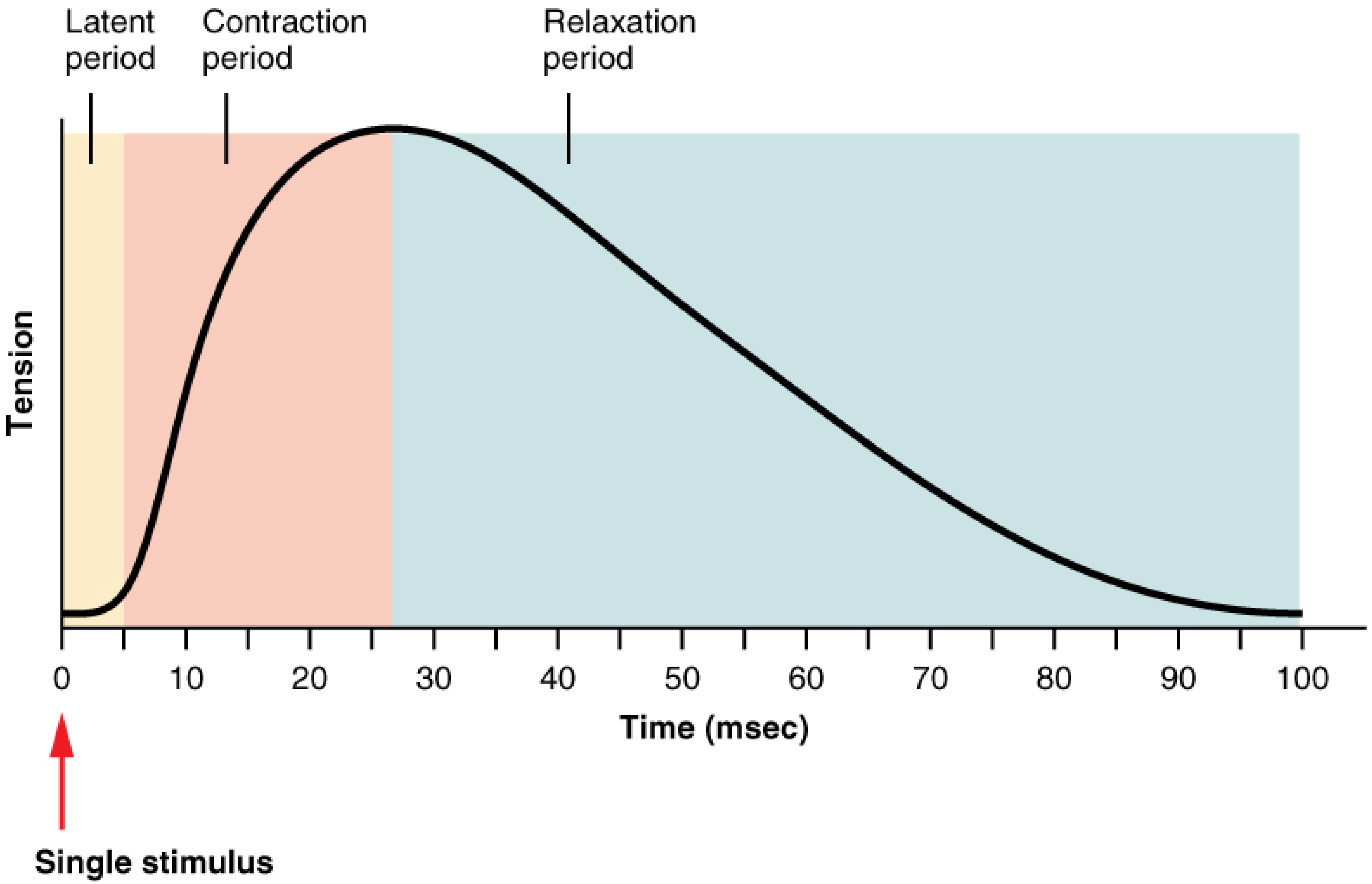
## The Muscle Twitch



# The Muscle Twitch

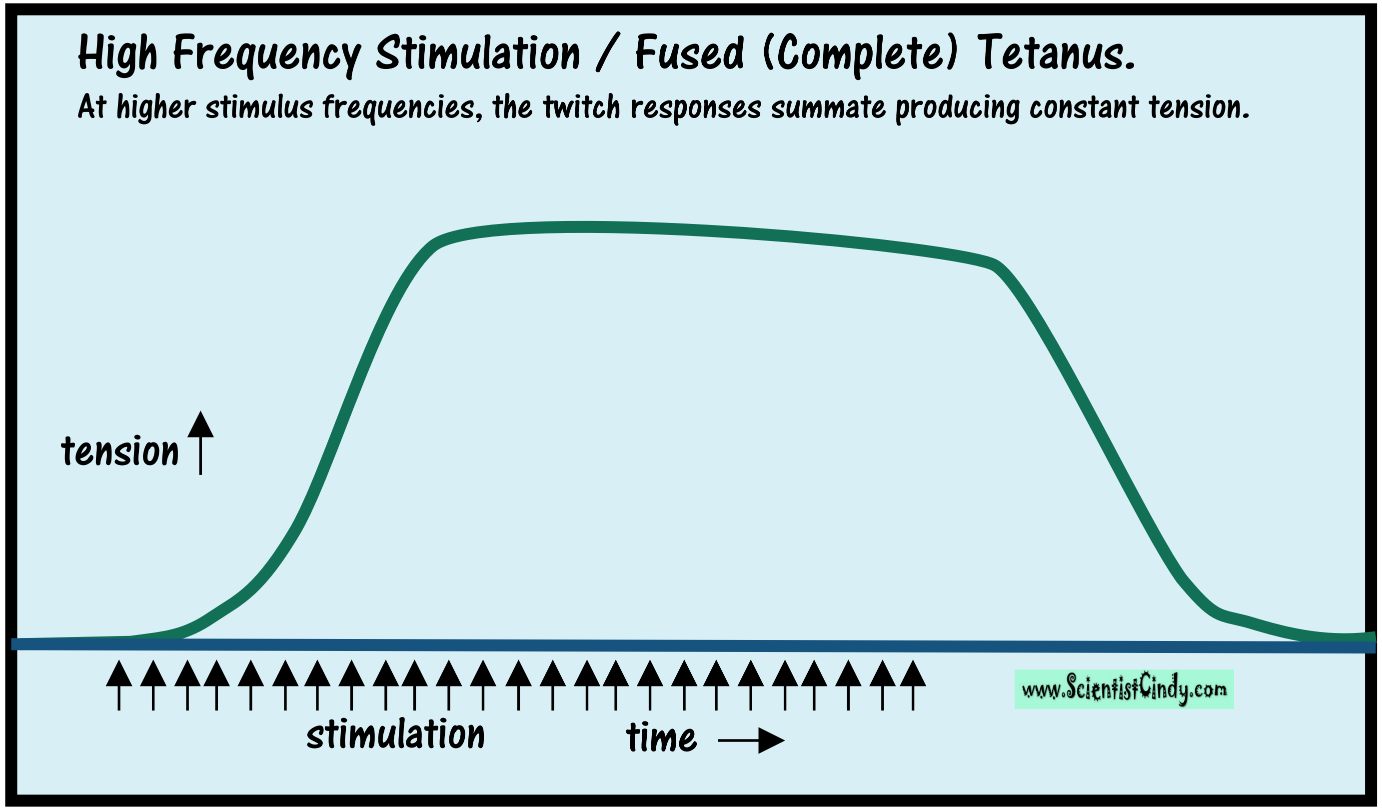
## 3. Period of relaxation.

- Ca2+ reenters the SR.
- The number of active cross bridges is declining.
- Contractile force is declining.
- Muscle tension decreases to zero.
- Myogram tracing returns to the baseline.



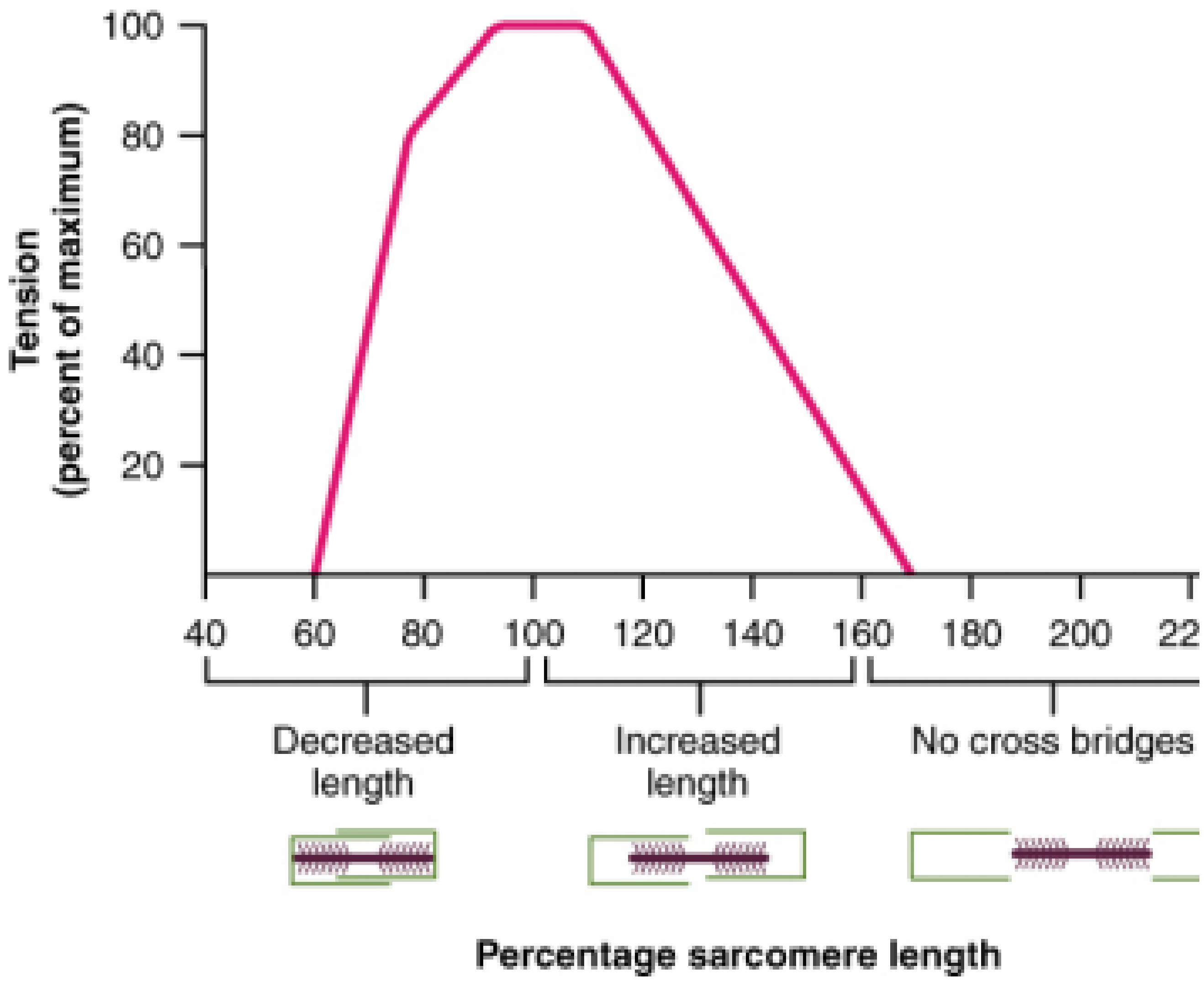
# tetanus

- When there is repeated stimulation, the twitch responses can stack up on top of each other (they are additive) creating prolonged muscle tension, called tetanus or tetanic contractions.



# Length-Tension Relationship

- The amount of tension developed by a muscle is directly proportional to the overlap between the thick and thin filaments. The greater the number of myosin head groups that



# Muscle Fatigue

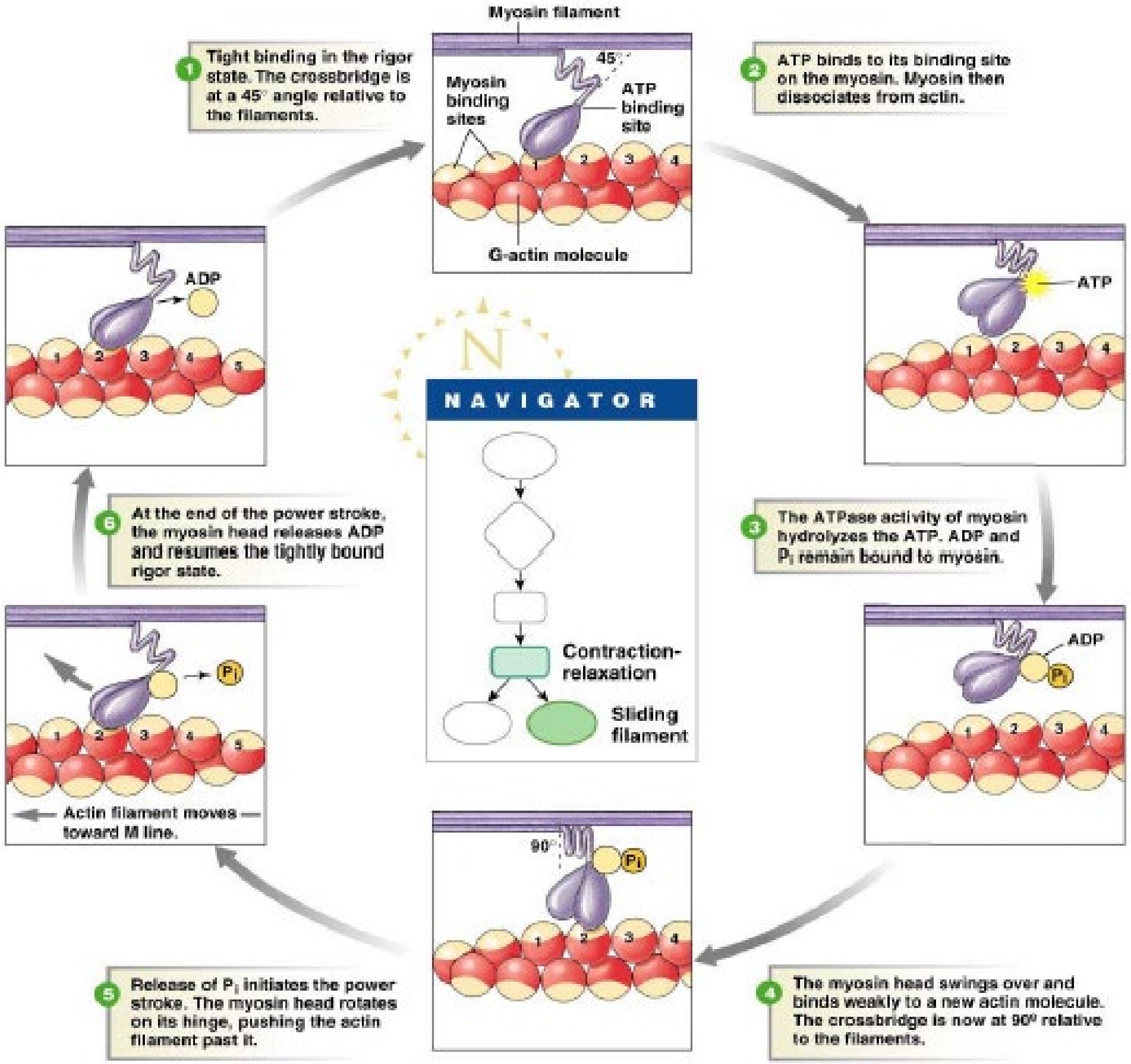
- Muscle fatigue is a state of physiological inability to contract even though the muscle still may be receiving stimuli.

# CROSS-BRIDGE CYCLING

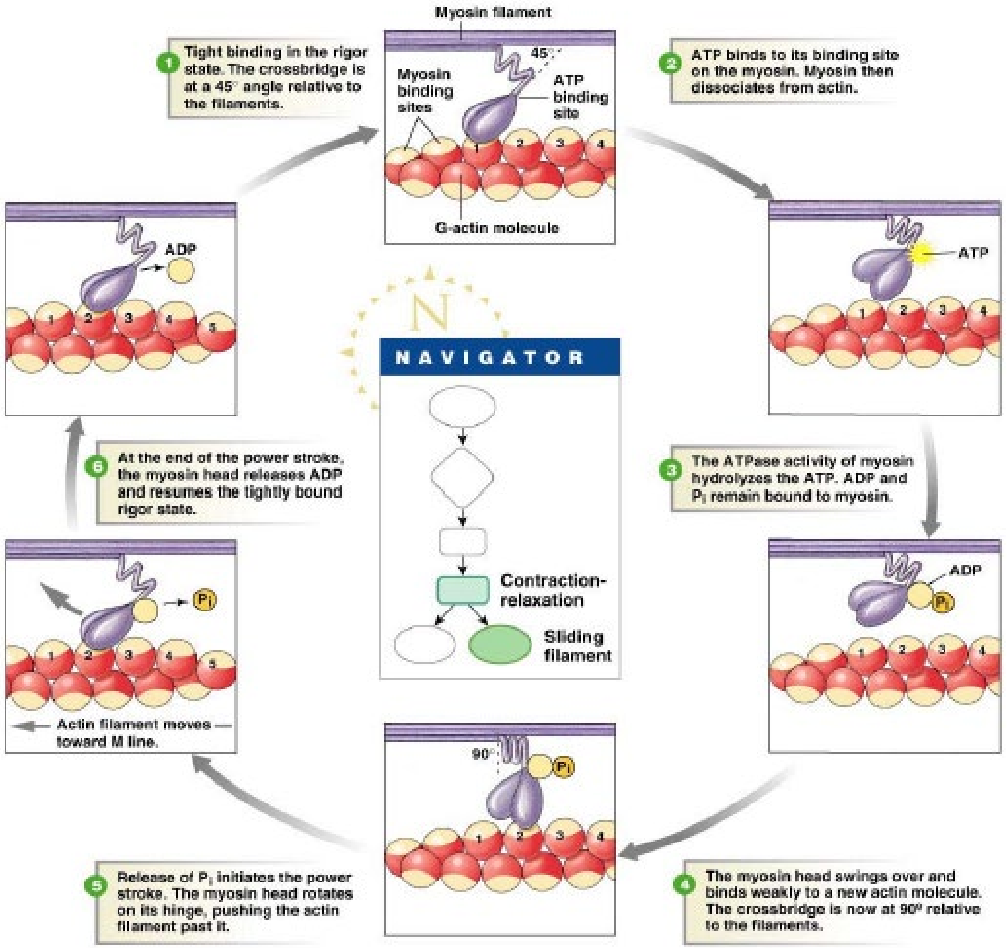
# cross-bridges

- Muscles relax when neural stimulation stops, and calcium is pumped back into the sarcoplasmic reticulum using **ATP**.
- Additionally, ATP stimulates cross-bridge detachment.
- Muscles contract after death, causing what we call **rigor mortis**.
- As dead cells can't make ATP, calcium continues to bind troponin, and cross-bridges remain attached.

# Cross-Bridge Cycling



# Cross-Bridge Cycle

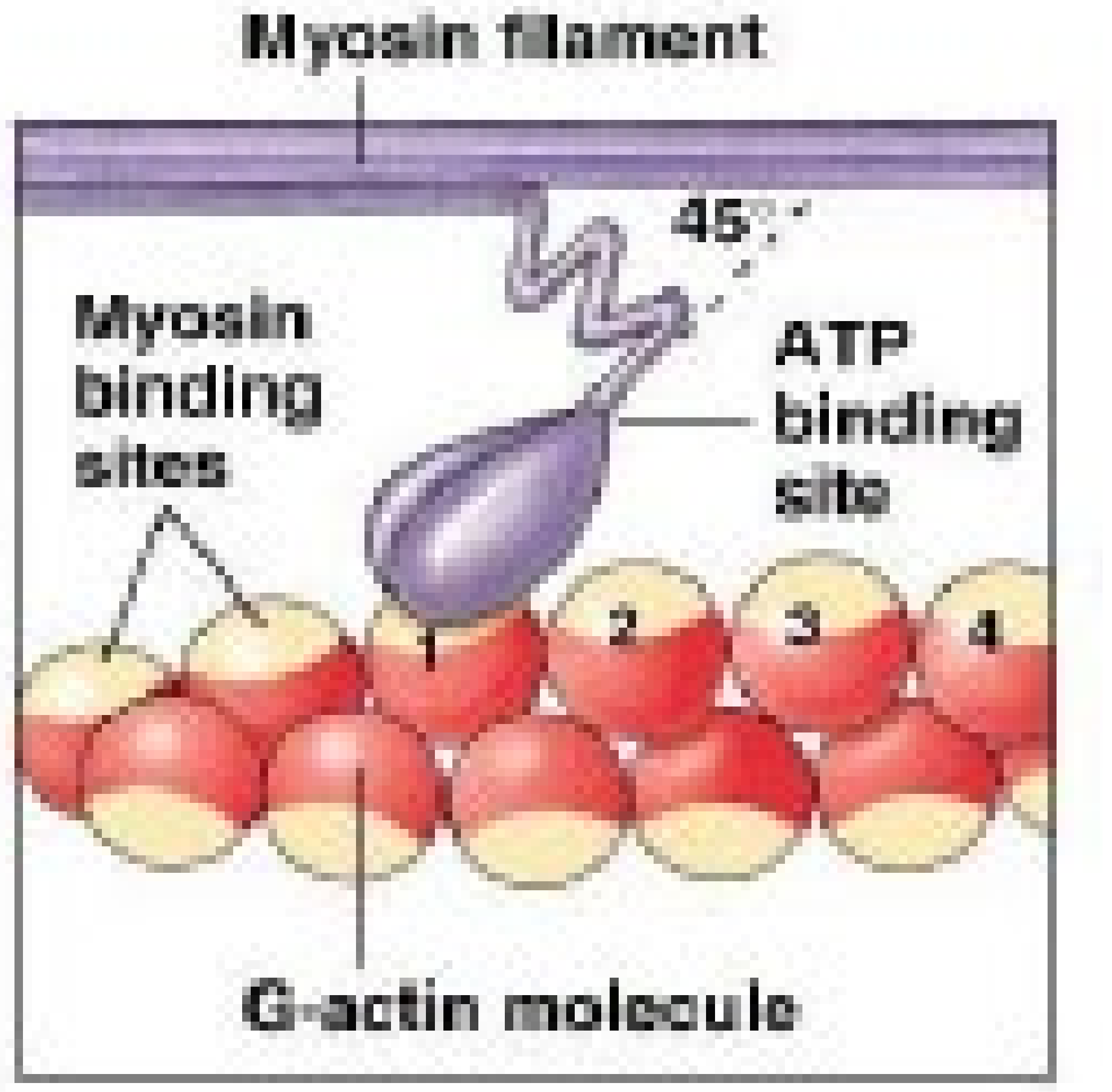


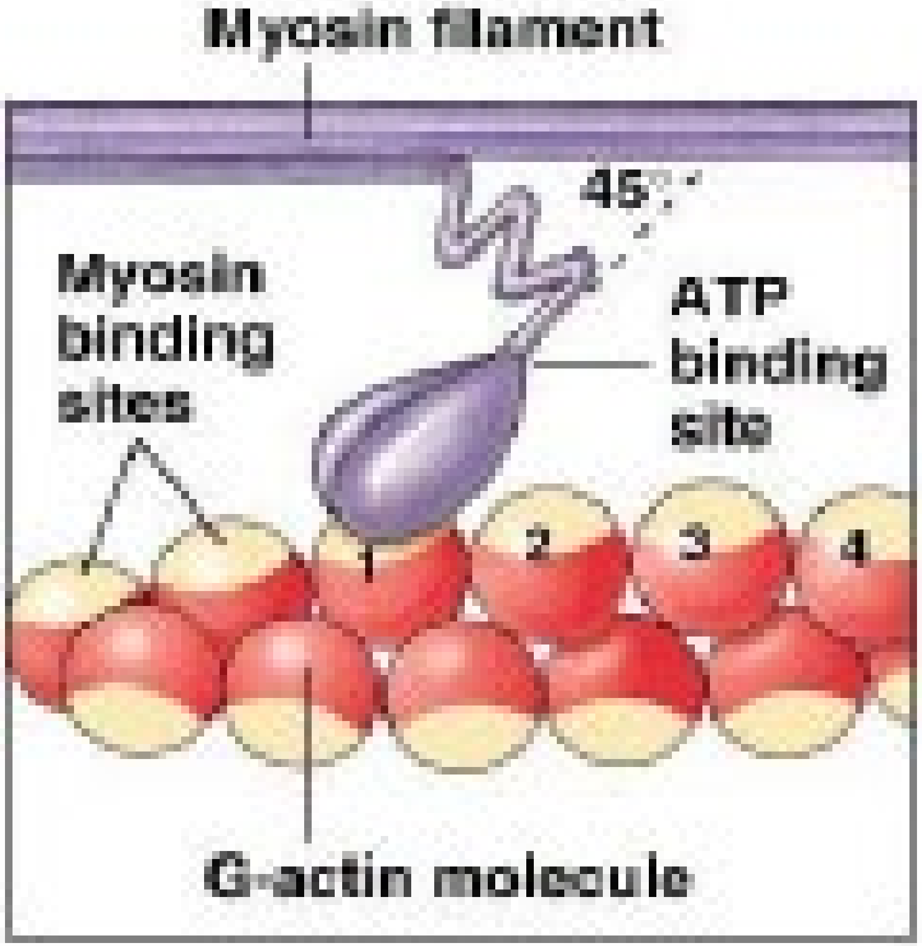


The cross-bridge cycle may be arbitrarily divided into six steps:

# Cross-Bridge Cycle

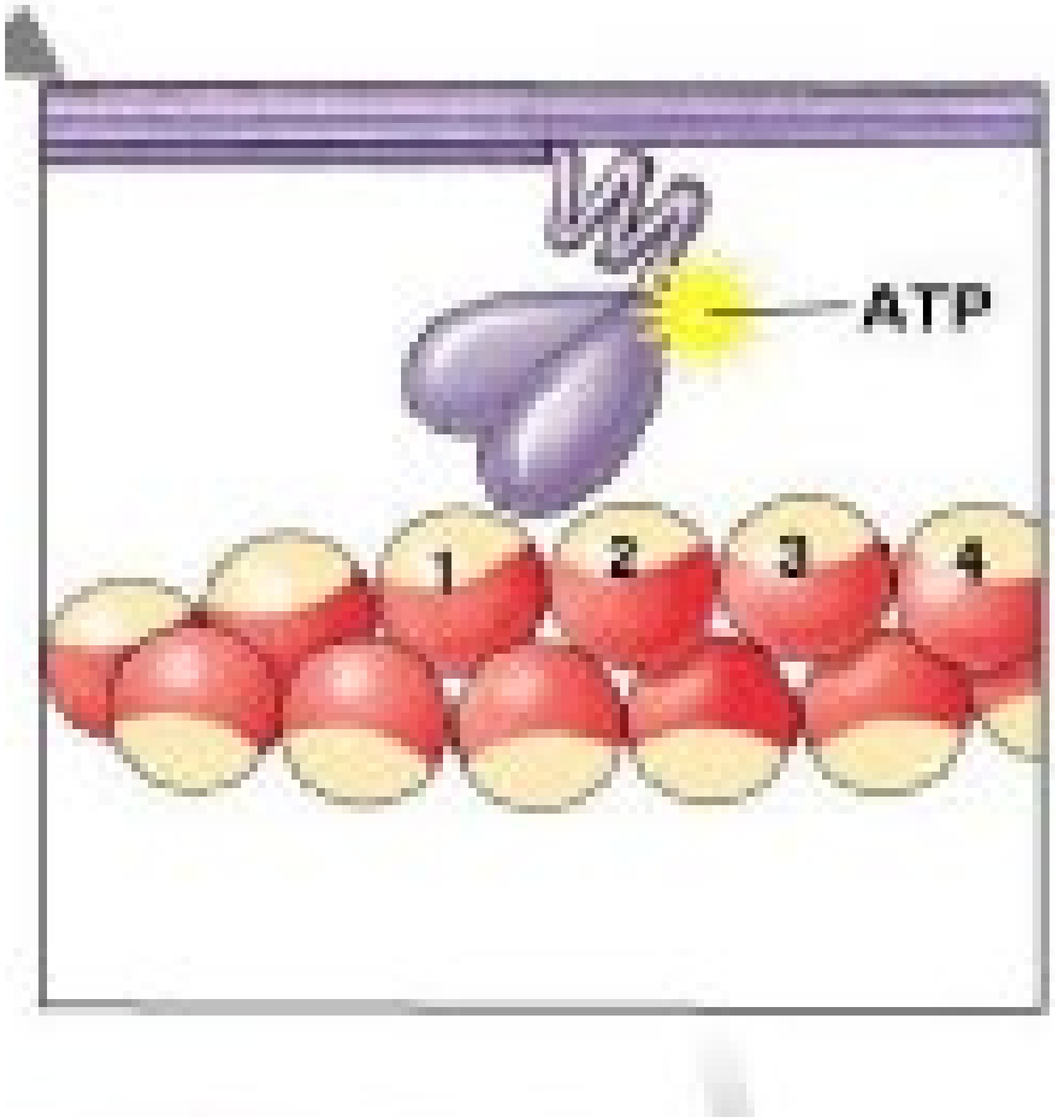
- Step 1. In this step, the myosin head interacts tightly with a G-actin of the thin filament.
- The part of the myosin head group that interacts with actin is referred to as the actin- binding site, and the part of the G-actin molecule that interacts with myosin is referred to as the myosin-binding site.





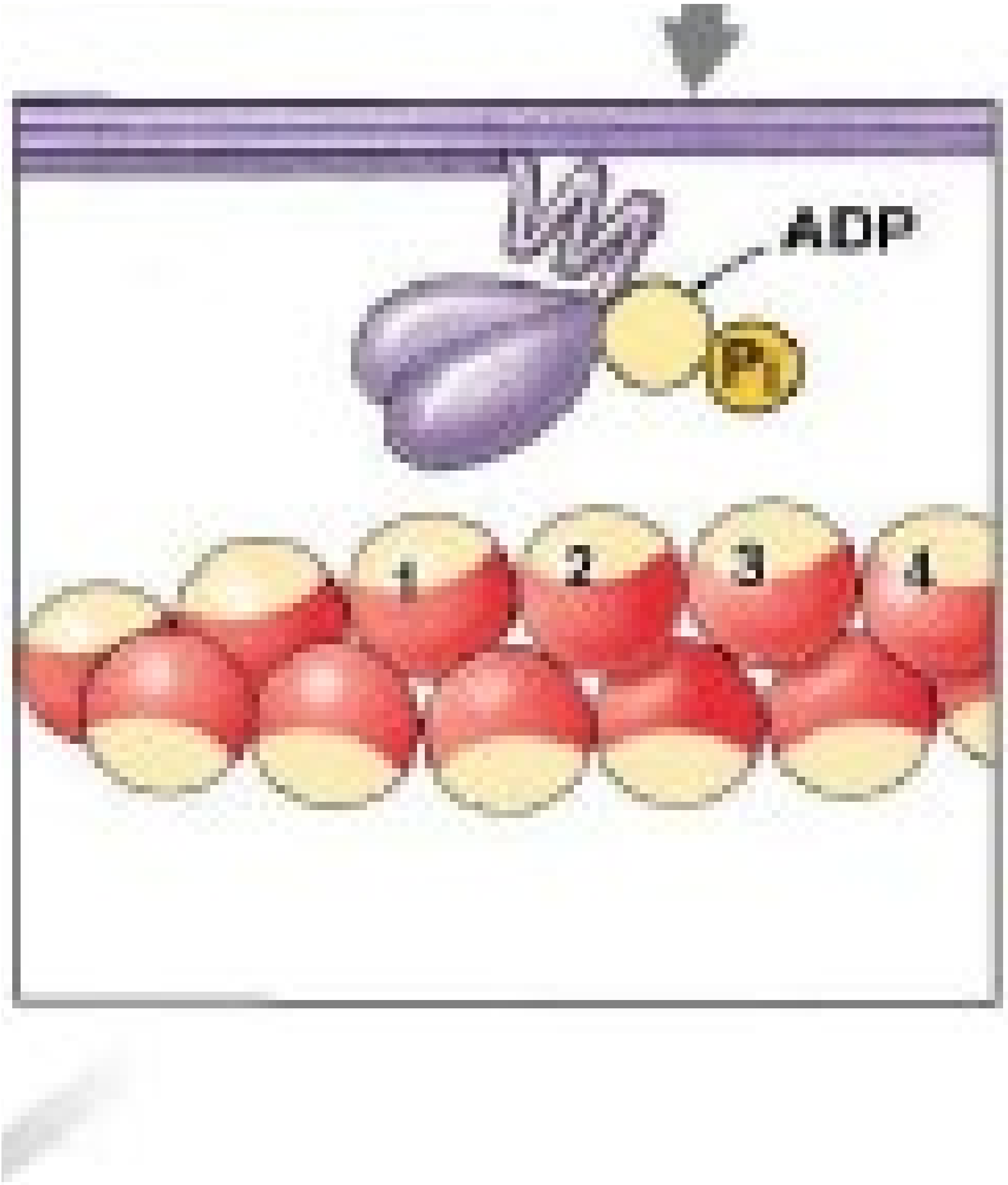

# Cross-Bridge Cycle

- Step 1. In this step, the myosin head makes a 45-degree angle with the thick filament. This is referred to as the rigor state because if there is no ATP present (such as after death), the thin and thick filaments maintain this tight interaction rendering the muscle very stiff.
- Rigormortis




# Cross-Bridge Cycle

- Step 2. In addition to the actin-binding site, the myosin head also has a nucleotide- binding site.
- This is a site where ATP and ADP interact with myosine.
- The cytoplasmic ATP concentration in skeletal muscle cells is 3–5 mM.
- In this step, an ATP molecule binds to the nucleotide-binding site of the myosin head. Binding of ATP causes the release of the myosin head from the G-actin molecule.

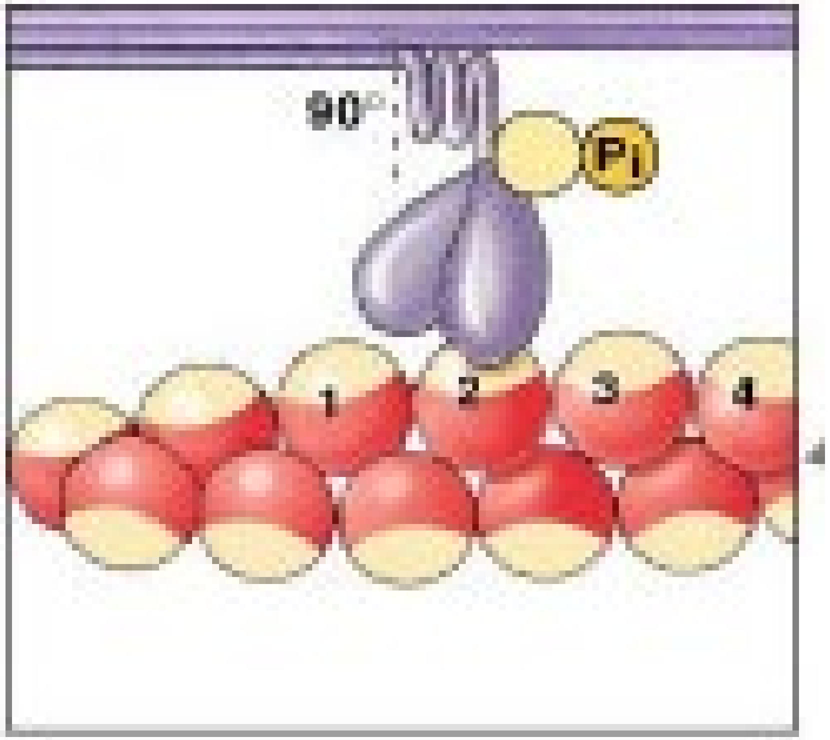



# Cross-Bridge Cycle

- Step 3. Myosin is an ATPase (myosin ATPase) in that it has the ability to hydrolyze ATP to ADP and inorganic phosphate (Pi). In this step, the myosin head converts the bound ATP to ADP and Pi. Both ADP and Pi remain bound to the myosin head.

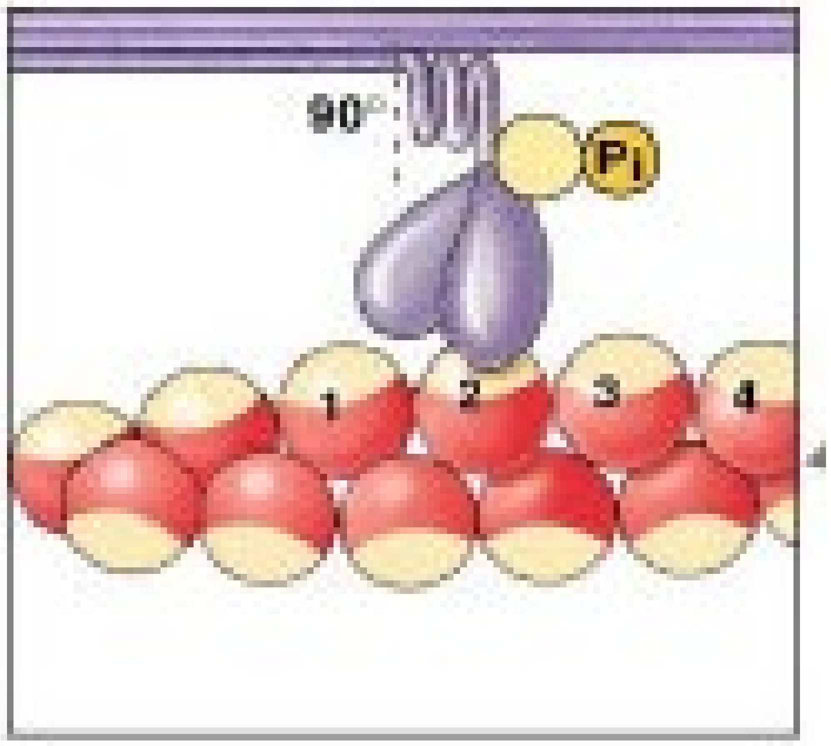
# Cross-Bridge Cycle

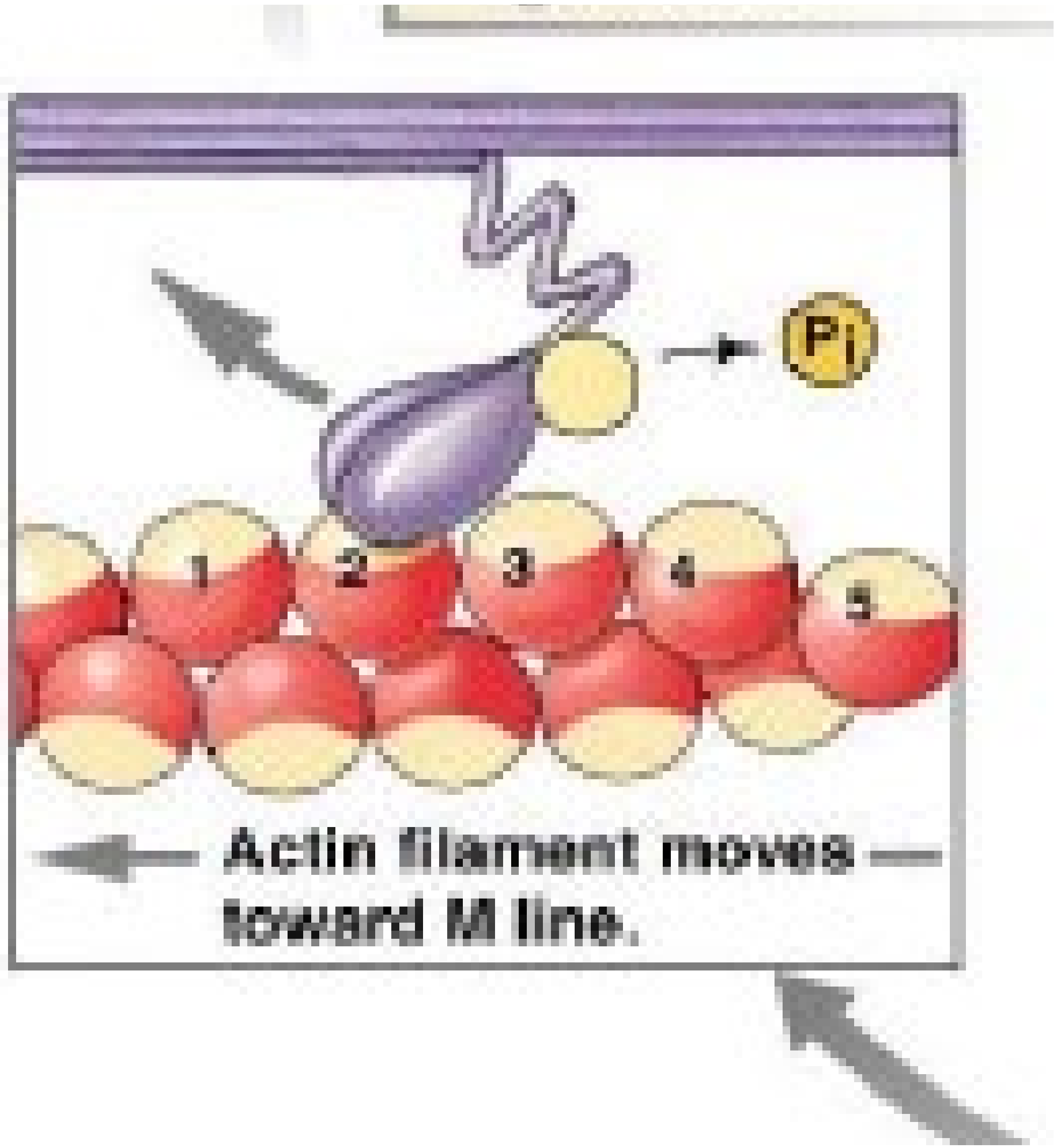
- Step 4. The energy released from the hydrolysis of ATP is used to change the conformation of the myosin head, so that now it makes a 90-degree angle with the thick filament.
- This change in conformation "energizes" the myosin head (i.e., it places it in a high-energy state). At this point, if sufficient Ca2+ is present in the cytoplasm (see Excitation-Contraction Coupling below), the myosin head attaches to a G-actin one or two positions away from the one bound in Step 1.



# Cross-Bridge Cycle

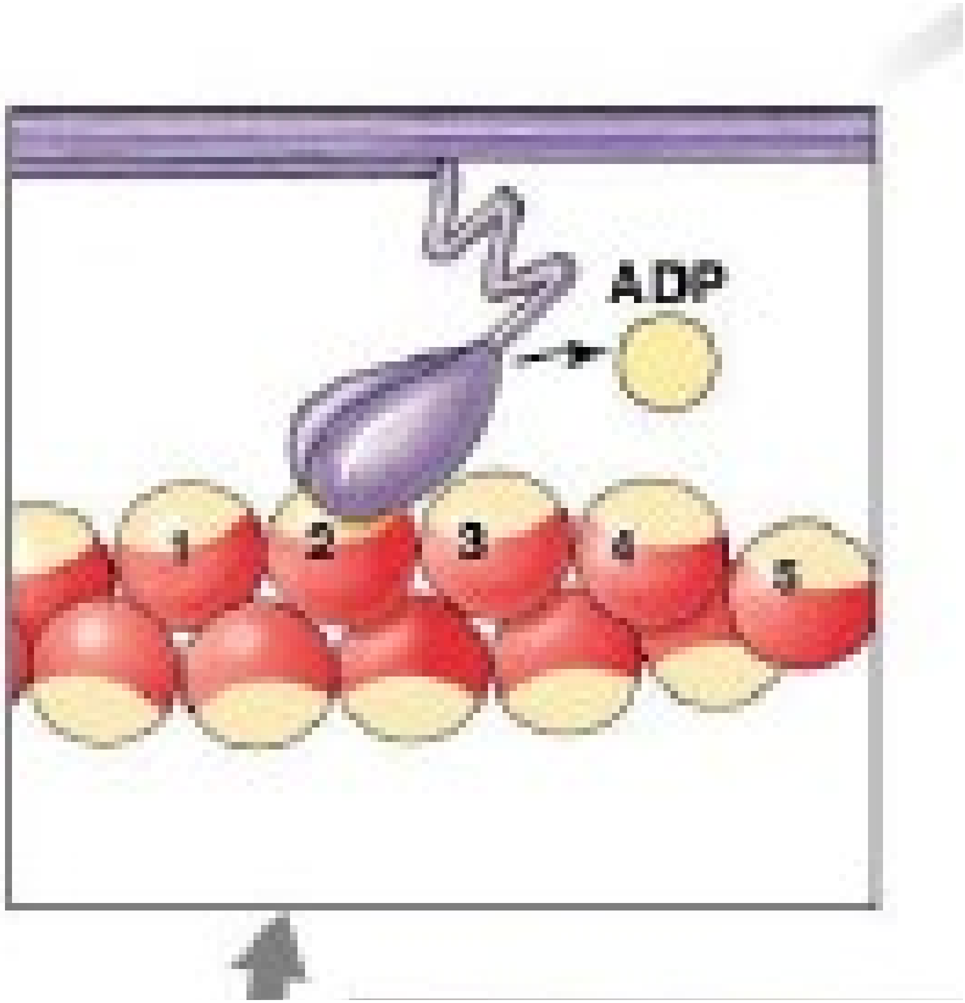
- Step 4. If there is not enough Ca2+ present in the cytoplasm, the myosin head remains in this energized 90-degree angle.
- A rise in cytoplasmic Ca2+ concentration is essential and evokes a series of events that facilitates the binding of myosing head to G-actin again.
- Please note that the relaxed state refers to the muscle cell and not to the conformation of the myosin molecule. At rest, most skeletal muscle fibers are in this “relaxed state”.





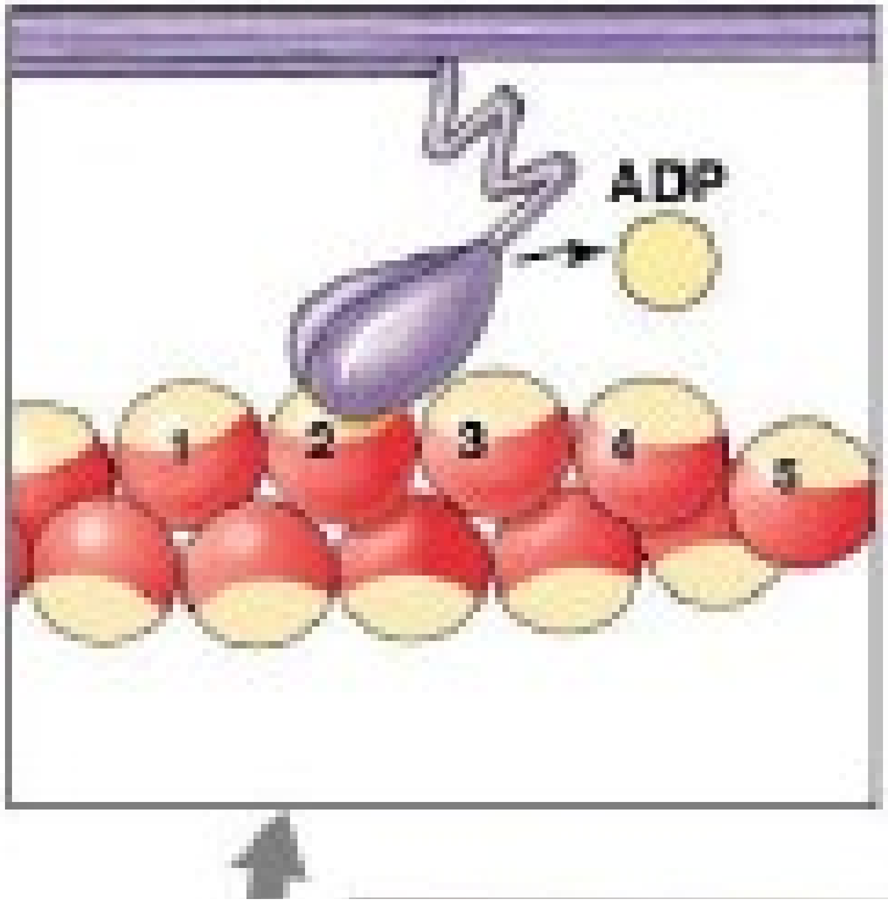

# Cross-Bridge Cycle

- Step 5. This is the power stroke step. Now Pi is released from the myosin head. As Pi  is released, the energized 90-degree angle myosin head begins to assume its original 45- degree angle.
- However, as it is bound to a G-actin of the thin filament, the change back  to the 45-degree angle moves the actin thin filament toward the center of the sarcomere (M line).



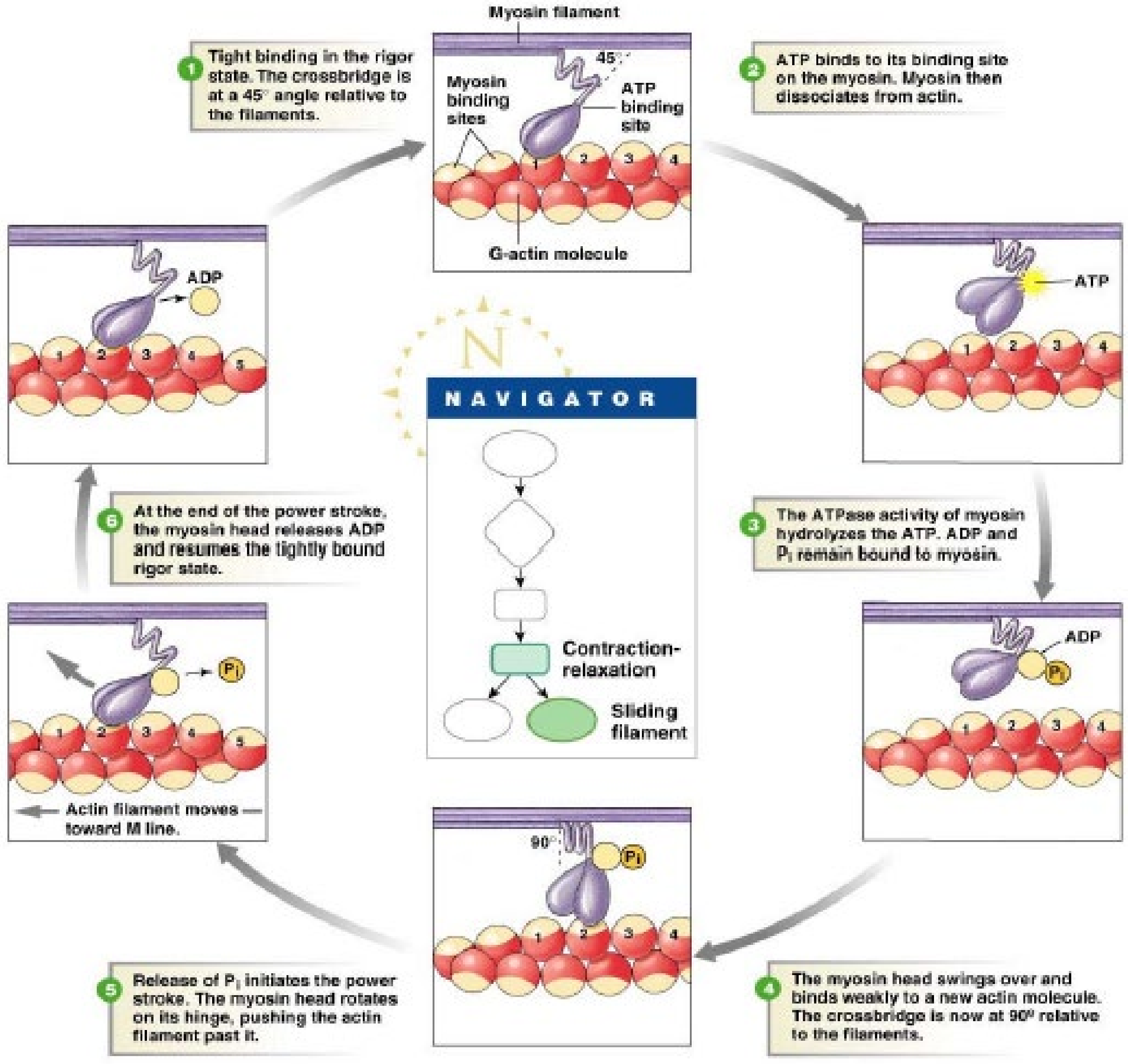

# Cross-Bridge Cycle

- Step 6. At this point, ADP is released from the myosin head, and the myosin head remains tightly bound to the G-actin. This brings us back to the beginning of the cycle at Step 1. If there is ATP around (and if the cytoplasmic Ca2+ concentration is high; see below), the cycle will repeat itself again and again. The repeated action of the cross- bridge cycle results in the sliding of the thin filaments over the thick filaments, which will lead to muscle shortening.

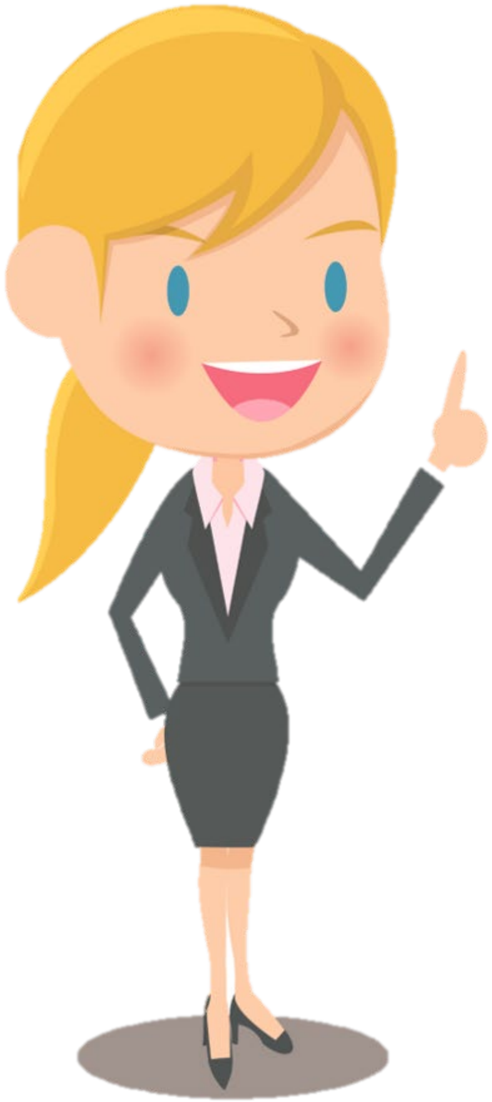


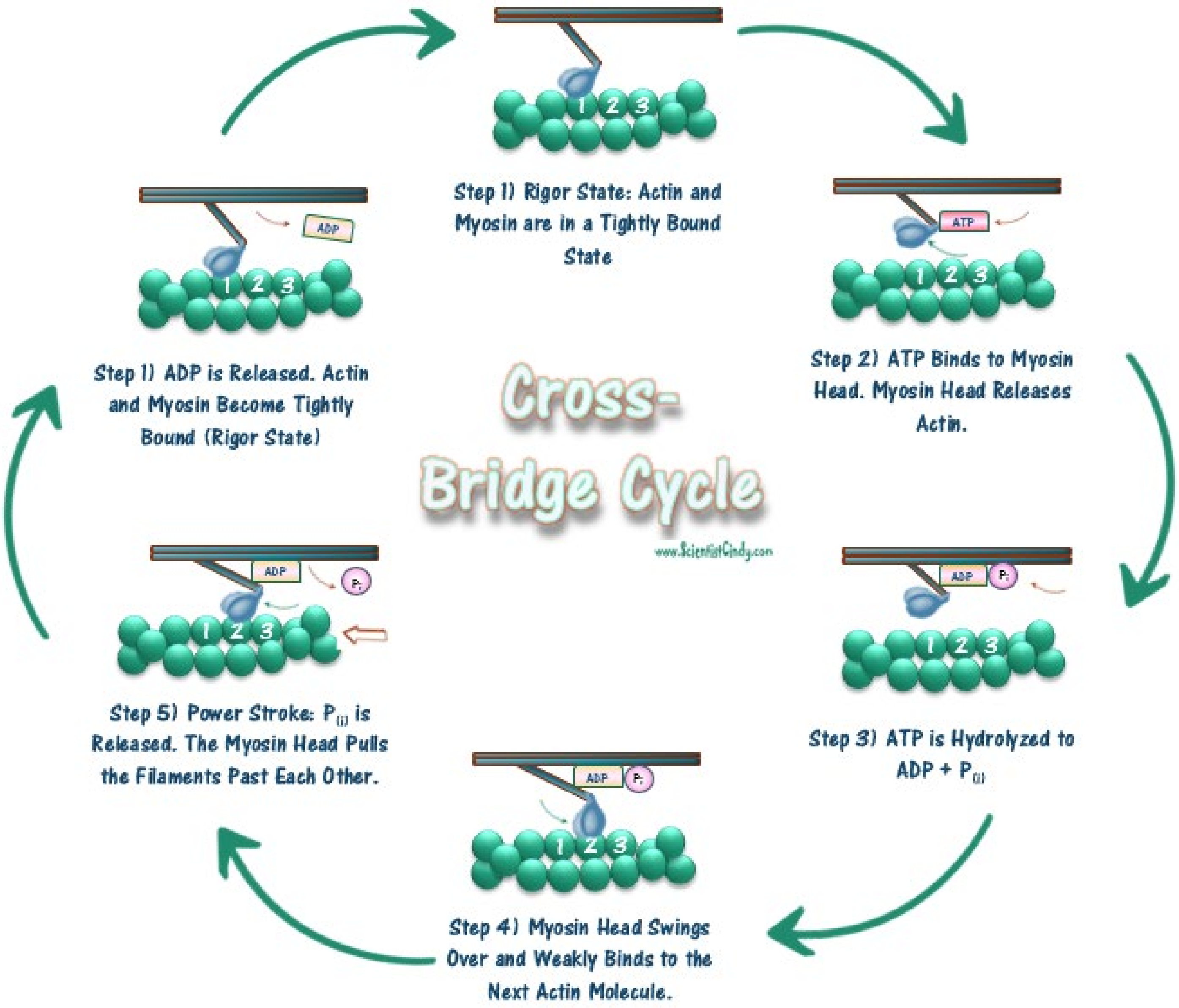

- It is important to emphasize that the cross-bridge cycle can take place only if the cytoplasmic Ca2+ concentration is high.
- Thus, when skeletal muscles are at rest and the cytoplasmic Ca2+ concentration is low, the cross-bridge cycle does not take place.
- Instead, the myosin head groups remain in an "energized" state.

# Cross Bridge Cycle

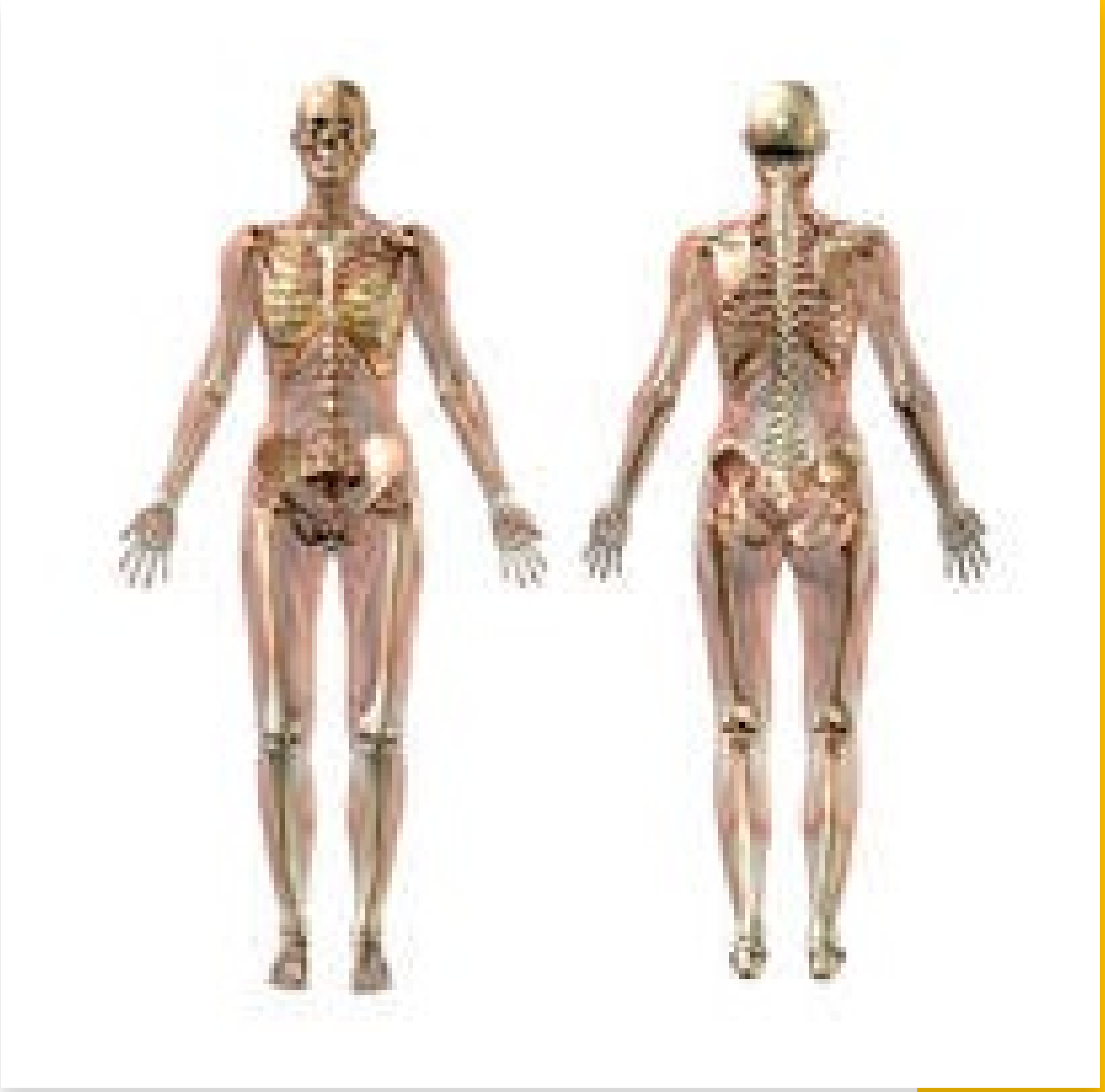


# Cross Bridge Cycle





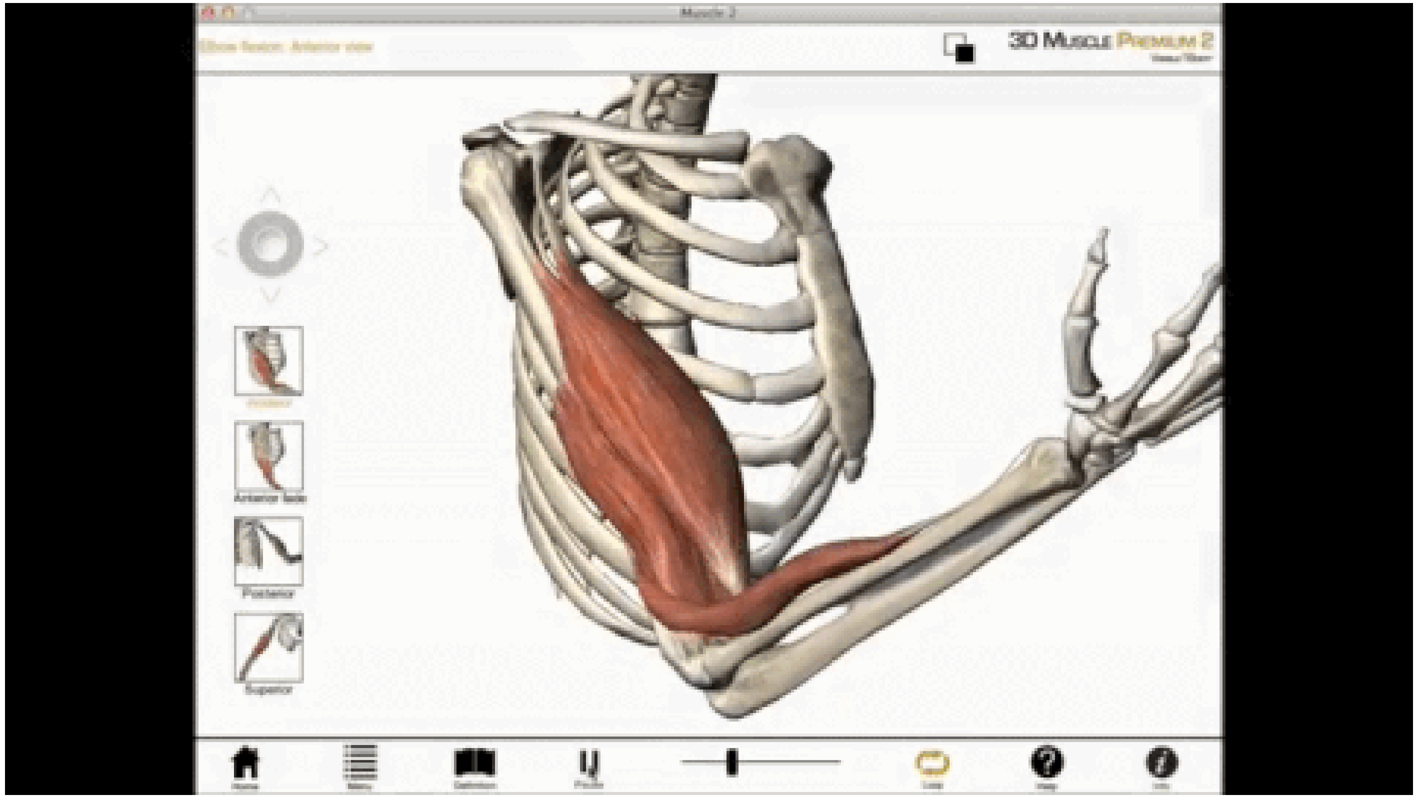
# The Muscles of the Limbs



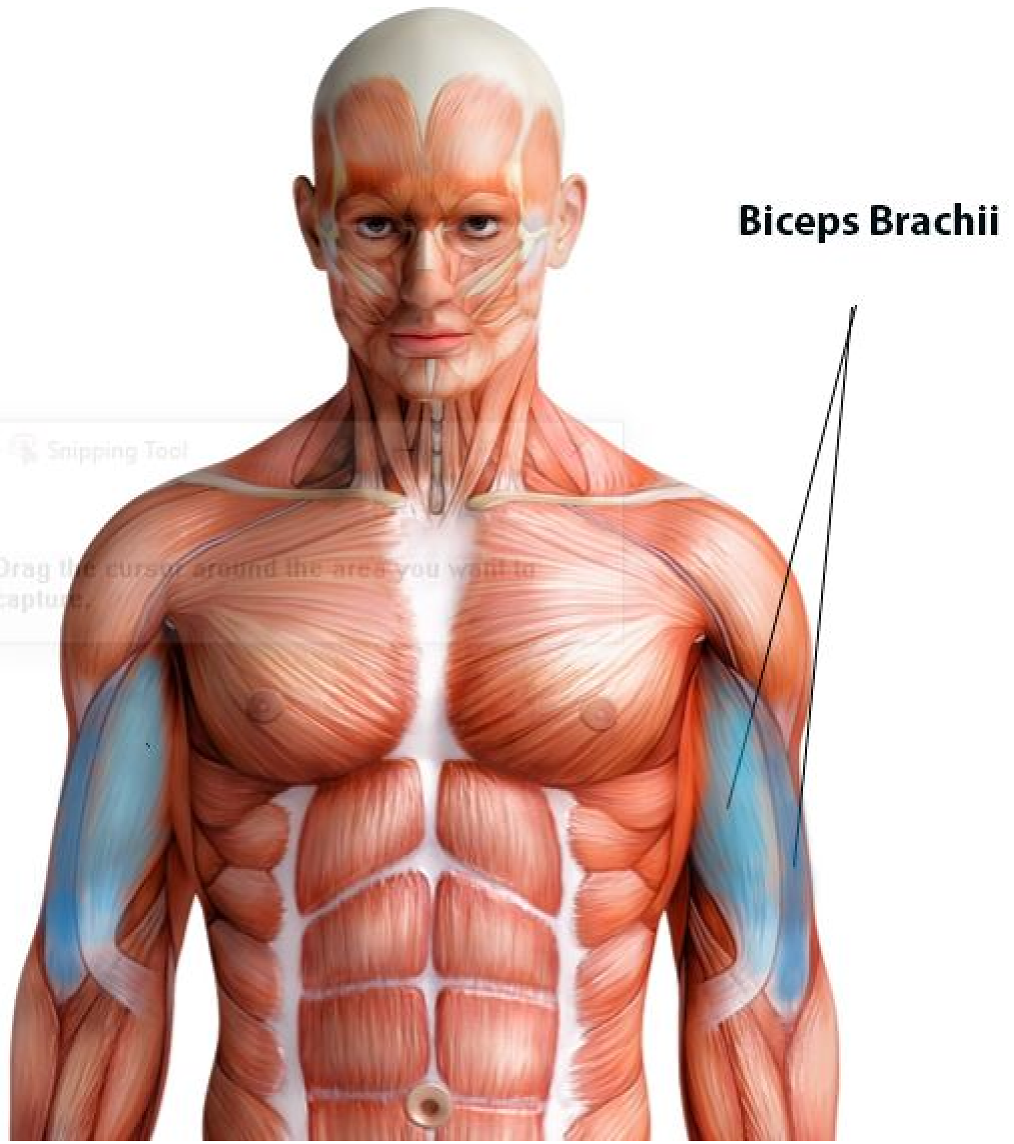
# The muscles of the brachial region

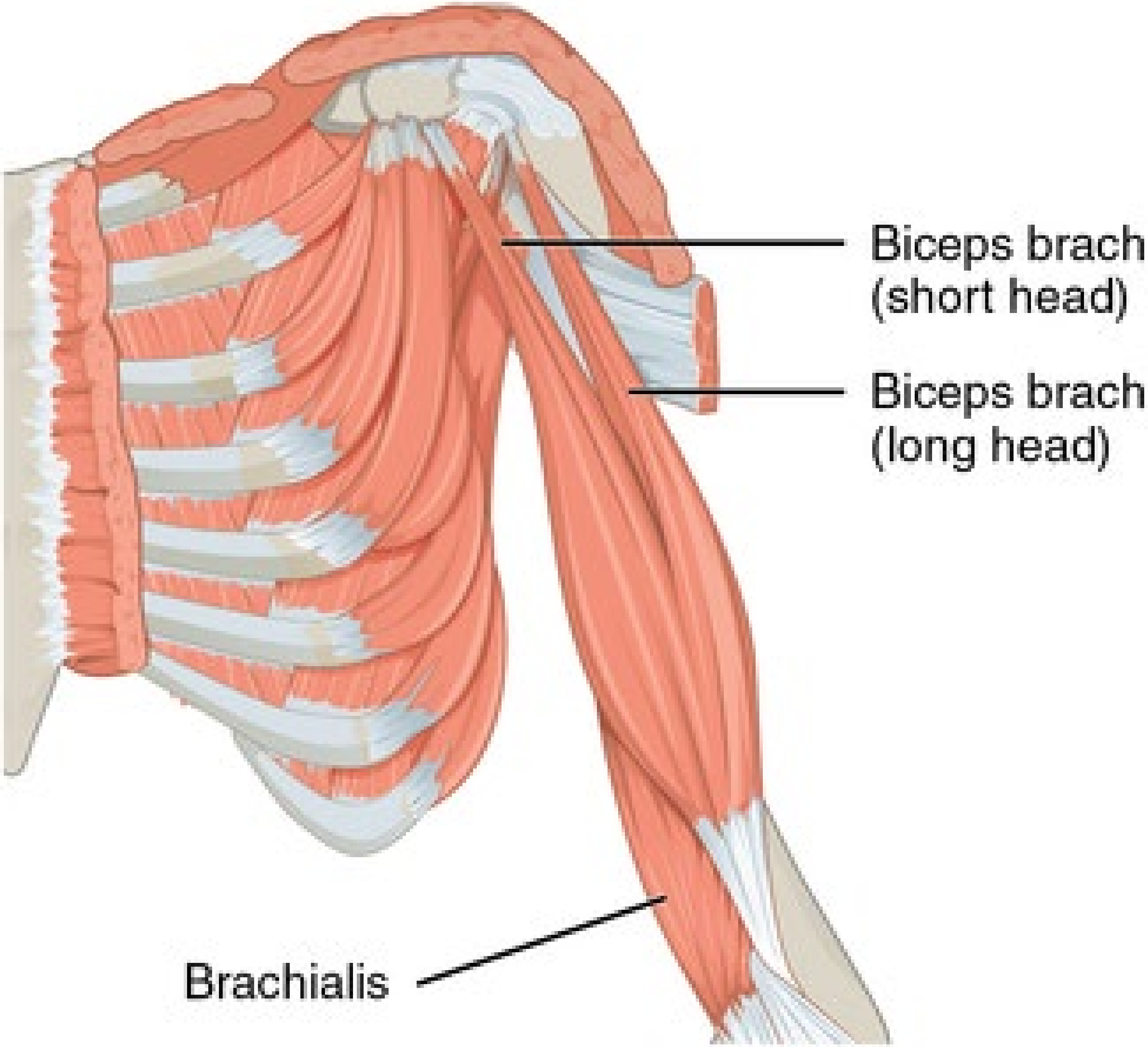
- The muscles of the brachial region span the elbow joint.
- The muscle of the brachial region have their origin in the brachial region (upper arm area) and attach to the antebrachial region (lower arm area) on the forearm bones (radius and ulna).

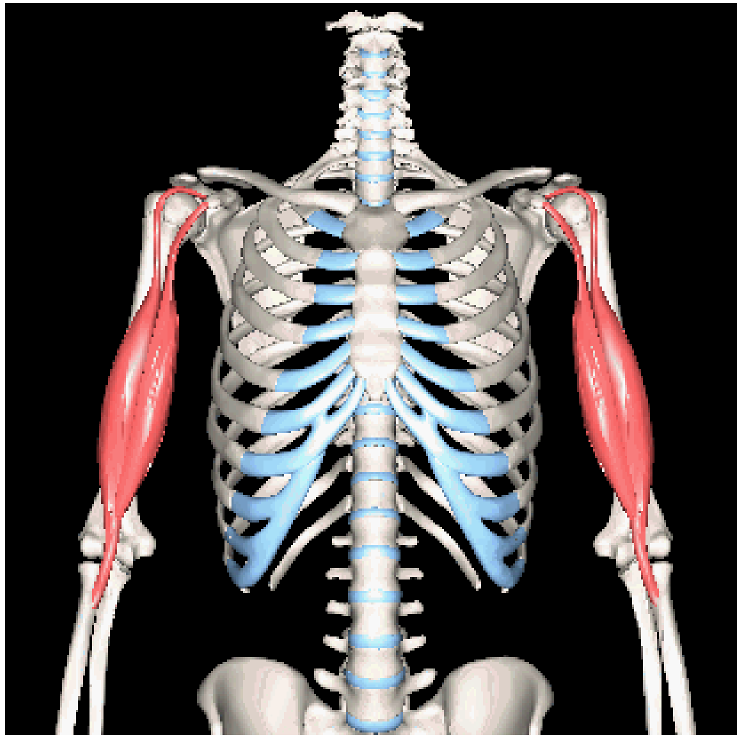
# The Biceps Brachii
# Function = Flexion of forearm

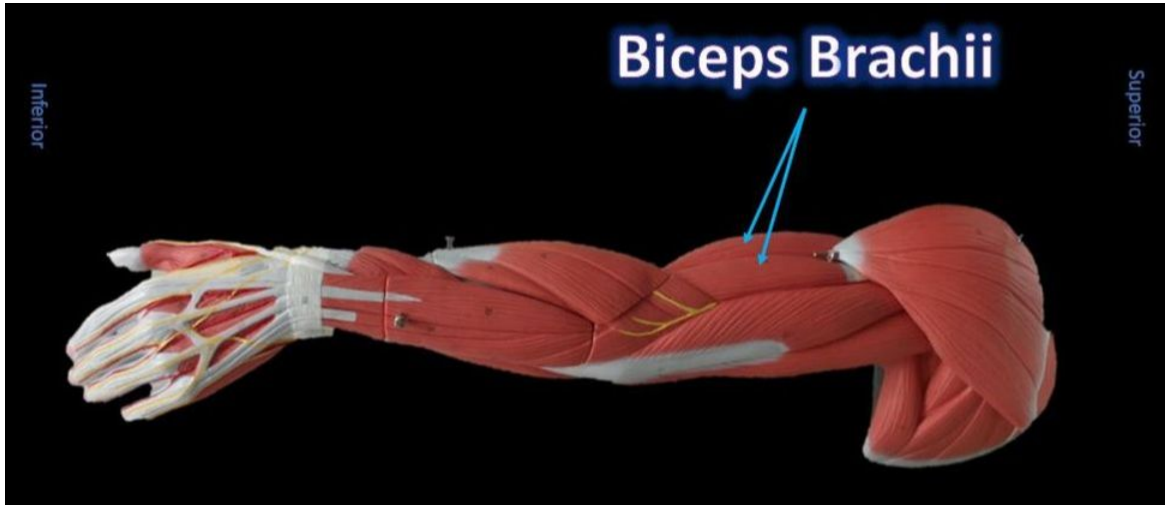


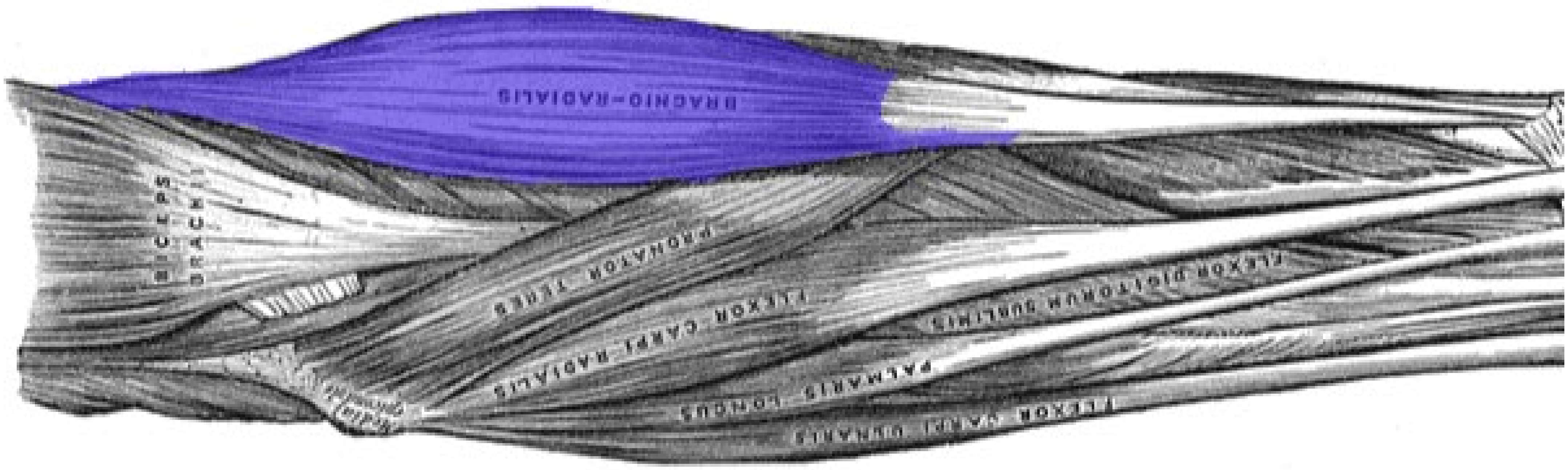

- The biceps brachii is a "two-headed" fusiform muscle. The biceps brachii functions to flex the forearm and to supinates it.
  - This muscle cannot flex the forearm without also supinating it, so it is ineffective when one lifts a heavy object with a pronated hand that must stay pronated.
  - (This is why doing chin-ups with palms facing anteriorly is harder than with palms facing posteriorly.)


Biceps Brachii
Snipping Tool
Drag the cursor around the area you want to capture.


Biceps brach
(short head)
Biceps brach
(long head)
Brachialis

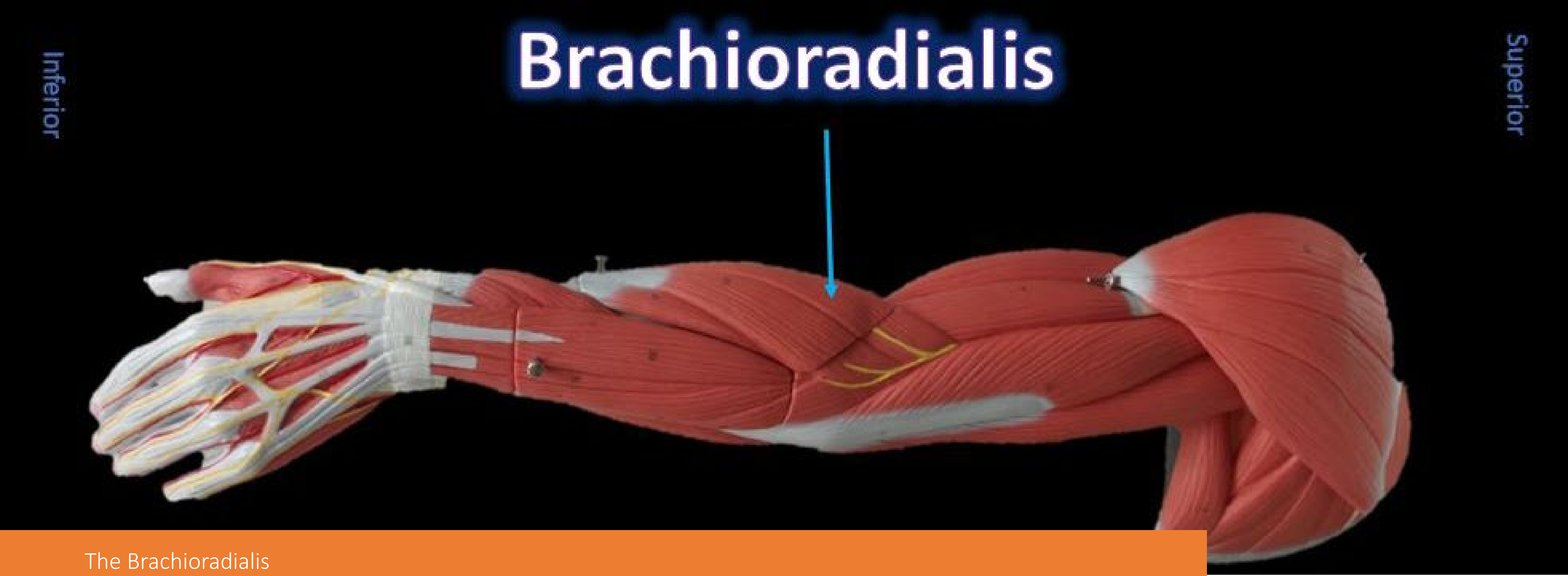



Biceps Brachii
Inferior
Superior



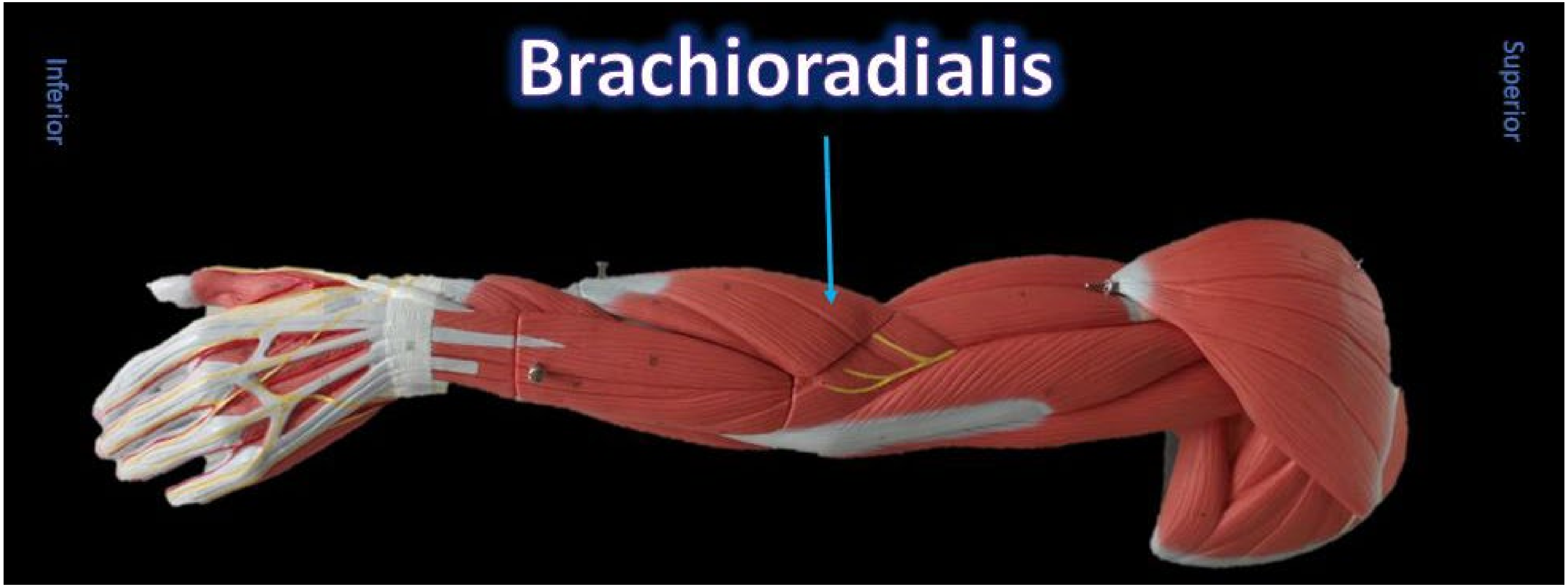
# The Brachioradialis Function = Flexes forearm at the elbow

- The brachioradialis is a weak flexor muscle of the forearm that functions to flex the forearm at the elbow.
  - It is the superficial muscle that lies mostly in the forearm.




The Brachioradialis
Function = Flexes forearm at the elbow

- The brachioradialis is a weak flexor muscle of the forearm that functions to flex the forearm at the elbow.
  - It is the superficial muscle that lies mostly in the forearm.



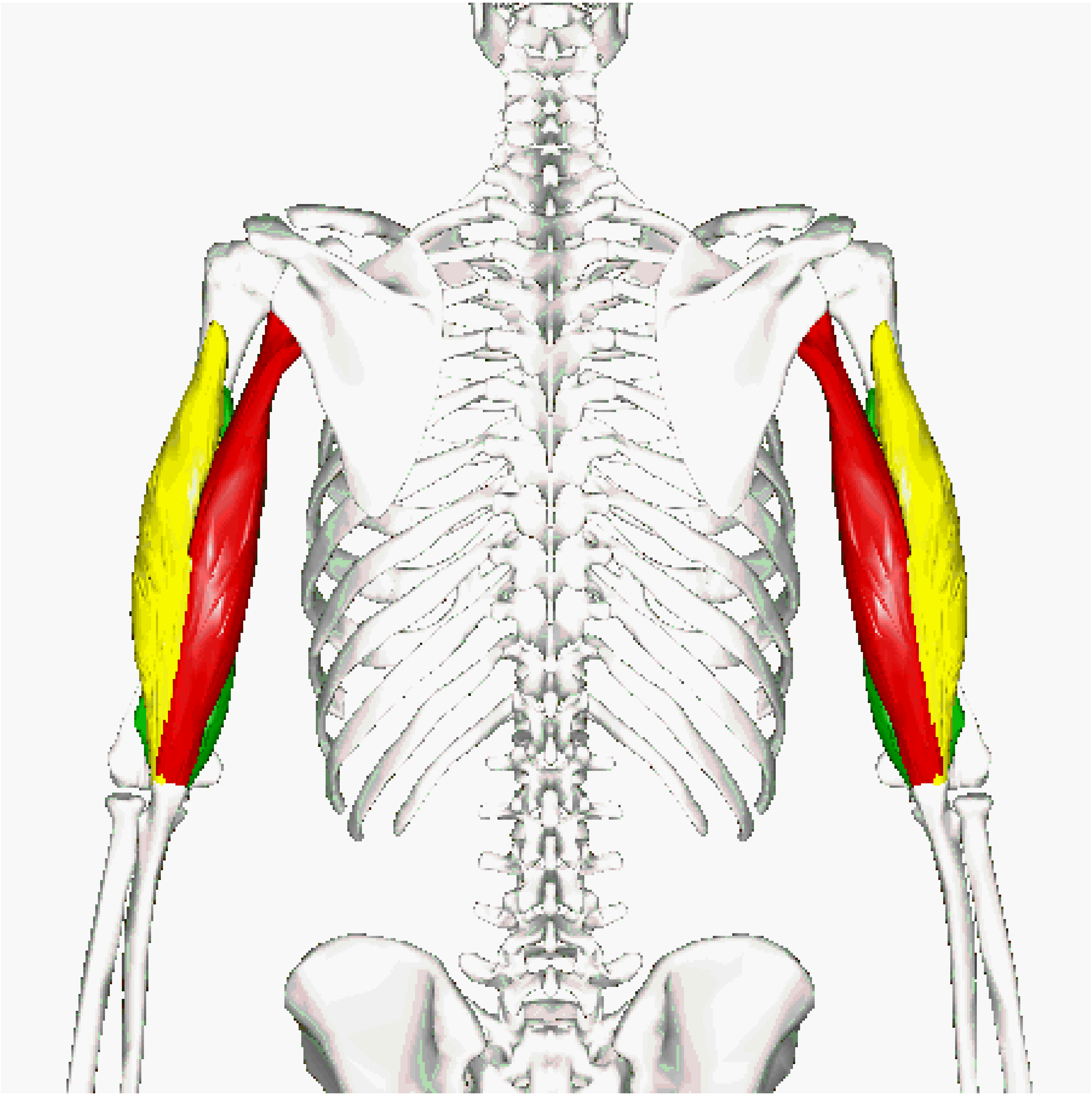

# The Brachioradialis Function = Flexes forearm at the elbow

- The brachioradialis lies at the radial side of the proximal antebrachial region.
- On the anatomical model, this muscle is found by following the lateral most nerve (yellow) at the elbow region.

# Triceps Brachii Function = Main extensor of forearm

- **The Triceps gets its name from the fact that it has three "heads";**

**KEY -**
**Long head (RED)**
**Lateral head (YELLOW)**
**Medial head (GREEN)**



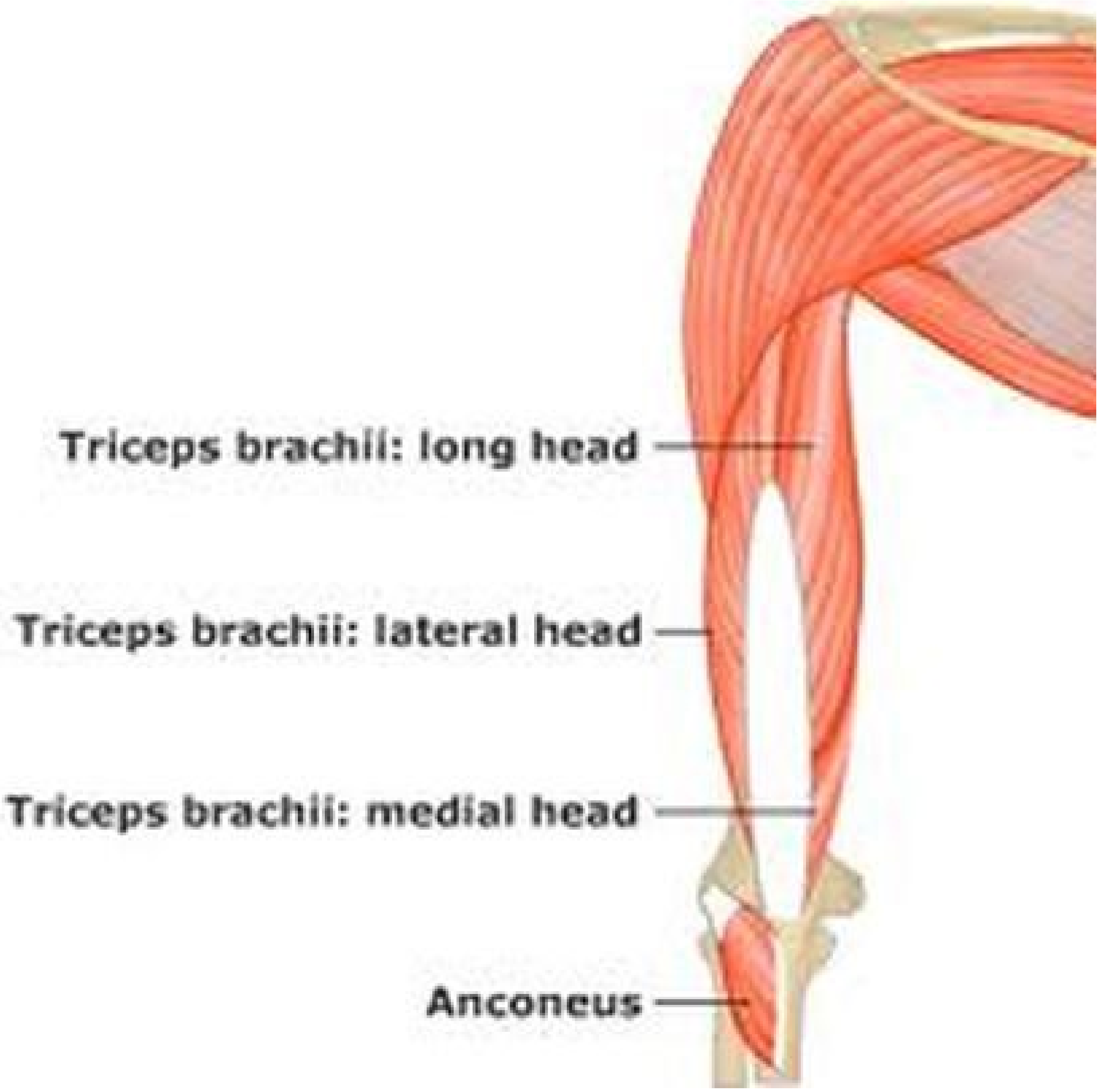
# Triceps Brachii

- The main extensor (prime mover) of the forearm is the triceps brachii.
- The triceps brachii function to extend the arm, which increases the angle between the upper and lower arm.

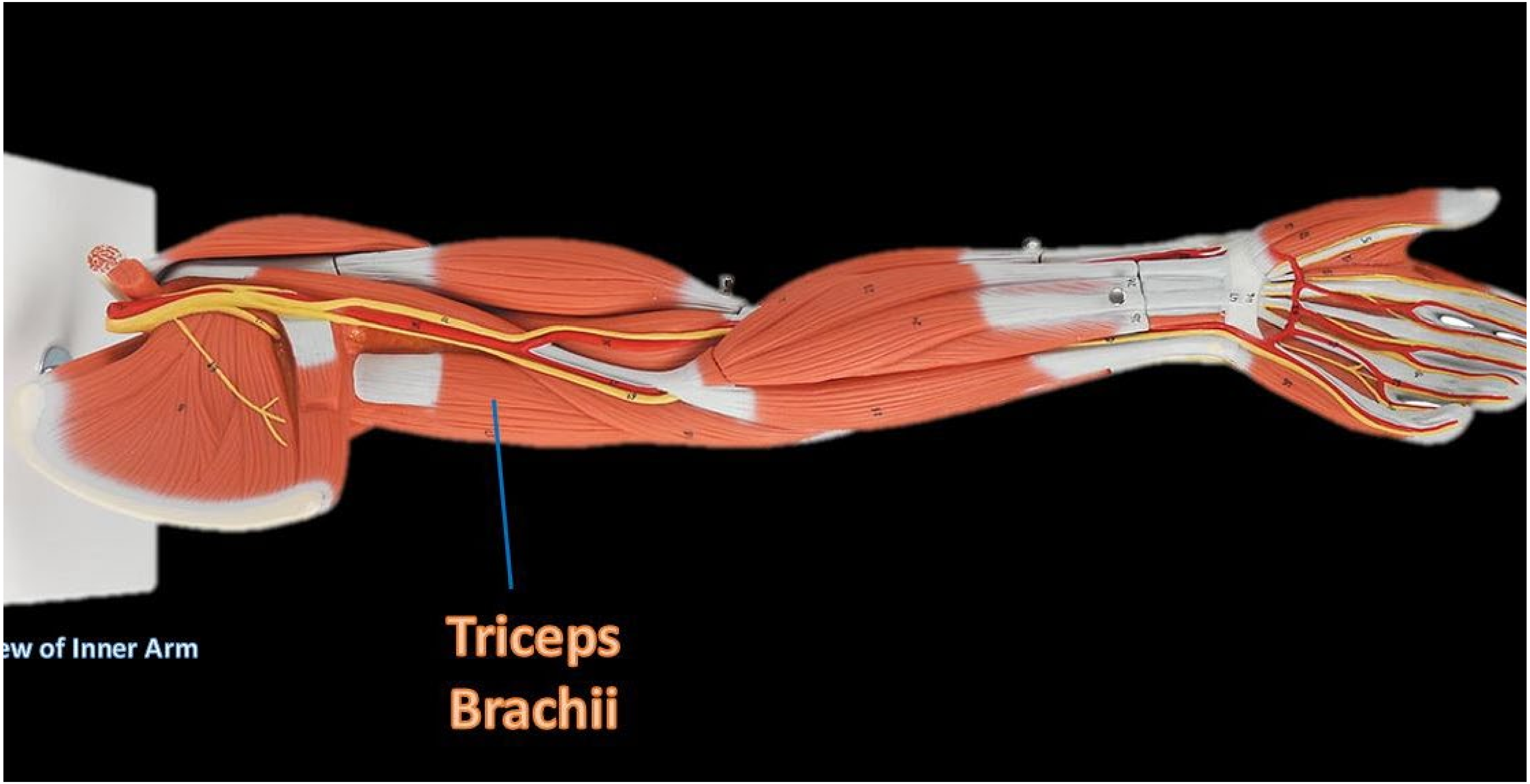
# Triceps Brachii

- As the arm extends, the elbow straightens.

- The triceps brachii is the antagonist of the flexors of the forearm.



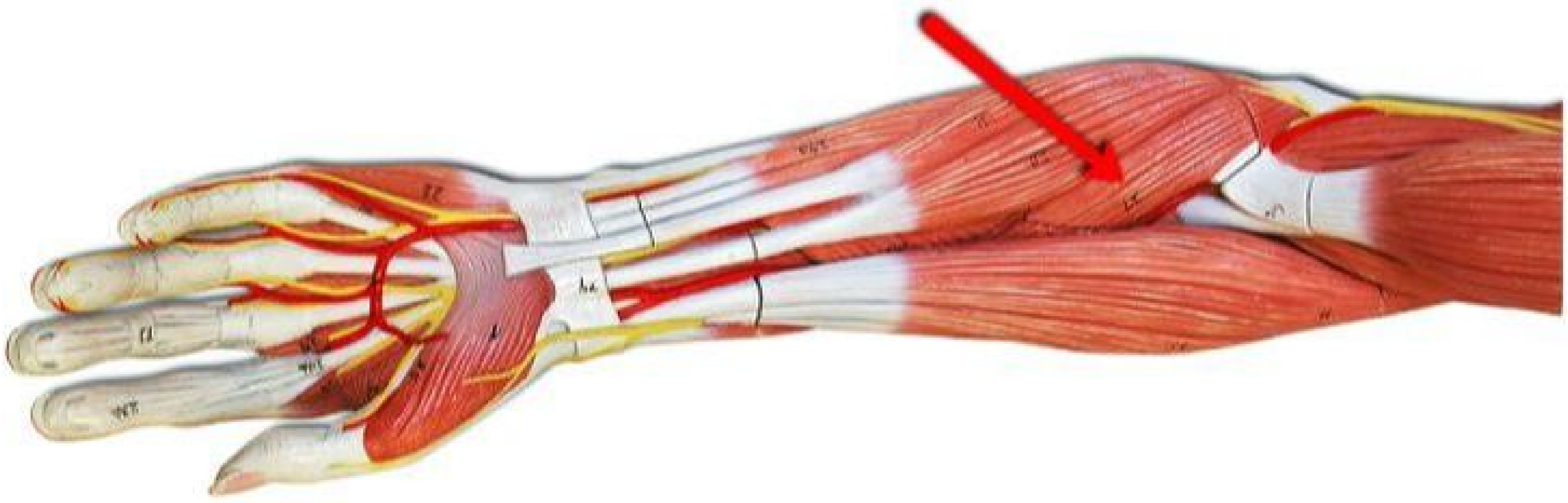

# Triceps Brachii


ew of Inner Arm
Triceps
Brachii

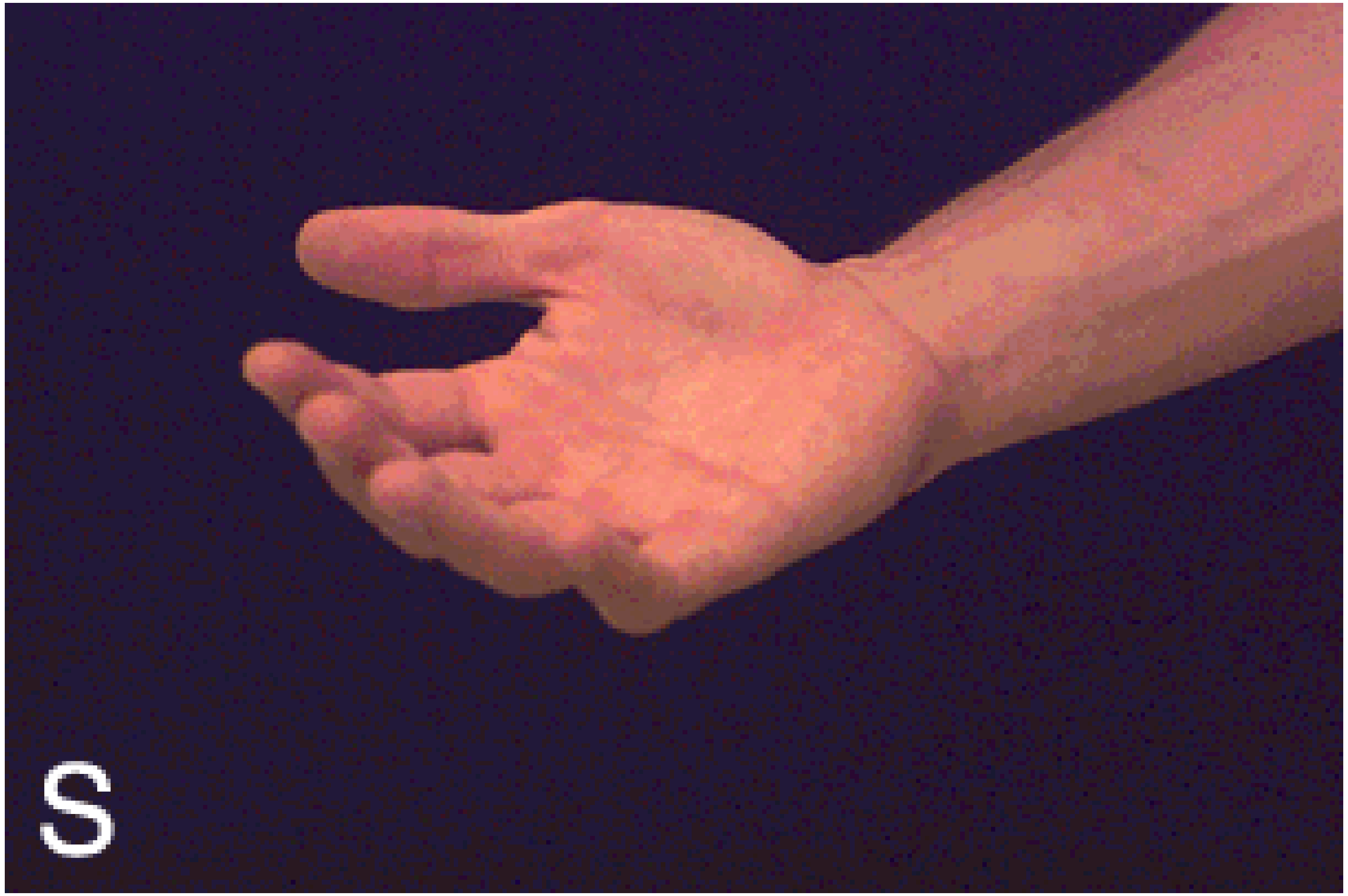
# Pronator Teres
# Function = Pronation of forearms and hands

# Pronator Teres
# Function = Pronation of forearms and hands

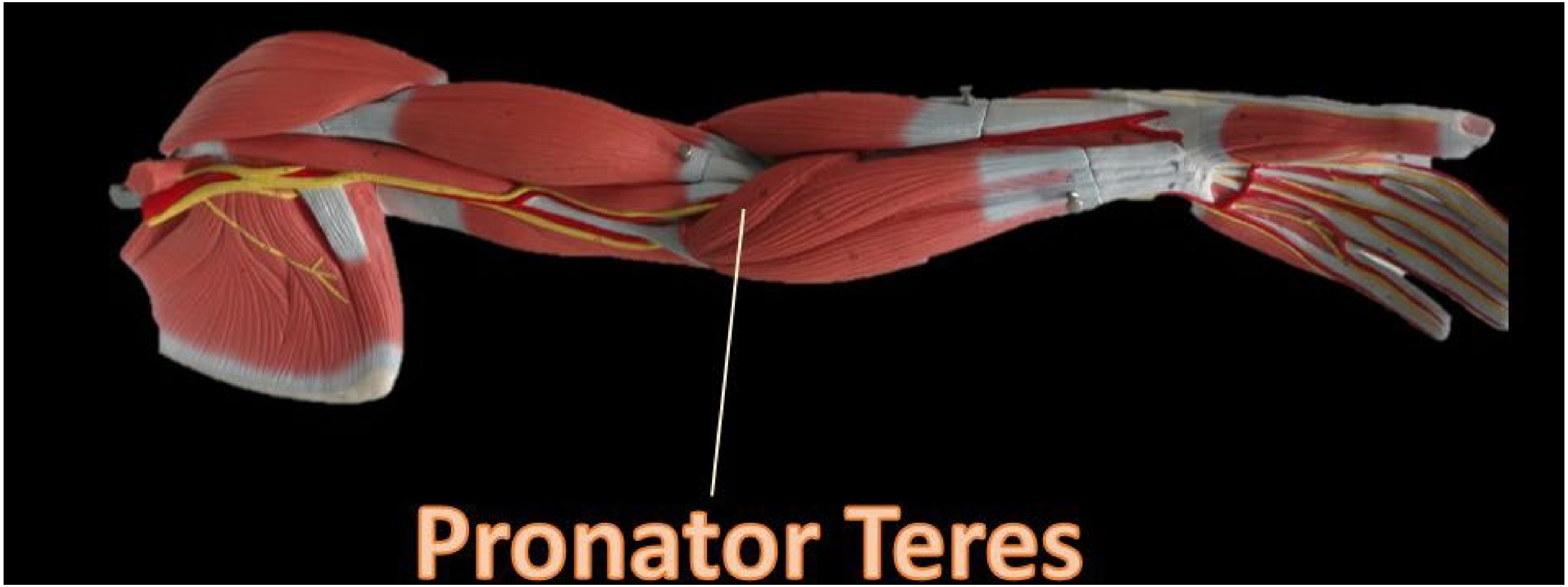
- The **pronator teres** is a muscle of the human body (located mainly in the forearm) that assists in the pronation of the forearm.



# Pronator Teres
# Function = Pronation of forearms and hands

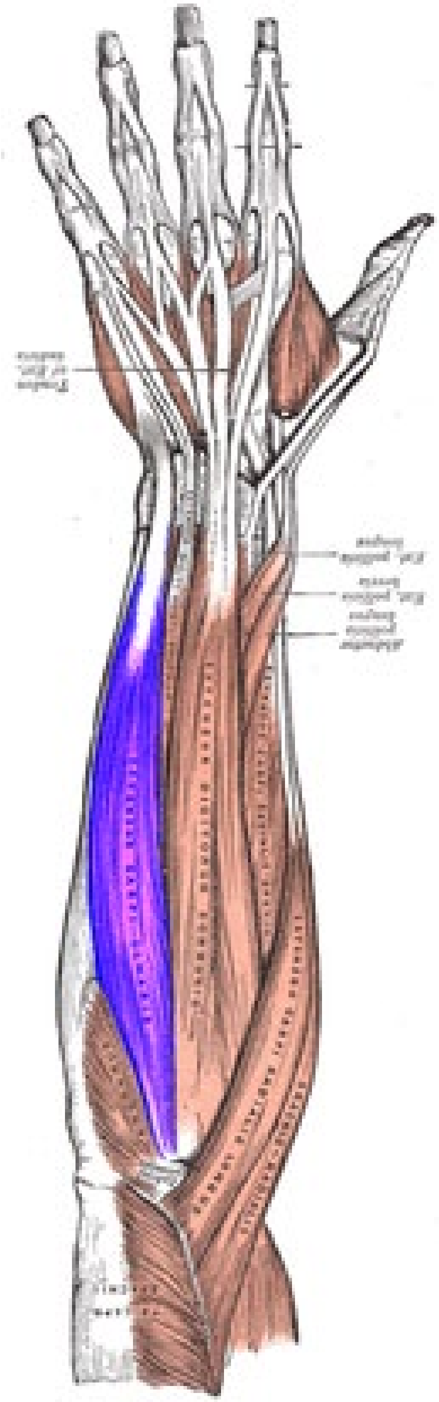



# Pronator Teres Function = Pronation of forearms and hands




# Pronator Teres Function = Pronation of forearms and hands

- The pronator teres muscle is located on the anterior portion of the forearm just below the antecubital region (inner elbow area).

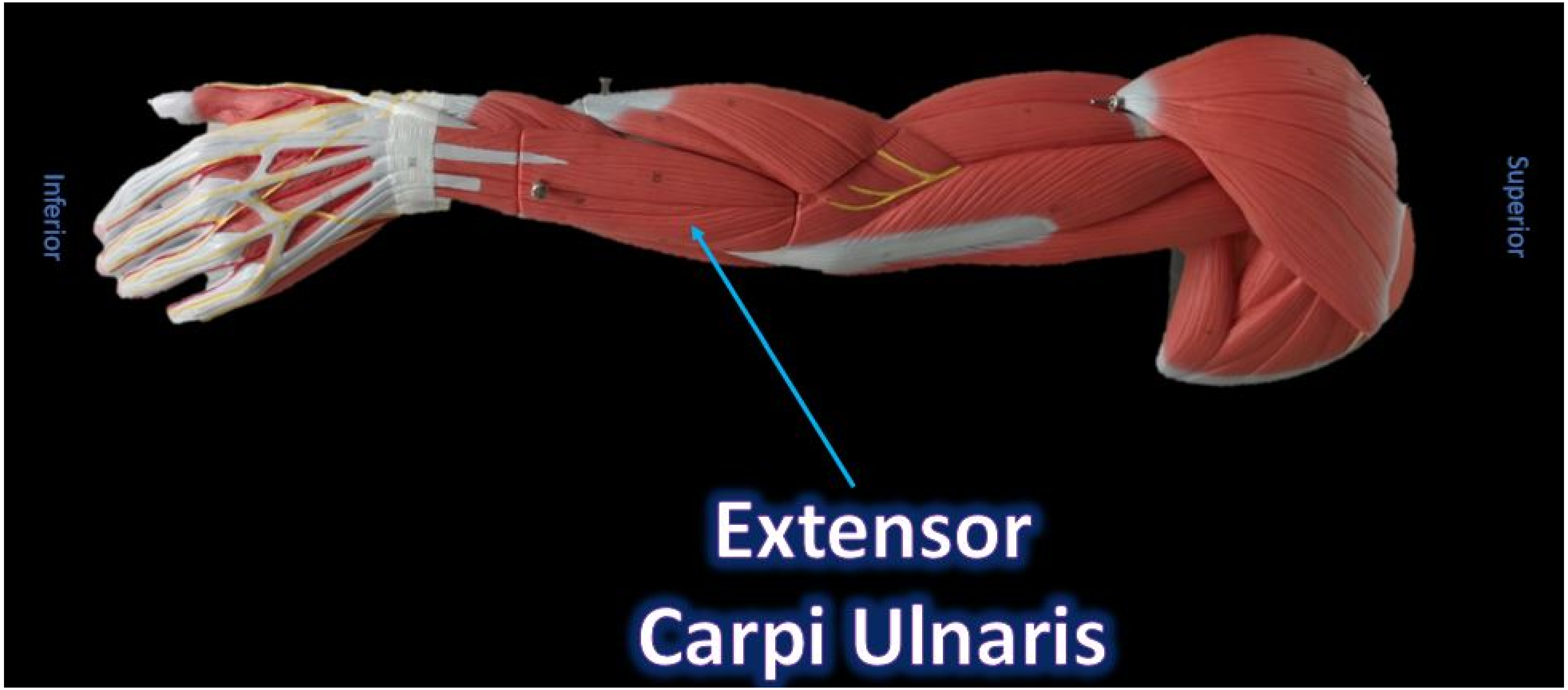


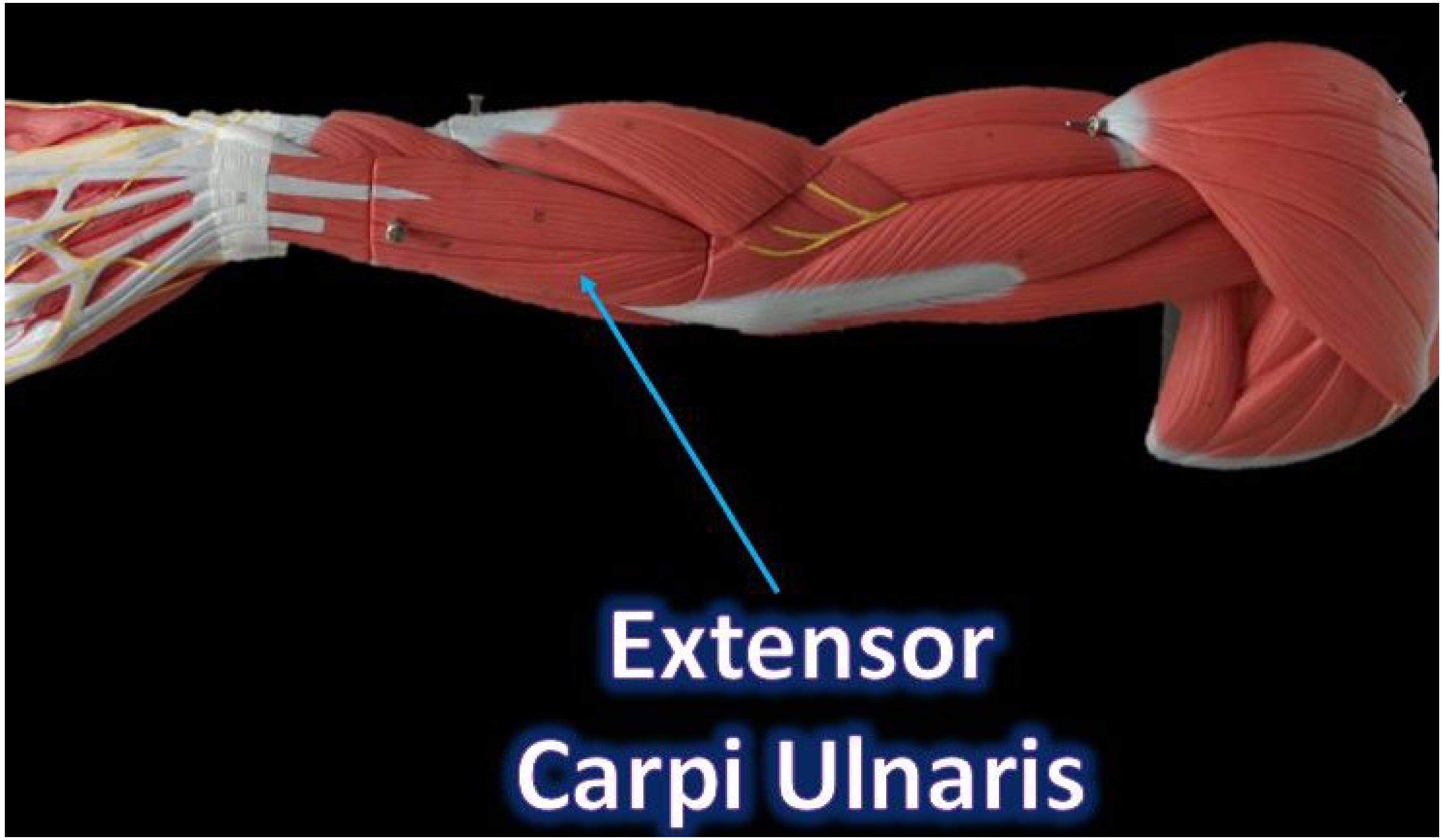
# Extensor Carpi Ulnaris Function = Flexes and adducts wrist/hand

All flexors of the wrist will be located at the inner forearm.

# Extensor Carpi Ulnaris

- The **extensor carpi ulnaris** is a skeletal muscle located on the "ulnar side" of the forearm (this is the portion of the arm that is "under" the radius when you do a "thumb up").

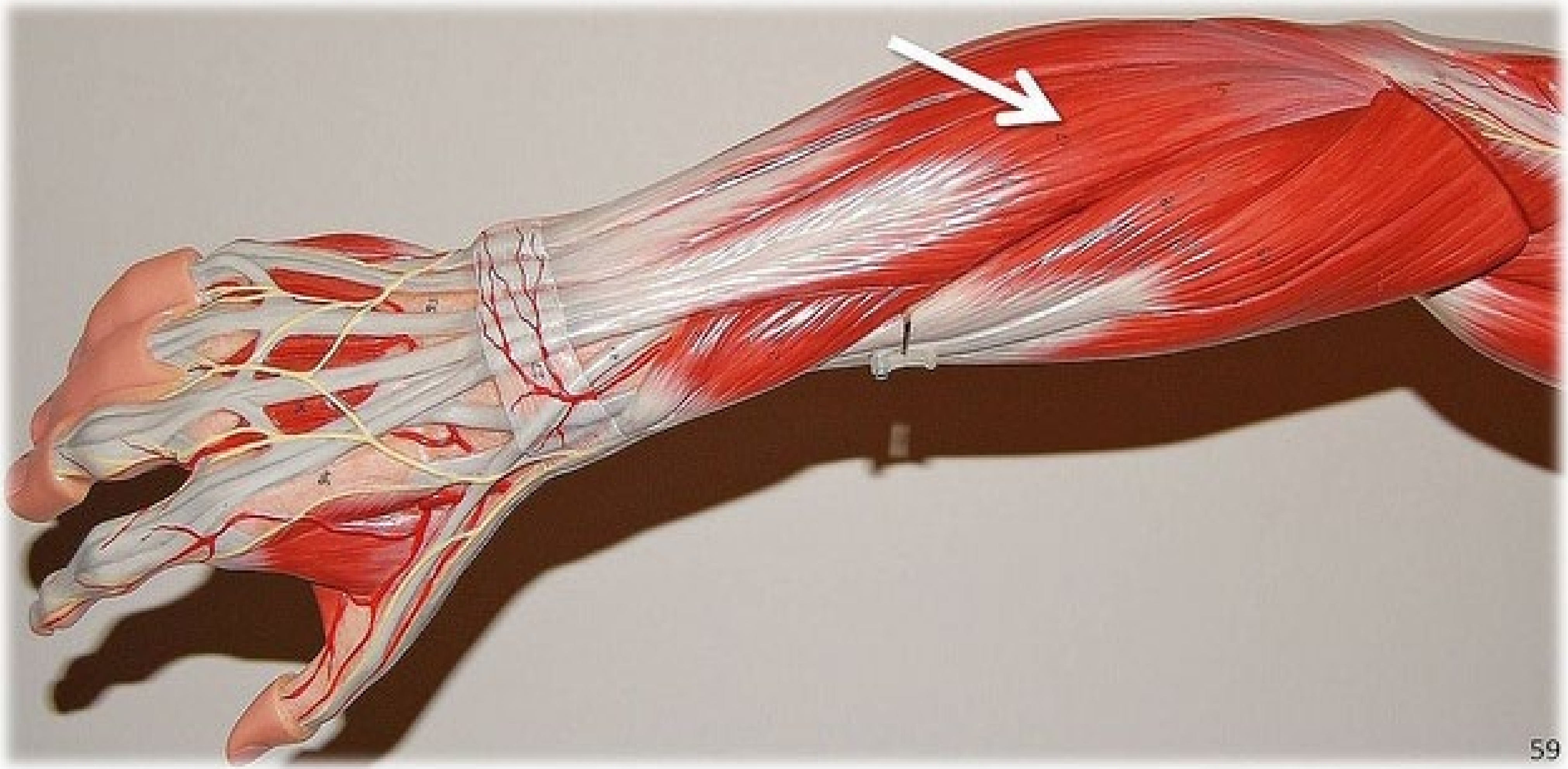


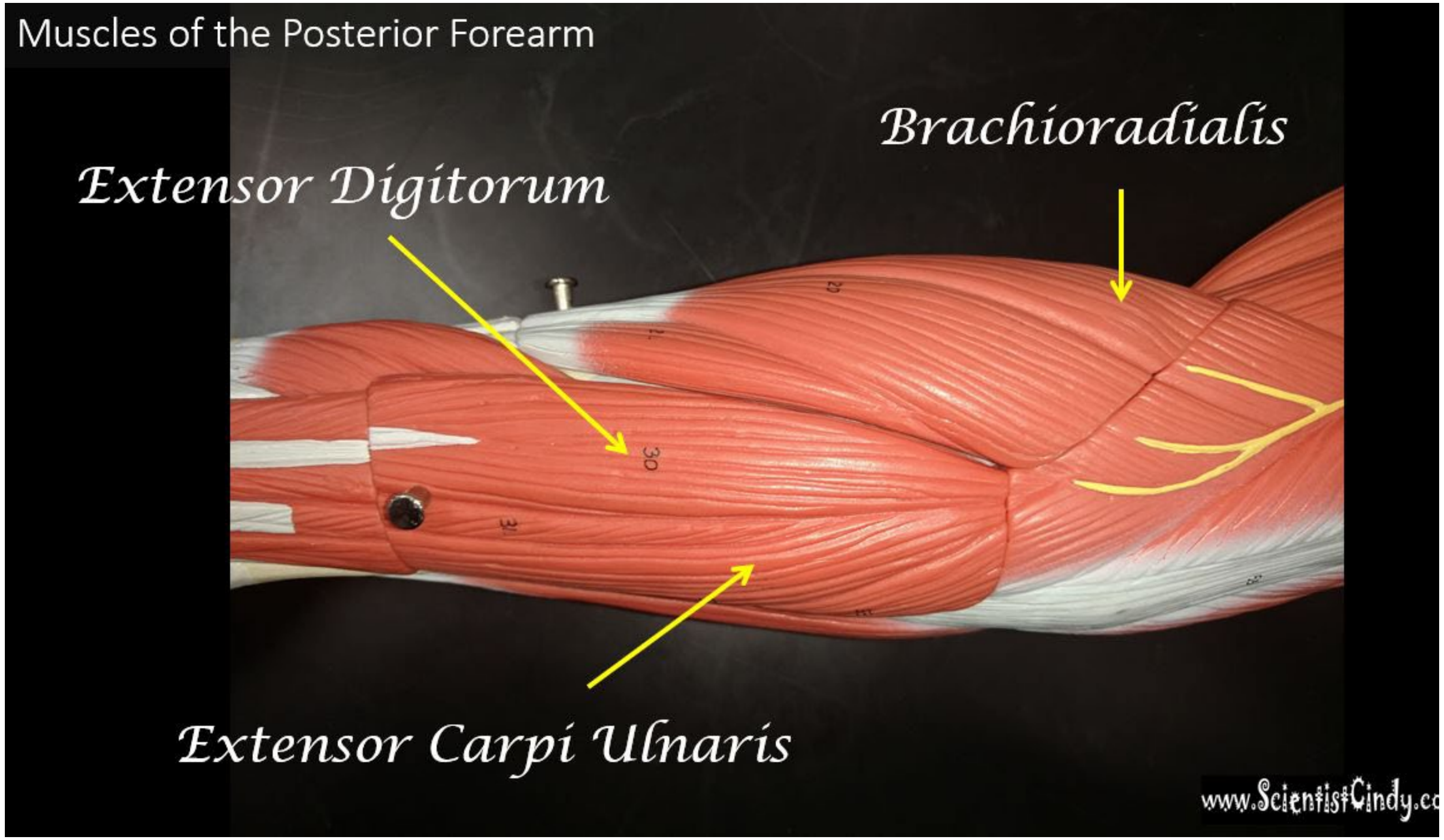



# Extensor Carpi Ulnaris

- It is visible on the posterior aspect of the forearm. It acts to extend and adduct at the carpus/wrist from anatomical position.
- Being an extensor muscle, extensor carpi ulnaris is on the posterior side of the forearm.

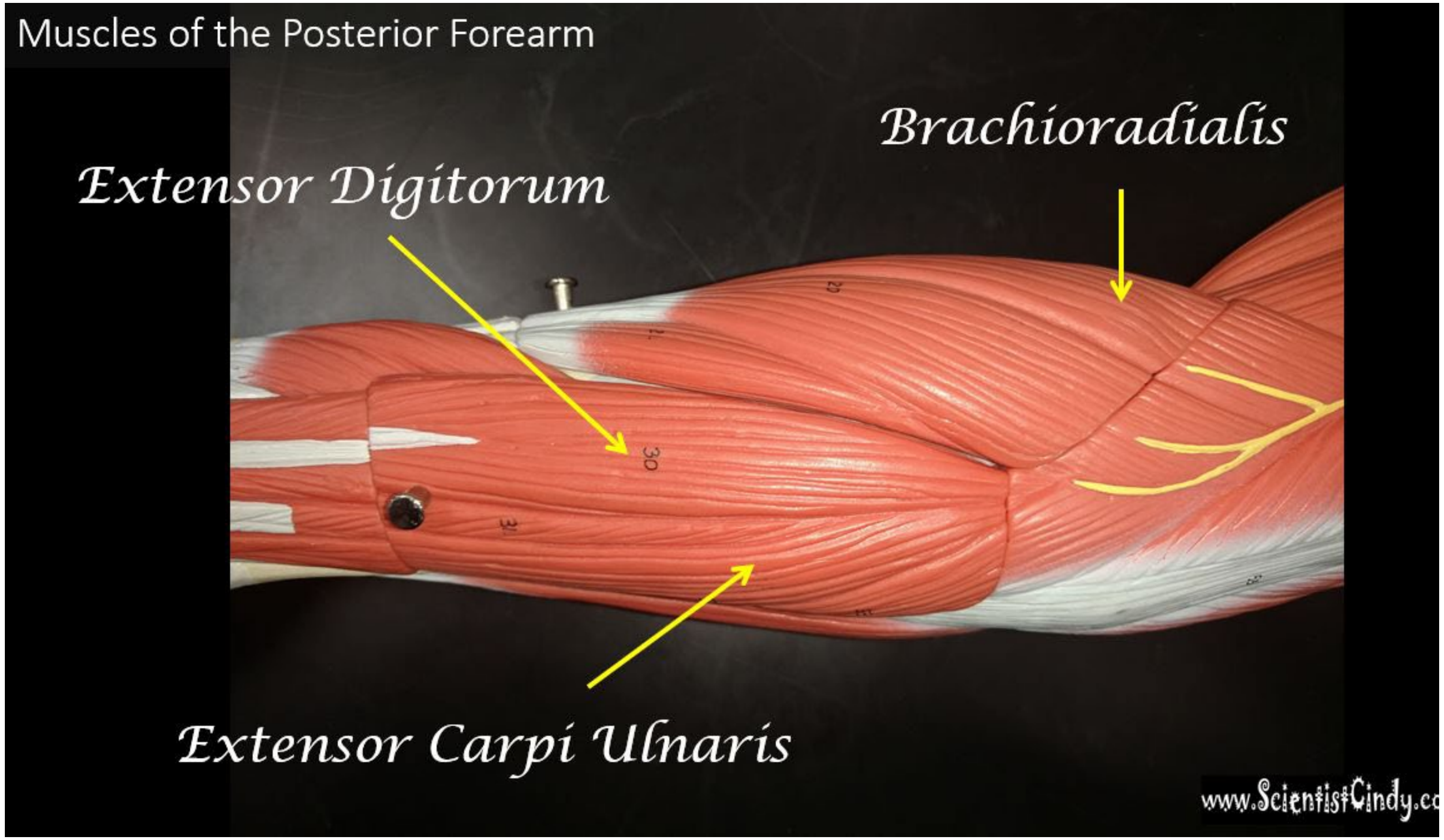
# Extensor Digitorum
# Function = Extends wrist and medial digits (phalanges)





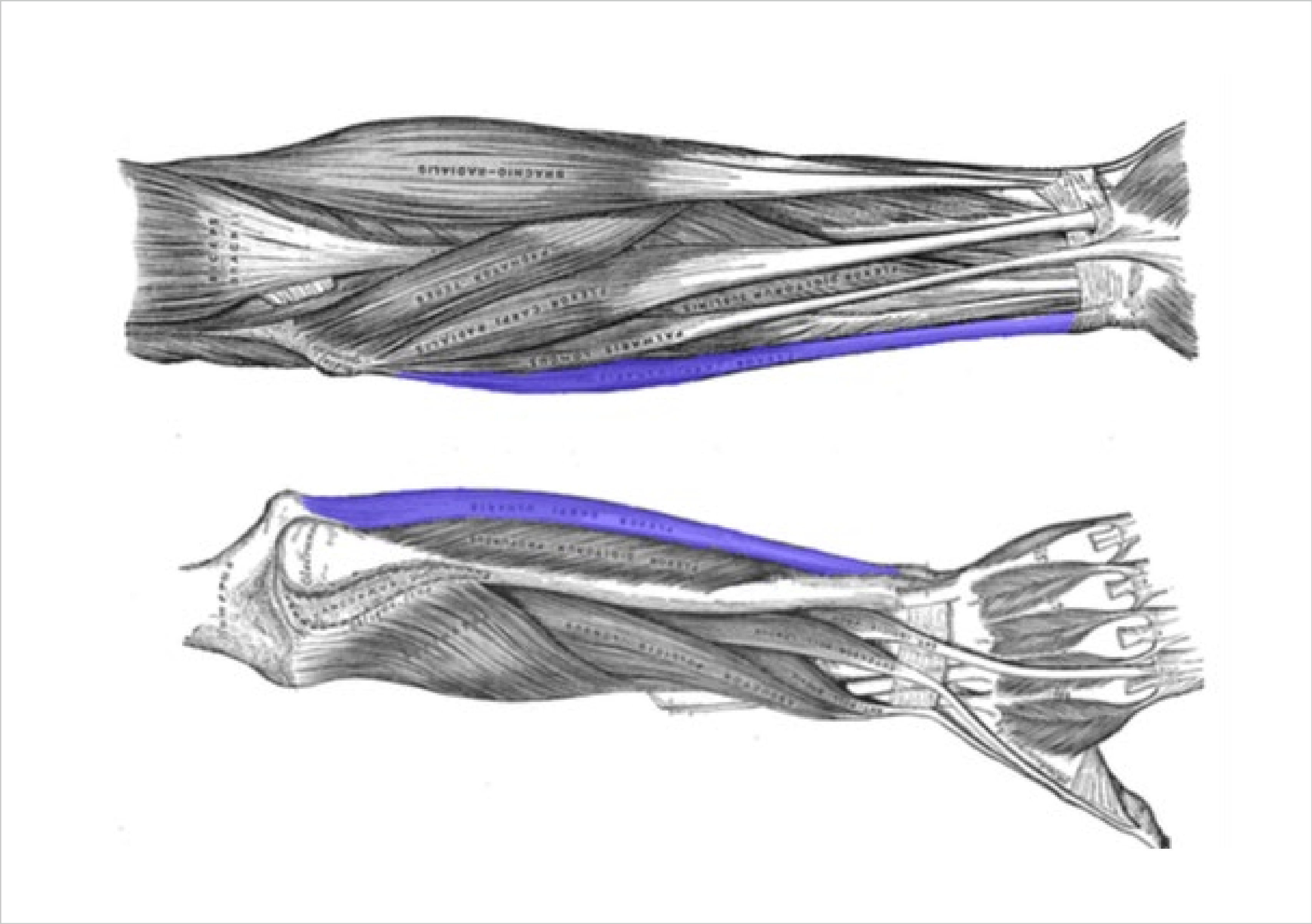

Extensor Digitorum
Function = Extends wrist and medial digits (phalanges)

- All wrist extensors are located on the back of the forearm.



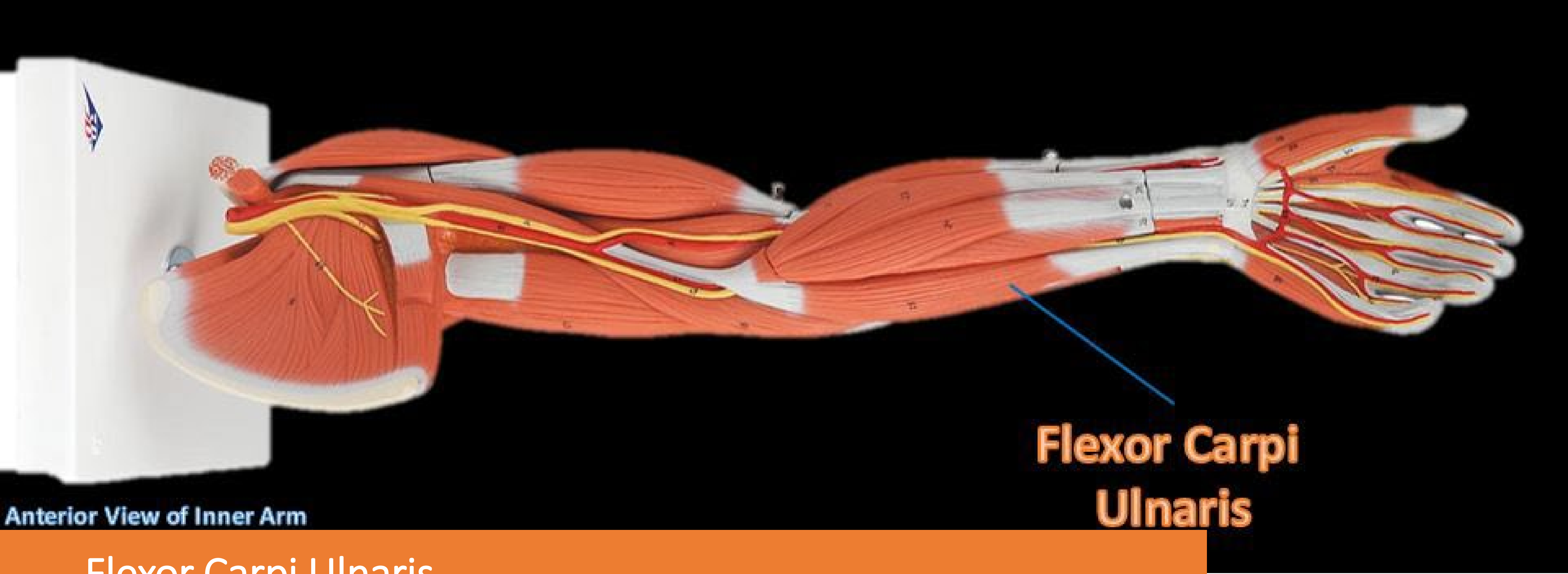

Extensor Digitorum
Function = Extends wrist and medial digits (phalanges)

- The **extensor digitorum** muscle is located at the posterior forearm.
- It extends the medial four digits of the hand, the wrist, and the elbow. It tends to separate the fingers as it extends them.



# Flexor Carpi Ulnaris

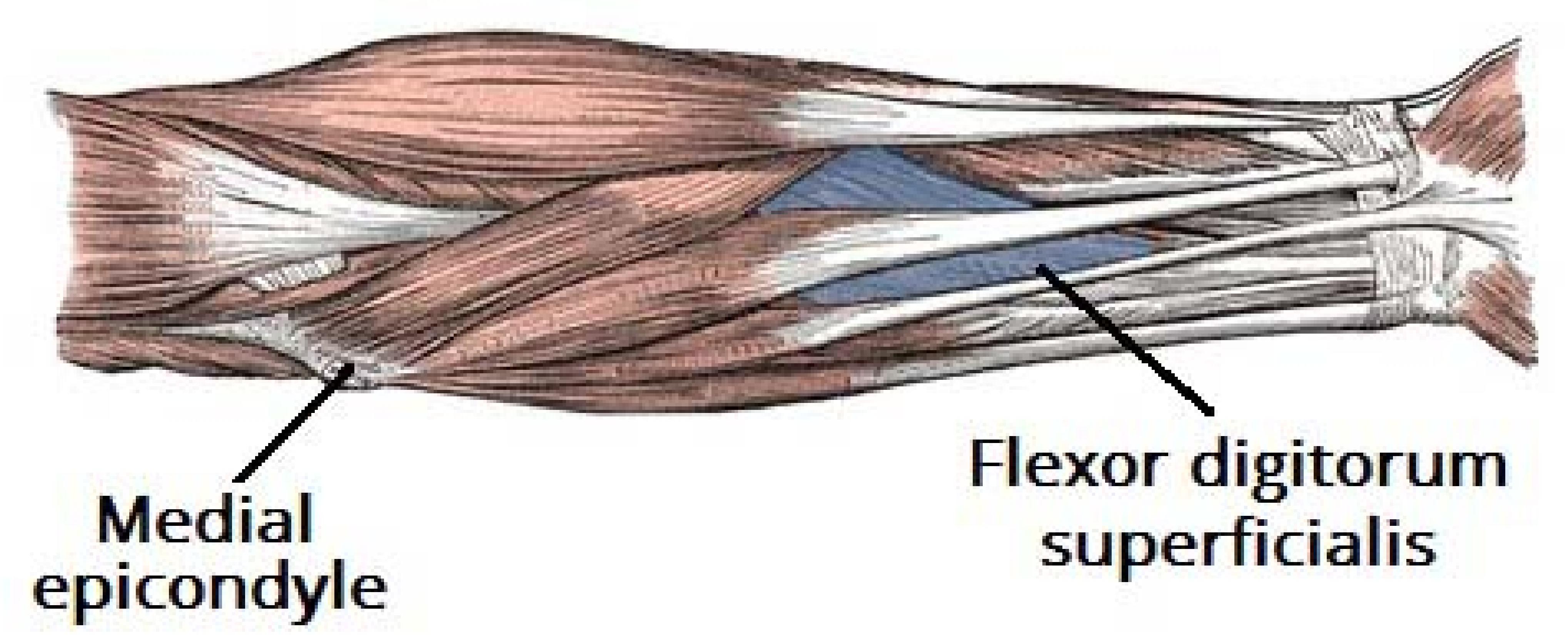
Function = flexion and adduction the hand

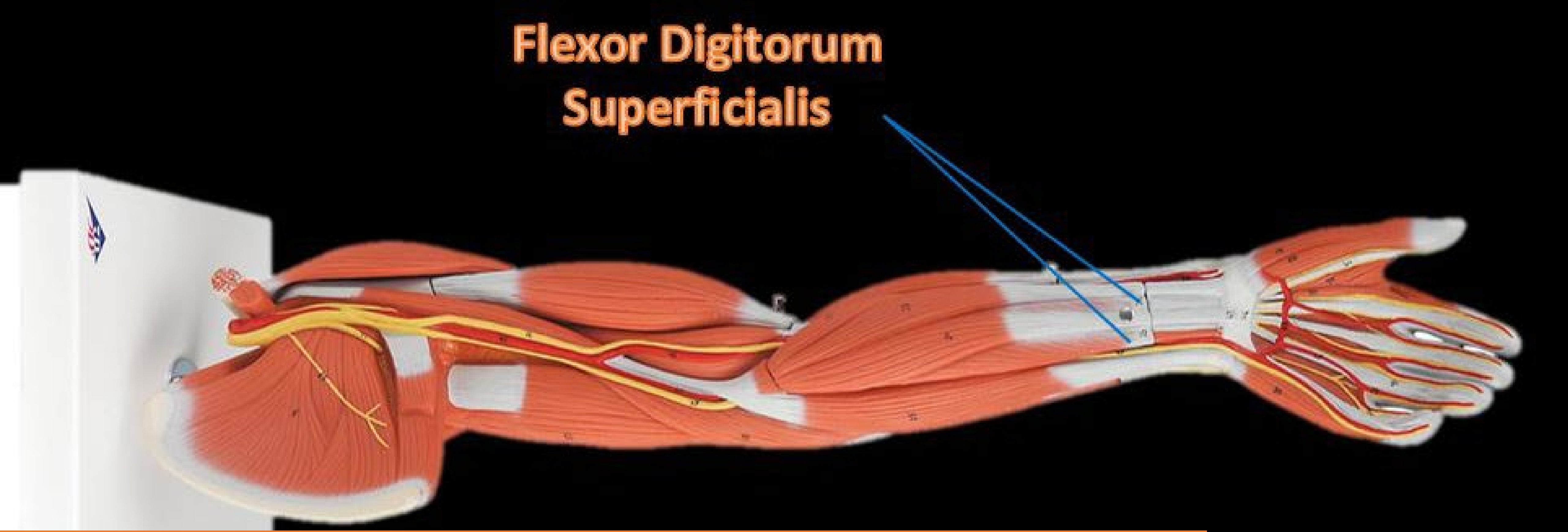



# Flexor Carpi Ulnaris

- The **flexor carpi ulnaris muscle** is a muscle located on the posterior aspect of the forearm that functions to flex and adduct the hand.

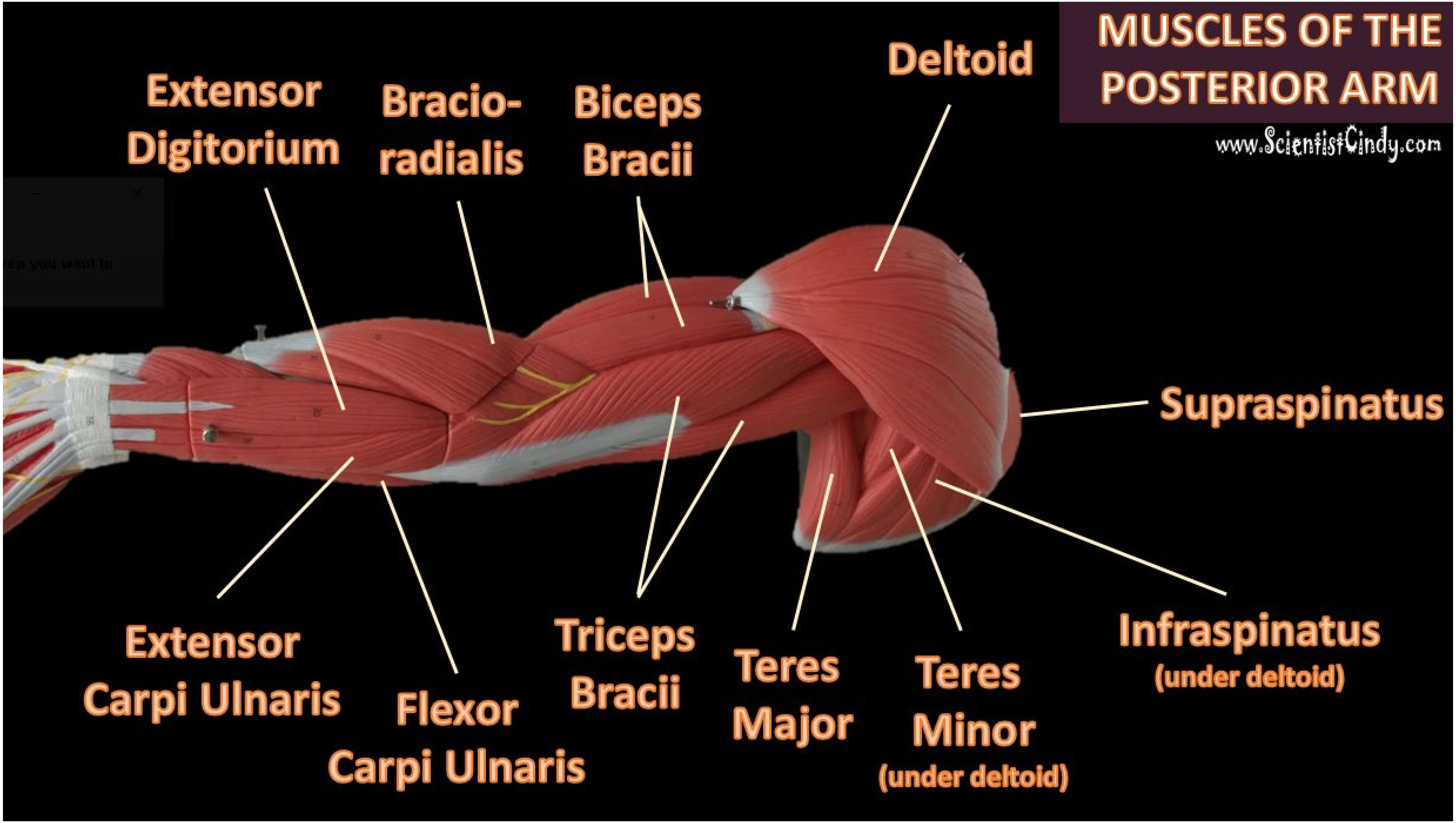
# Extensor Digitorium Superficialis
# Function = Flexes hand and middle phalanges.

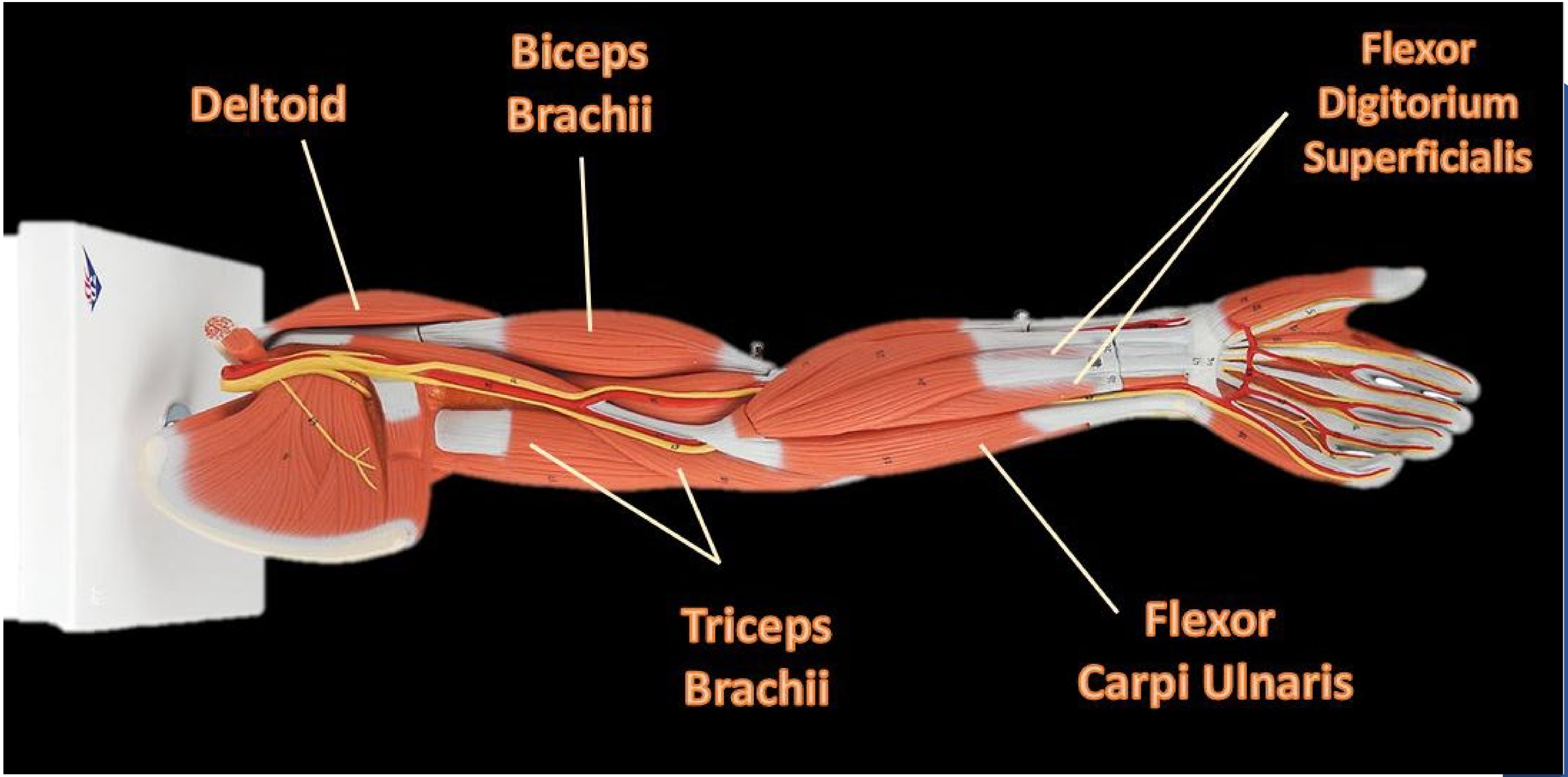


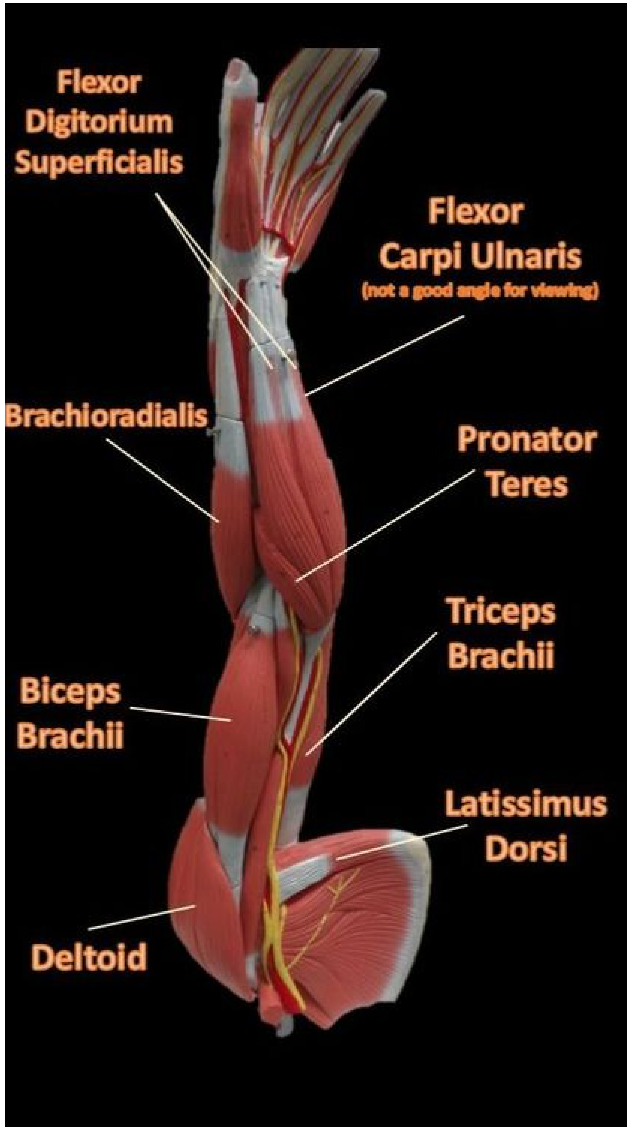


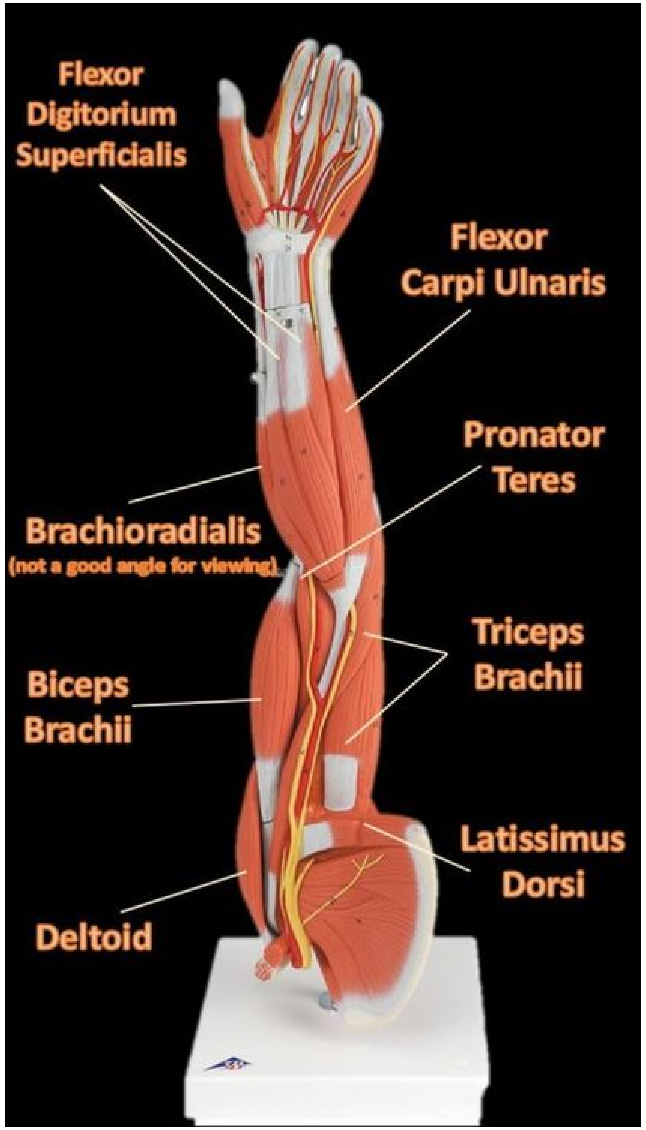

Extensor Digitorium Superficialis
Function = Flexes hand and middle phalanges.

- Flexes hand and middle phalanges.
- This flexor muscle is the important for speed and flexion against resistance.

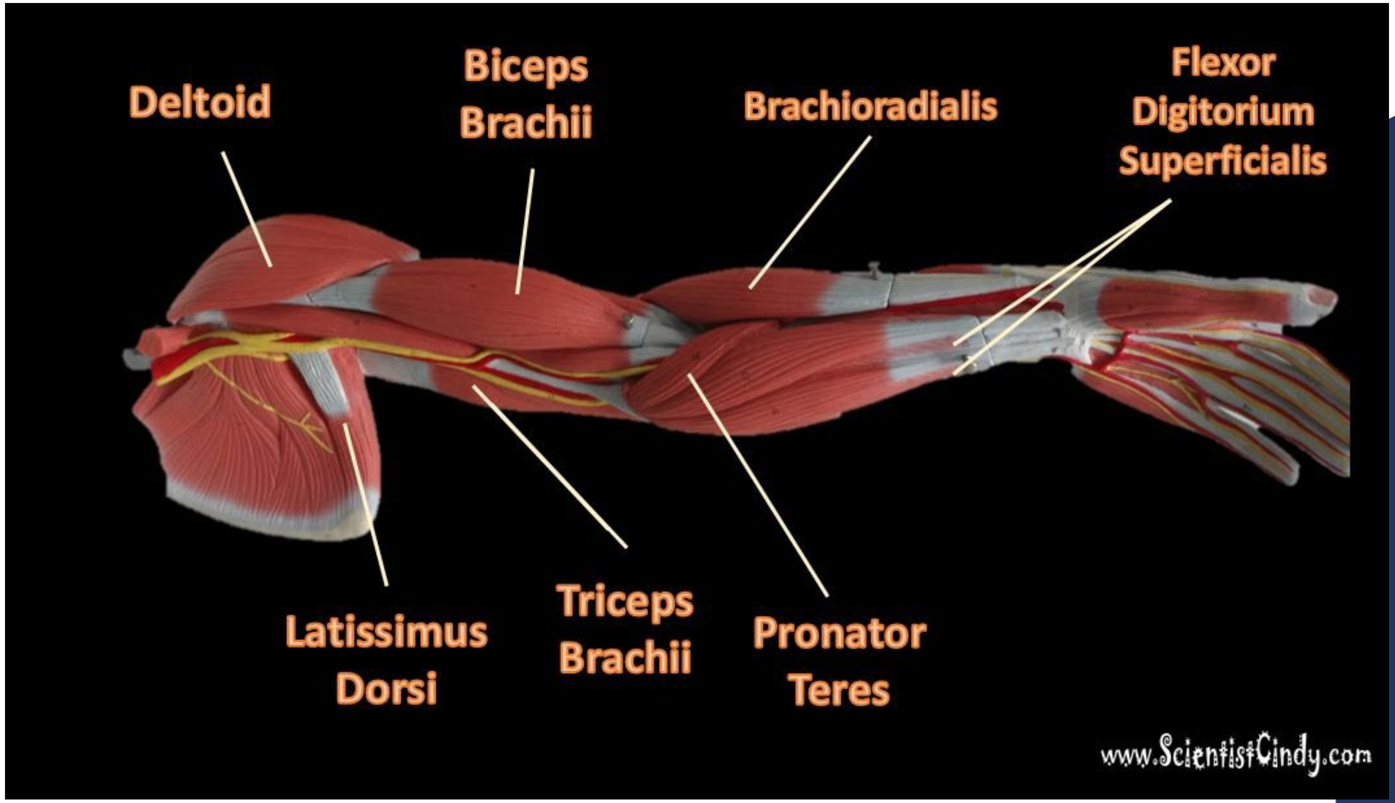

MUSCLES OF THE POSTERIOR ARM
www.ScientistCindy.com
Deltoid
Extensor Digitorium
Bracio-radialis
Biceps Bracii
Supraspinatus
Extensor Carpi Ulnaris
Flexor Carpi Ulnaris
Triceps Bracii
Teres Major
Teres Minor (under deltoid)
Infraspinatus (under deltoid)


Deltoid
Biceps Brachii
Flexor Digitorium Superficialis
Triceps Brachii
Flexor Carpi Ulnaris

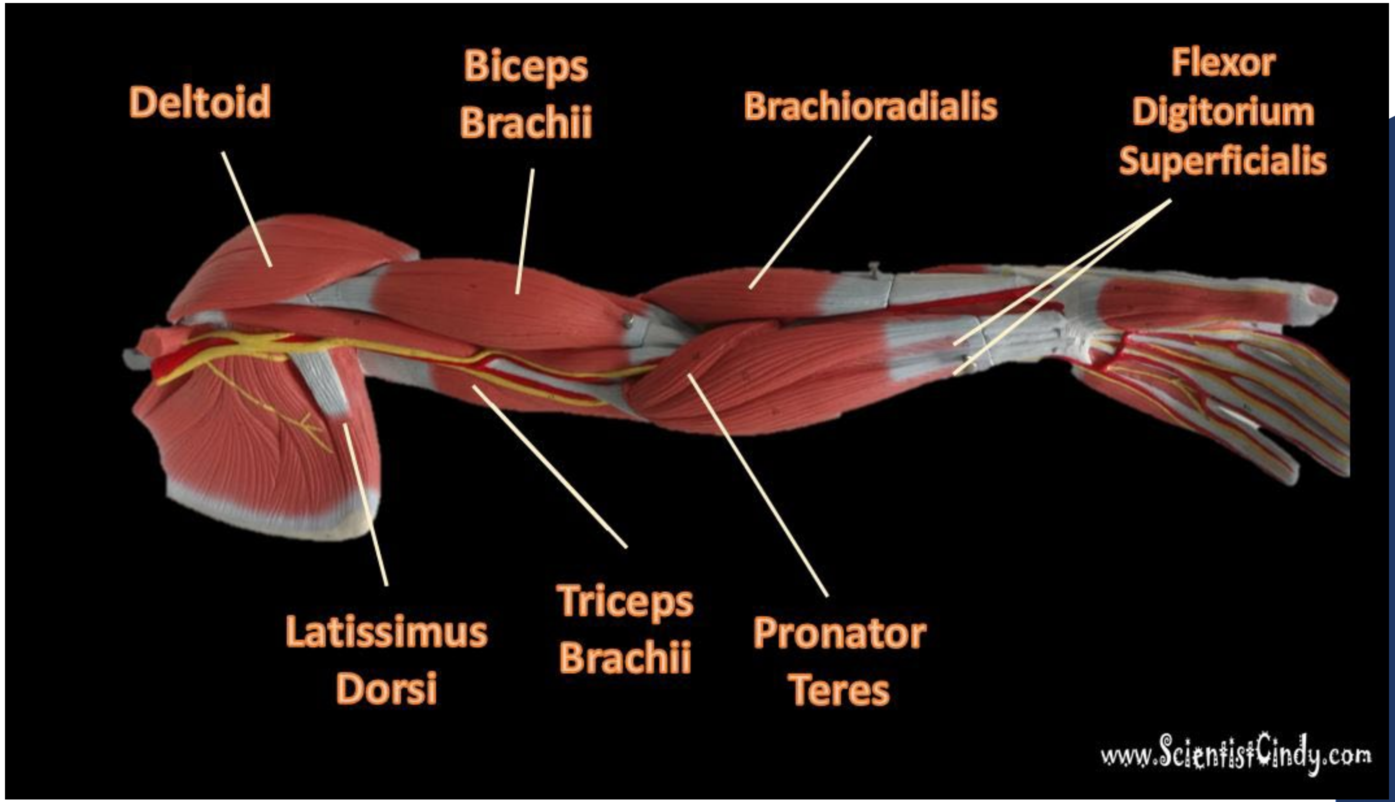



Muscles of anterior arm showing the flexor carpi ulnaris in the orientation of the body and in the orientation of the counter top display.




Muscles of anterior arm showing the brachioradialis in the orientation of the body (below) and orientation on counter top.

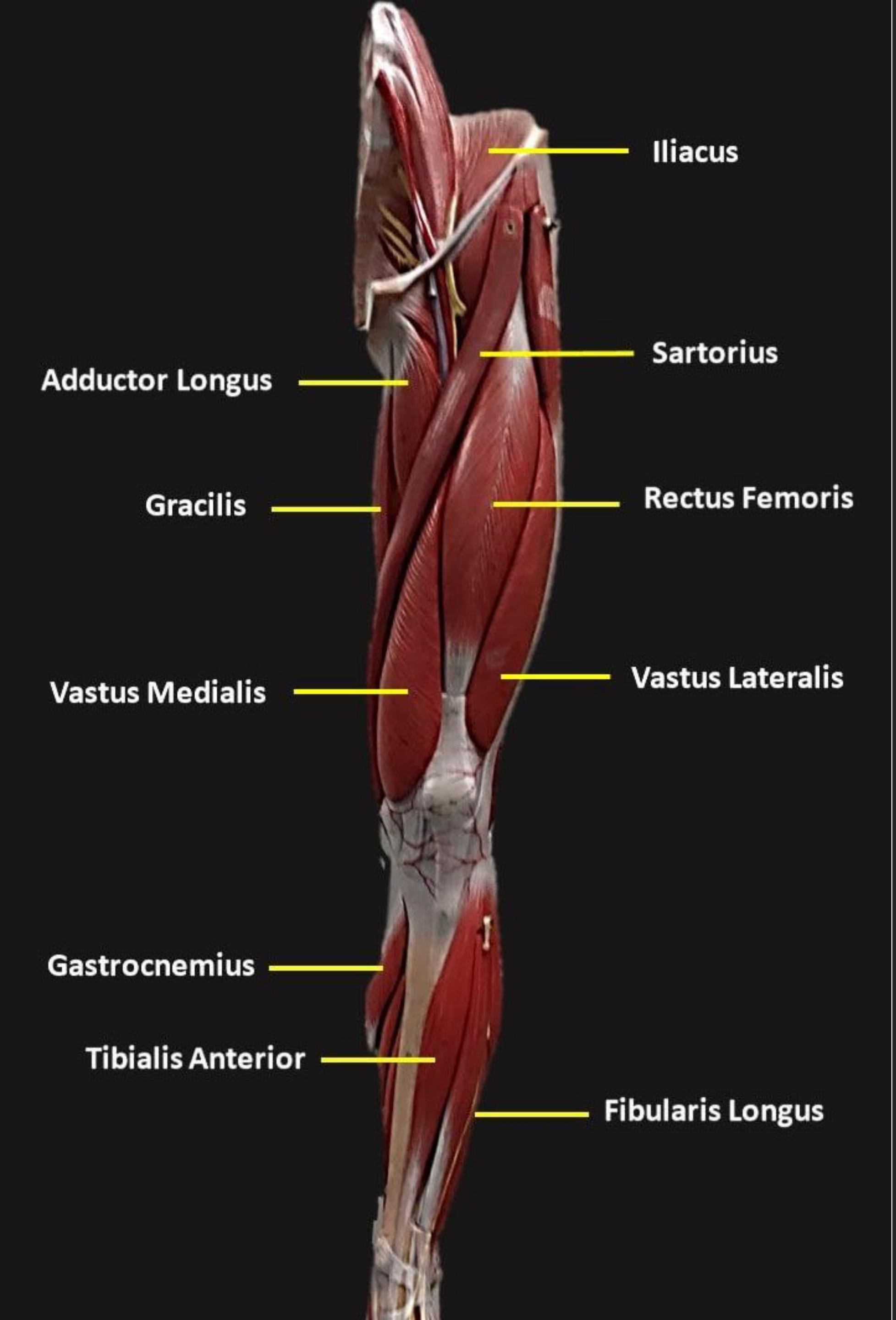


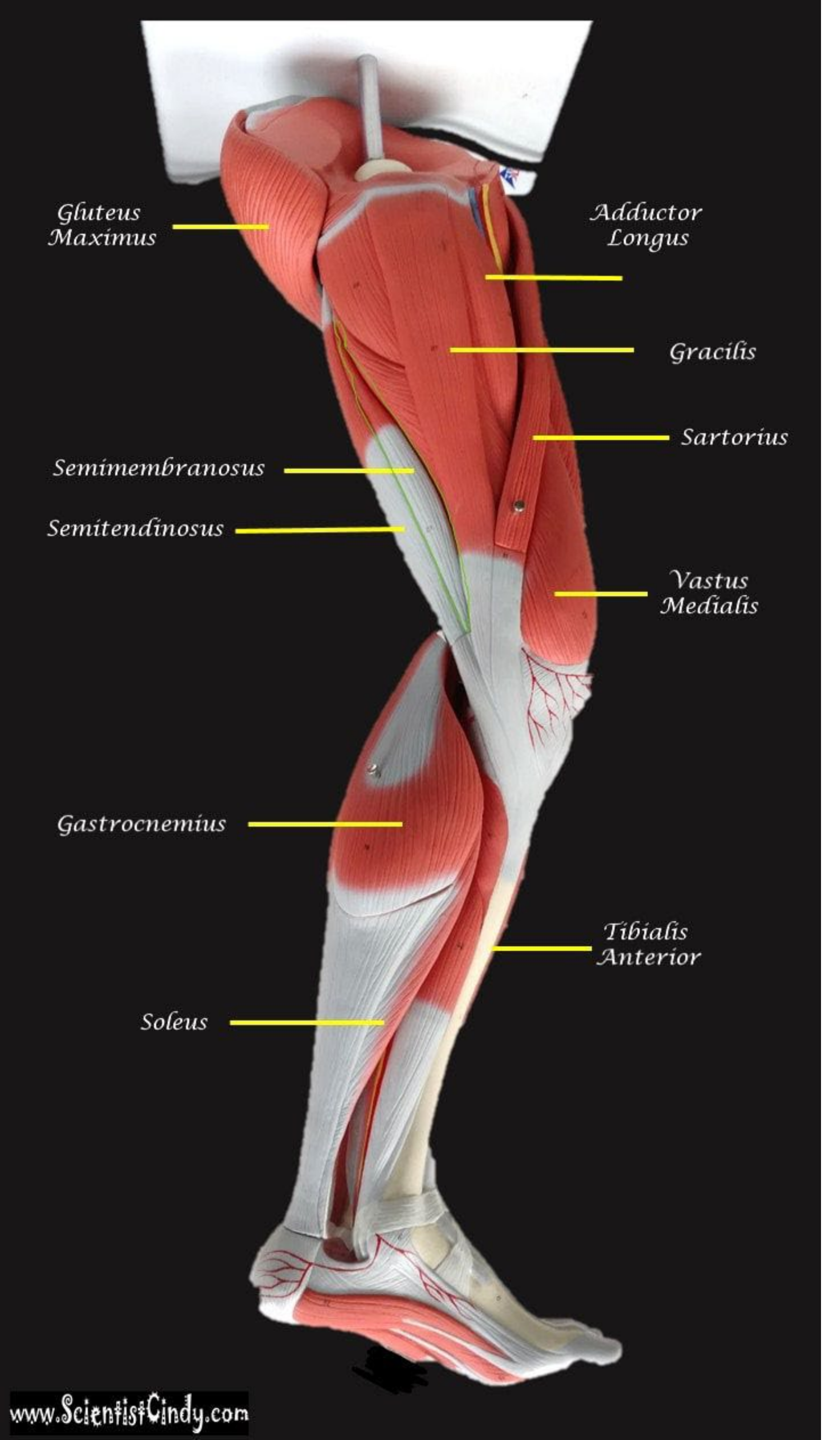

Muscles of anterior arm showing the brachioradialis in the orientation of the body (below) and orientation on counter top.

# Muscles of the Legs

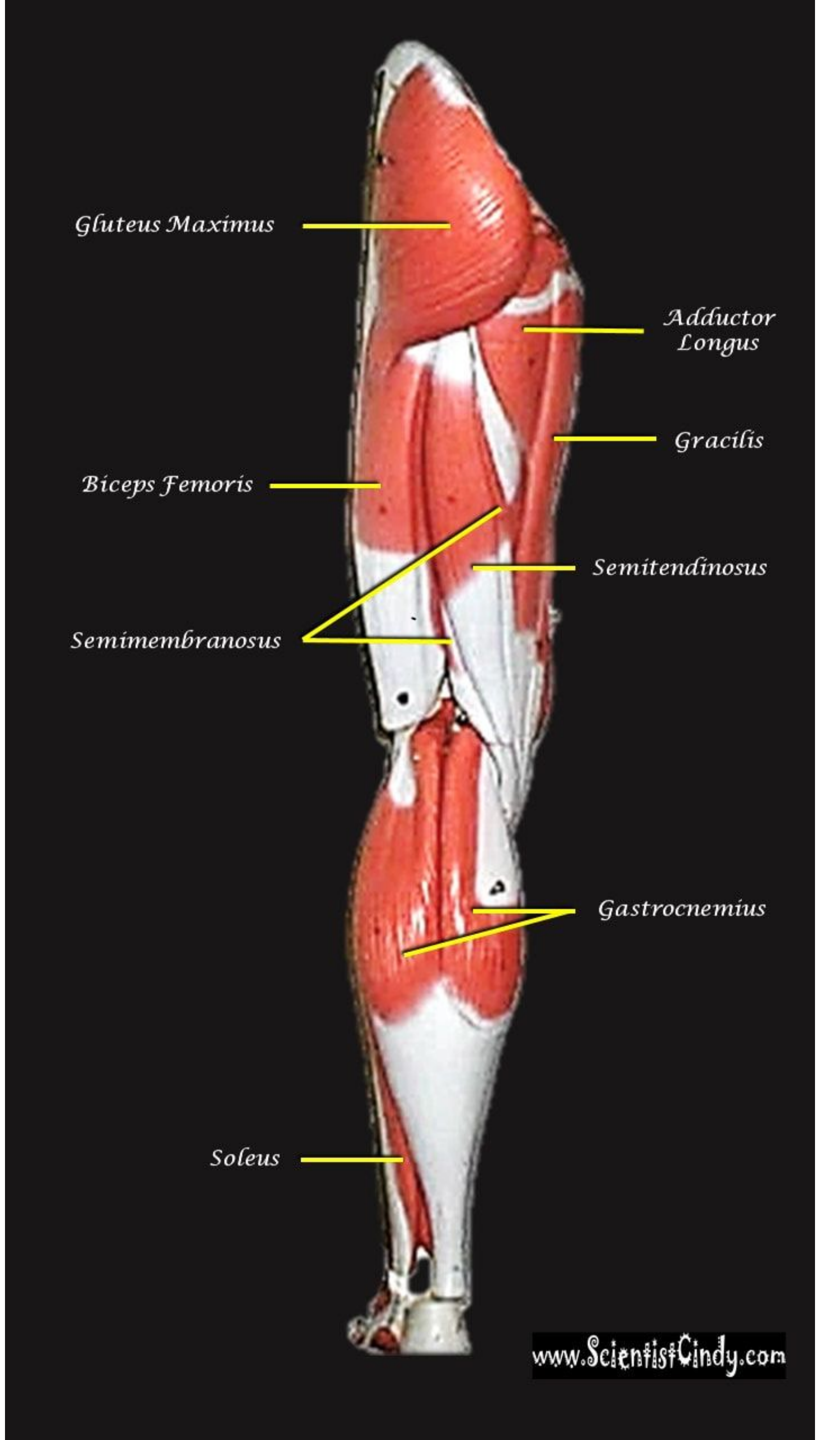
- Supporting, balancing, and propelling the body is the work of the muscular system of the legs and feet.
- From the large, strong muscles of the buttocks and legs to the tiny, fine muscles of the feet and toes, these muscles can exert tremendous power while constantly making small adjustments for balance – whether the body is at rest or in motion.

# Anterior View of Leg Muscles

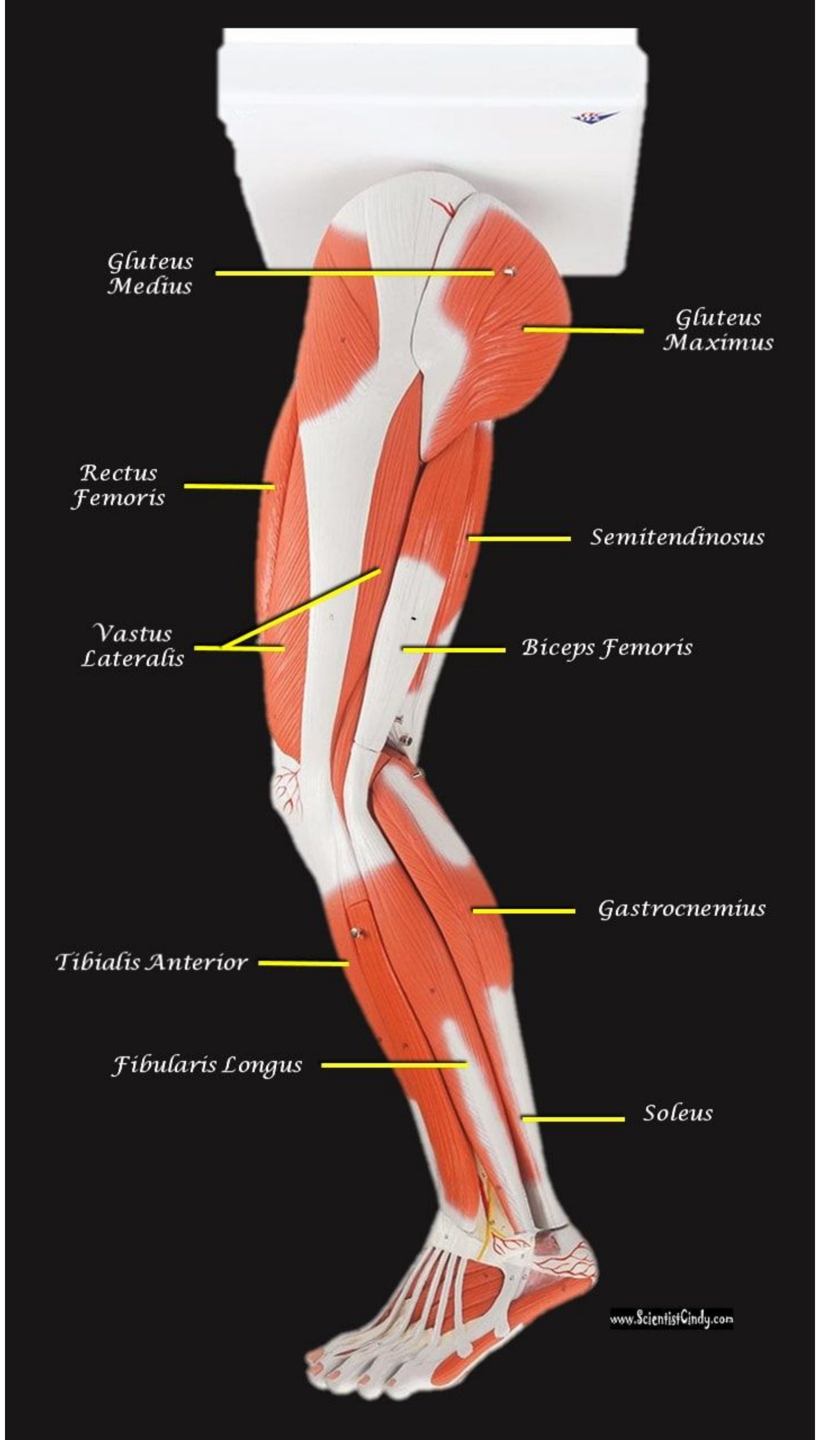





# Medial View of Leg Muscles



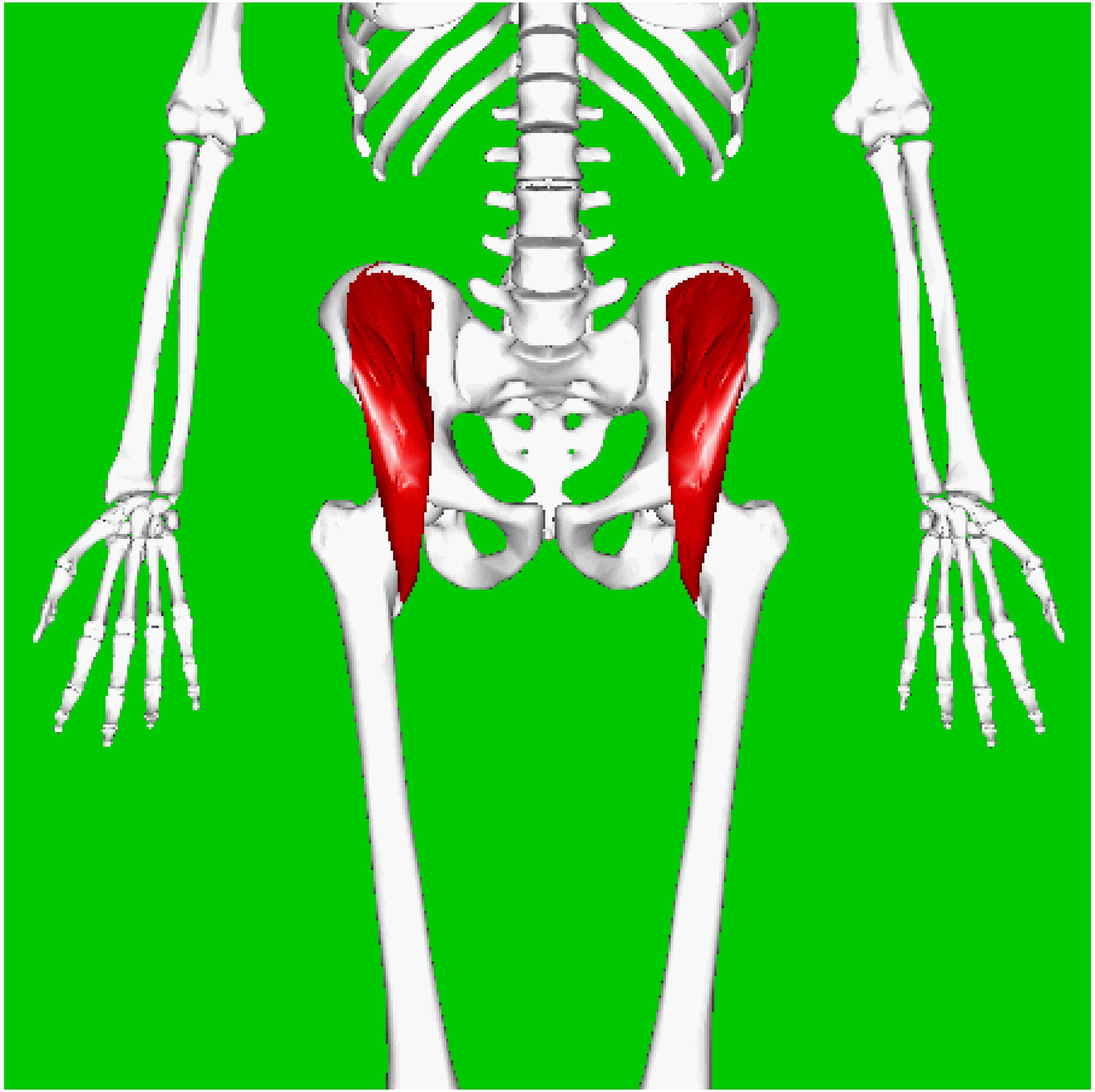

# Posterior View of Leg Muscles




# Lateral View of Leg Muscles

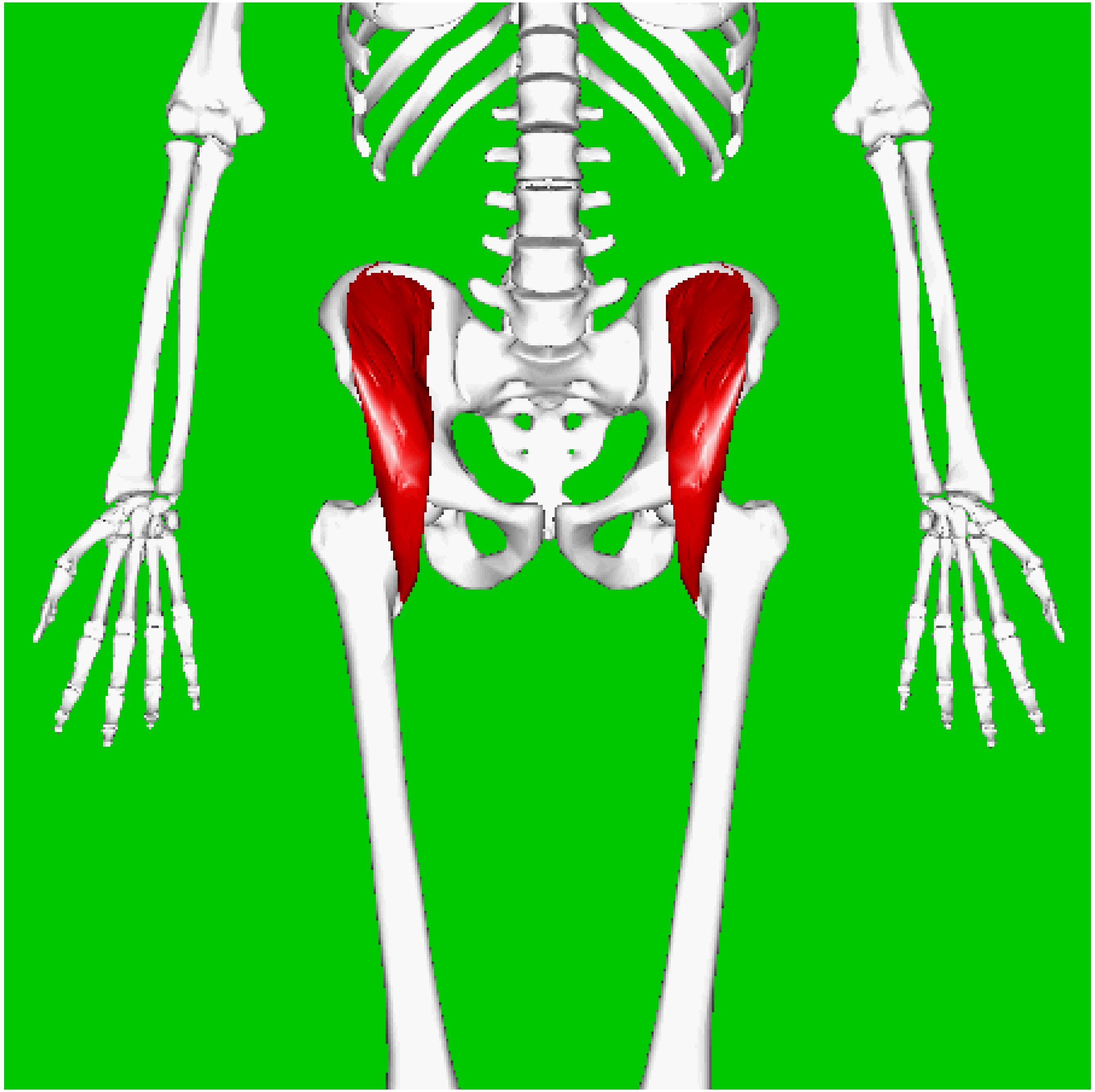
# Iliacus Muscles

Function = flexes the thigh (femur) at the hip, adducts thigh, medially rotates thigh.



# Iliacus Muscles

- The iliacus muscle originates at the illium, which is located on the inside of the hip (coxal) bones (at the anterior aspect).

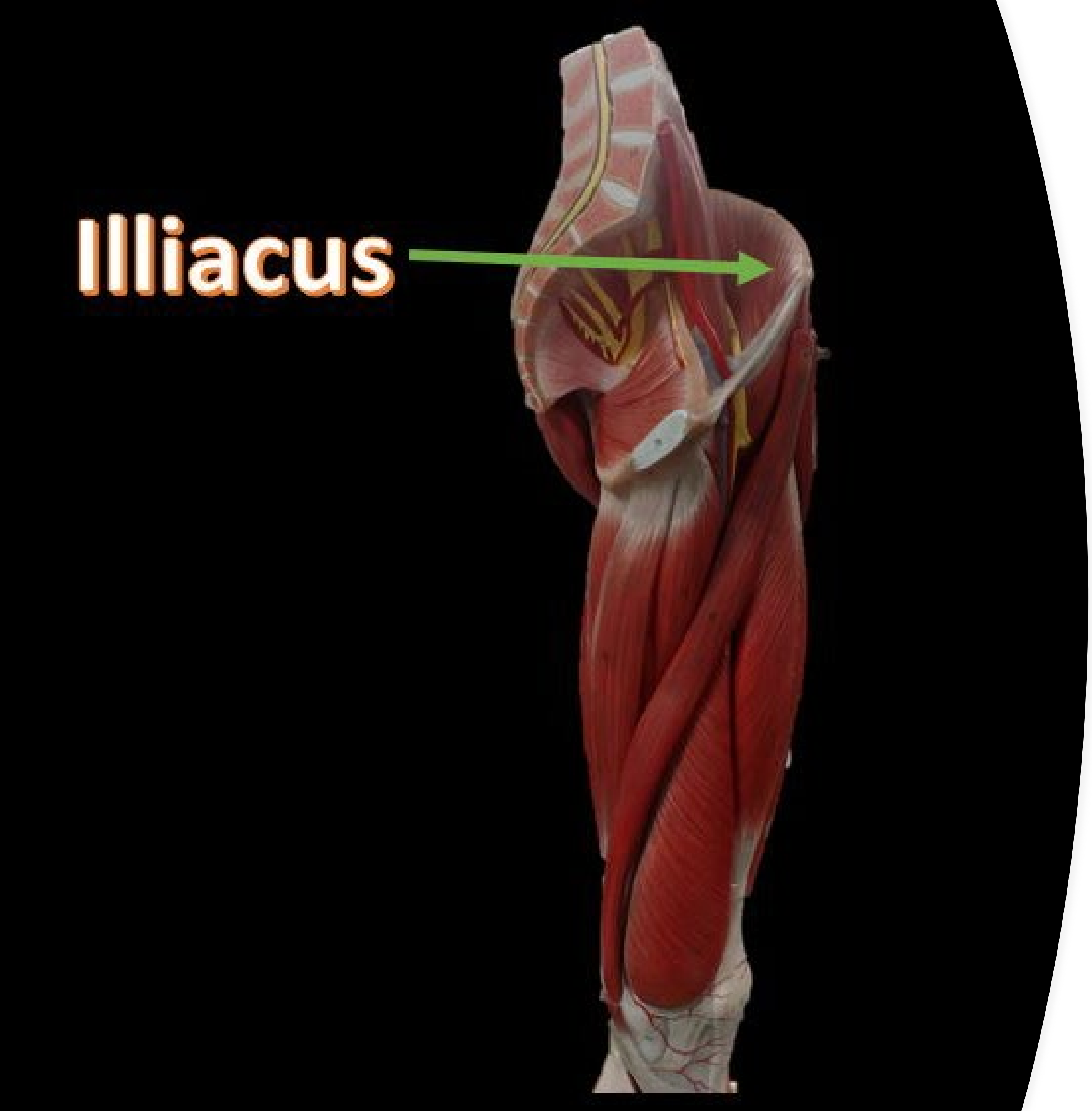


# Iliacus Muscles

- The function of the iliacus muscles are to lifting (flex) the femur forward.
- The iliacus muscle is part of the Iliopsoas which is the prime mover in thigh flexion and in flexing trunk (as when bowing).

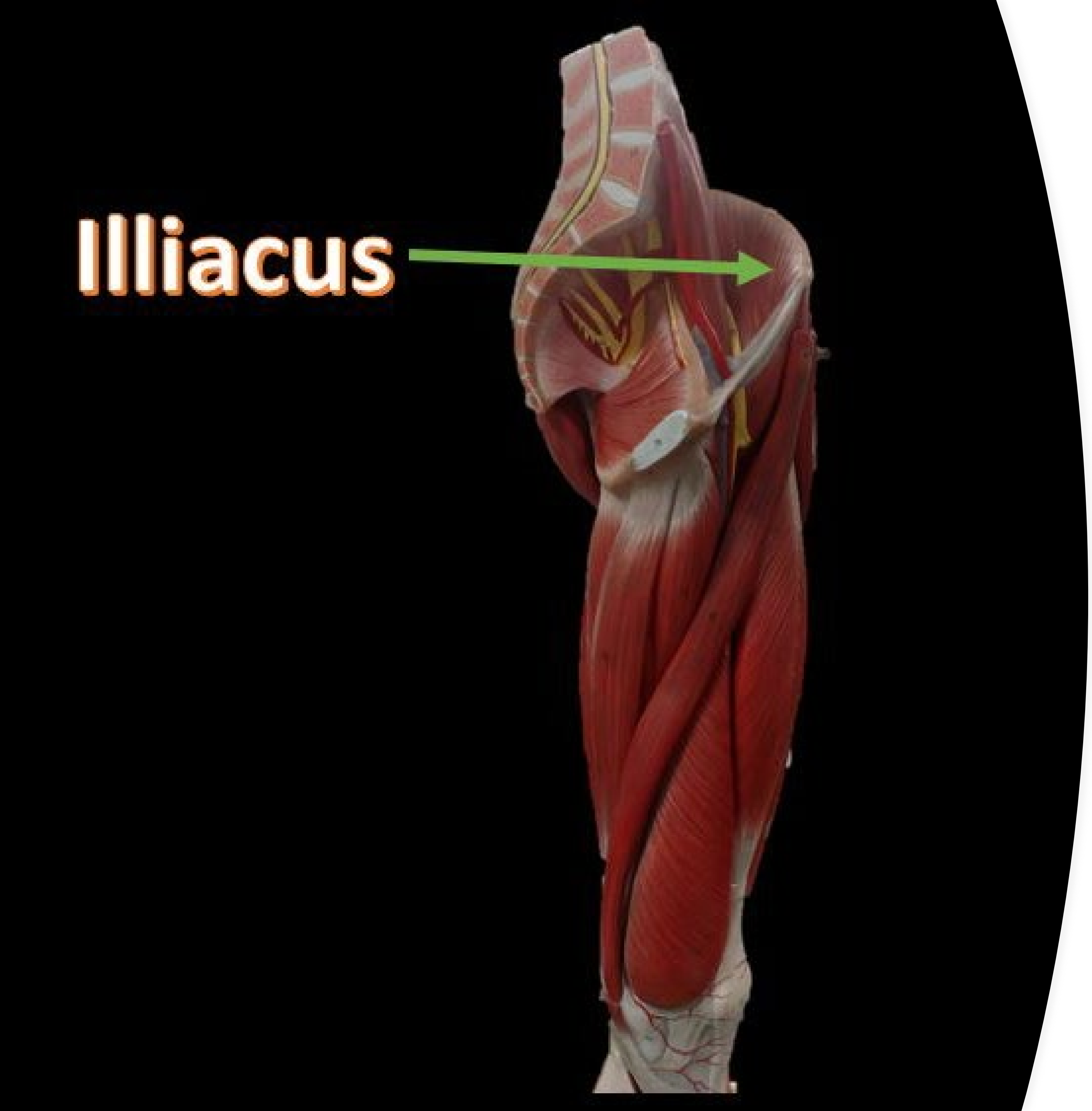

# Iliacus Muscles

- The hip is a ball-and-socket joint that permits flexion, extention, adduction, abduction, and rotation of the thigh.



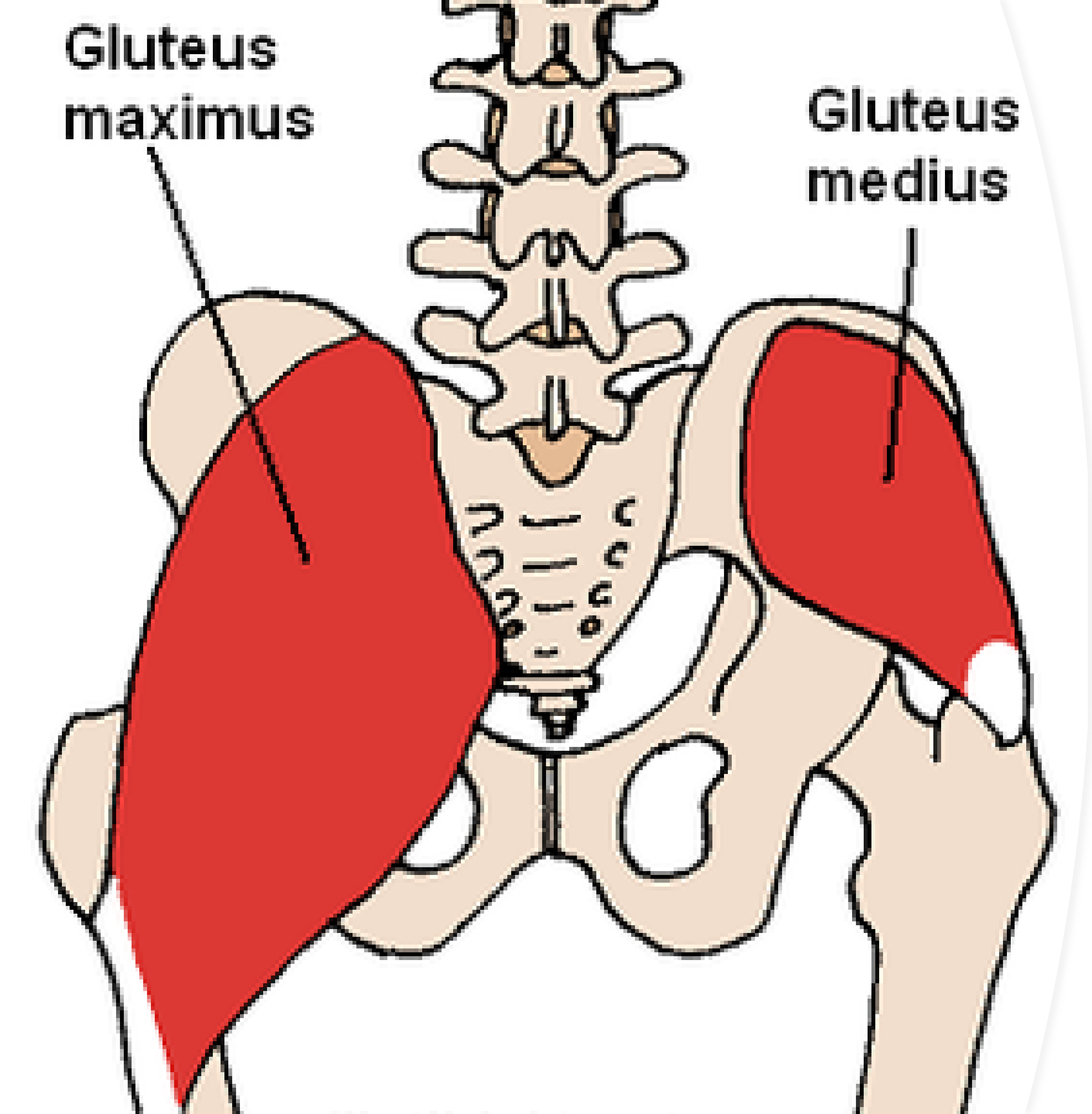

## Iliacus Muscles

- The muscles that flex the thigh at the hip originate from the vertebral column and pelvis and pass anterior to (in front of ) the hip joint.
- These muscles include the **illiacus muscles** and the **rectus femoris**.




## Iliacus Muscles

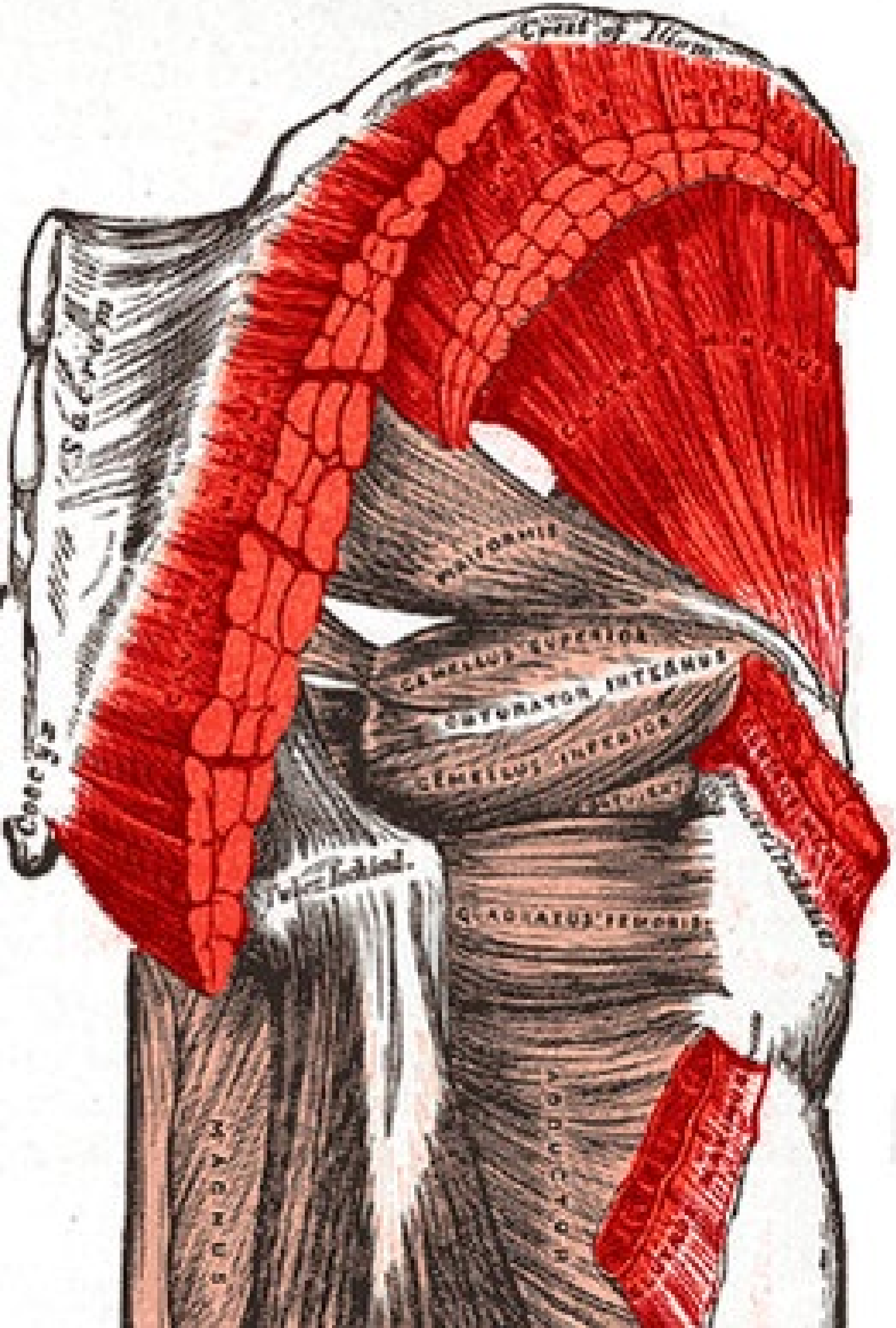
- The muscles that flex the thigh at the hip originate from the vertebral column and pelvis and pass anterior to (in front of ) the hip joint.
- These muscles include the **illiacus muscles** and the **rectus femoris**.




# GLUTEAL MUSCLES

**The muscles of the buttocks (gluteal muscles) include.**

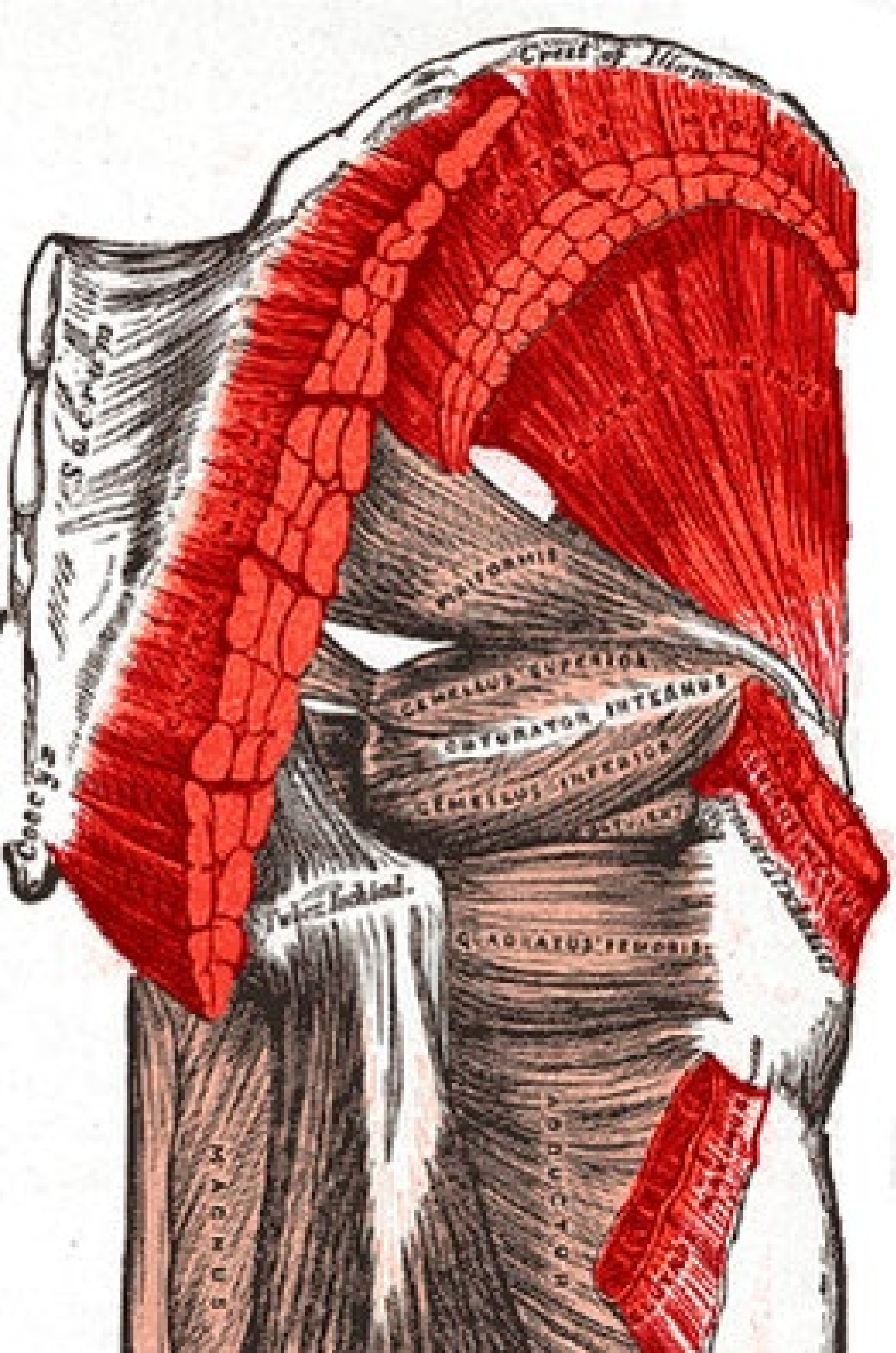
- gluteus maximus
- gluteus medius
- gluteus minimus




# GLUTEAL MUSCLES

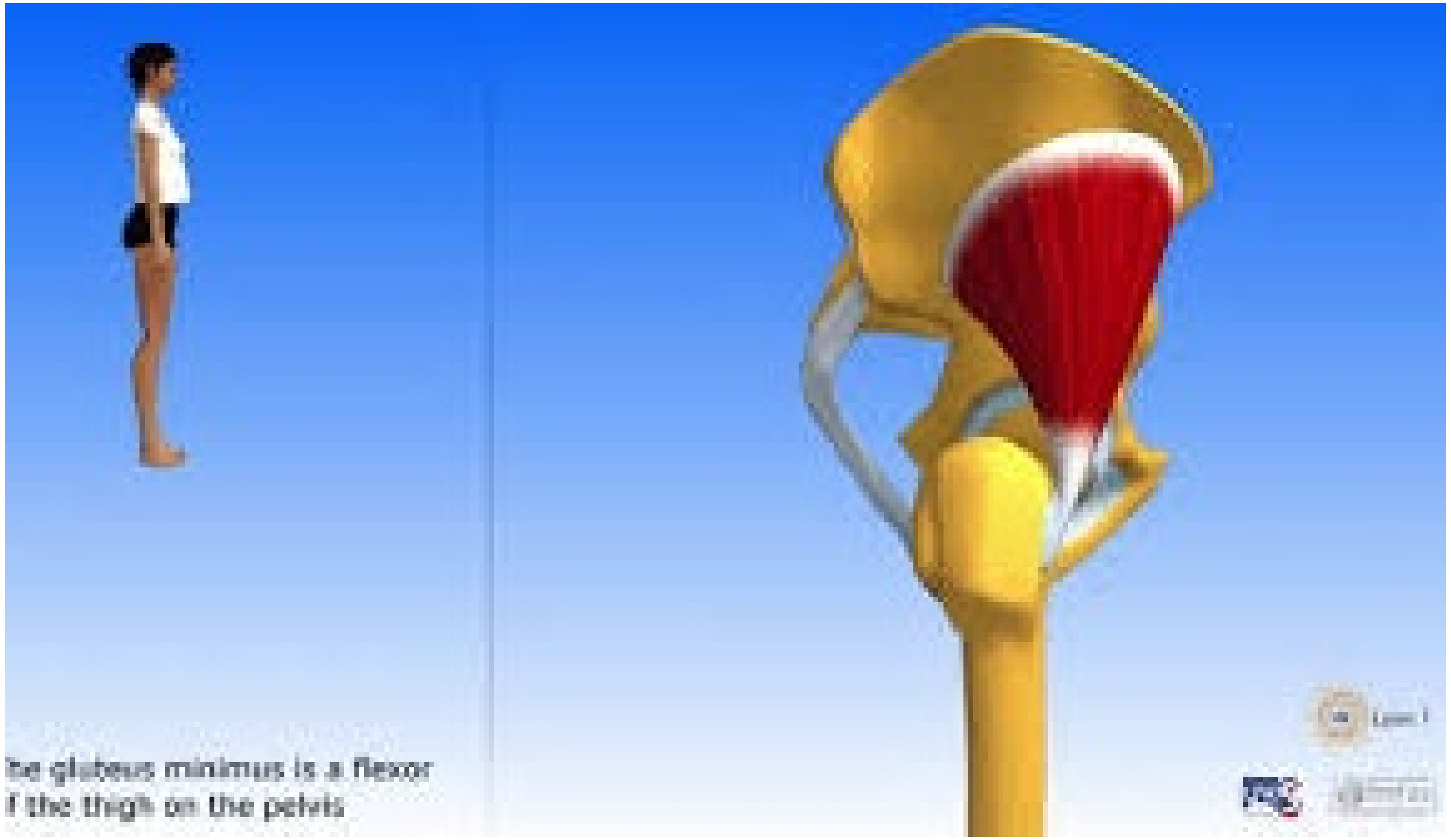
**The muscles of the buttocks (gluteal muscles) include.**

- gluteus maximus
- gluteus medius
- gluteus minimus




# GLUTEAL MUSCLES

- Each of these muscles originate at the ilium and the sacrum and insert at the femur.

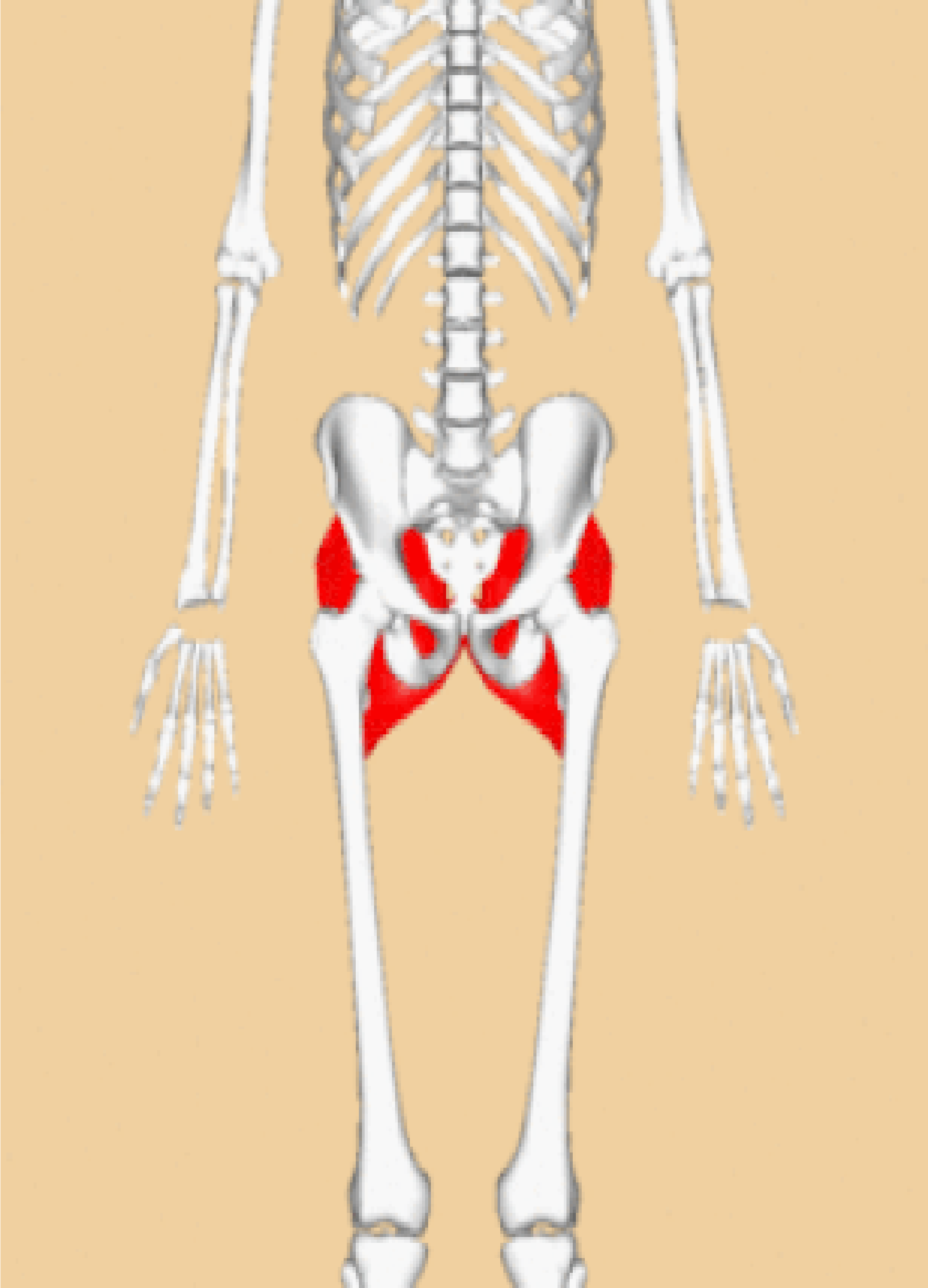


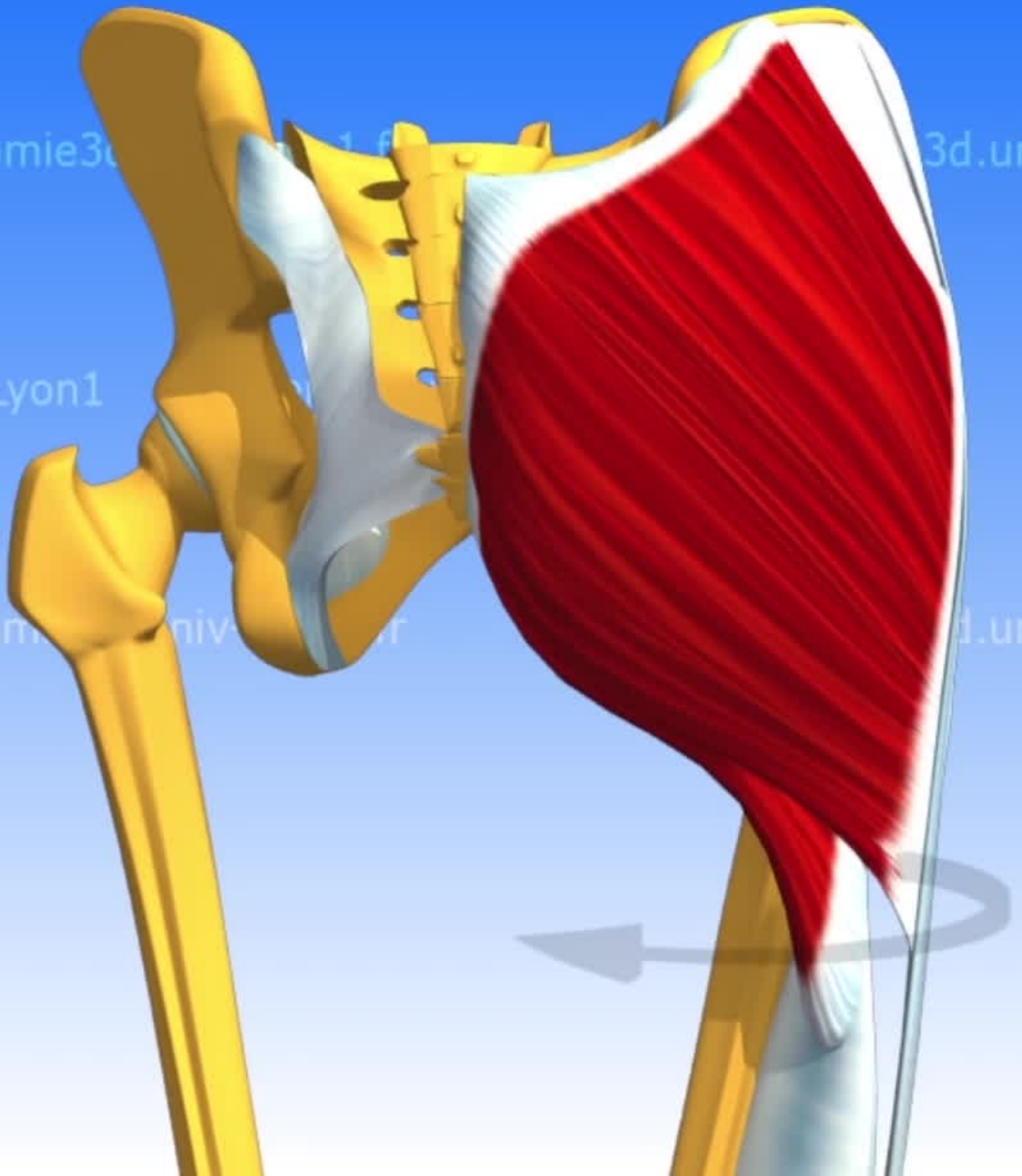

# GLUTEAL MUSCLES

- The gluteal muscles allow for the extension of the thigh (femur) and abduction of the thigh (femur), as well as the external
  rotation and internal
  rotation of the hip joint.

# Gluteus Maximus

- The thigh extensors arise posterior to the hip joint and include the gluteus maximus and hamstrings.
- It is the largest and most superficial of gluteus muscles.
- This muscle forms most of the mass of the buttocks.
- The gluteus maximus is the main extensor of thigh.
- It functions to assist in stair climbing and is able to laterally rotate and adduct the thigh.

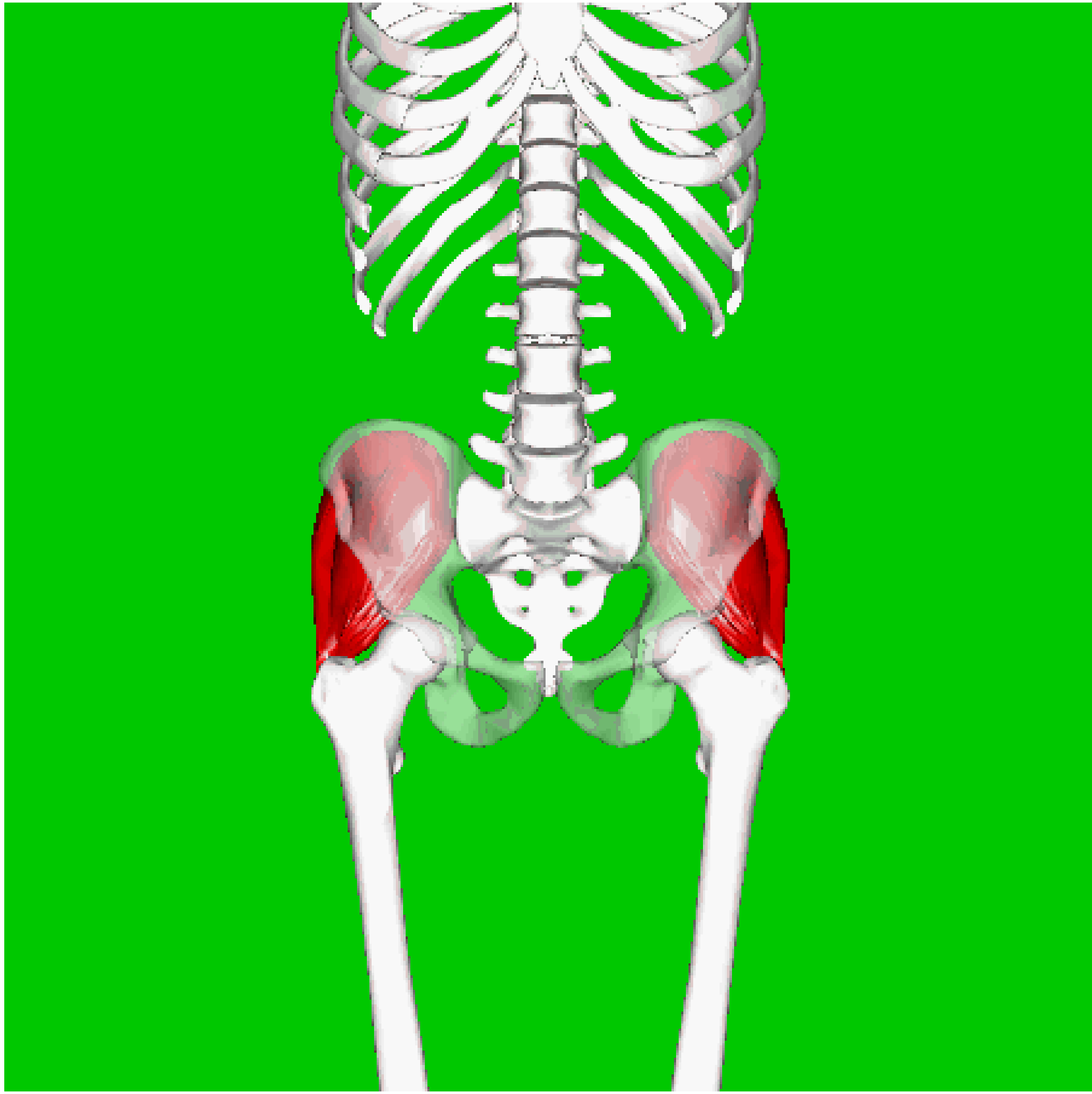




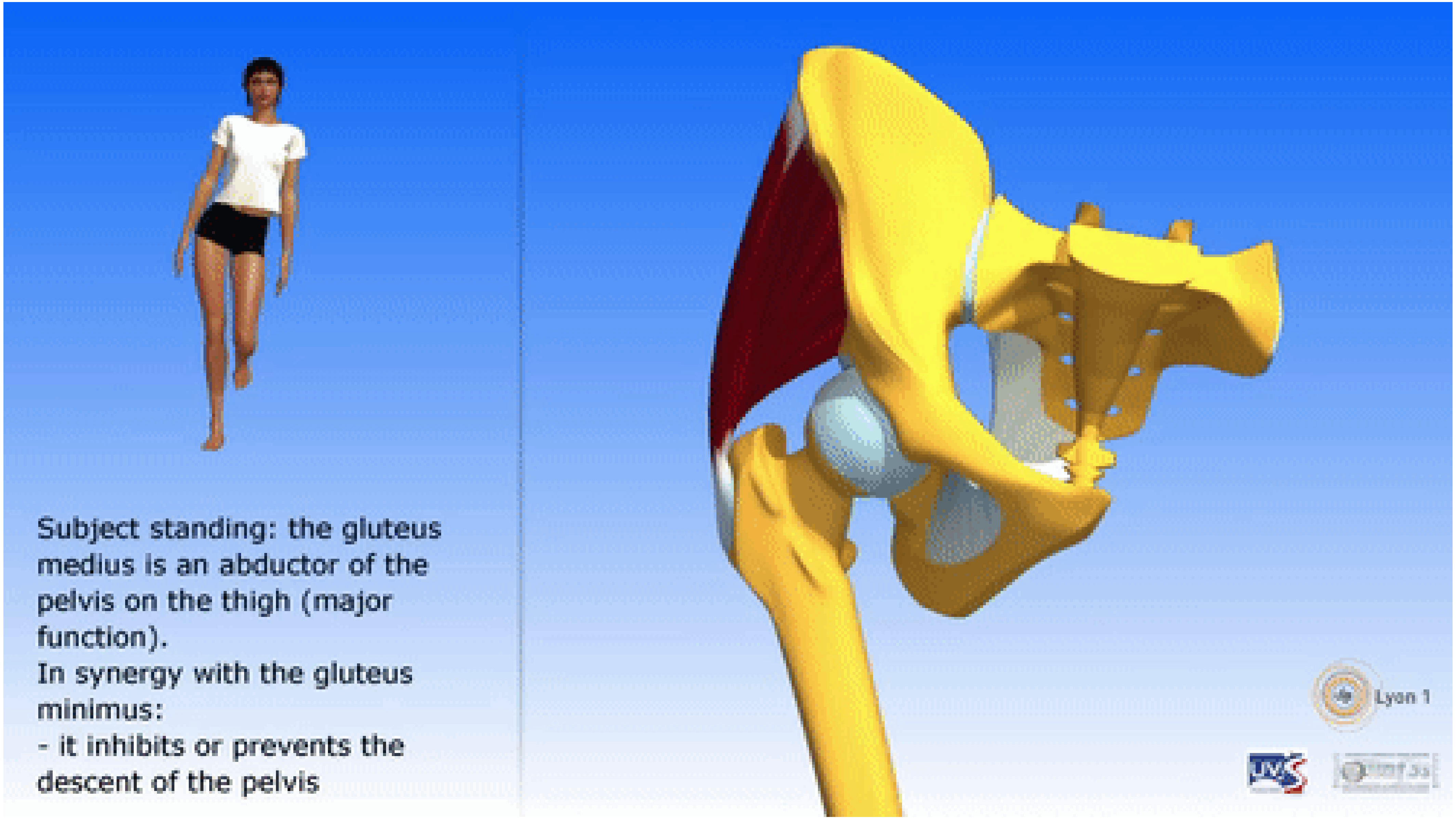
The gluteus maximus is a
lateral rotator of the thigh

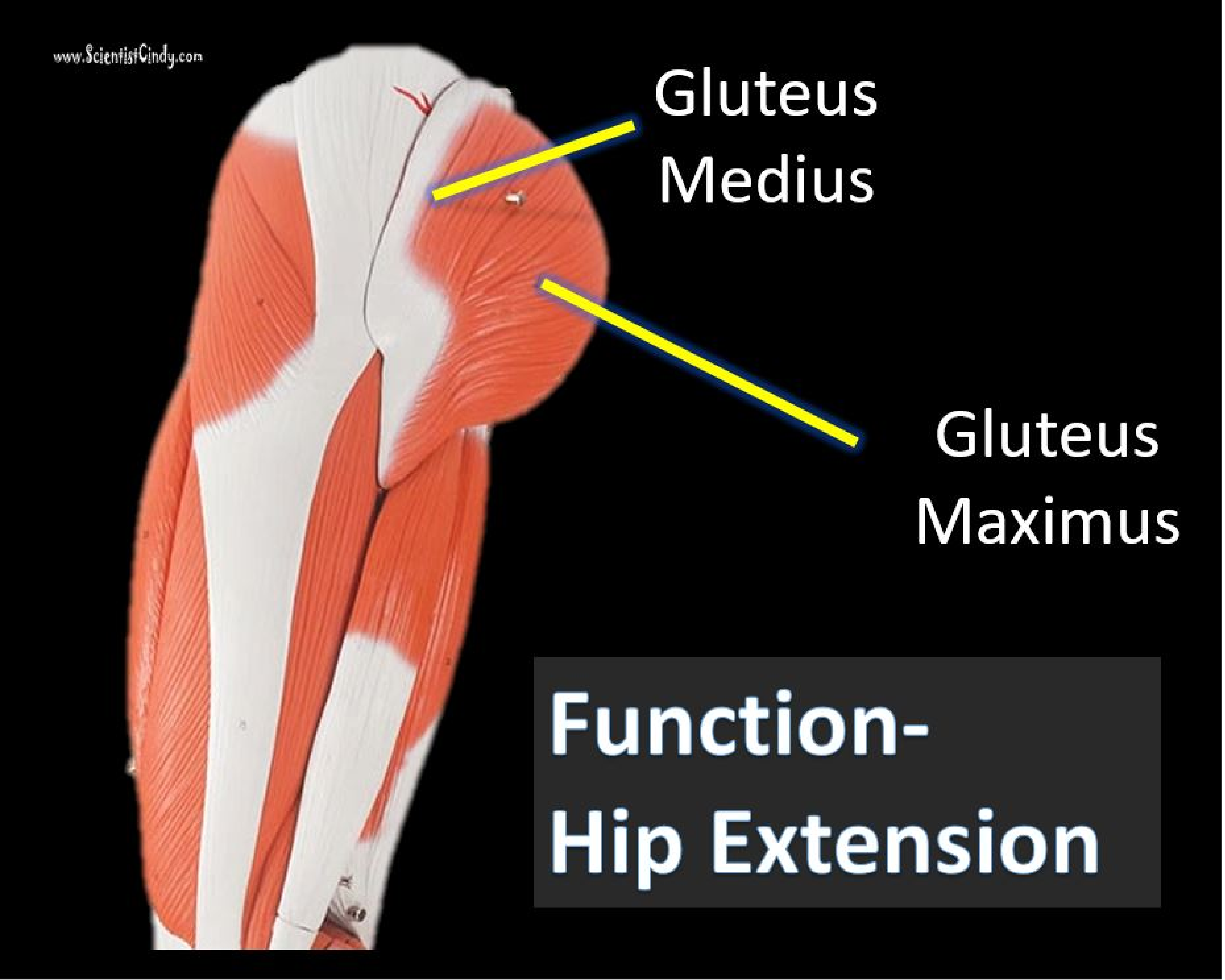
# Gluteus Medius

- A portion of the **gluteus medius** lies superior to gluteus maximus.
- The inferior portion of the gluteus medius lies underneath (deep to) the gluteus maximus.
- The gluteus medius is one of the three gluteal muscles which lie on the outer portion of the pelvis at the posterior aspect.



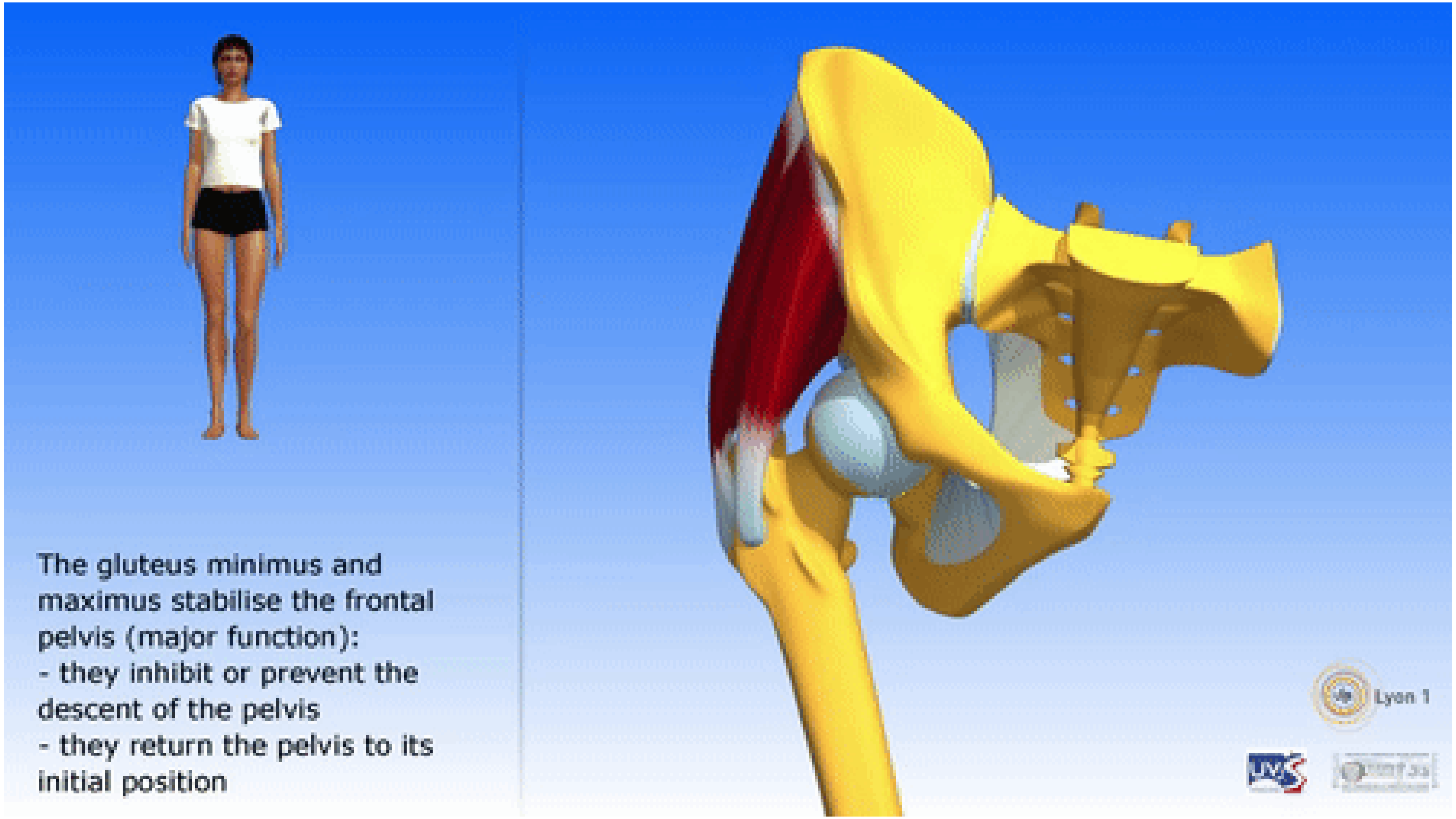
# Gluteus Medius



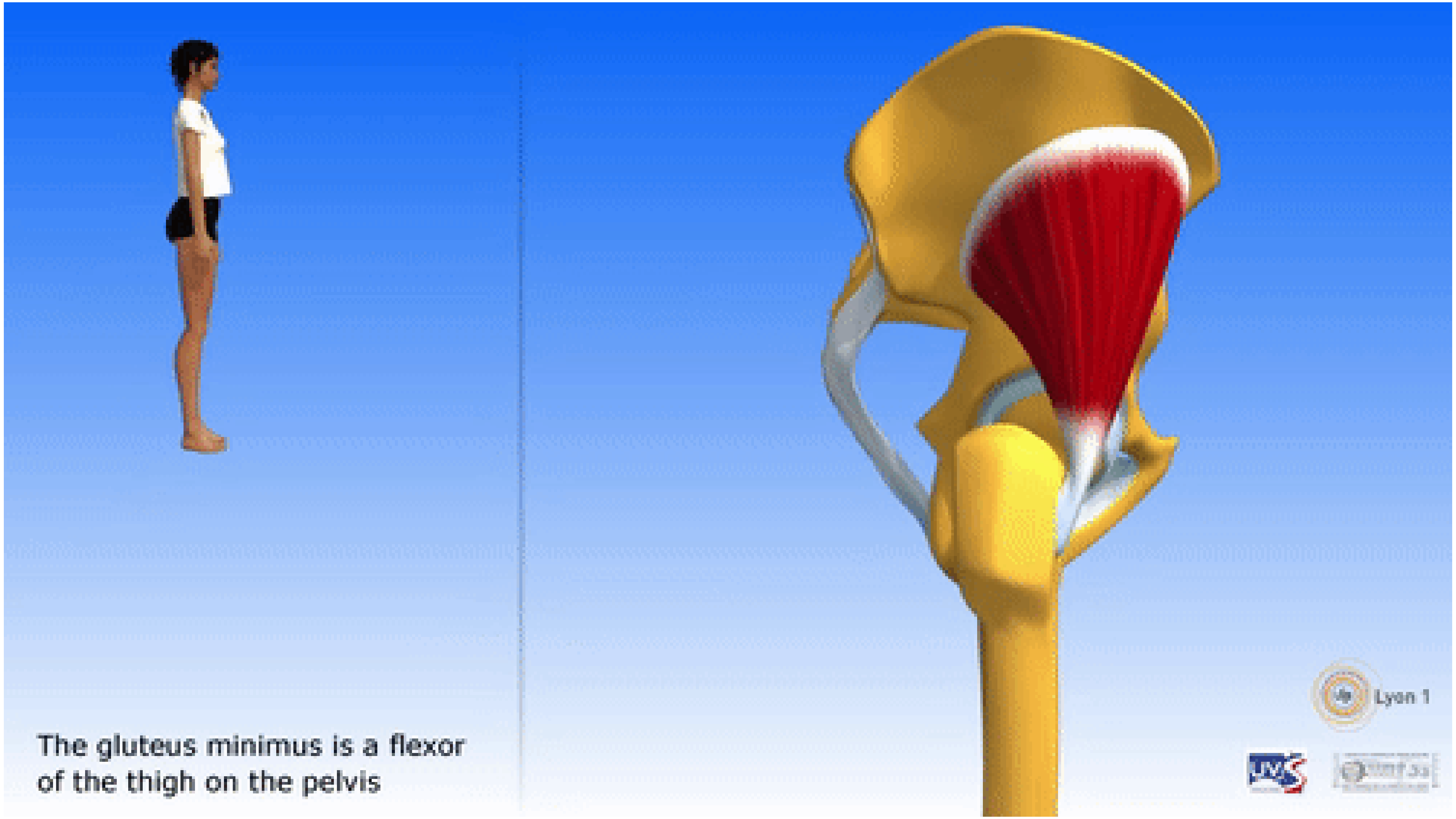



- The gluteus minimus is not shown on the muscular model of the leg.
- The gluteus minimus muscle lies directly beneath the gluteus medius muscle.

# Gluteus Minimus

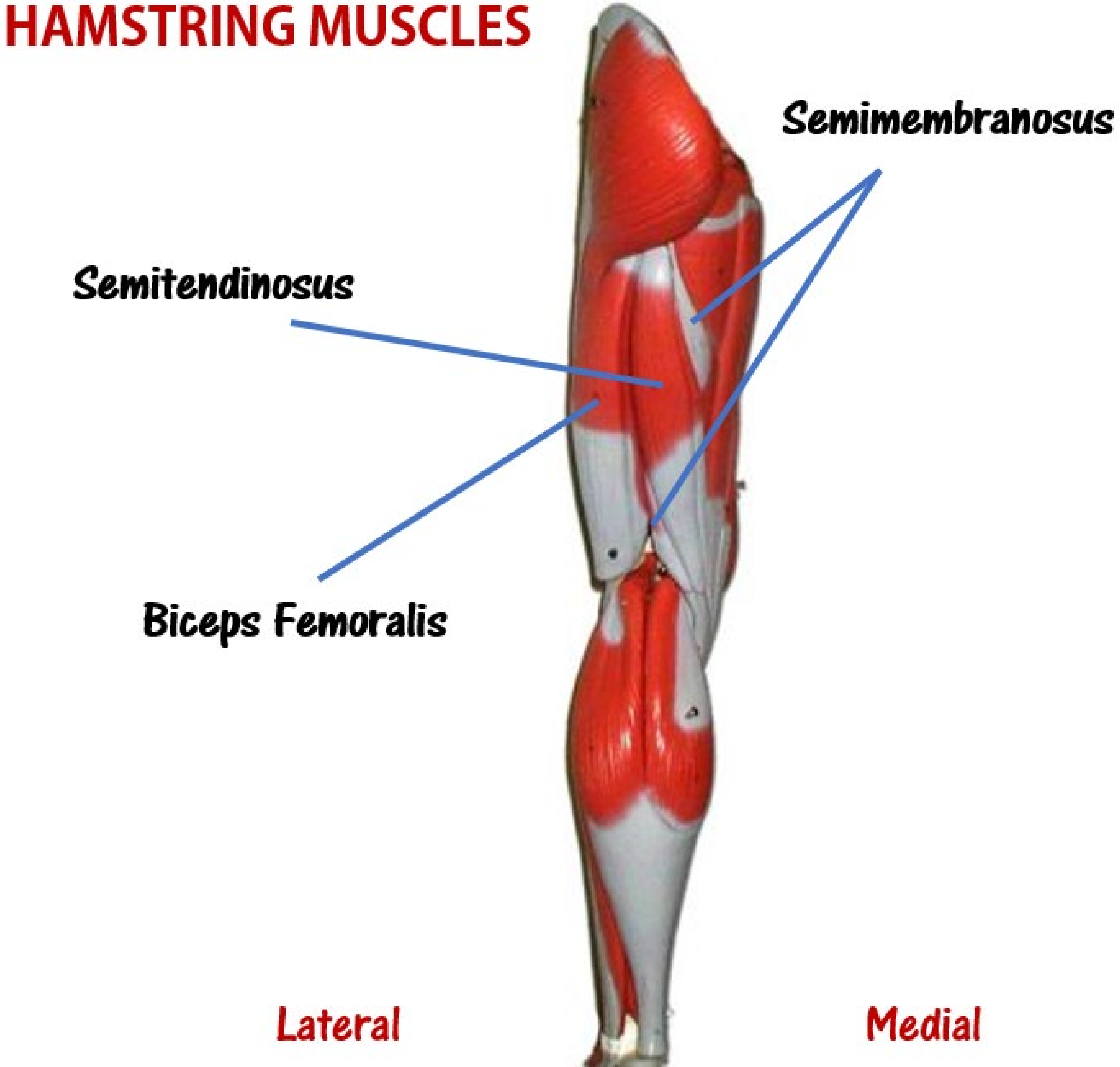


# Gluteus Minimus



# Hamstring Muscles

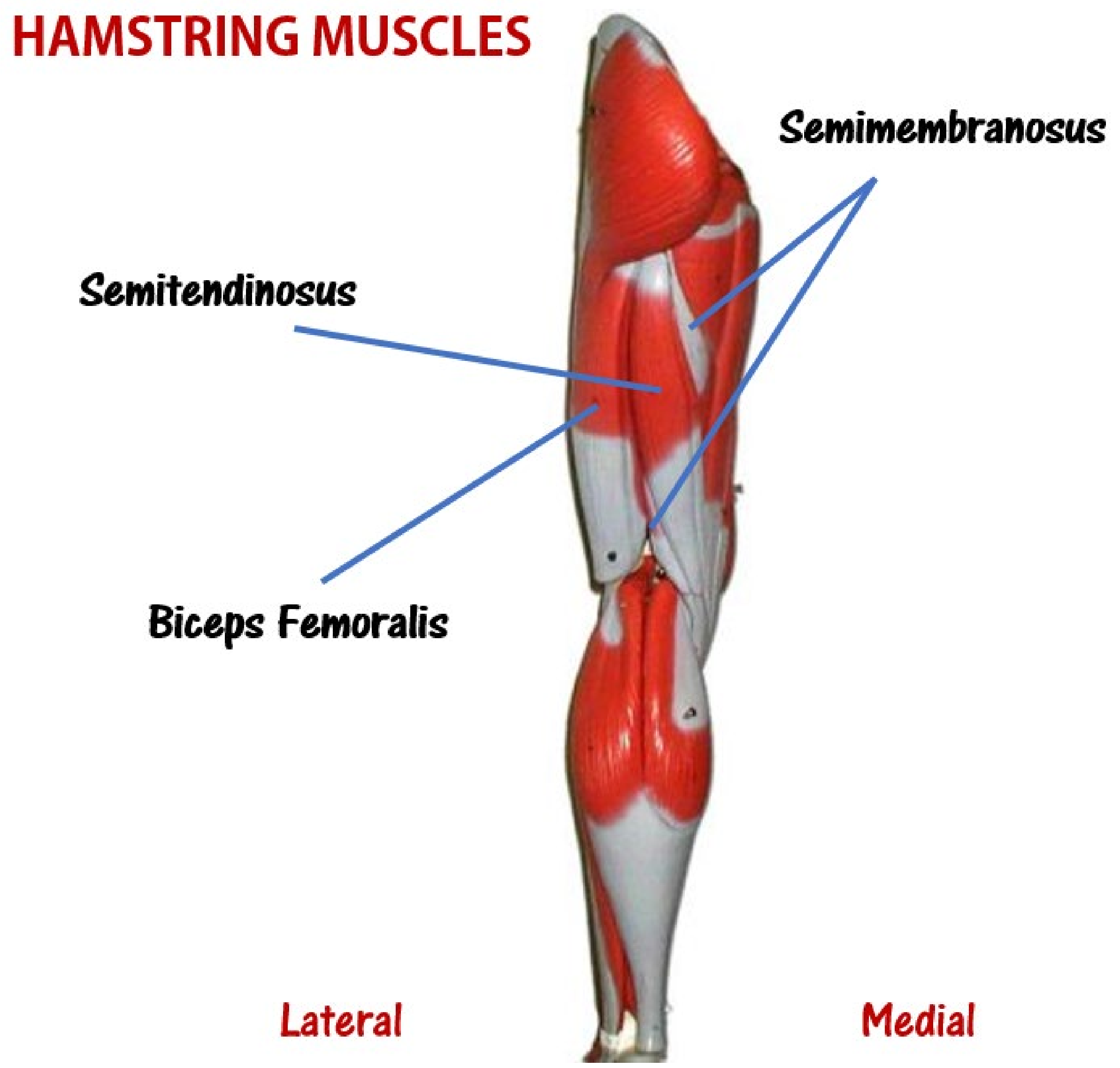
- The **hamstring** refers to a group of muscles that lie at the posterior aspect of the thigh.
- The hamstring muscles cross (and therefore act upon) both the hip joint and the knee joint.
- The hamstring is the single large tendon found behind the knee or comparable area.



# Hamstring Muscles

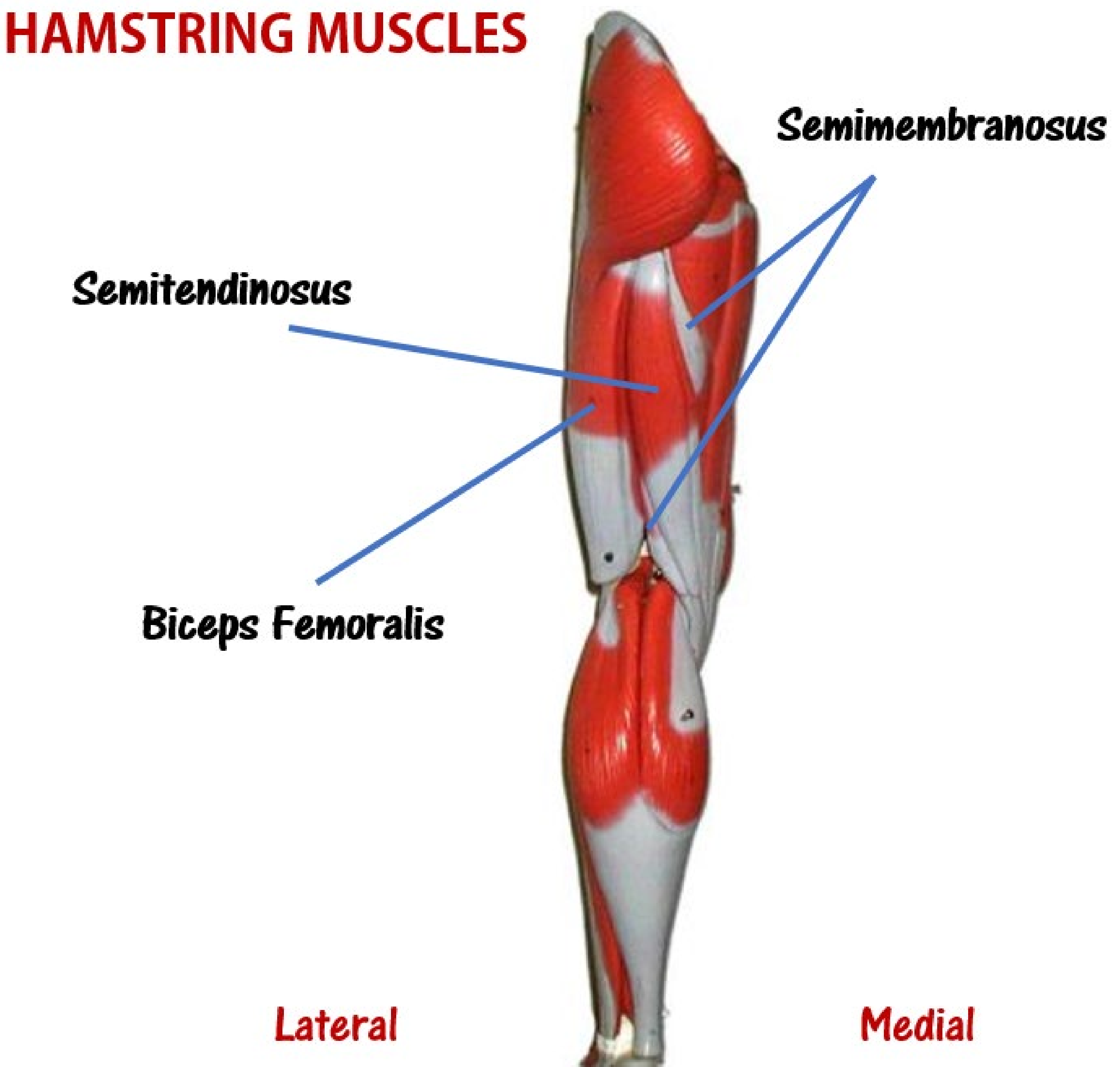
The hamstrings include the following muscles from medial to lateral:

- **The semimembranosus**
- **The semitendinosus**
- **The biceps femoris**



# Hamstring Muscles

- Theses hamstring muscles have similar structure and function.
- They each originate at the ischial tuberosity of the hip bone and travel over the posterior of the knee joint and inserts in either the tibia or the fibula of the lower leg.



# Hamstring Muscles

- The hamstring muscle function in the flexion of the knee joint and extension of the hip joint.

## Hamstring Muscles

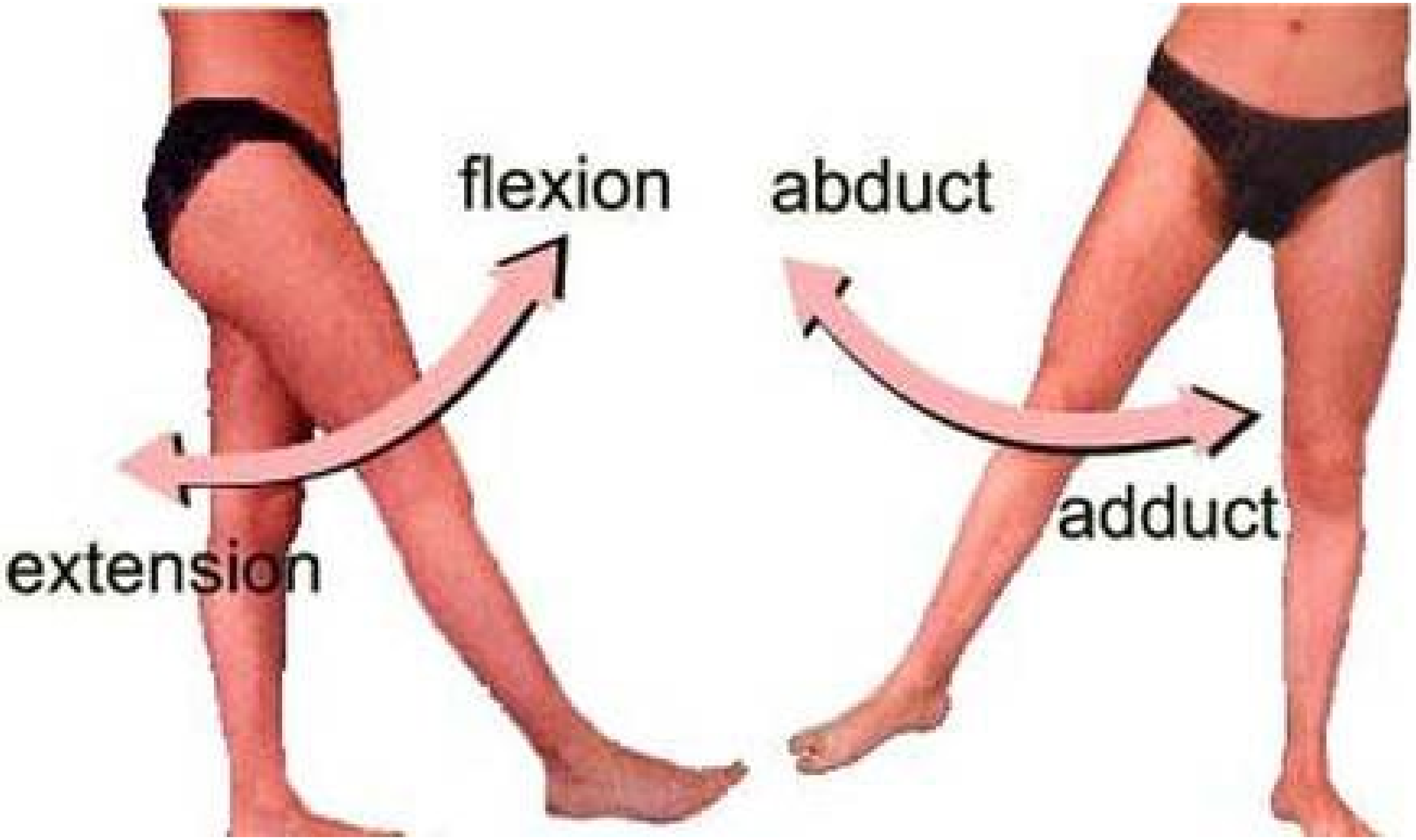
- The hamstrings play a crucial role in many daily activities such as walking, running, jumping, and controlling some movement in the trunk.
- In walking, they are most important as an antagonist to the quadriceps in the deceleration of knee extension.

# Hamstring Muscles

- The hamstrings play a crucial role in many daily activities such as walking, running, jumping, and controlling some movement in the trunk.
- In walking, they are most important as an antagonist to the quadriceps in the deceleration of knee extension.

# The Hamstring Muscles:
# The Semimembranosus Muscle


- **Function = Extends thigh; flexes leg; medially rotates leg.**
- The semimembranosus muscle is medial hamstring muscle, lying toward the posterior portion of the inner thigh, underneath (deep) to the semitendinous muscle.




# The Hamstring Muscles: The Semitendinosus Muscle

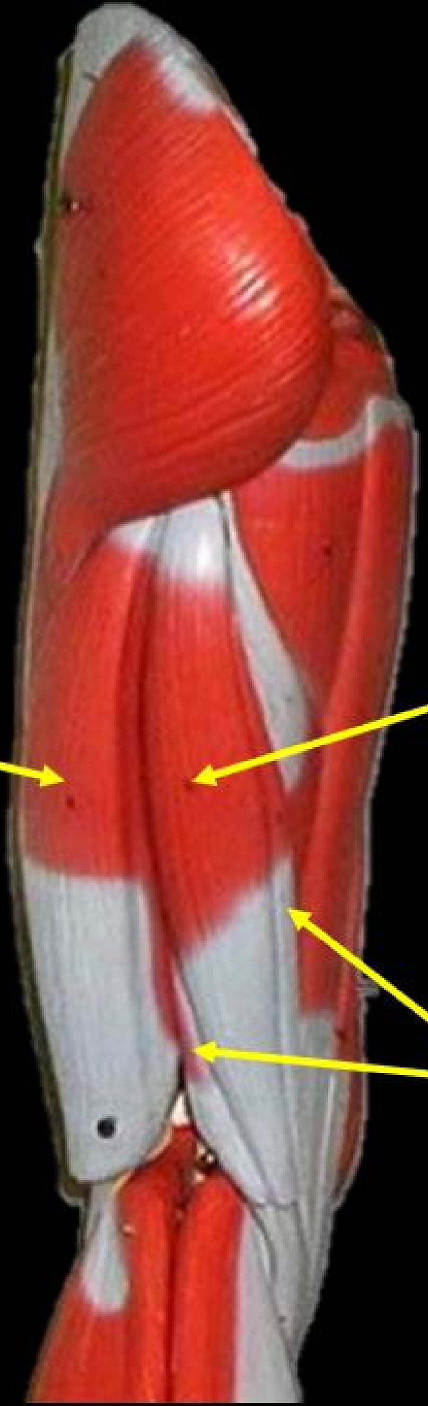
- **Function = Extends thigh; flexes leg; medially rotates leg.**
- The semitendinosus muscle lies medial to biceps femoris. It is superficial, and has a long, slender tendon at the posterior aspect of the thigh.

# The Biceps Femoris

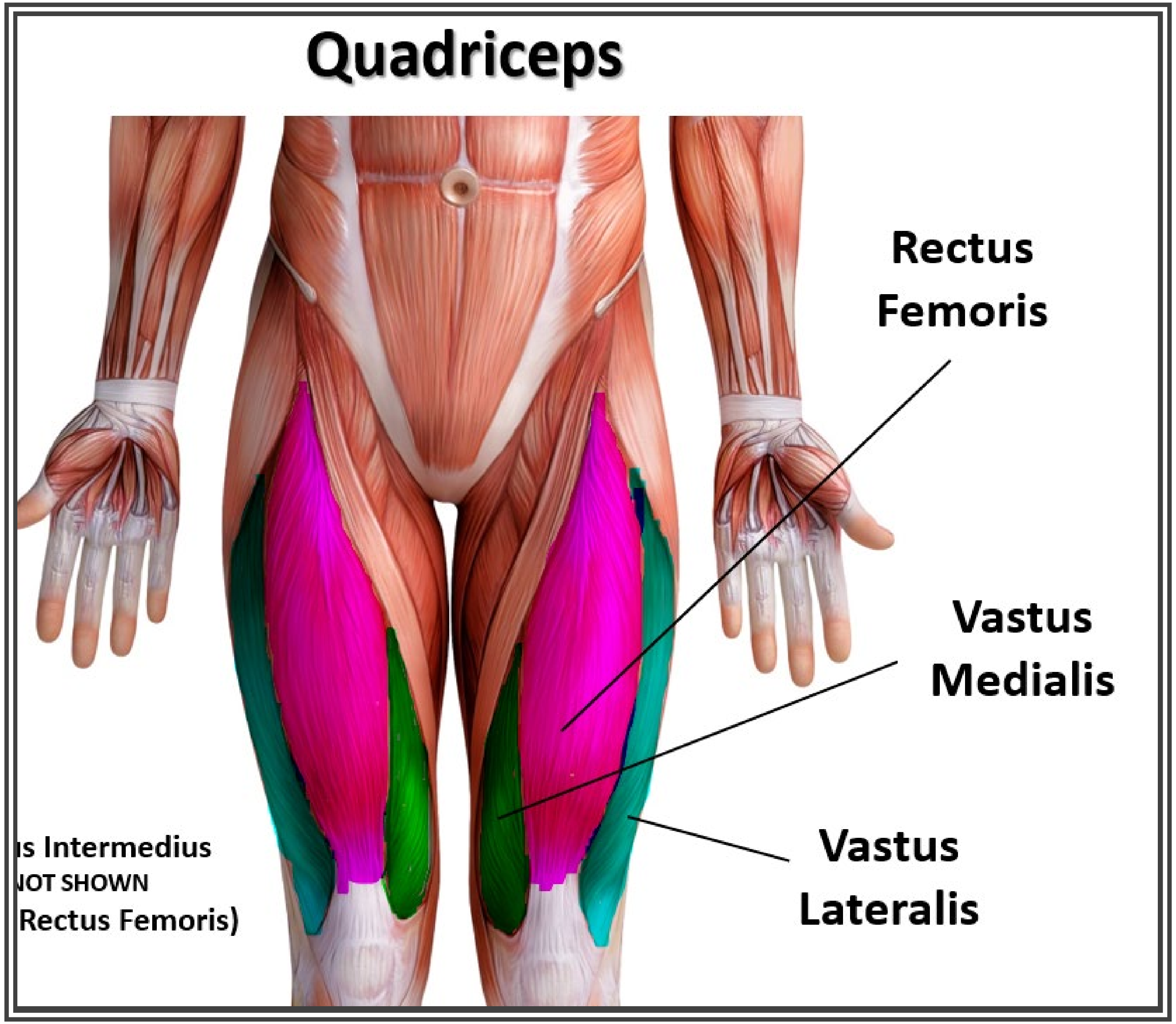
- Function = Extends thigh; flexes leg; medially rotates leg.
- The biceps femoris gets its name because it has "two heads"; a long head and a short head.
- The long head of the biceps femoris extends the hip, as when beginning to walk; both short and long heads flex the knee and laterally (outwardly) rotate the lower leg when the knee is bent.

# Hamstring Muscles

The hamstring is composed of the
1. semitendinosus
2. semimembranosus
3. biceps femoris




FXN – These three muscles work collectively to FLEX the KNEE and EXTEND the THIGH




# Muscles of the Quadriceps

- extensors of the knee.

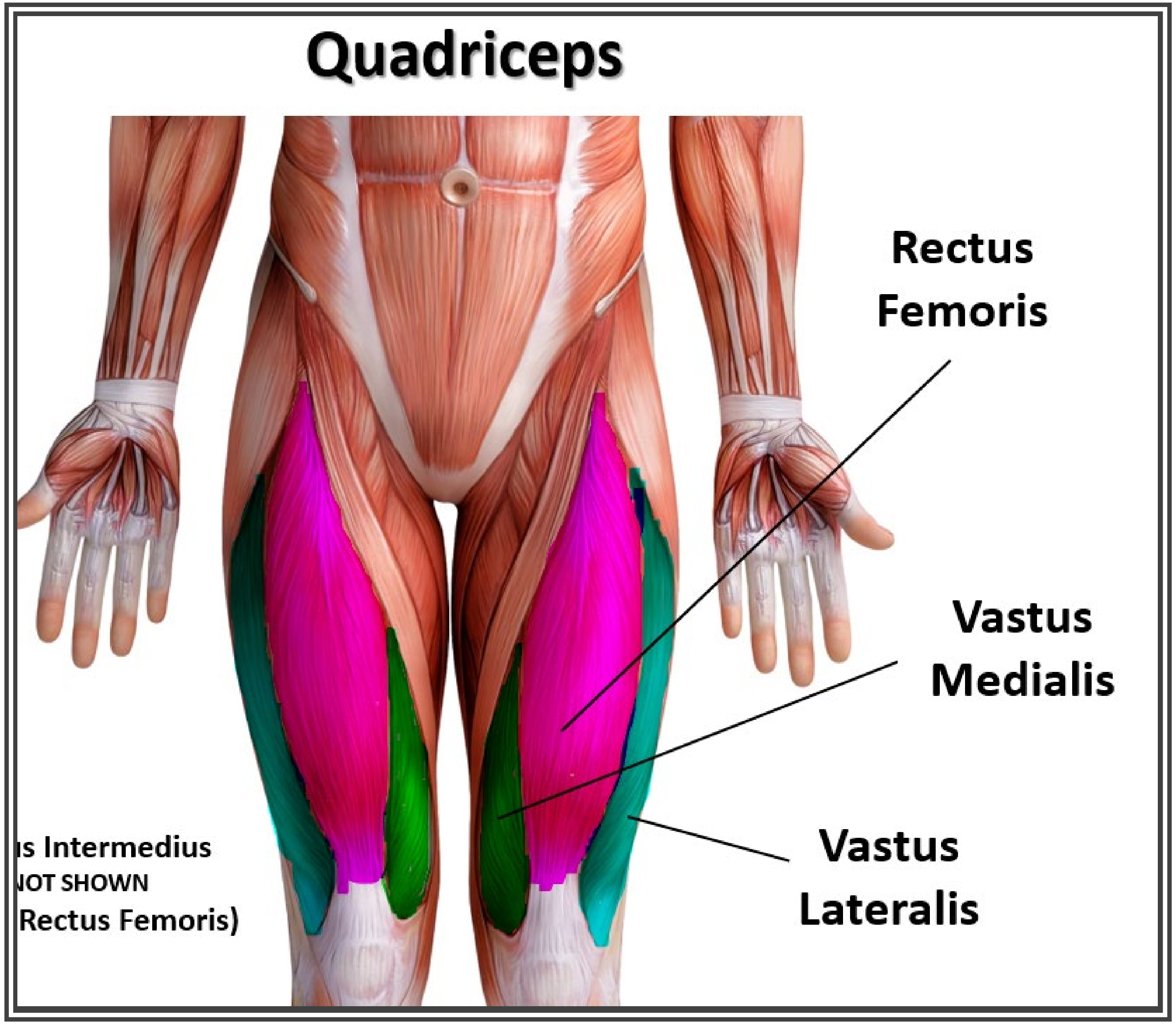
# Muscles of the Quadriceps

- The animated GIF shows the 4 muscles of the quadriceps as the following colors:

  *rectus femoris* - **blue**
  *vastus lateralis* - **yellow**
  *vastus intermedius* - **green**
  *vastus medialis* - **red**

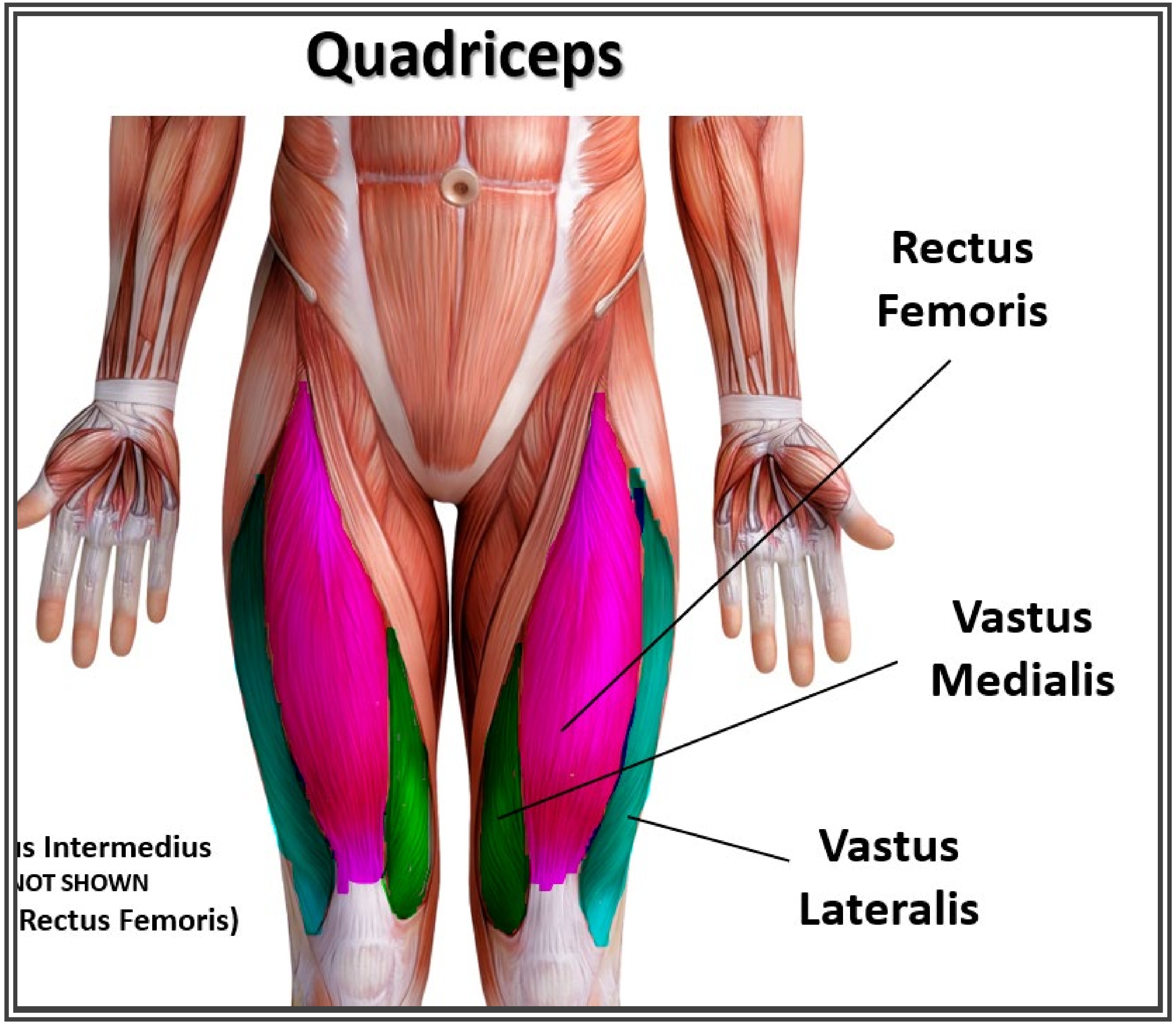
# Muscles of the Quadriceps

- *The hip is a ball-and-socket joint that permits flexion, extension, adduction, abduction, and rotation of the thigh.*
- *The muscles that flex the thigh at the hip originate from the vertebral column and pelvis and pass anterior to (in front of ) the hip joint.*



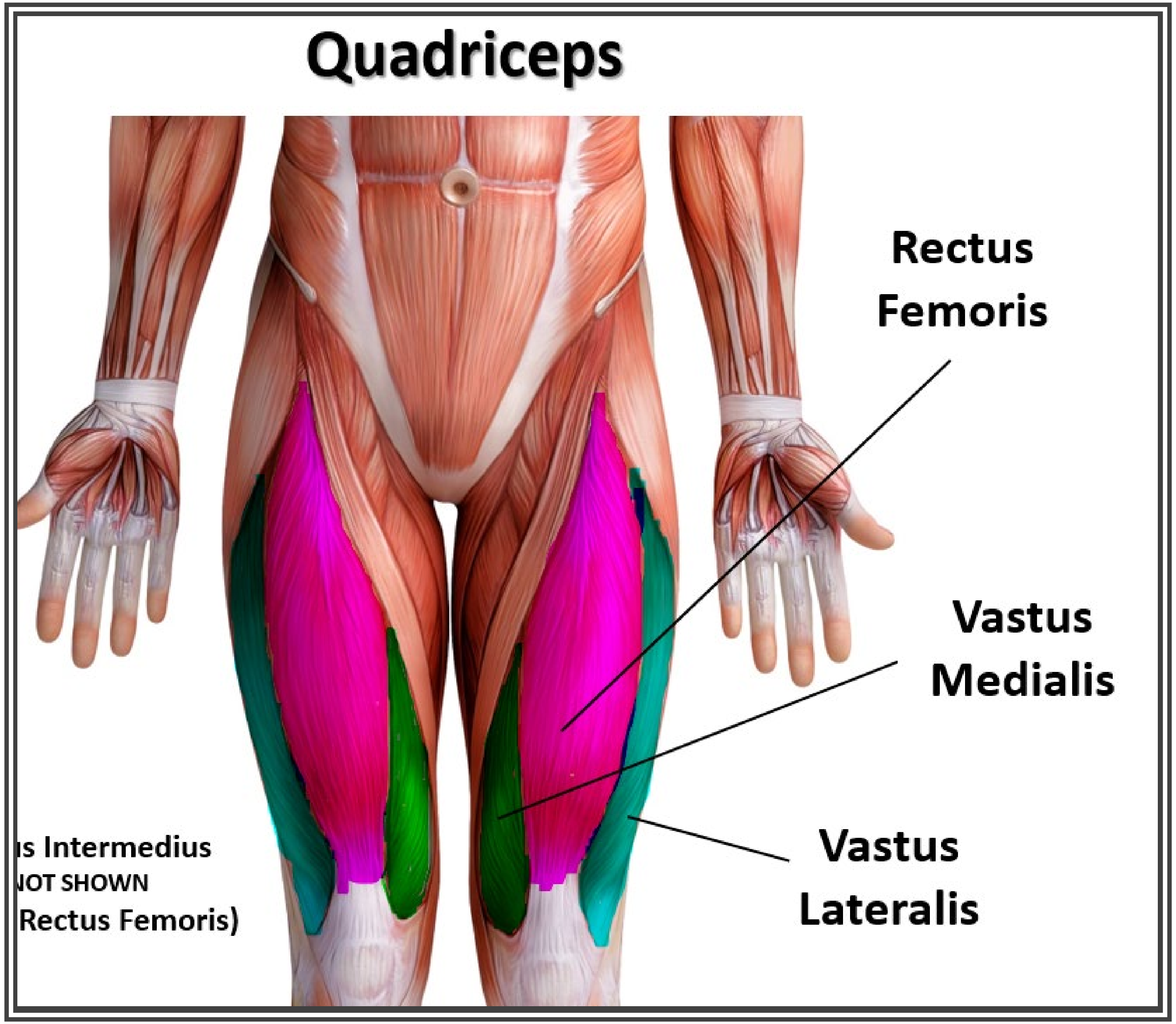

# Muscles of the Quadriceps

- The **quadriceps femoris** gets its name from the Latin words that mean "four-headed muscle of the femur".
- The quadraceps femoris refers to a muscle group that consists of 4 muscles of the anterior (front) thigh area (or the femoral area.
- The muscles are extensors of the knee.



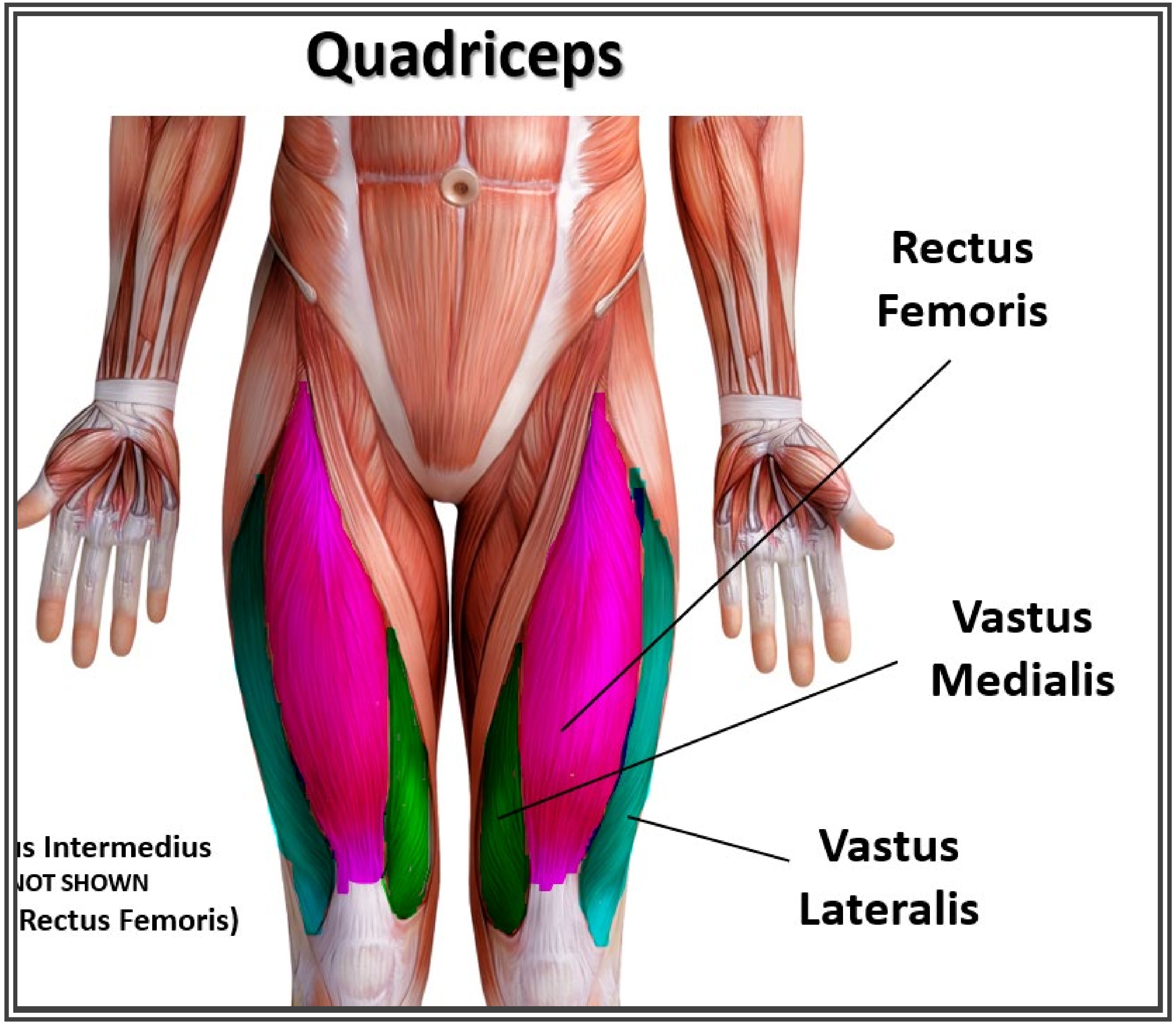

# Muscles of the Quadriceps: Rectus femoris

- **Rectus femoris** occupies the middle of the thigh, covering most of the other three quadriceps muscles. It originates on the ilium.
- It is named from its “straight course”.



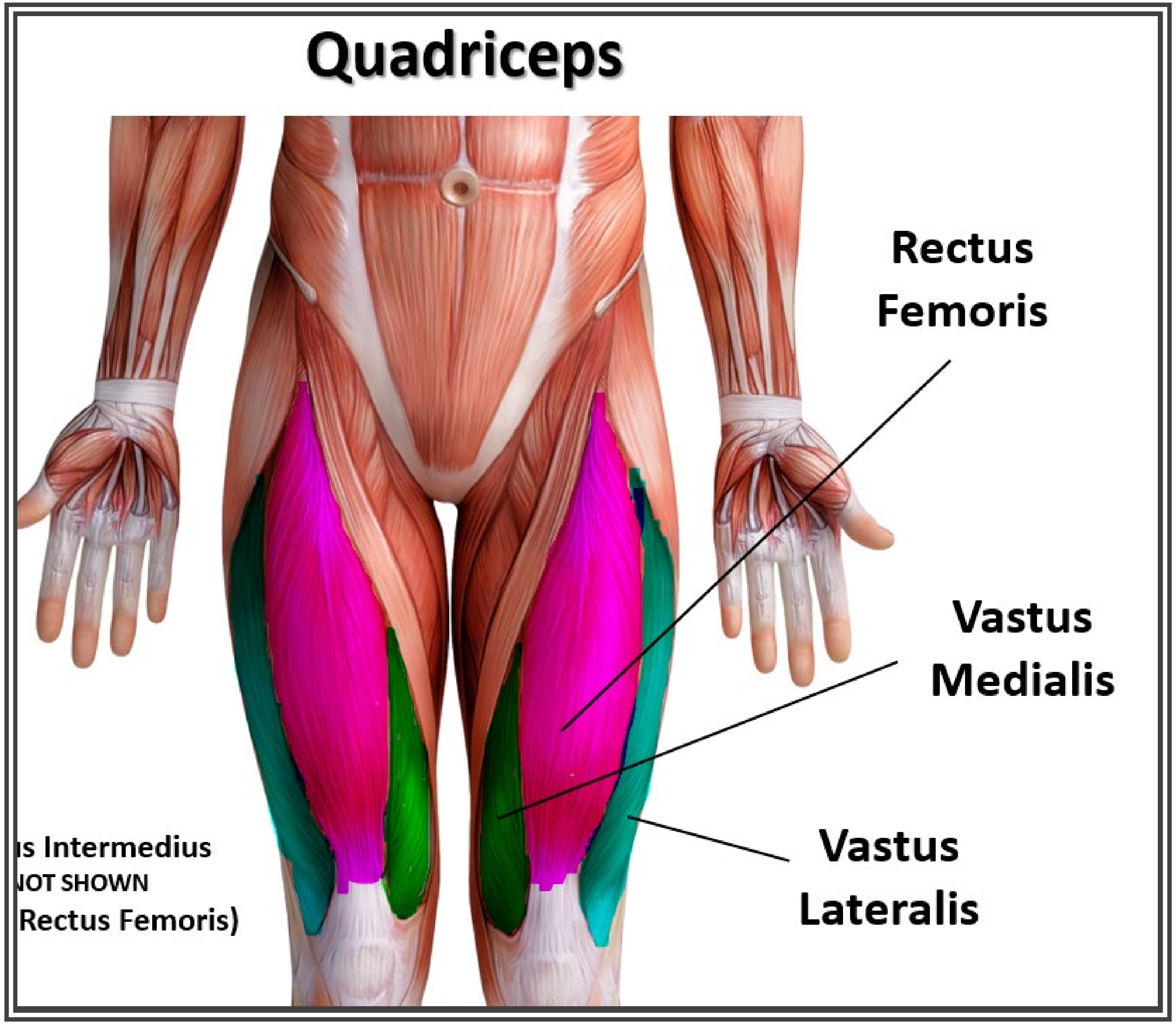

# Muscles of the Quadriceps

- The other three lie deep to rectus femoris and originate from the body of the femur, which they cover from the trochanters to the condyles.



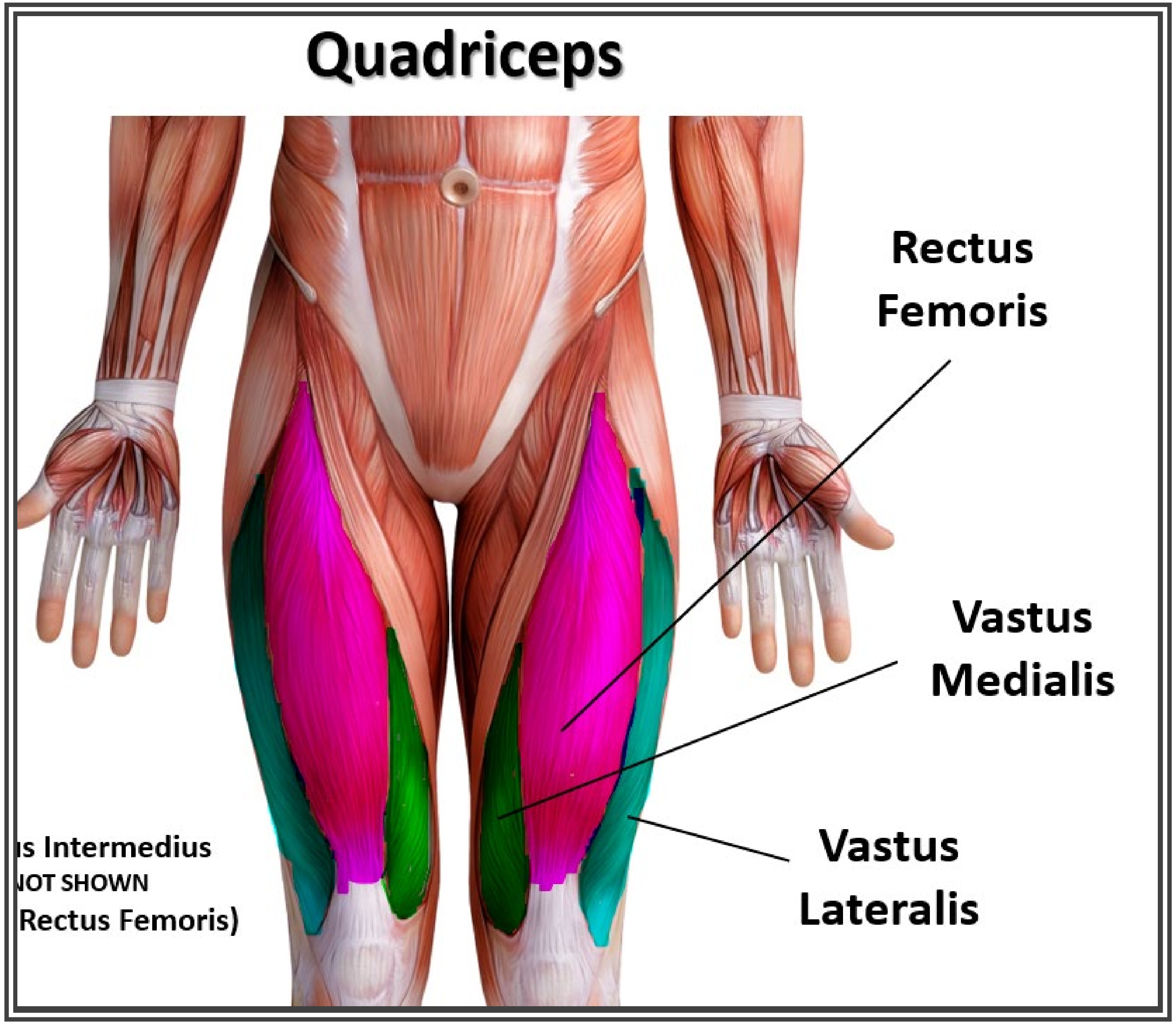

# Muscles of the Quadriceps: Vastus lateralis

- **Vastus lateralis** is on the *lateral side* of the femur (i.e. on the outer side of the thigh).



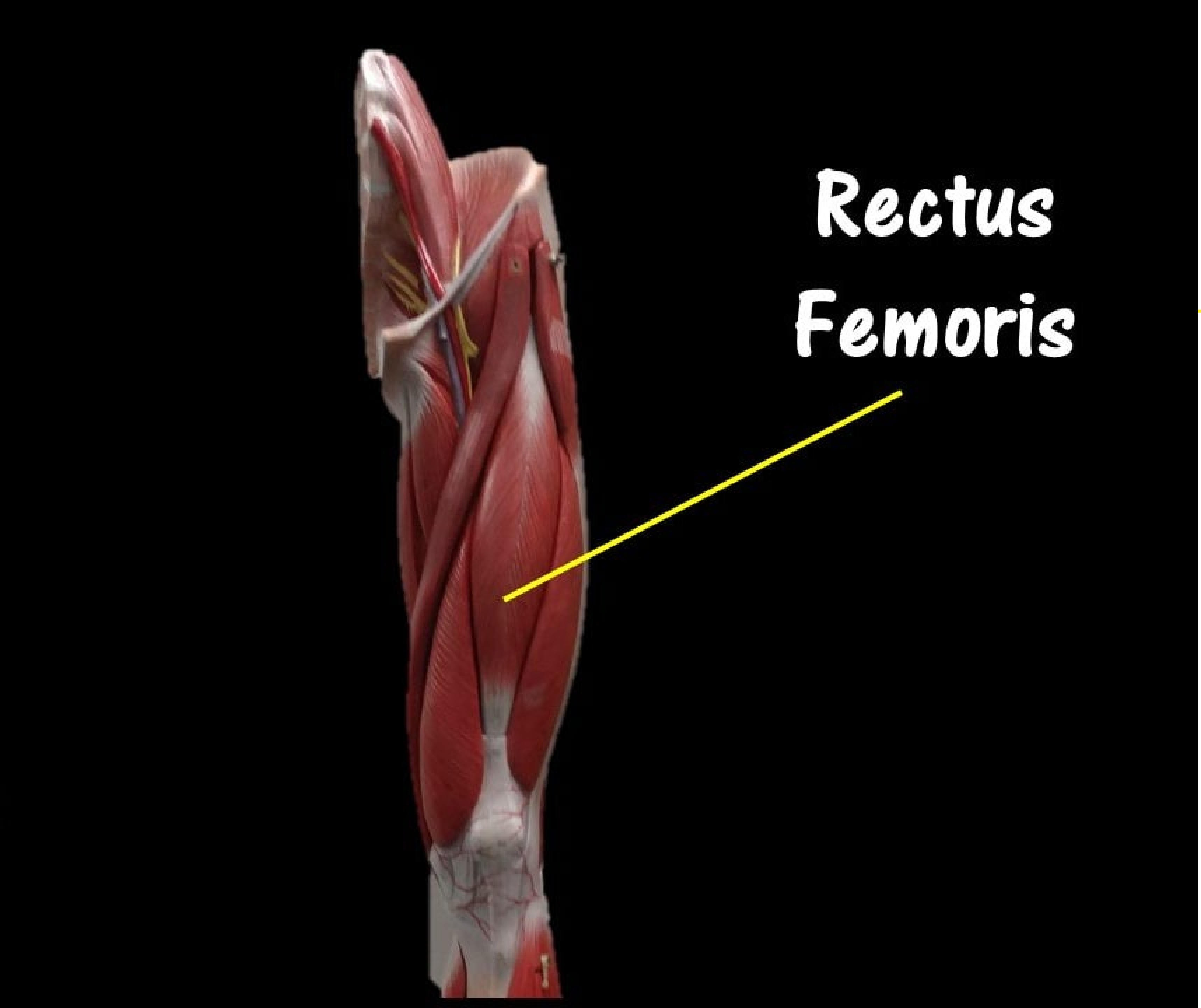

# Muscles of the Quadriceps: Vastus medialis

- **Vastus medialis** is on the *medial side* of the femur (i.e. on the inner part thigh).




# Muscles of the Quadriceps:
# Vastus medialis

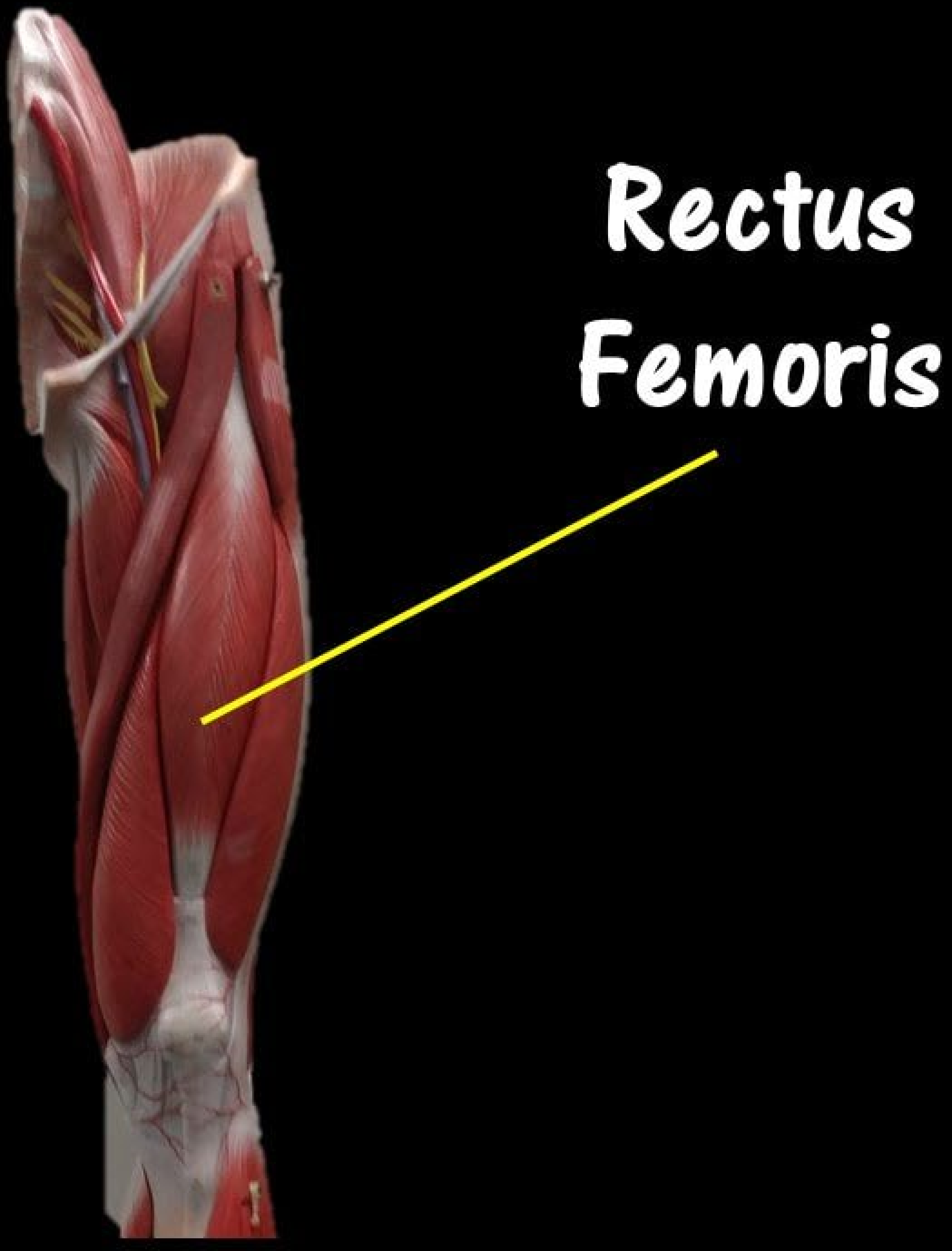
- **Vastus intermedius** lies between vastus lateralis and vastus medialis on the *front* of the femur (i.e. on the top or front of the thigh), but underneath (deep) to the rectus femoris.
- Typically, it cannot be seen without dissection of the rectus femoris.

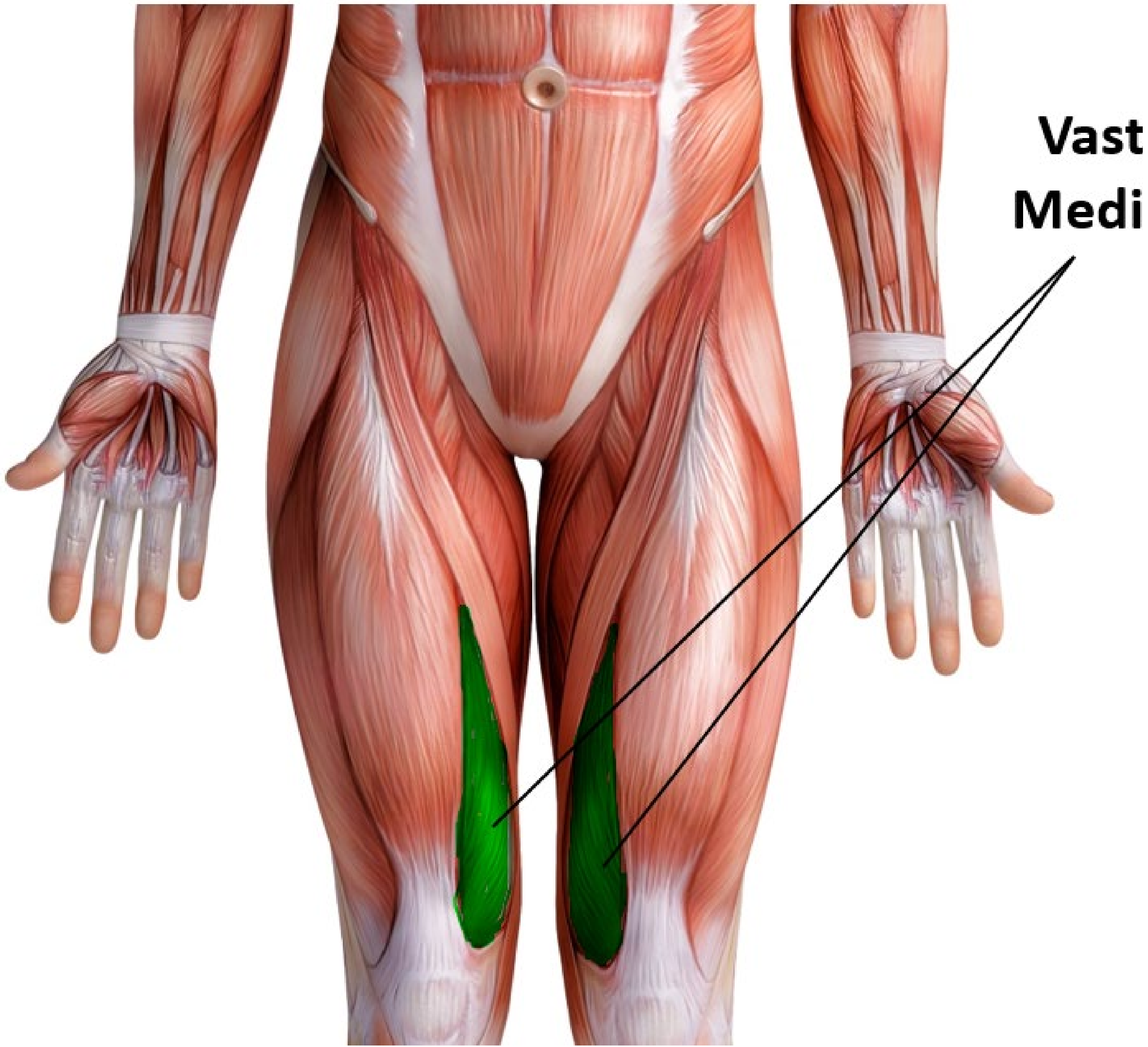



# Rectus Femoris

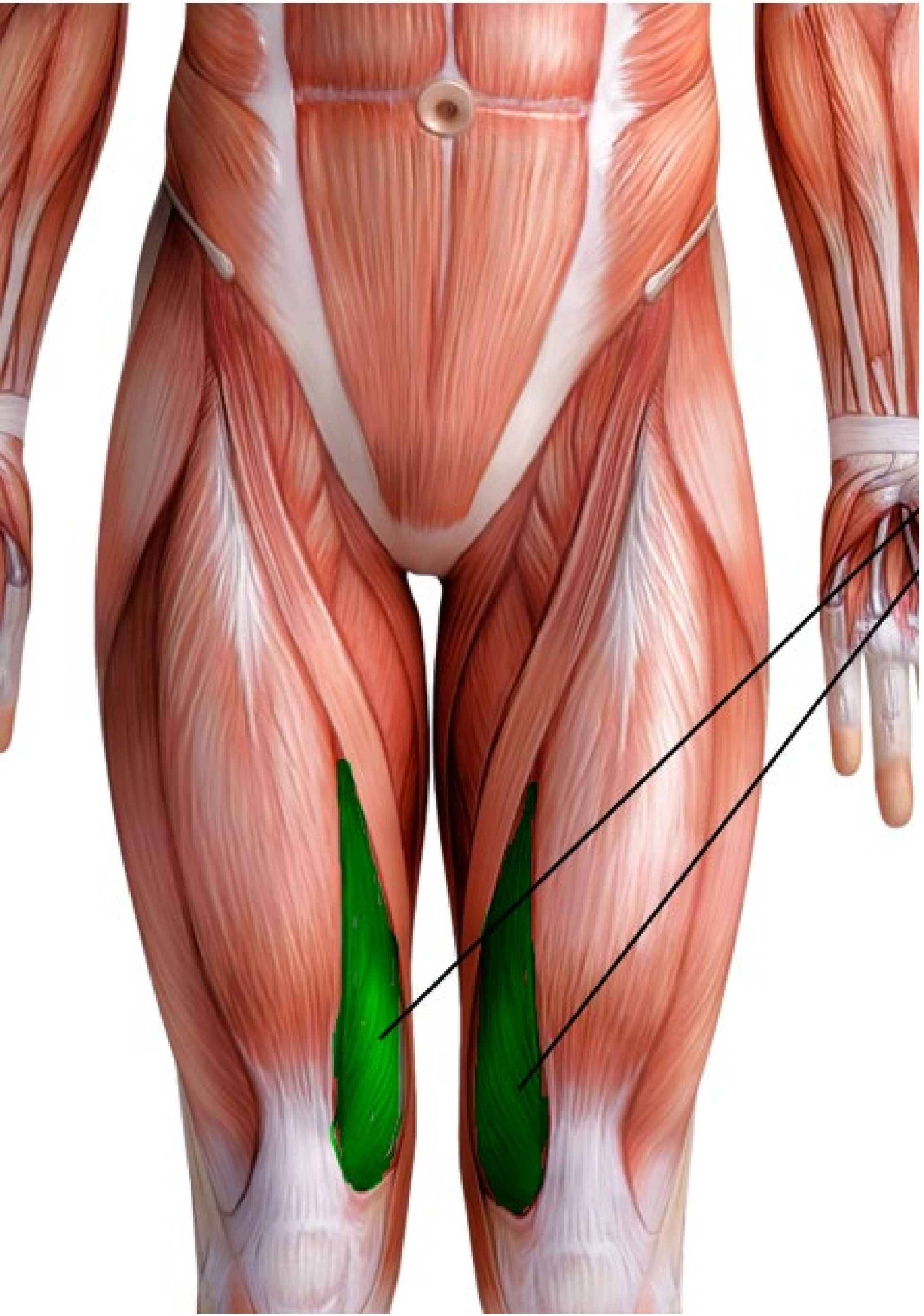
- Function = Extends leg and flexes thigh (brings thigh up)
- The rectus femoris is the quadriceps muscle that lies at the middle of the front part of the thigh.
- It lies (wholly or partially) on top of the other three quadriceps muscles. It originates on the ilium.
- It is named from its straight-appearing orientation at the front of the thigh.

Prime Mover of Knee Flexion and Hip Extension






*Vastus Medialis*
Function
= Extends leg; stabilize knee (patella)



# The vastus medialis

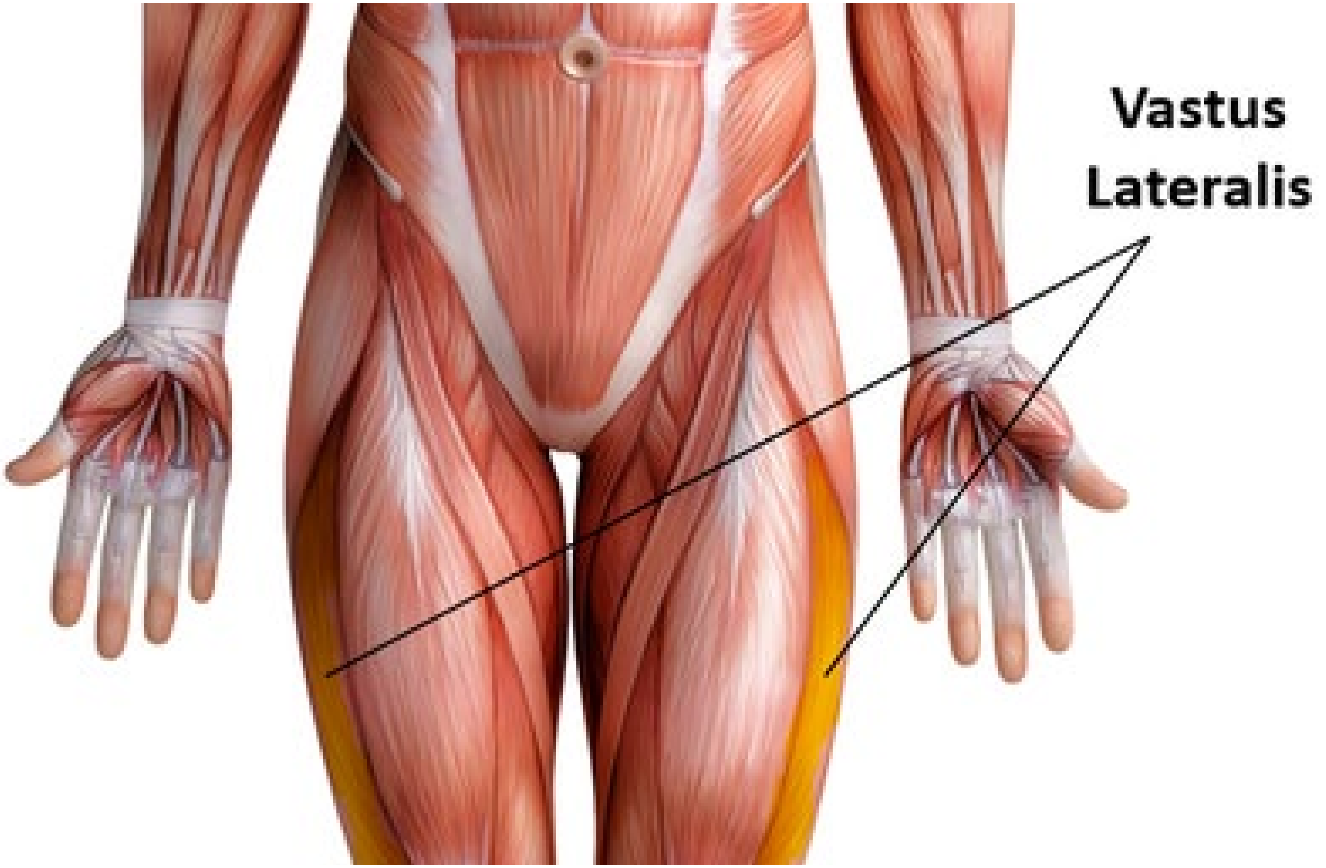
- The vastus medialis is located on the front medial portion of the thigh. It is one of the quadraceps muscles.

  The vastus medialis originates medially along the entire length of the femur.

  It is connected to the other quadriceps muscle.

Vastus Medialis

Function = Prime Mover of Knee Extension




*Vastus Lateralis*
Function = Extends leg (brings leg straight) and stabilizes knee

- The vastus lateralis muscle is the largest head of the quadriceps group. It forms the lateral aspect of the thigh.

Vastus Lateralis

Function =
Prime Mover of
Knee Extension

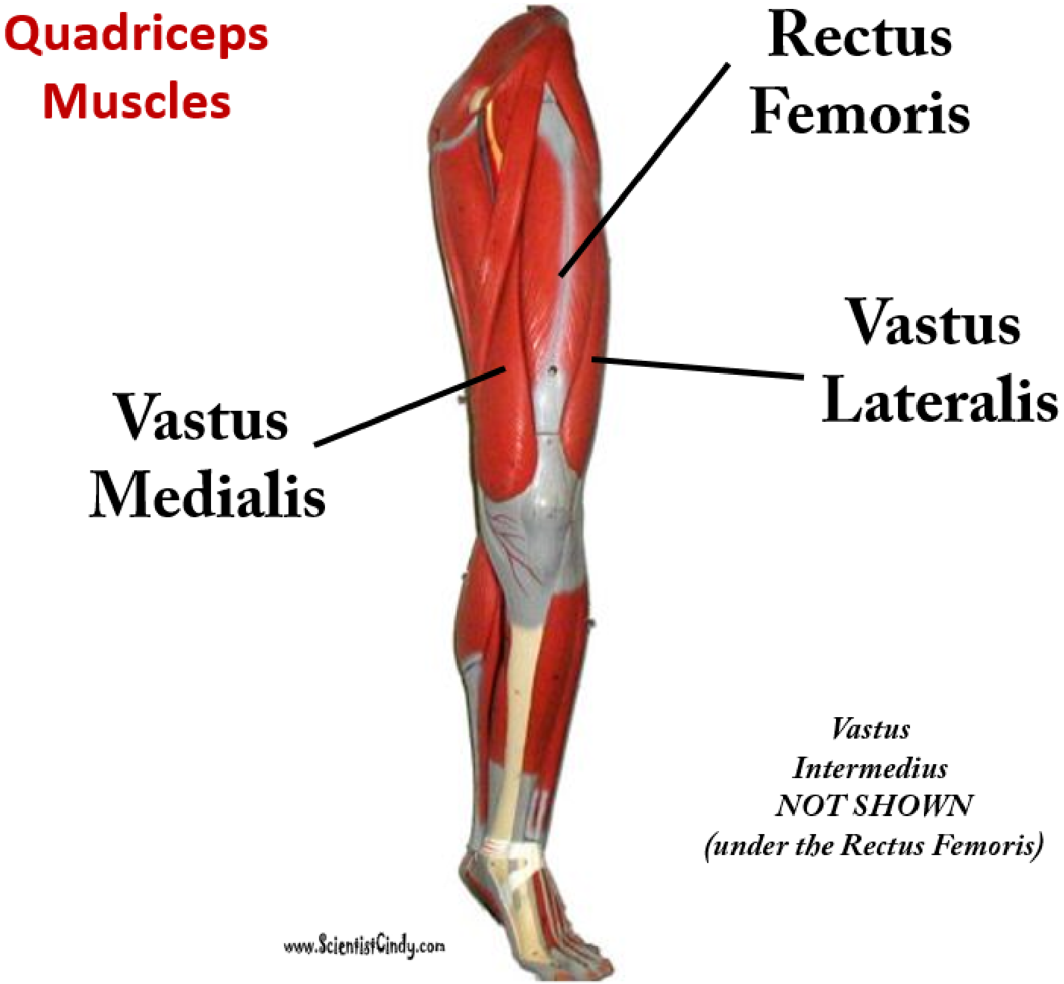
- **Vastus Intermedius Cannot be Viewed in the Muscular Leg Model Without Removing the Rectus Femoris.**

  **Vastus intermedius** lies between vastus lateralis and vastus medialis on the *front* of the femur (i.e. on the top or front of the thigh), but underneath (deep) to the rectus femoris. Typically, it cannot be seen without dissection of the rectus femoris.

- In the 3D model, you will have to remove the rectus femoris in order to view the vastus intermedius.

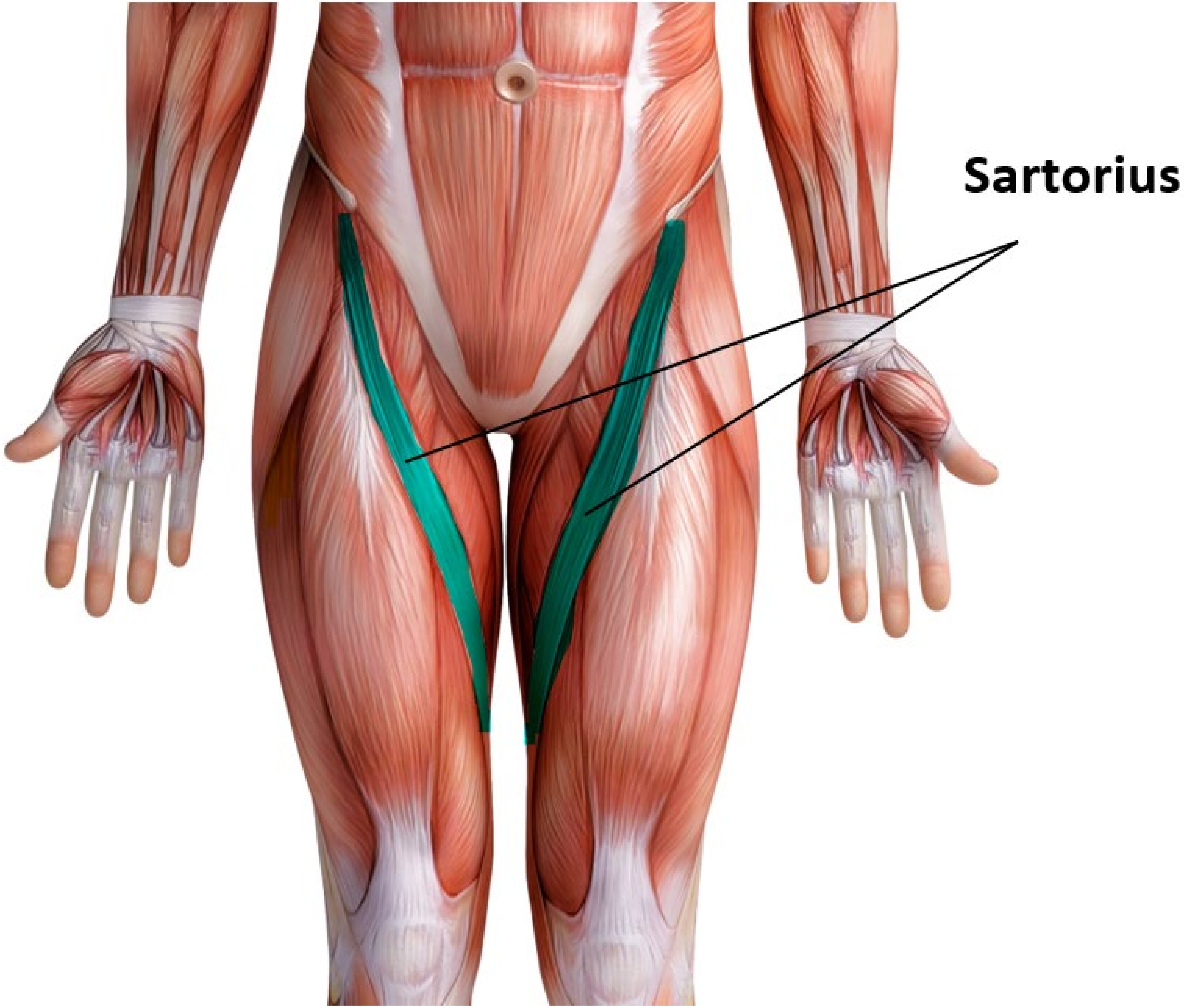
# *Vastus Intermedius*

# Function = Extends leg



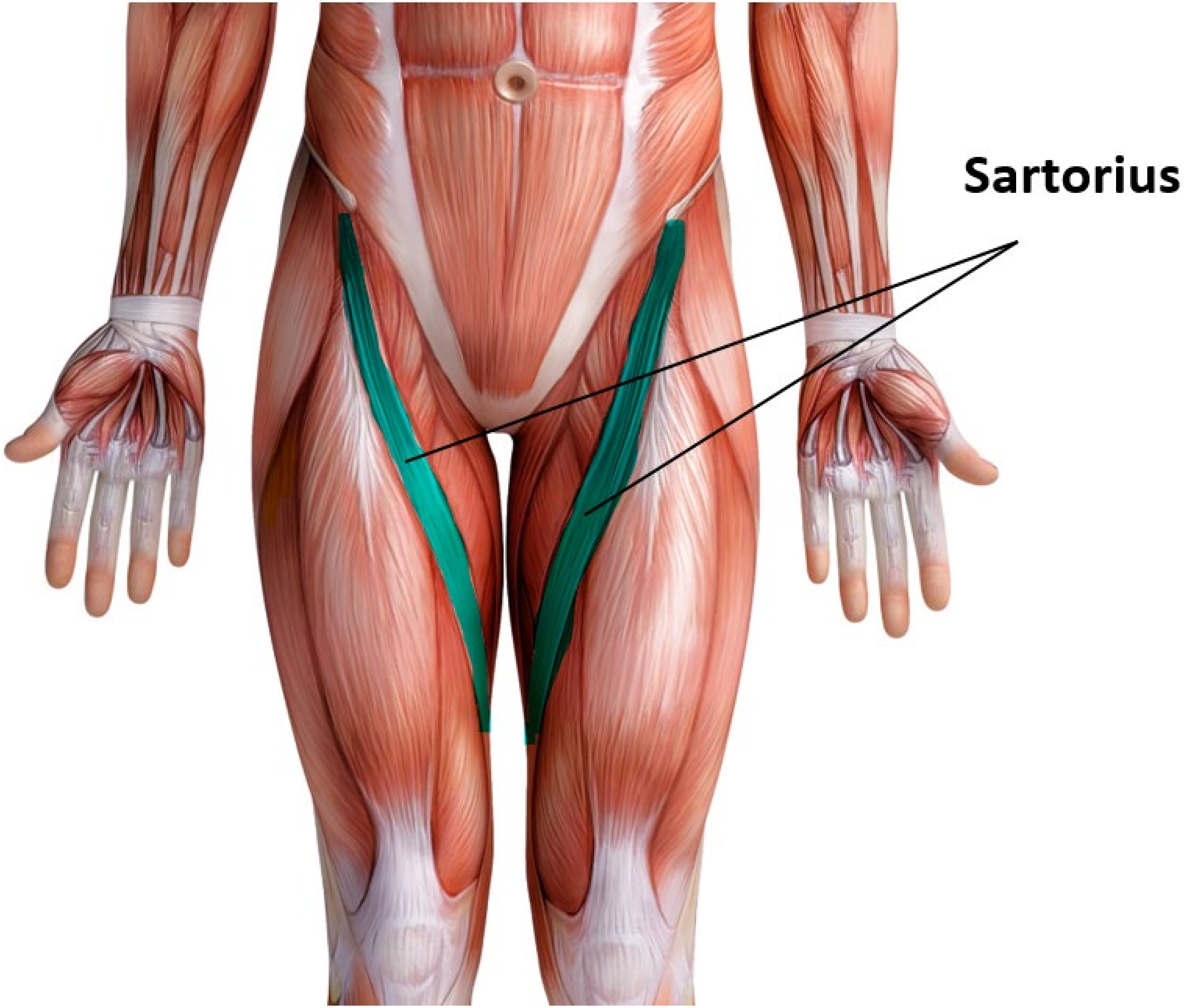
# Sartorius Muscles

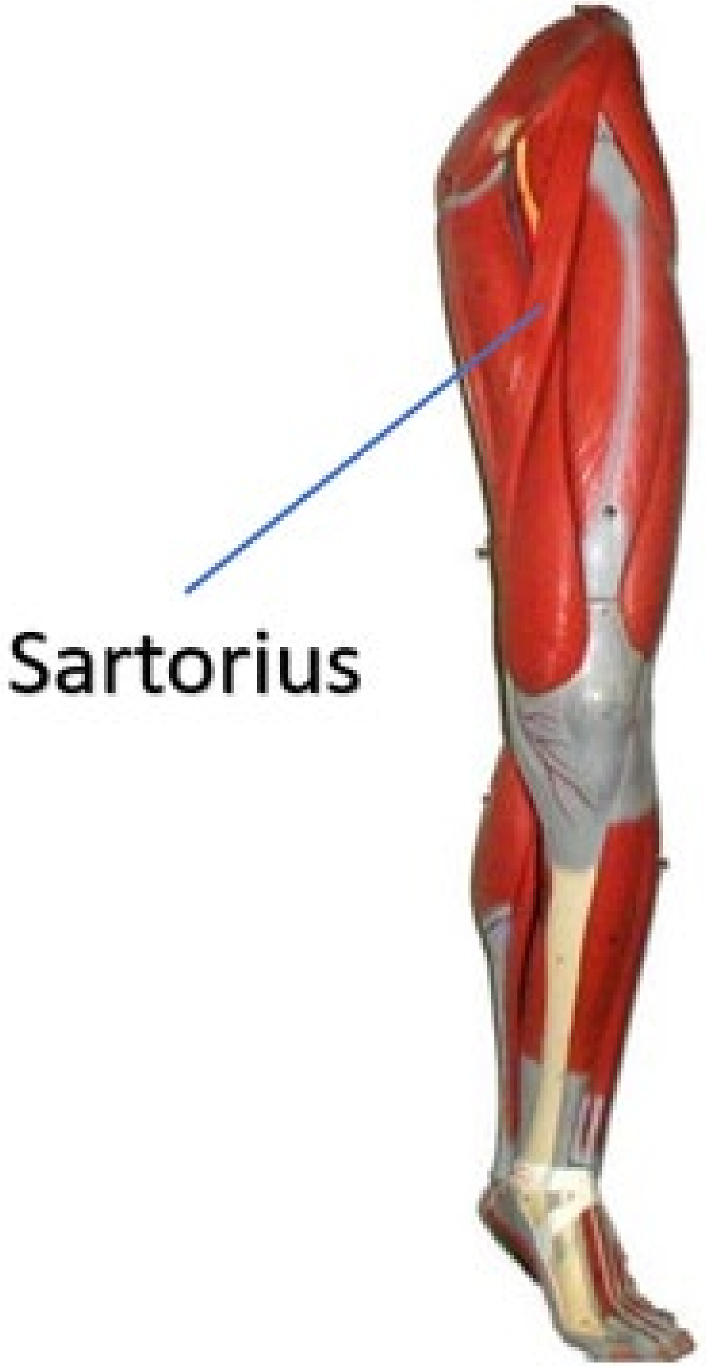
- Function = Flexes, abducts, and laterally rotates thigh; flexes leg (weak) as in a soccer kick; helps produce the cross-legged position.



# Sartorius Muscles

- The sartorius muscle is able to flex, adduct and laterally rotate the thigh. It also is able to flex the knee and medially rotates the leg.
- Turning the foot to look at the sole or sitting cross-legged demonstrates all four actions of the sartorius.

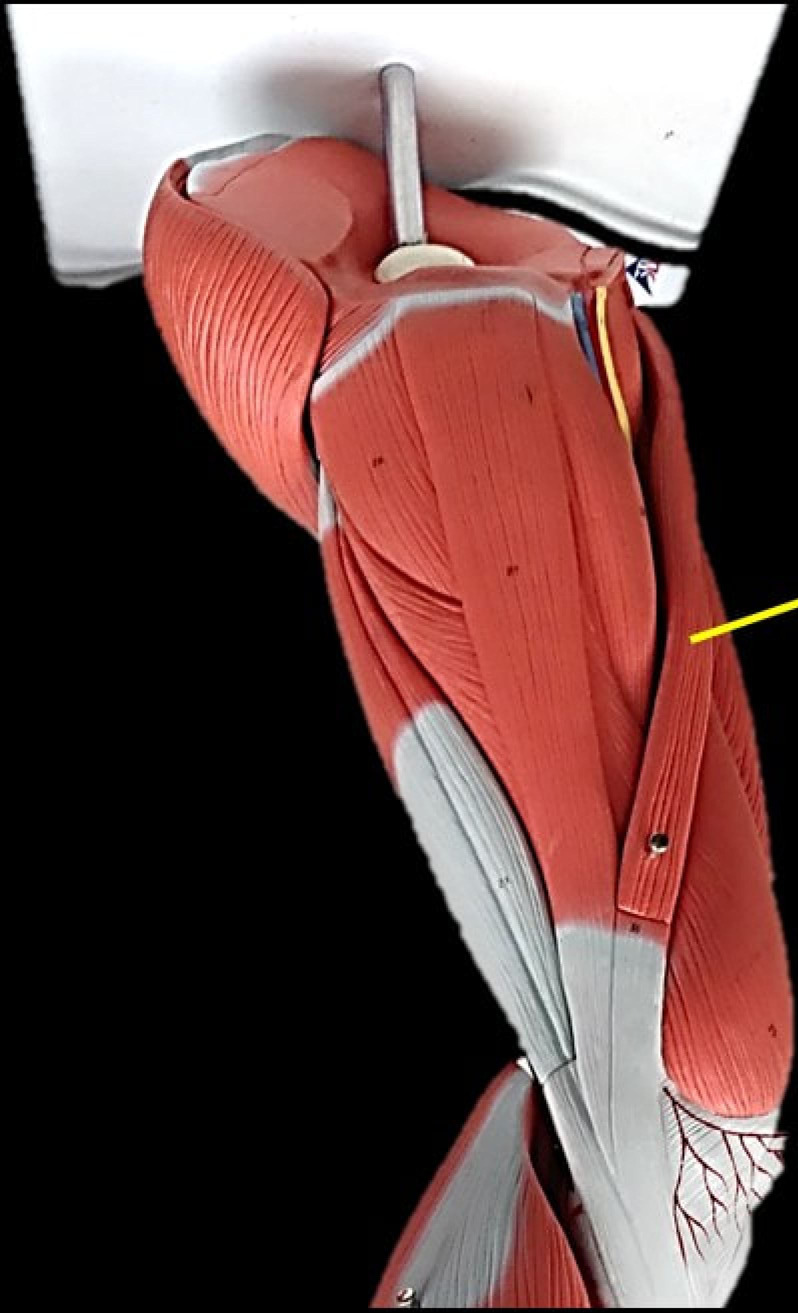





# The **sartorius** **muscle**

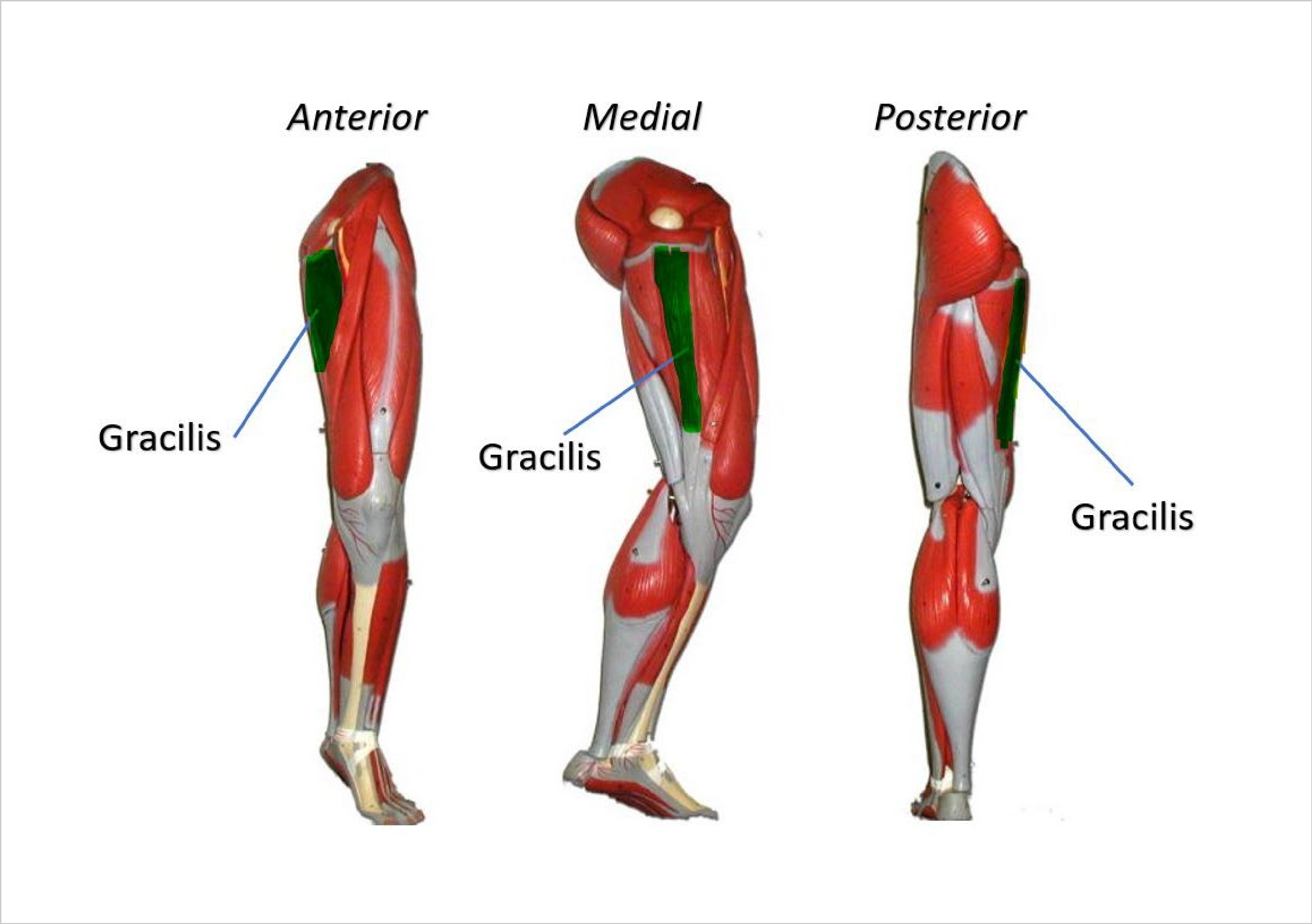
- The **sartorius muscle** is the longest muscle in the human body. It is easily recognized because it is superficial, long and thin. It is a strap-like superficial muscle that runs obliquely across the front (anterior surface) of the thigh and inserts at the knee. The sartorius muscle is weak, but it assists other muscles in moving the hip joint and the knee joint.

Medial View of Inner Thigh




**Function = Extends hip and extends and laterally rotates the knee.**

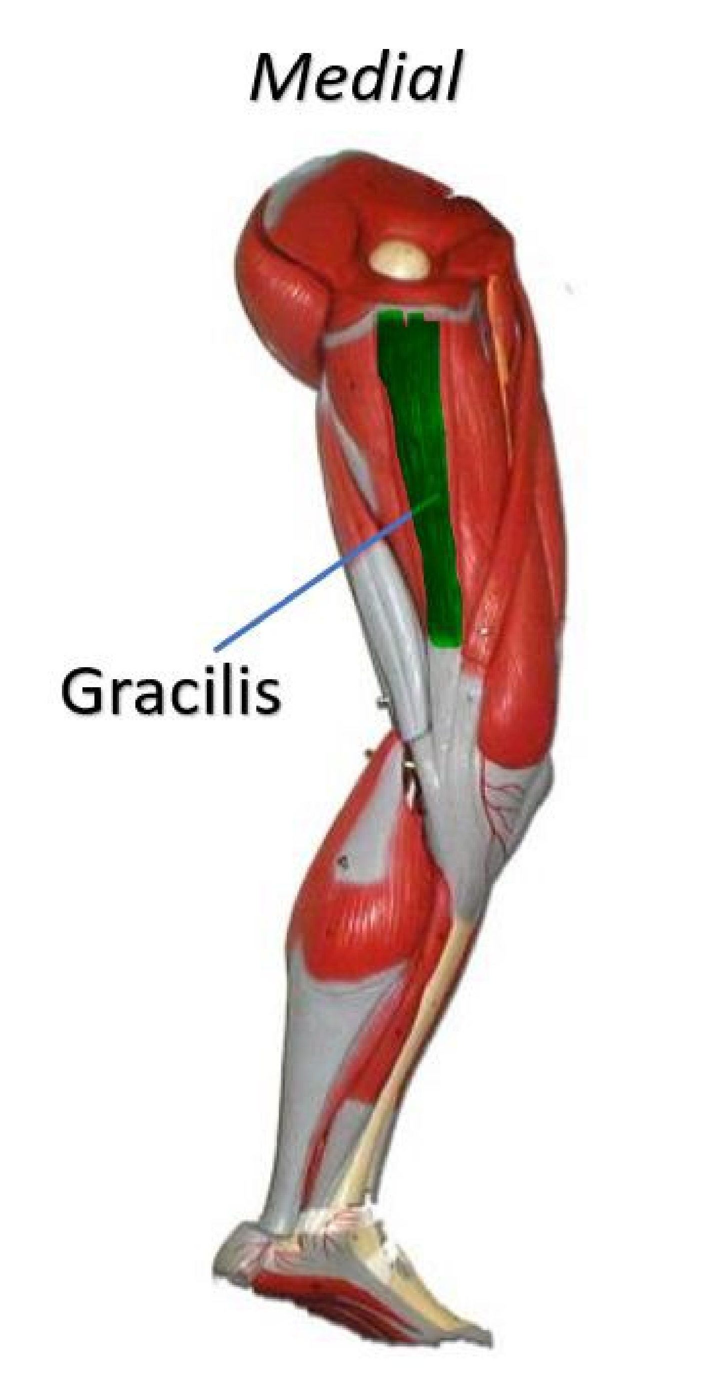
***Think "HACKY SAC muscle!"***




# Gracilis Muscle

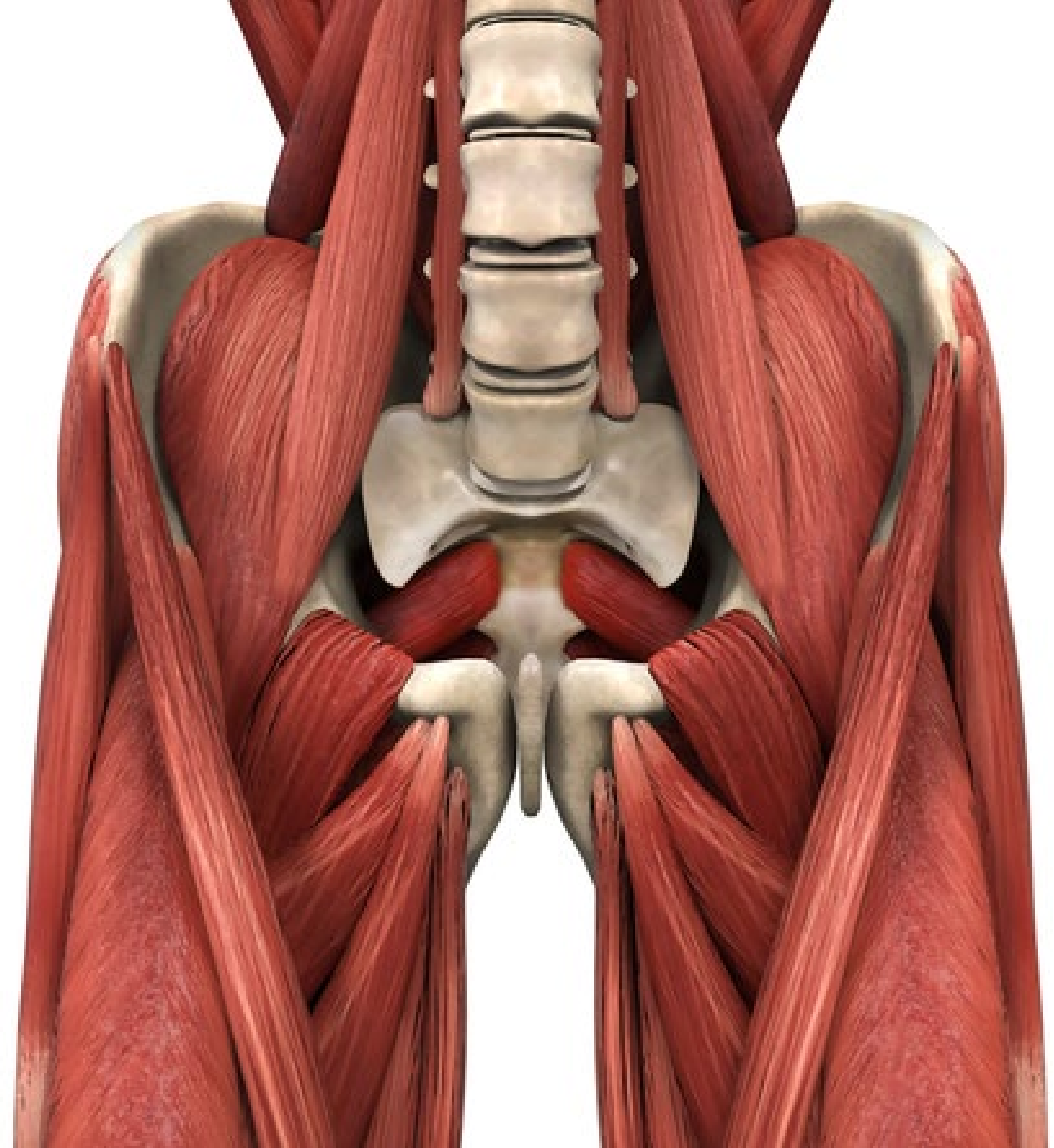
Function = Adducts thigh, flexes and medially rotates leg

- The gracilis muscle is the most superficial muscle on the inner thigh.
- The muscle fibers originate at the pubis and run vertically downward, spans the knee joint, then inserts into the tibia.
- The gracilis muscle functions to adduct the lower limb.
- The muscle adducts, medially rotates, and flexes the hip as above, and also aids in flexion of the knee.



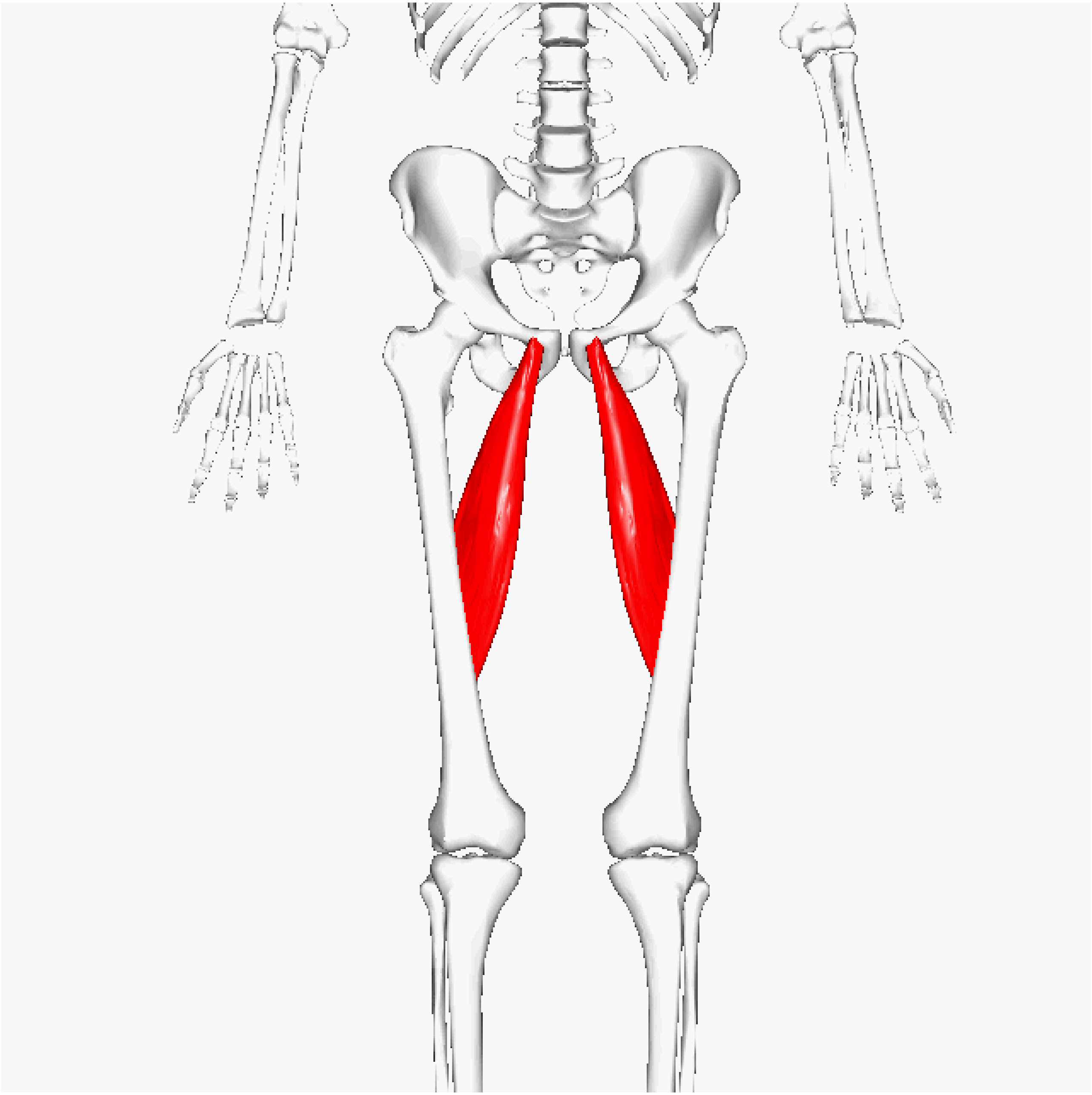
# Groin Muscles

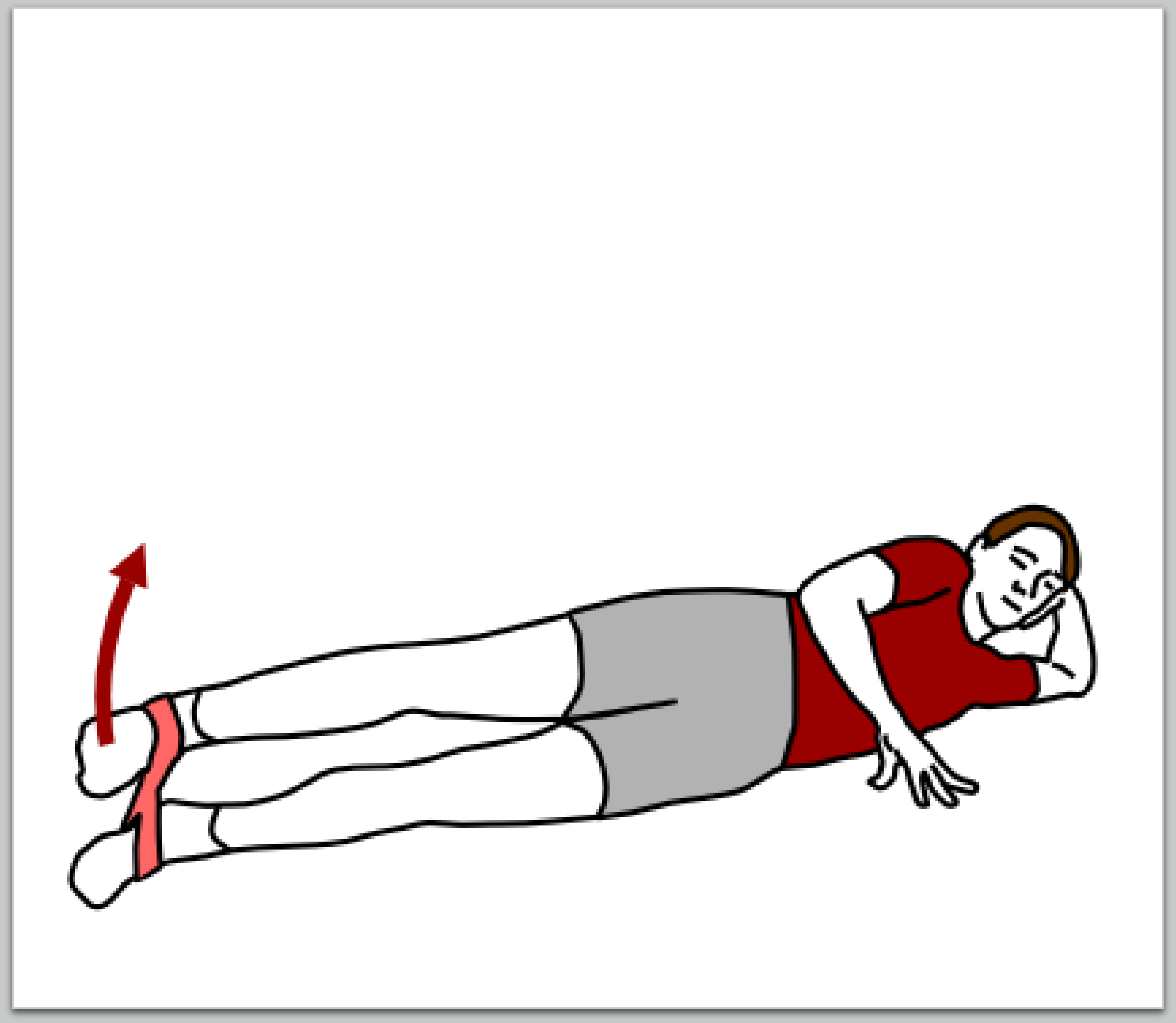
- There are five groin (**adductor**) **muscles**;
    - three of them are called the 'short **adductors**' (pectineus, **adductor** brevis and **adductor** longus)
    - and the other two are called the 'long **adductors**' and consist of gracilis and **adductor** magnus.



# Adductor Longus
**Function = adducts the thigh**

- The **adductor longus** is a muscle located in the inner thigh area.

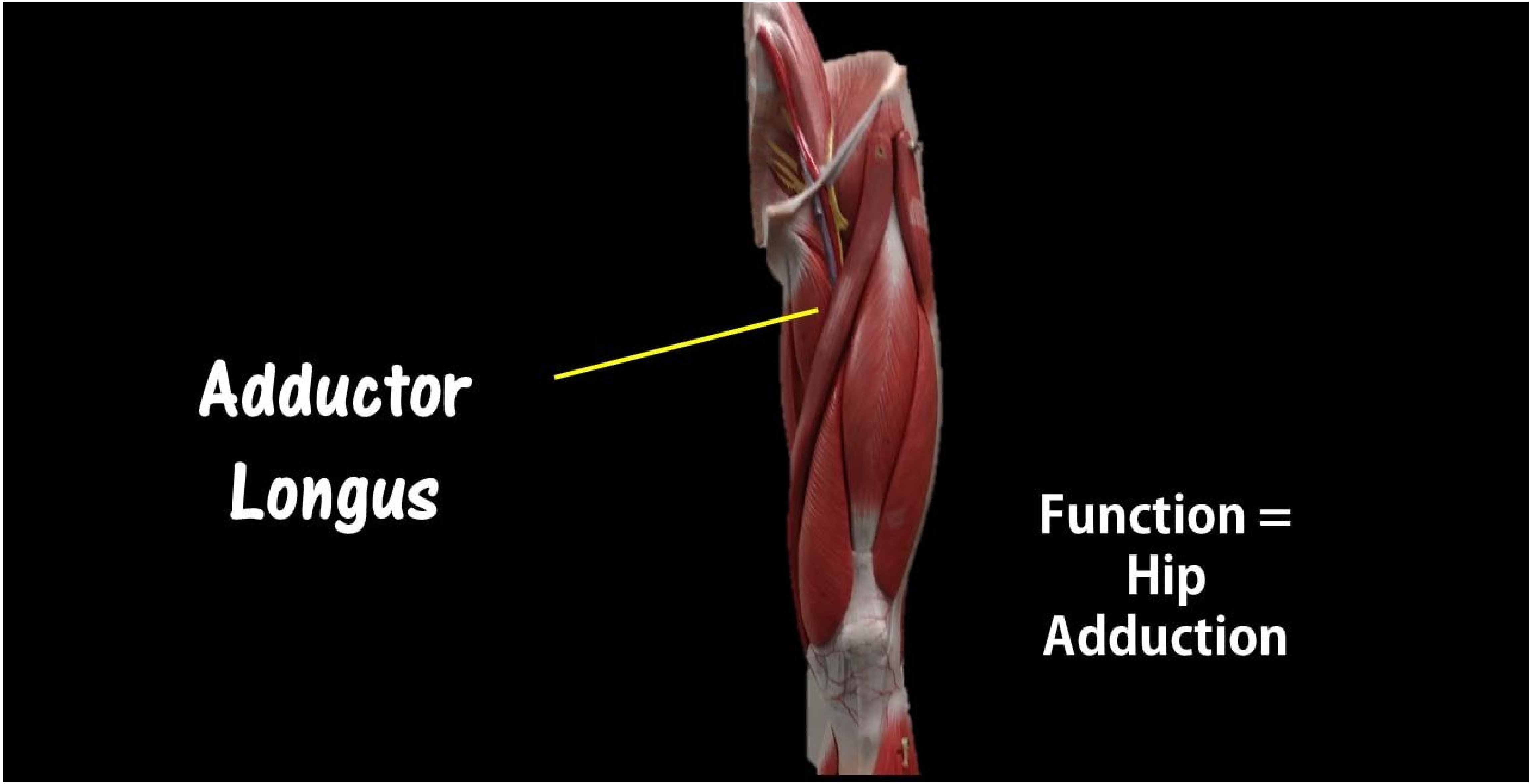


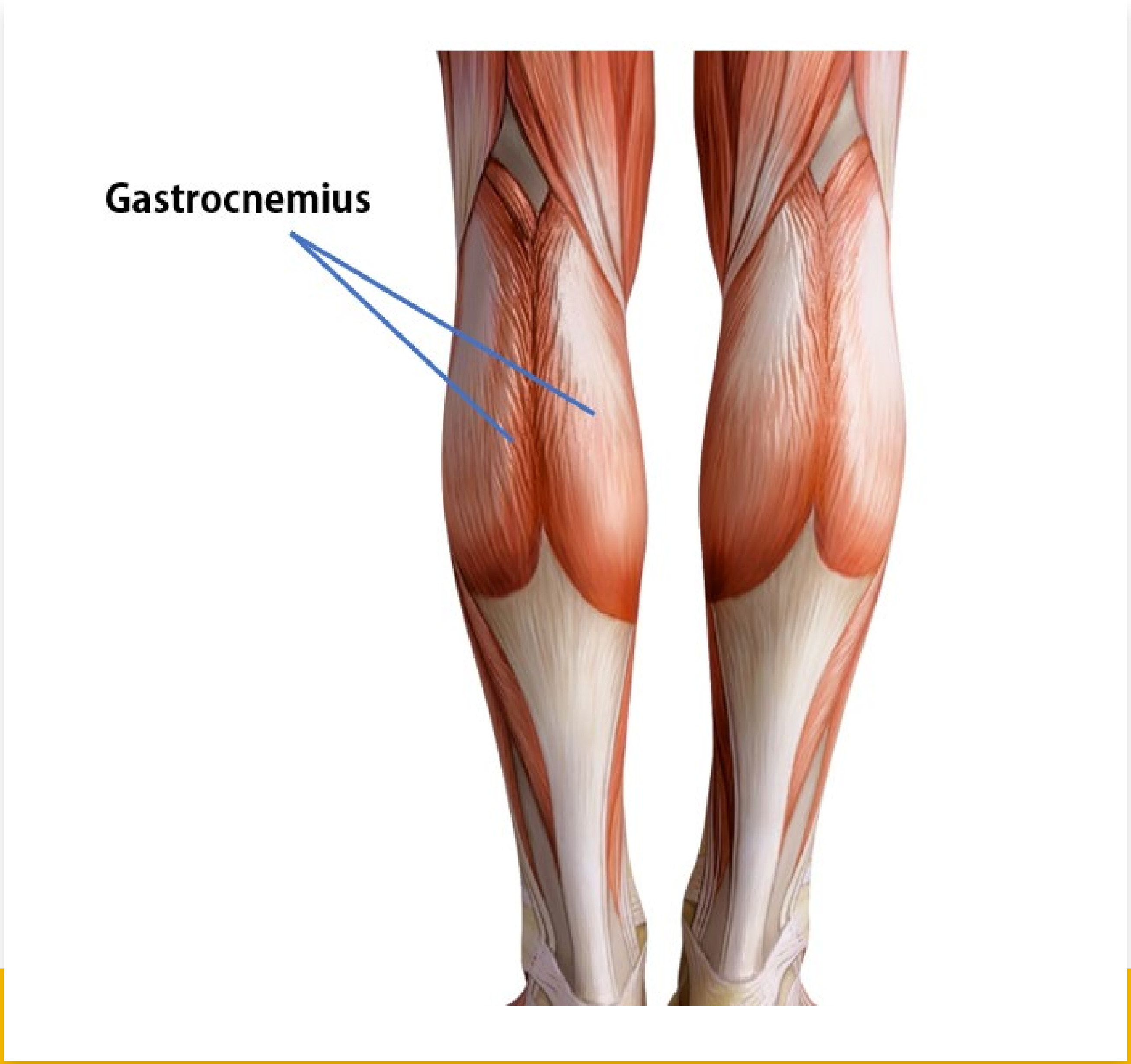


Adductor Longus

**Function =**
**adducts the thigh**

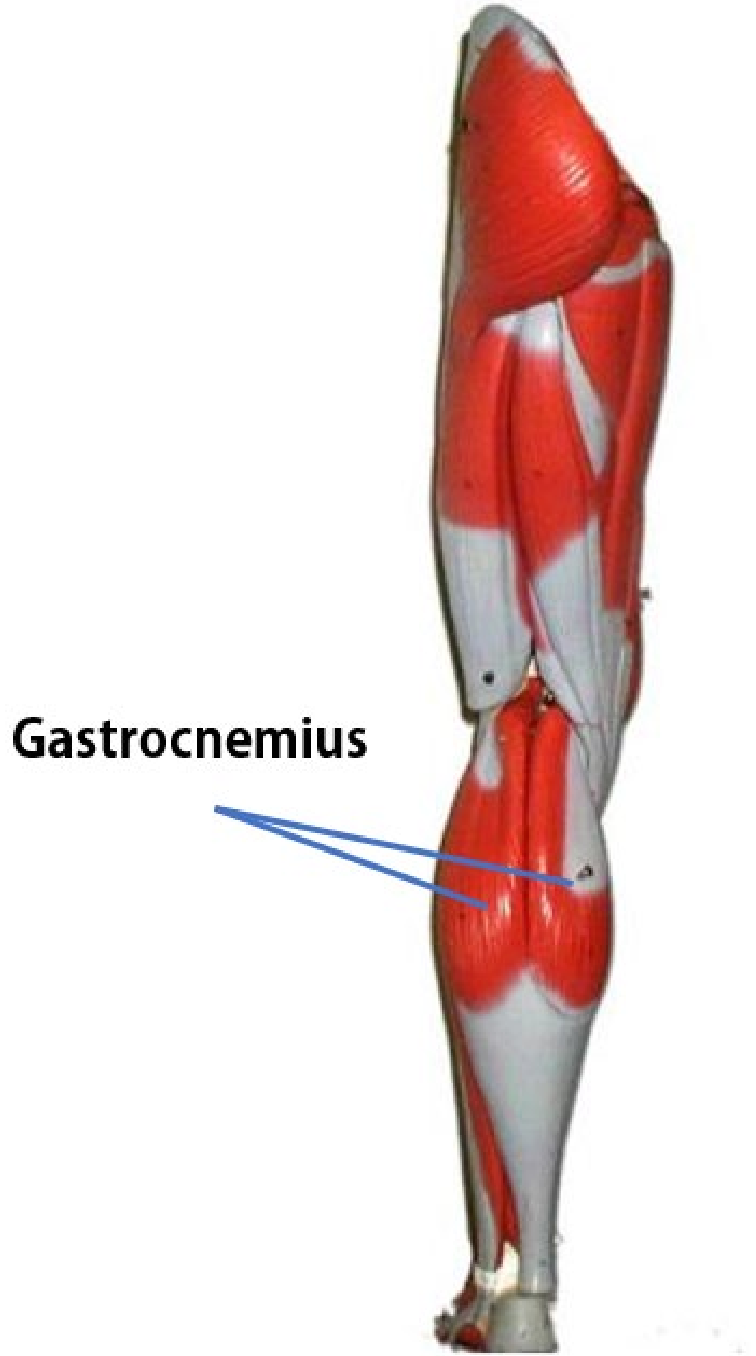
- It is one of the adductor muscles of the hip; its main function is to adduct the thigh.


Adductor
Longus
Function =
Hip
Adduction




# Gastrocnemius Muscle

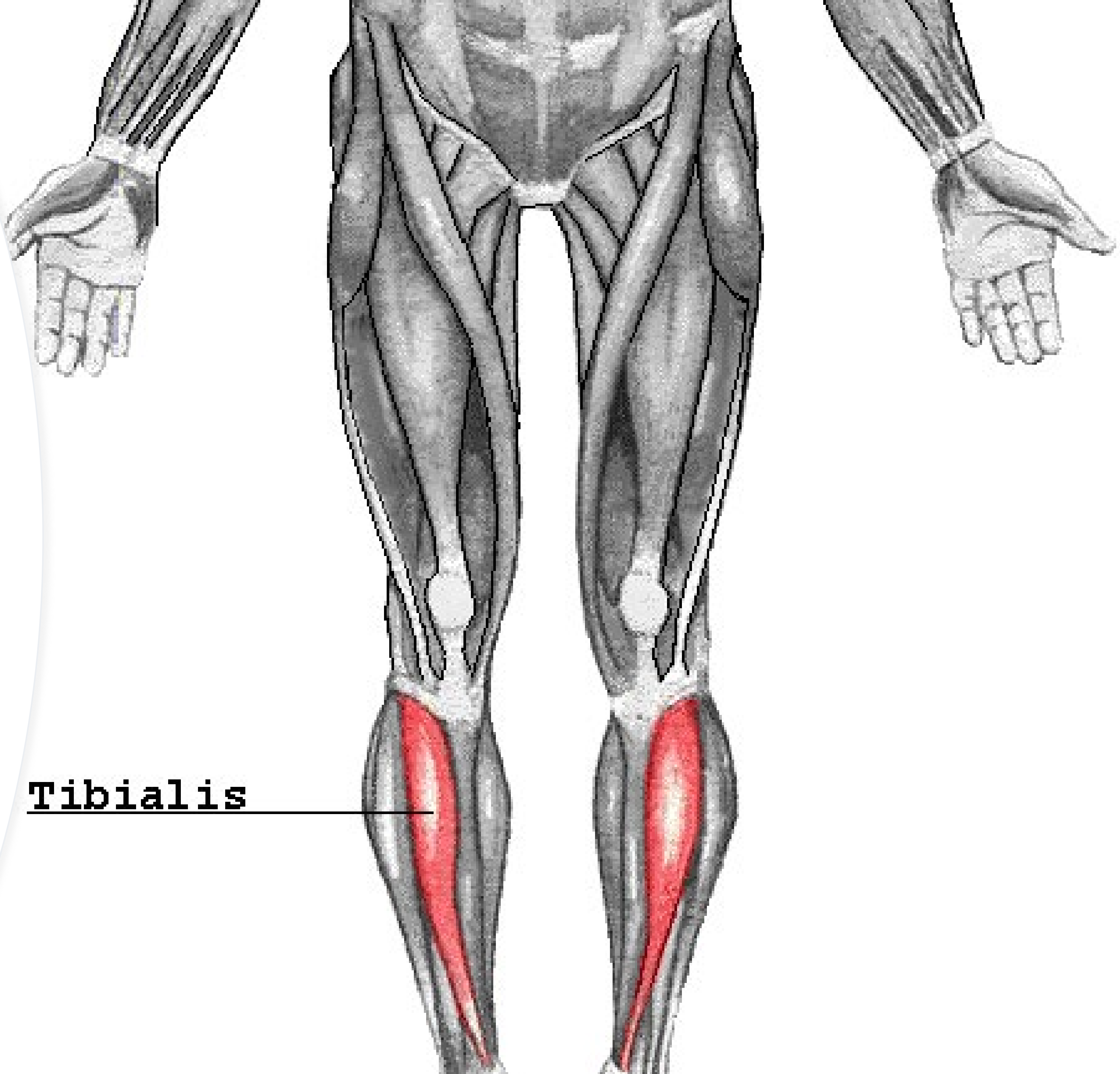
- The anatomical name for your calf muscle is the gastrocnemius.
- The **gastrocnemius muscle** is named from the Latin words for "stomach" and "leg", because is kind of looks like a stomach (bulging region) of your leg.




# Gastrocnemius Muscle

- It is a powerful muscle of the lower posterior leg that has two heads.
- The gastrocnemius muscles originate just above the knee and insert at the heel.

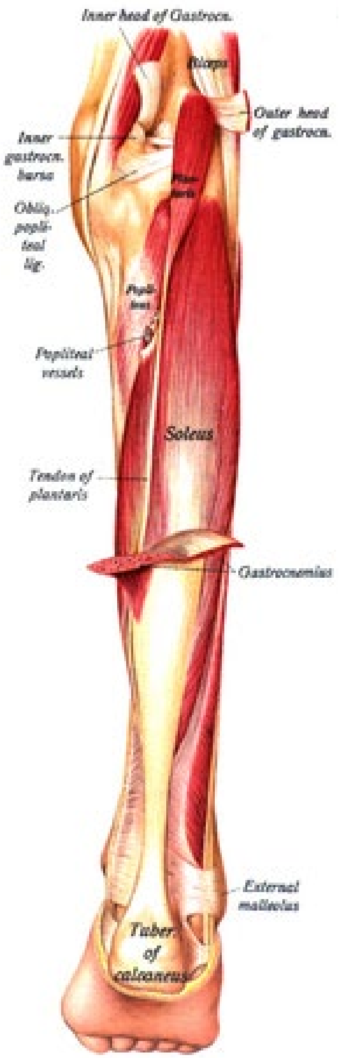
The **tibialis anterior** is a muscle in humans that originates in the upper two-thirds of the lateral (outside) surface of the tibia and inserts into the medial cuneiform and first metatarsal bones of the foot. It acts to dorsiflex and invert the foot.



# What is the muscle?

Prime Mover of Dorsiflexion

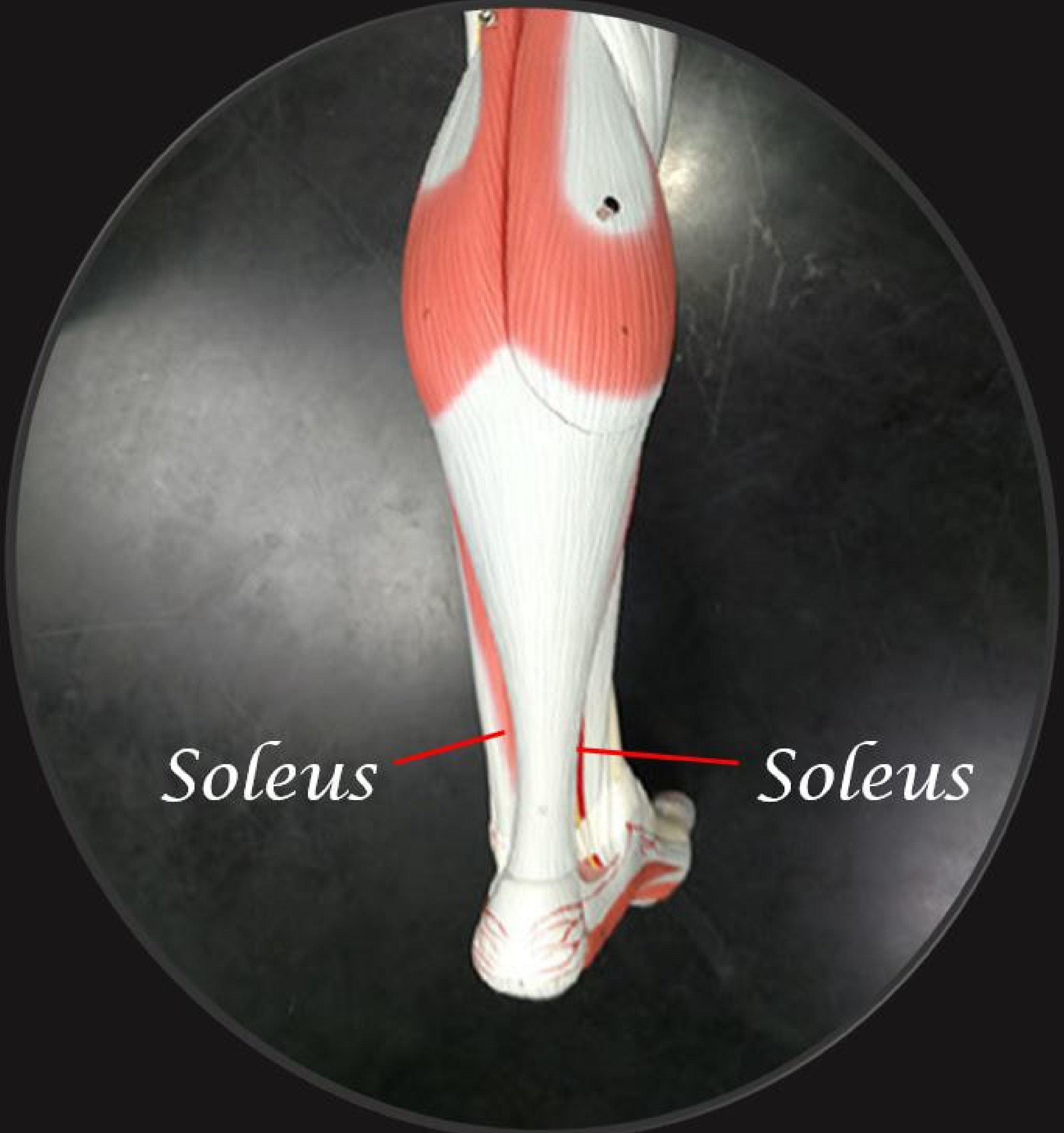
Tibialis Anterior

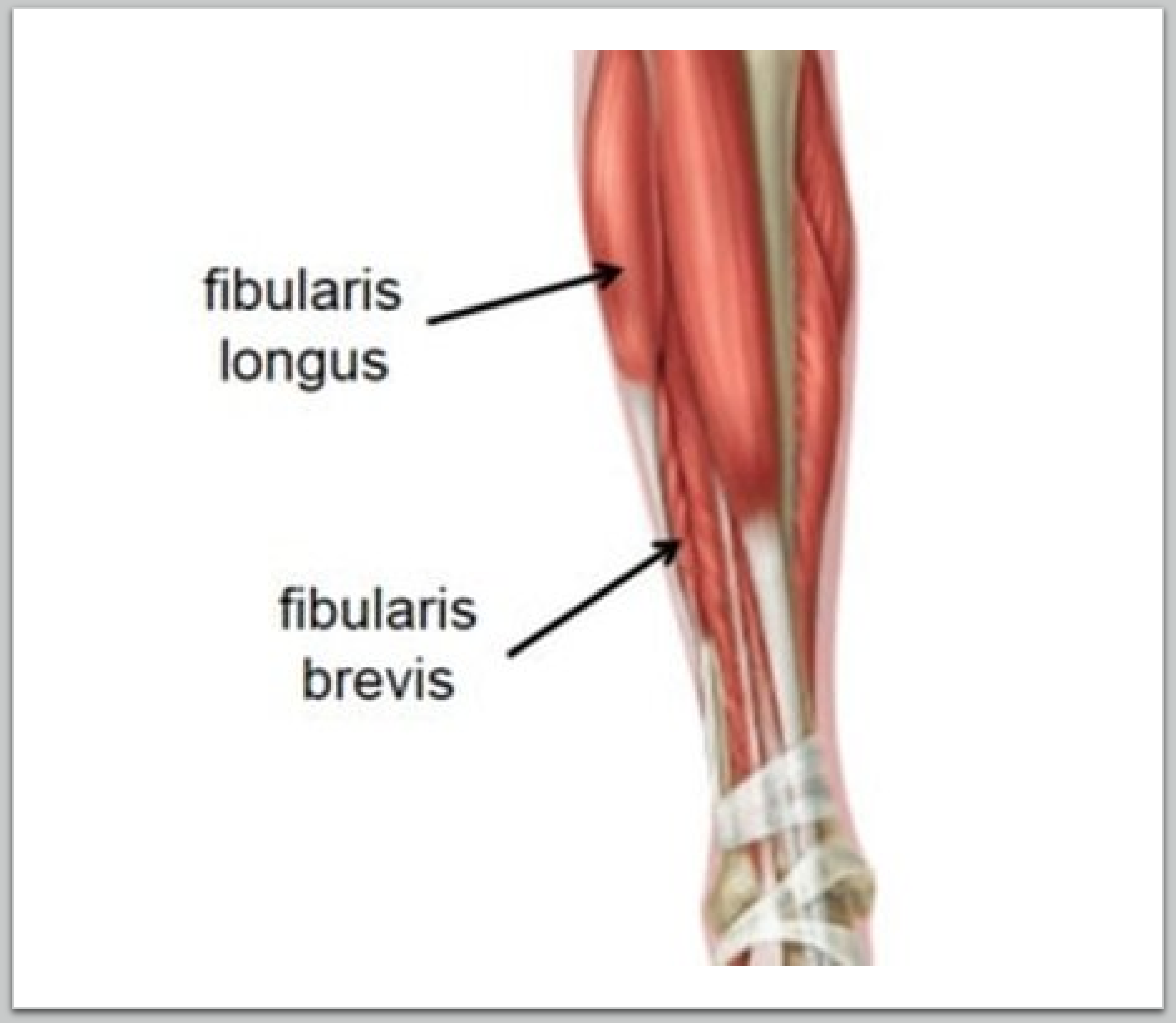



# The **soleus**

- The **soleus** is the plantar flexor muscle of the ankle.
- It is capable of exerting powerful forces onto the ankle joint.
- It is located on the back of the lower leg and originates at the posterior (rear) aspect of the fibular head and the medial border of the tibial shaft.

# SOLEUS






# Fibularis (Peroneus) Longus

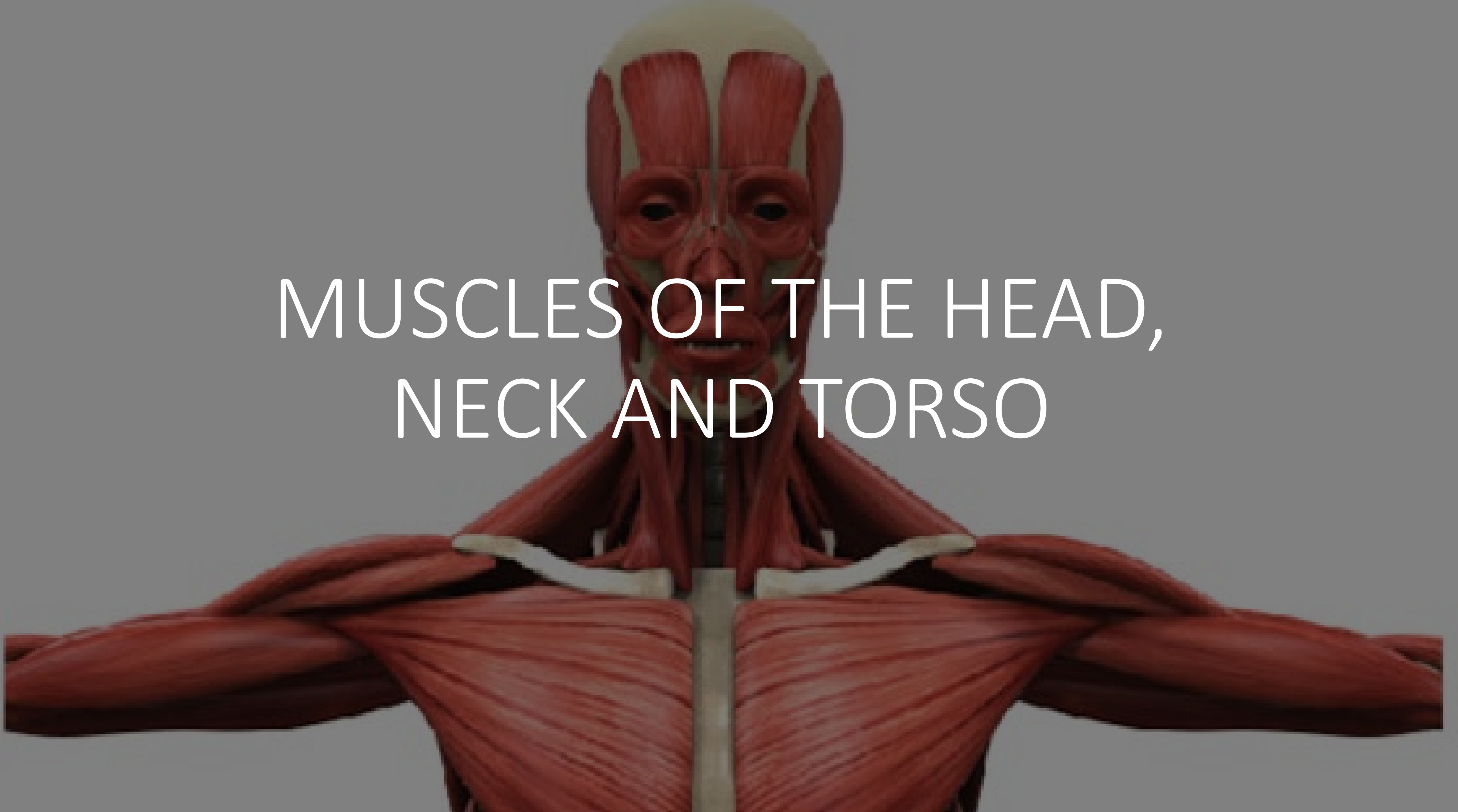
- The **peroneus longus** (also known as **fibularis longus**) is a superficial muscle in the lateral compartment of the leg, and acts to evert and plantarflex the ankle.

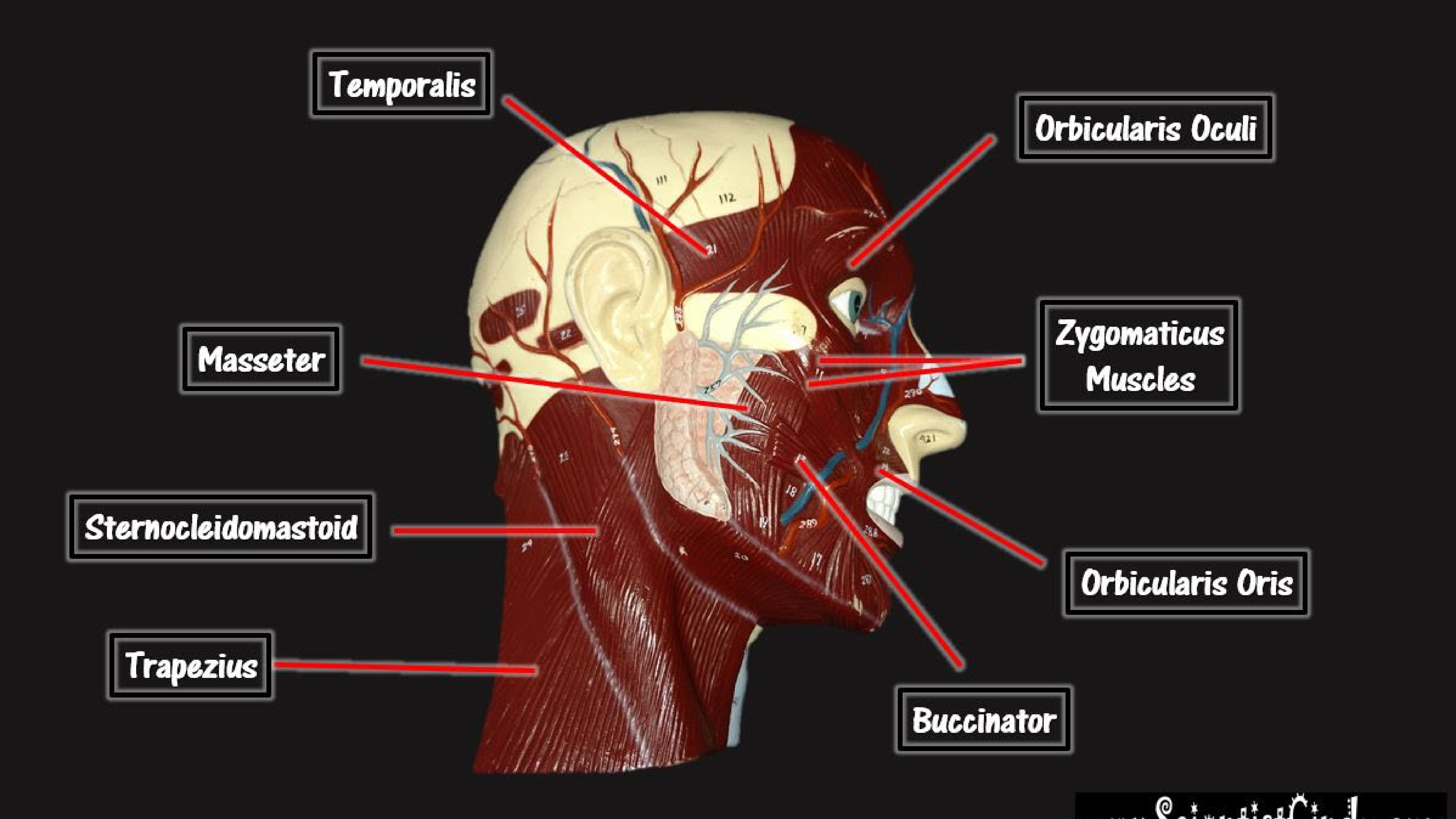
Function = Plantar Flexion

Fibularis Longus

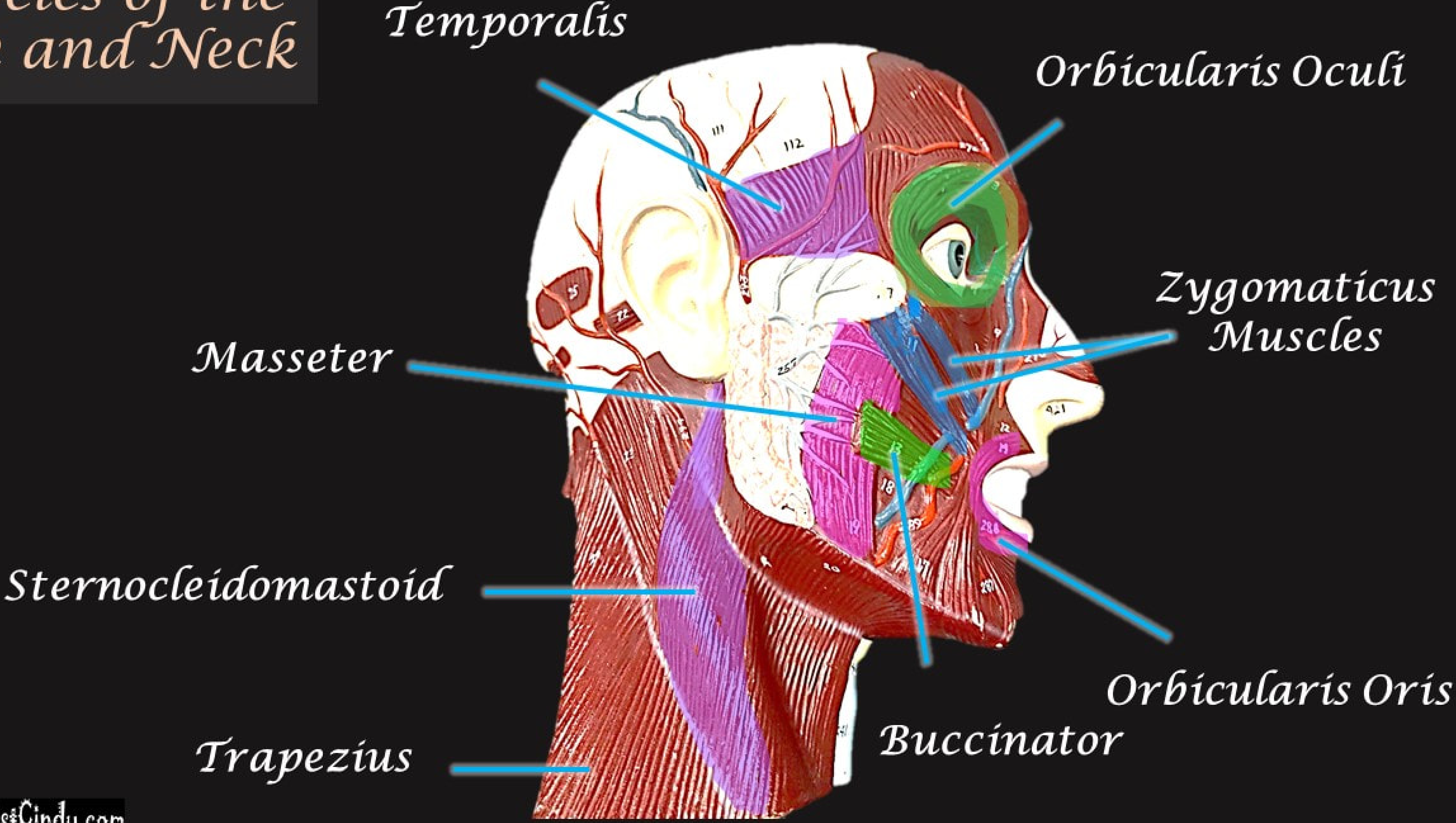
www.ScientistCindy.com

# MUSCLES OF THE HEAD, NECK AND TORSO



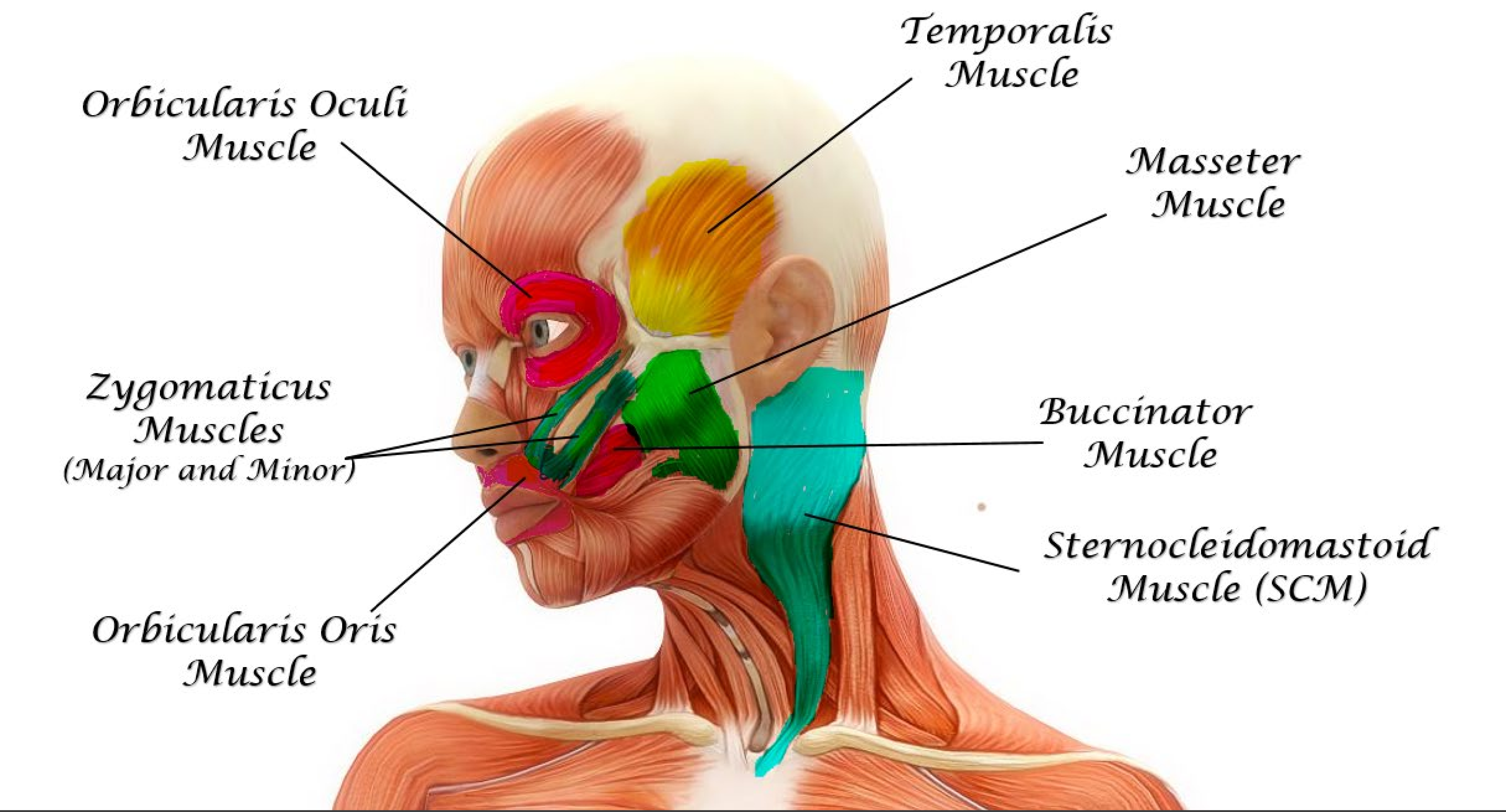

Temporalis
Orbicularis Oculi
Zygomaticus Muscles
Masseter
Sternocleidomastoid
Orbicularis Oris
Trapezius
Buccinator

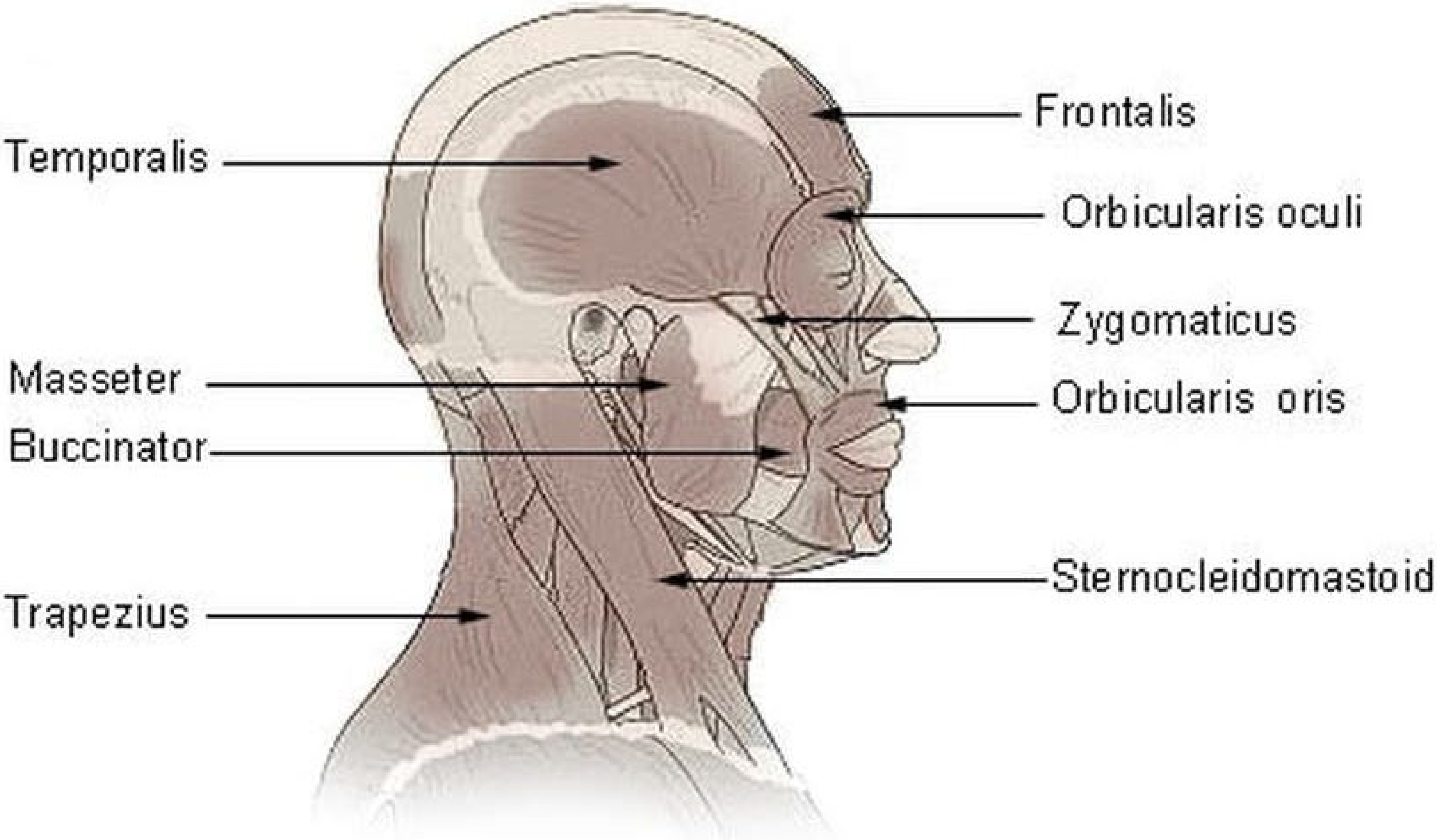
# Muscles of the Face and Neck



- https://youtu.be/INFJxYx9N8A

# MUSCLES OF THE HEAD AND FACE

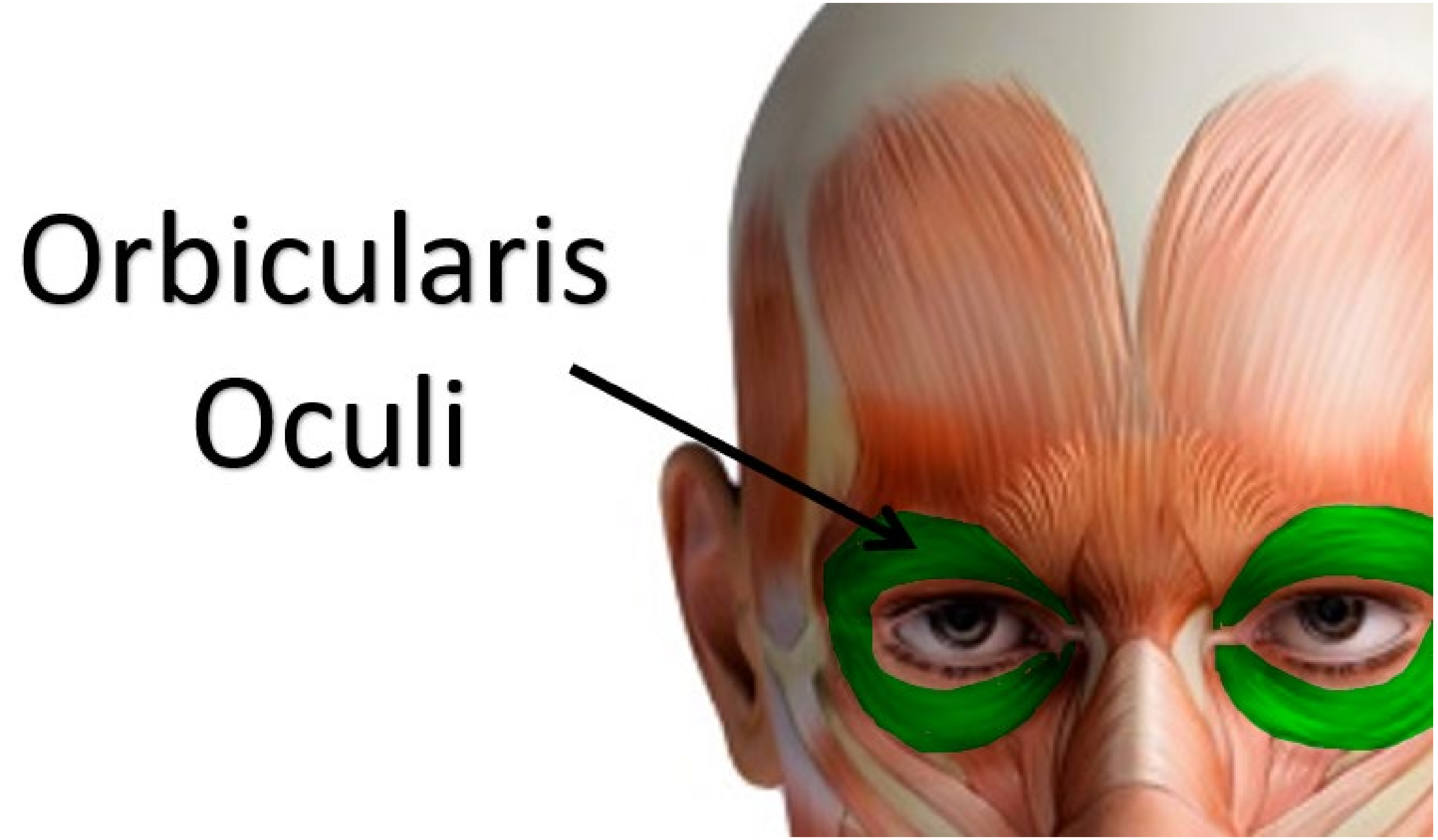

Temporalis Muscle
Orbicularis Oculi Muscle
Masseter Muscle
Zygomaticus Muscles (Major and Minor)
Buccinator Muscle
Sternocleidomastoid Muscle (SCM)
Orbicularis Oris Muscle


Frontalis
Temporalis
Orbicularis oculi
Zygomaticus
Masseter
Orbicularis oris
Buccinator
Sternocleidomastoid
Trapezius

# *Orbicularis Oculi Muscles*

- **Function: Closes the Eyes**

  **The *orbicularis oculi* muscle is in charge of your "blinking" motion and being able to squint or close your eye tightly.**




# *Orbicularis Oculi Muscles*

- **Function: Closes the Eyes**

  **The *orbicularis oculi* muscle is in charge of your "blinking" motion and being able to squint or close your eye tightly. It appears as a ring-like band of muscle, called a sphincter muscle, that surrounds the eye. Sphincter muscles are arranged in a circular pattern.**

# *Orbicularis Oris Muscles*

- **Function: Puckers (purses) Lips**

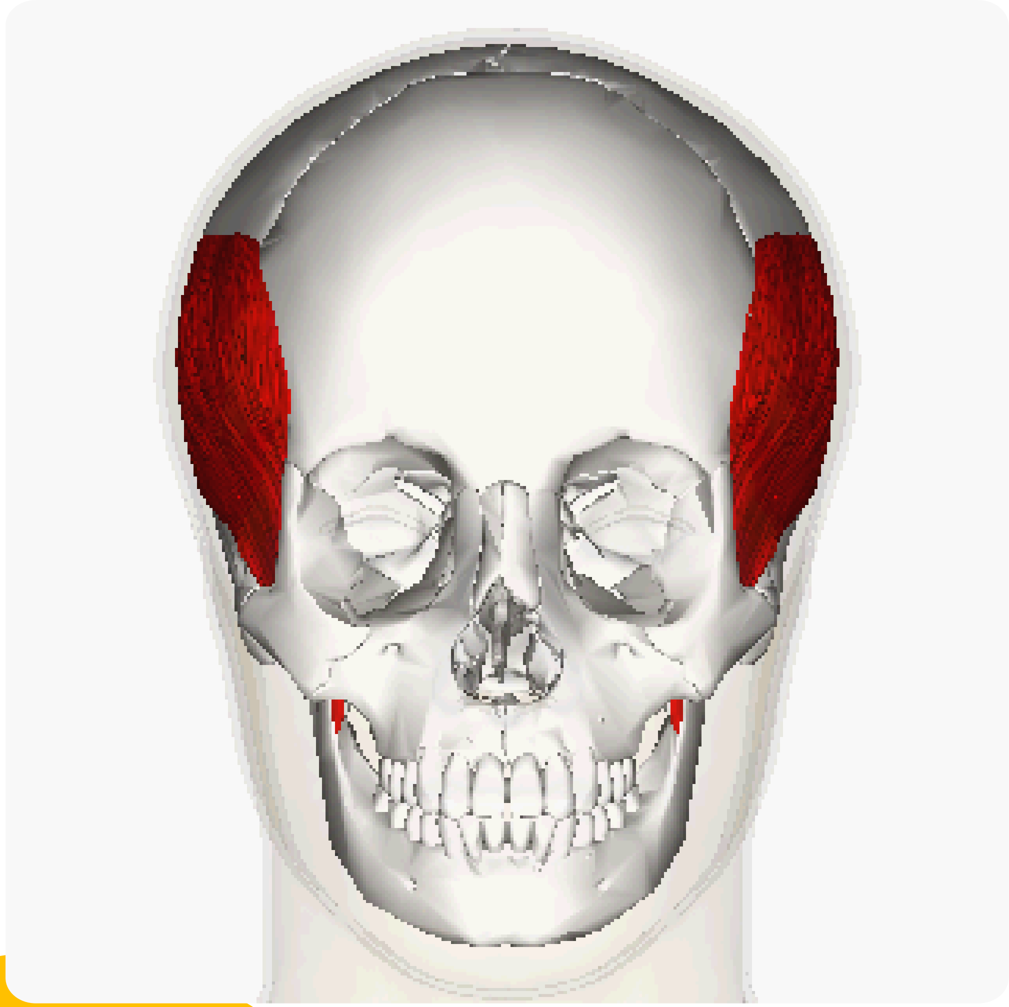
  **It is sometimes called the kissing muscle because it causes the lips to close and pucker.**


## *Orbicularis Oris Muscles*

**The orbicularis oris muscle is a sphincter muscle that encircles the mouth.**

# Muscles of Mastication (Temporalis and Masseter)

Mastication is the act of CHEWING

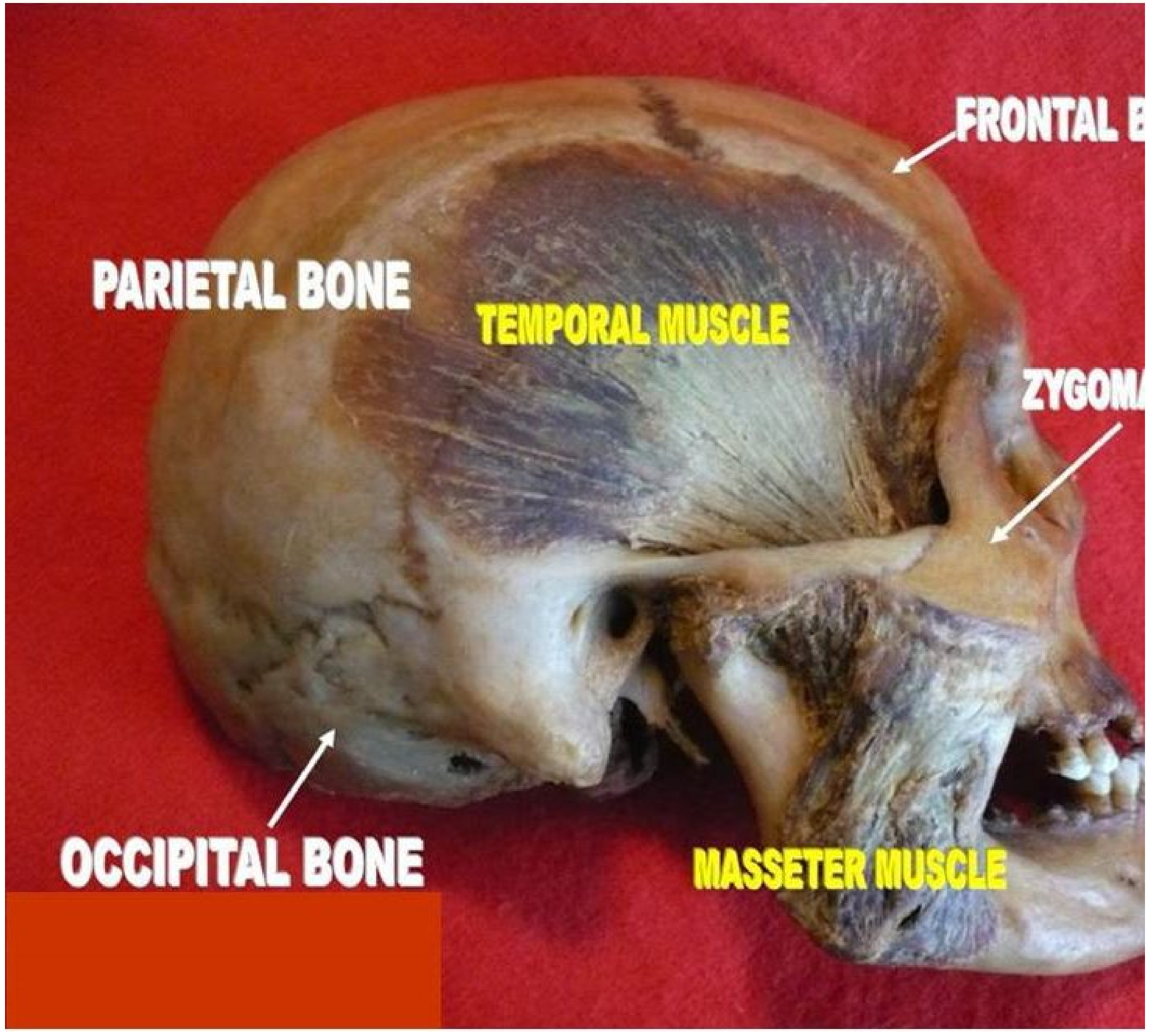


# *Temporalis Muscles*

- **Function:  Elevates Mandible**
- **The temporalis muscle** (or temporal muscle) is one of the muscles you use for chewing (mastication).
- When you clinch your jaw, you see a couple of muscles contract at the jaw joint.

# *Temporalis Muscles*

- If you clench your jaw, you can see and feel it contracting at the temples on both sides of your head.  It's attached to the mandible (jaw) and to the skull's temporal bone, or temporal fossa.
- When the jaw is clinched, the muscles of mastication are visible. The upper muscle is the temporalis and the lower, more noticeable muscle is the masseter.

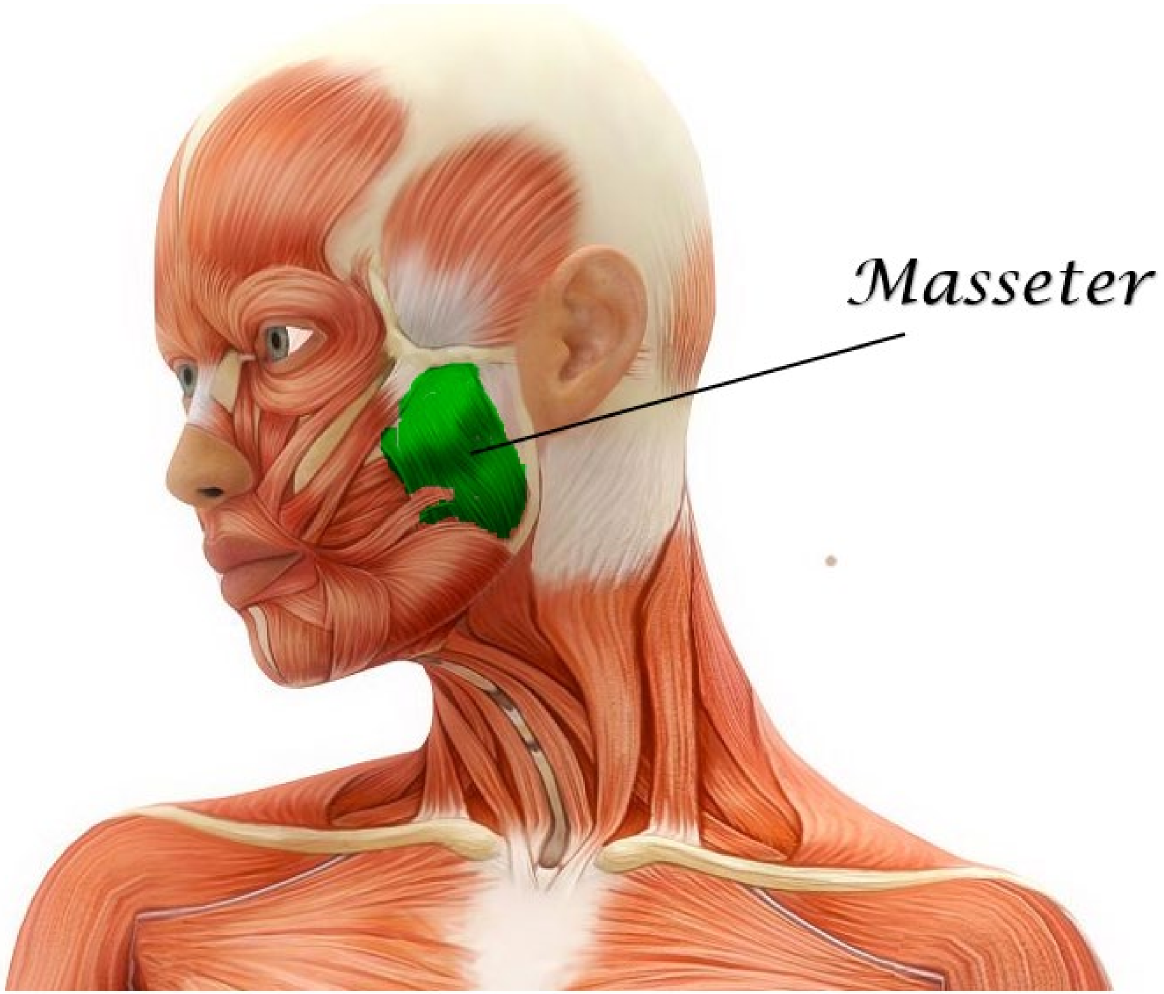


# *Masseter Muscles*

The name "masseter" comes from a Greek meaning *"one who chews".*

# *Masseter Muscles*

- The masseter is the major muscle of the jaw. It's principle action is to close the jaw, but it also acts in the side-to-side and forward and back (i.e. protraction and retraction) movement of the jaw.



# *Masseter Muscles*

**Function:  Closes Jaw**

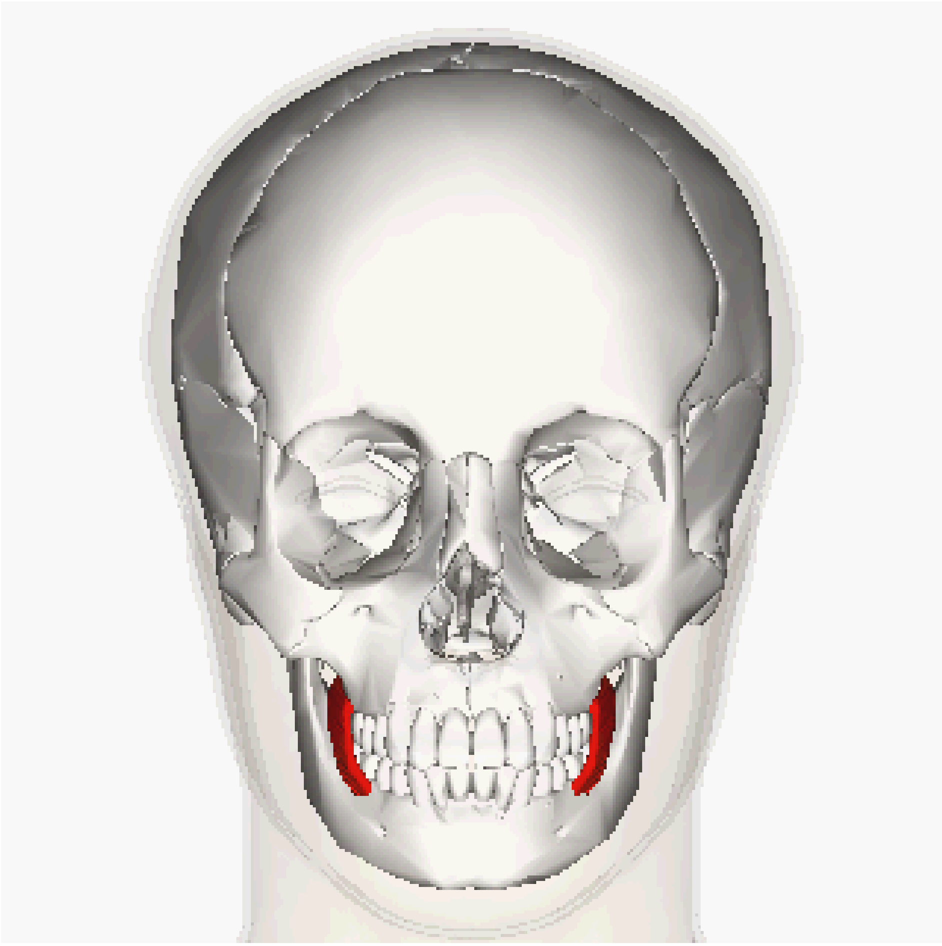
- The most visible muscle of mastication is the masseter muscle. It is a strong, superficial muscle that function to close the jaw.

# Buccinator Muscles

- Function: Holds Food in Mouth (Keeps Food Between Grinding Teeth)

# Buccinator Muscles

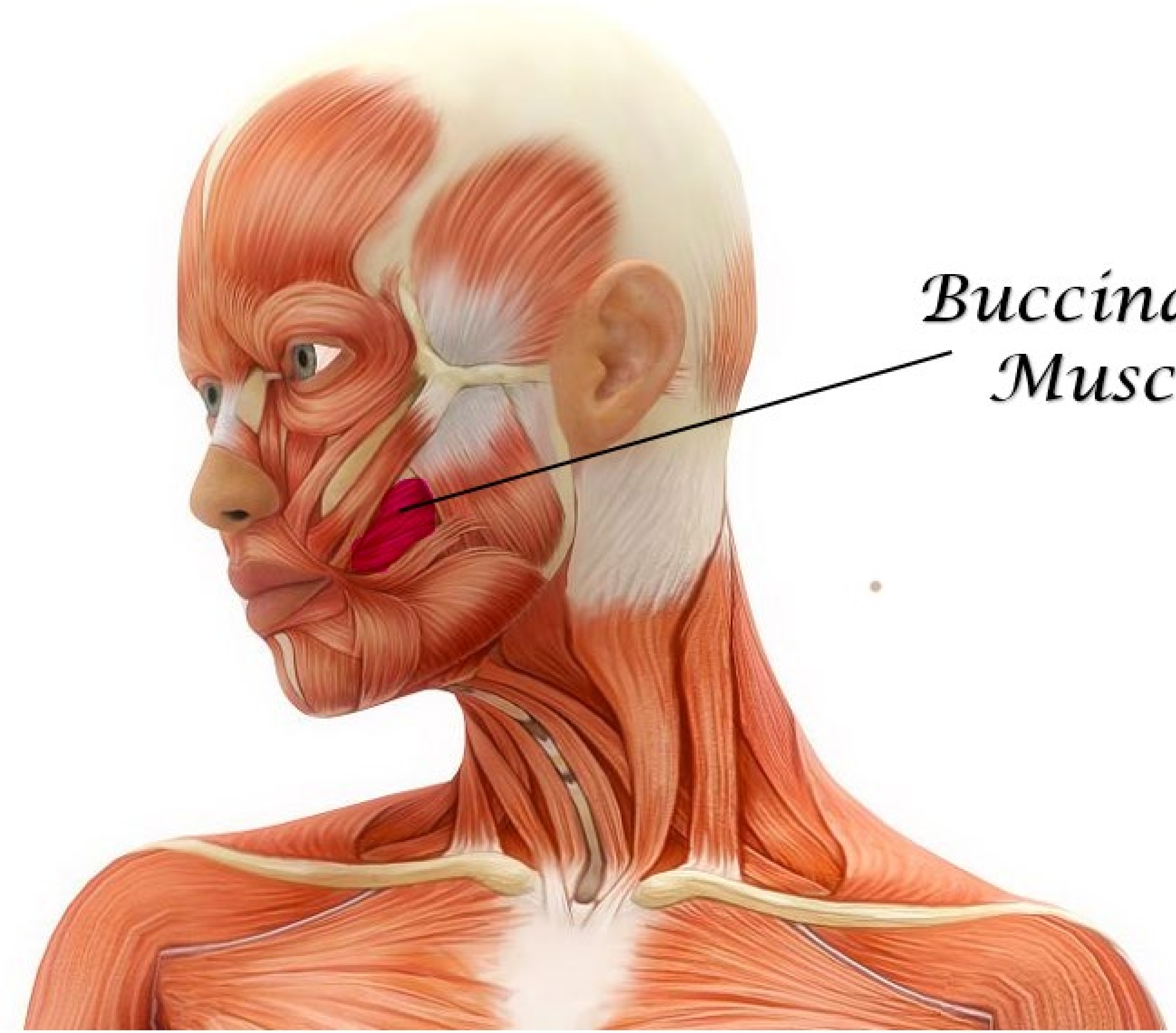
The buccinator functions to flatten the cheek area and help hold food in the right place so it can get chomped by your teeth, instead of falling into the pockets of your cheeks between the cheek and gums.



# Buccinator Muscles

Your buccinators are the muscles of your cheeks. You may recall that the cheek is considered the "buccal" region.

These anatomical terms come from the Greek word, "bucca".

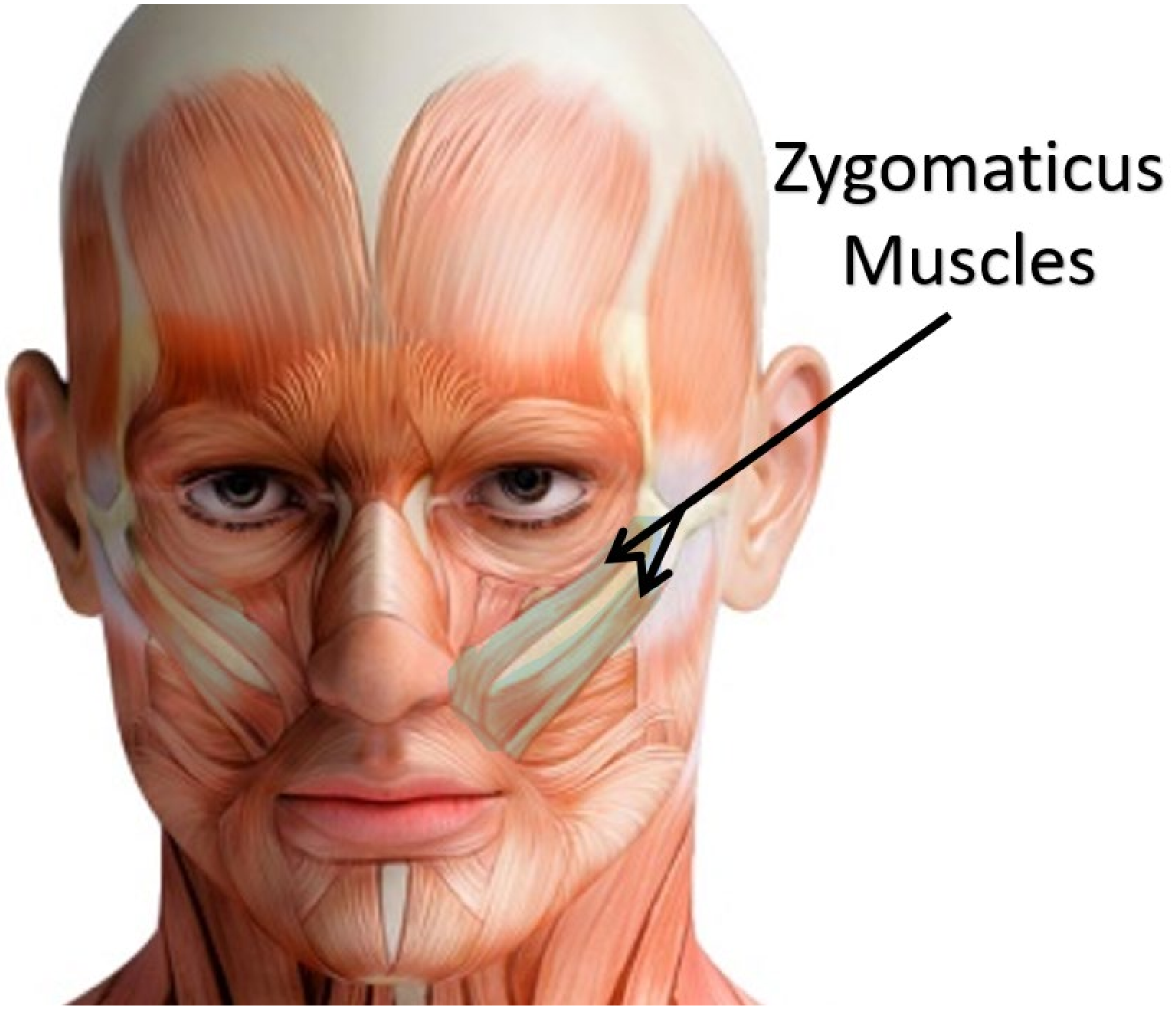


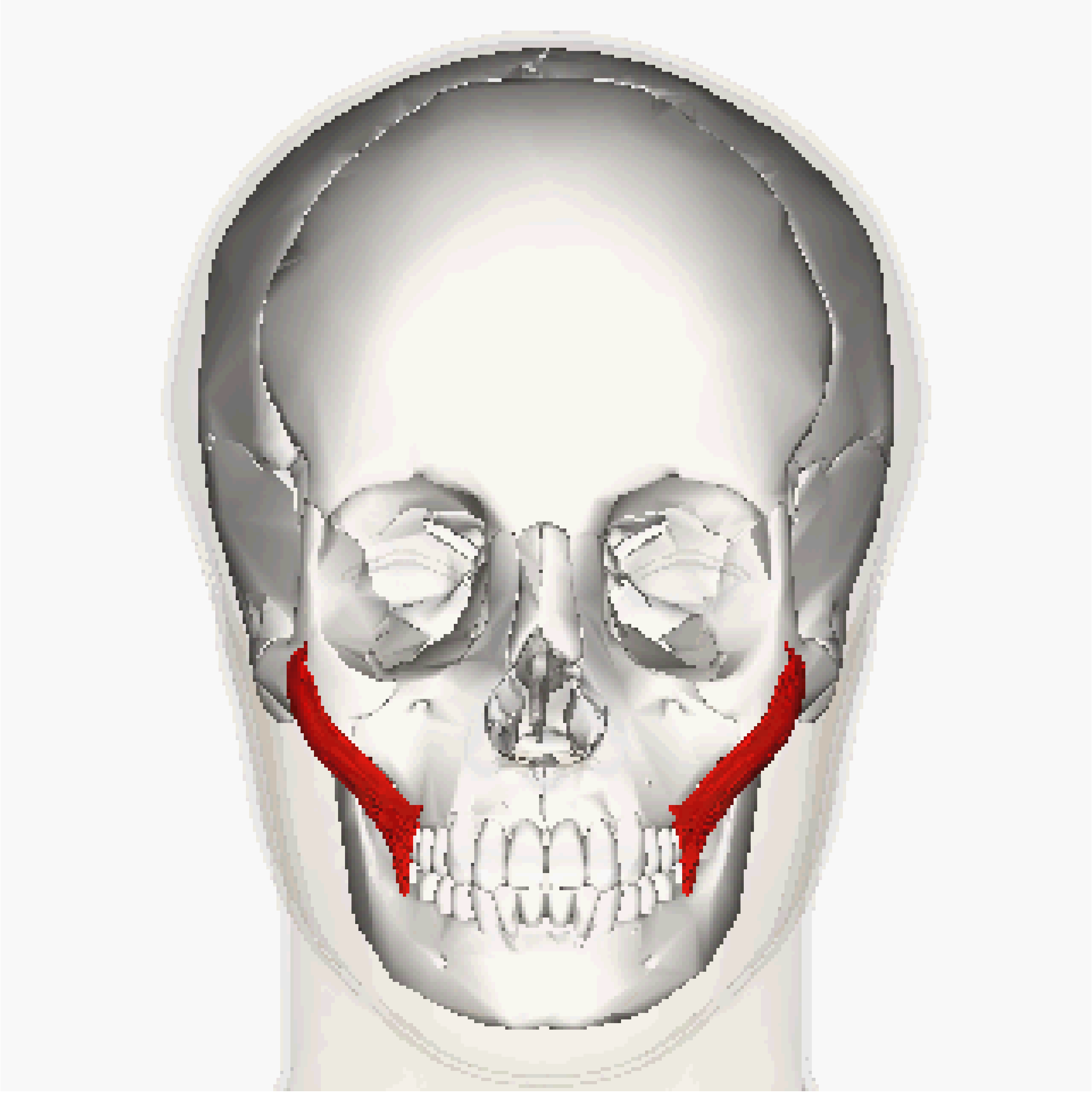
# *Zygomaticus Muscles*

- **Function:** Smiling
- **The zygomaticus muscles are the muscles of your face that help you show emotion by smiling.**

# *Zygomaticus Muscles*

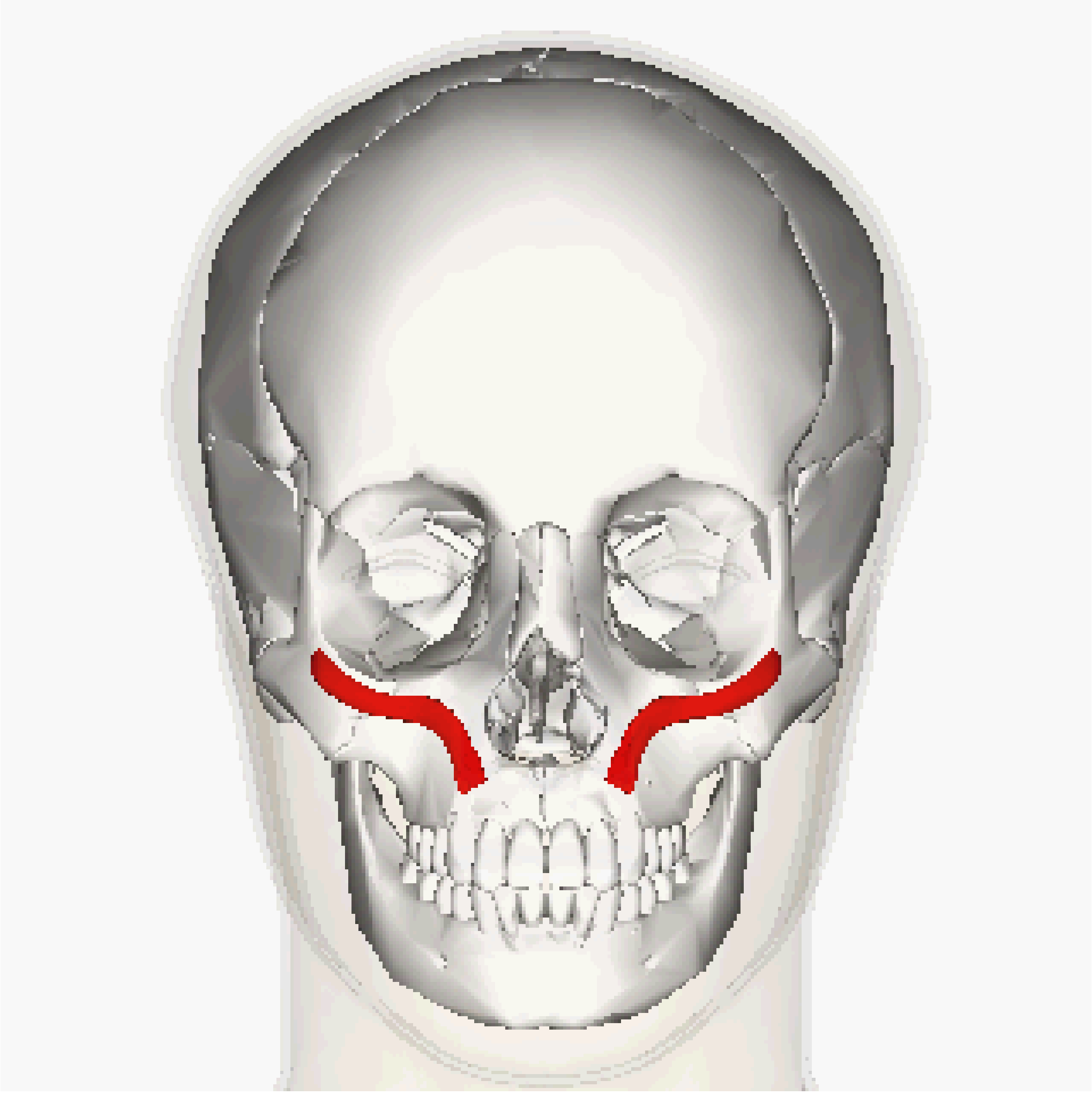
- **You have a zygomaticus major and a zygomaticus minor.**
- **These muscles act together to form the smile on your face by pulling up the corners of your mouth.**
- **This also allows the *poofing* out your 'happy' cheeks.**





# Zygomaticus Major Muscles of the face.

The zygomaticus major is larger than the minor and sits lower on the face, extending down to the mouth

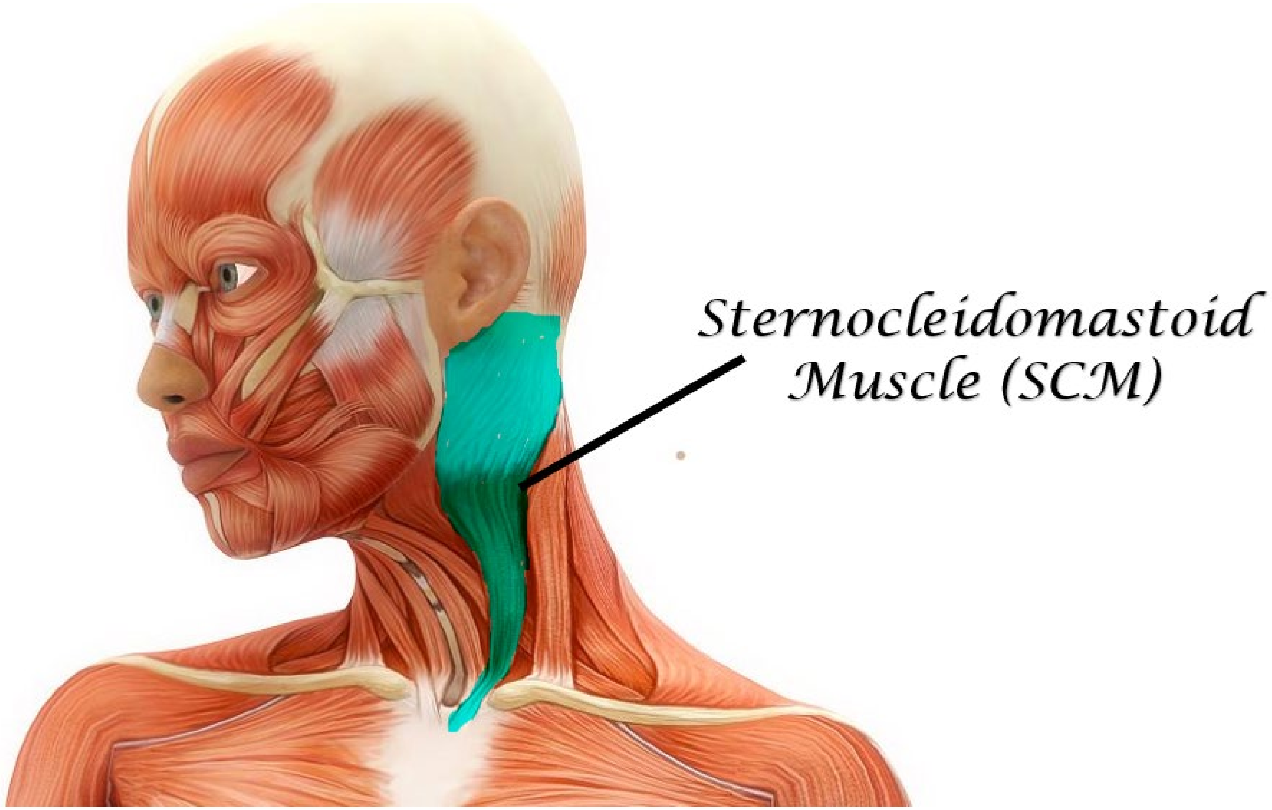


# Zygomaticus Minor Muscles of the face.

The zygomaticus minor is higher and closer to the nose and upper cheek. Both of the zygomaticus muscles also function to keep food in the mouth when chewing.

# *Sternocleidomastoid Muscles*

- **Function: Flexes the Head**
- The **sternocleidomastoid muscles** (**sternomastoid or SCM**) are the muscles of your neck responsible for rotation of your head and flexion (tilting head on one shoulder).

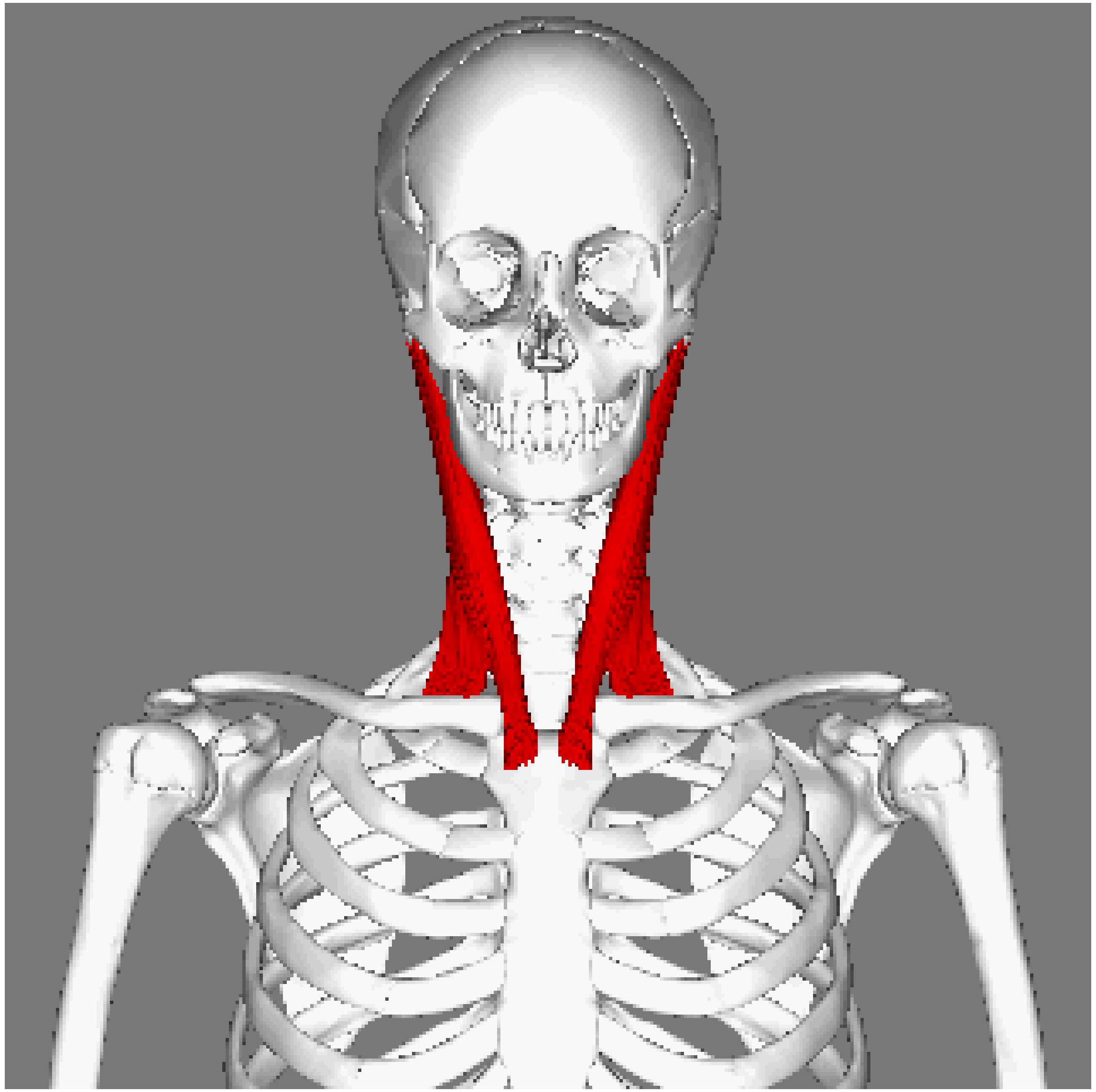


## *Sternocleidomastoid Muscles*

- It is one of the largest cervical muscles and is easy visible when a person turns their head from side to side.

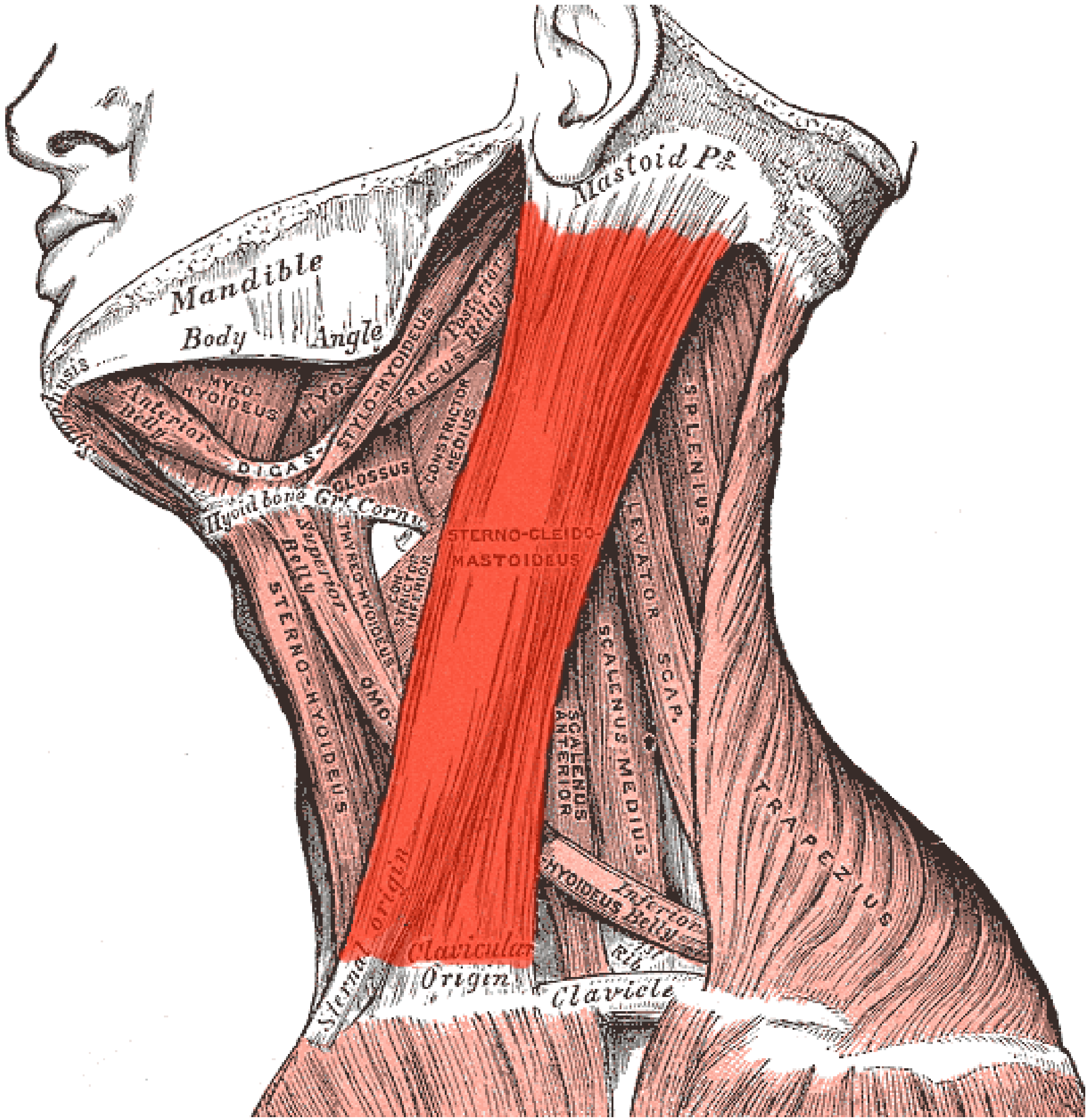
# *Sternocleidomastoid Muscles*

- The '*sterno-'* portion of its name comes from that fact that one of its origination points is at the sternum (more specifically at the manubrium which is the upper portion of the sternum).



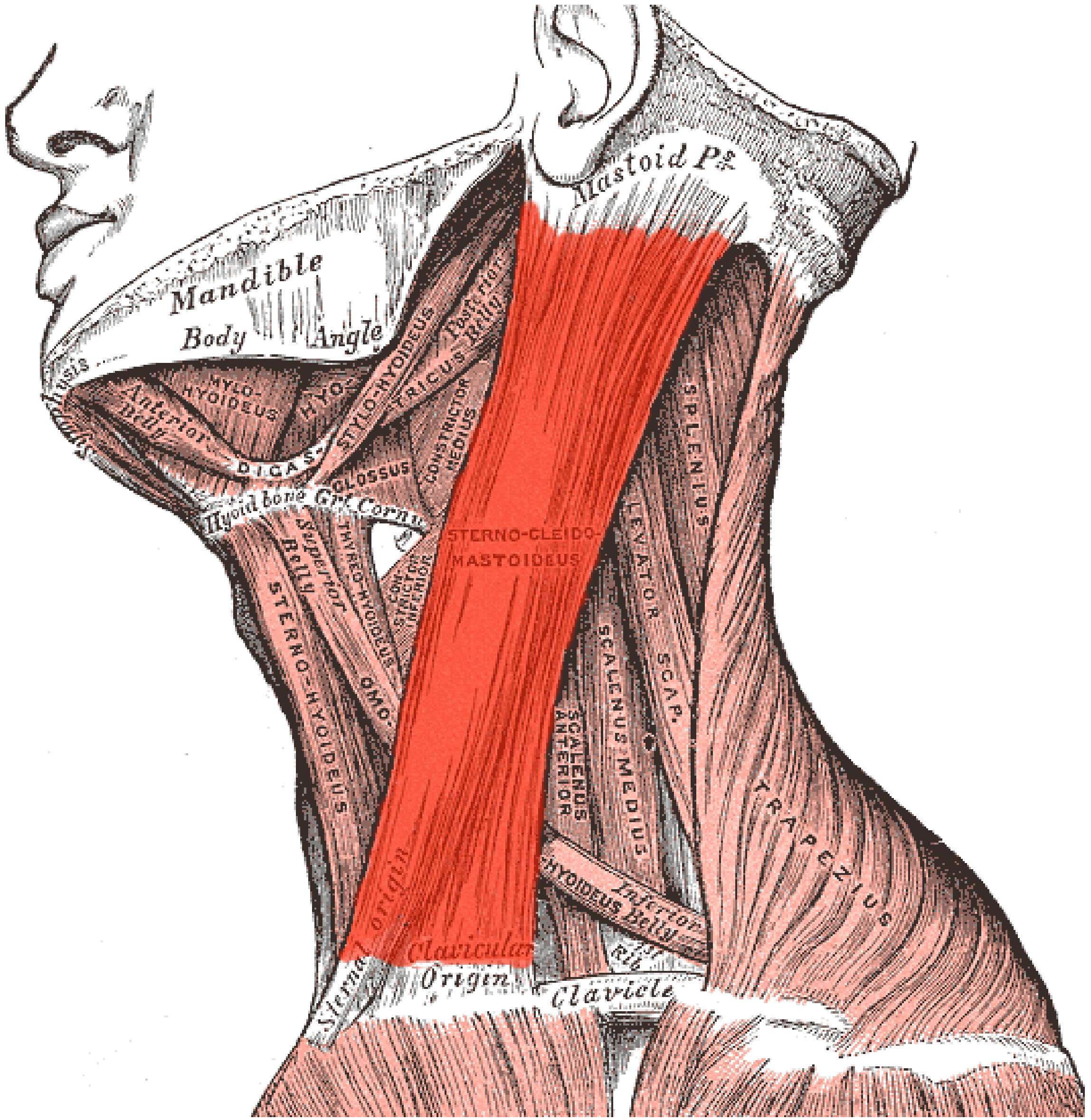
# *Sternocleidomastoid Muscles*

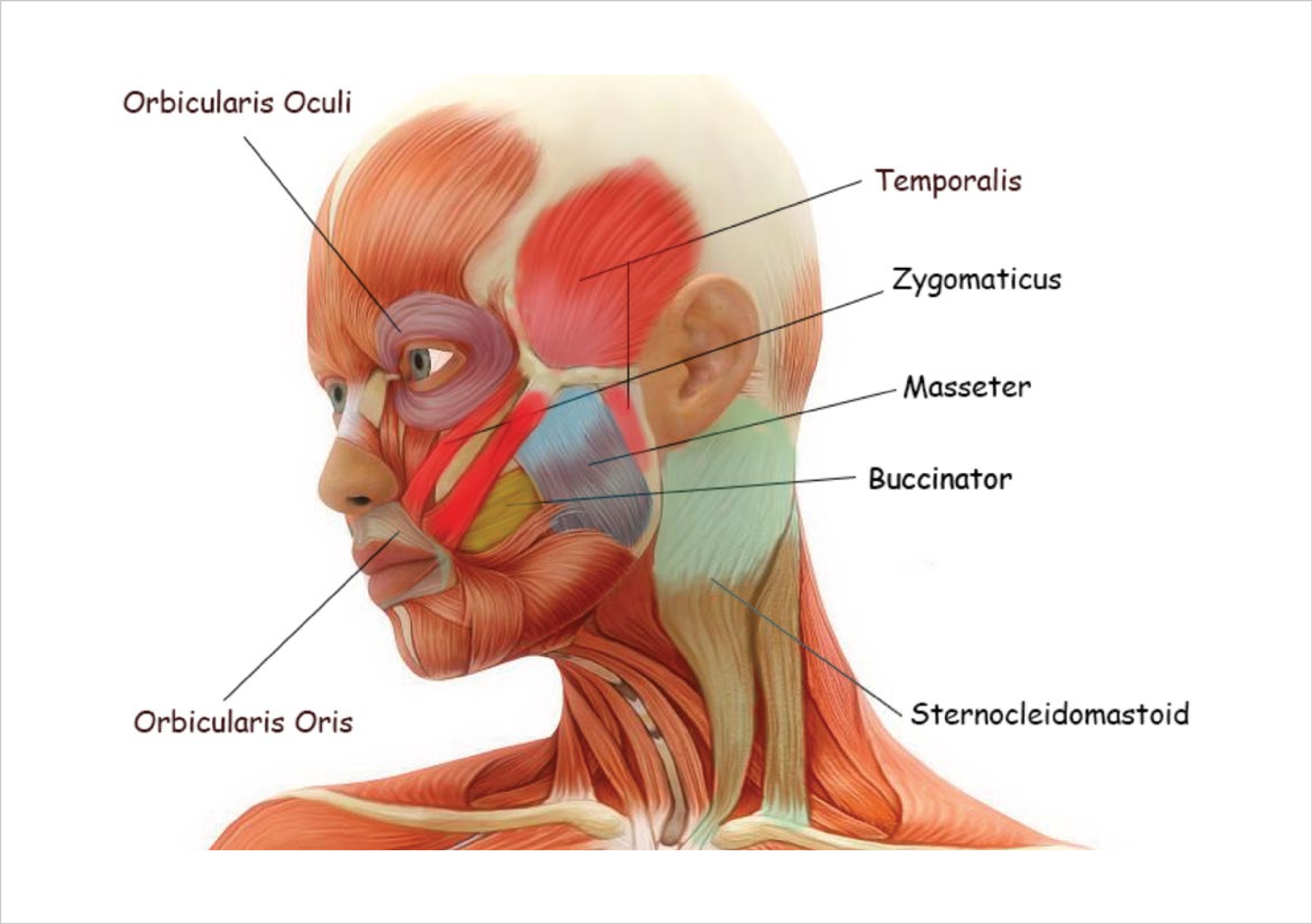
- It also originates at the clavicle (collar bone), which is where the 'cleido-'  portion of its name comes from.



# *Sternocleidomastoid Muscles*

- The name  ends with "mastoid", because the sternocleidomastoid muscle ends with an attachment at the mastoid process of the temporal bone    The name. sternocleidomastoid, describes the muscles' points of connectivity within the body.

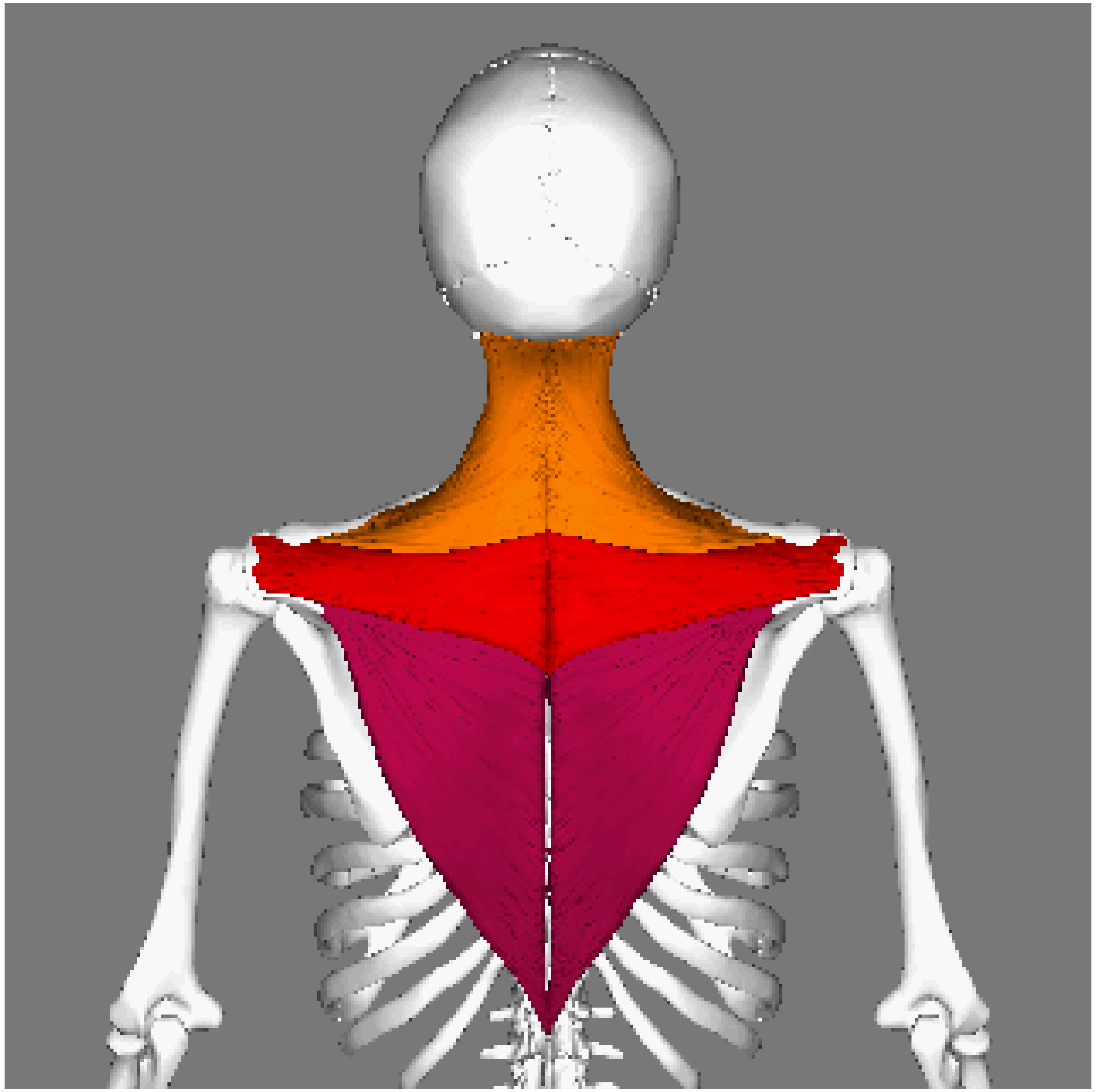





# Summary of the Muscles of Head and Neck

# MUSCLES OF THE TORSO (trunk)

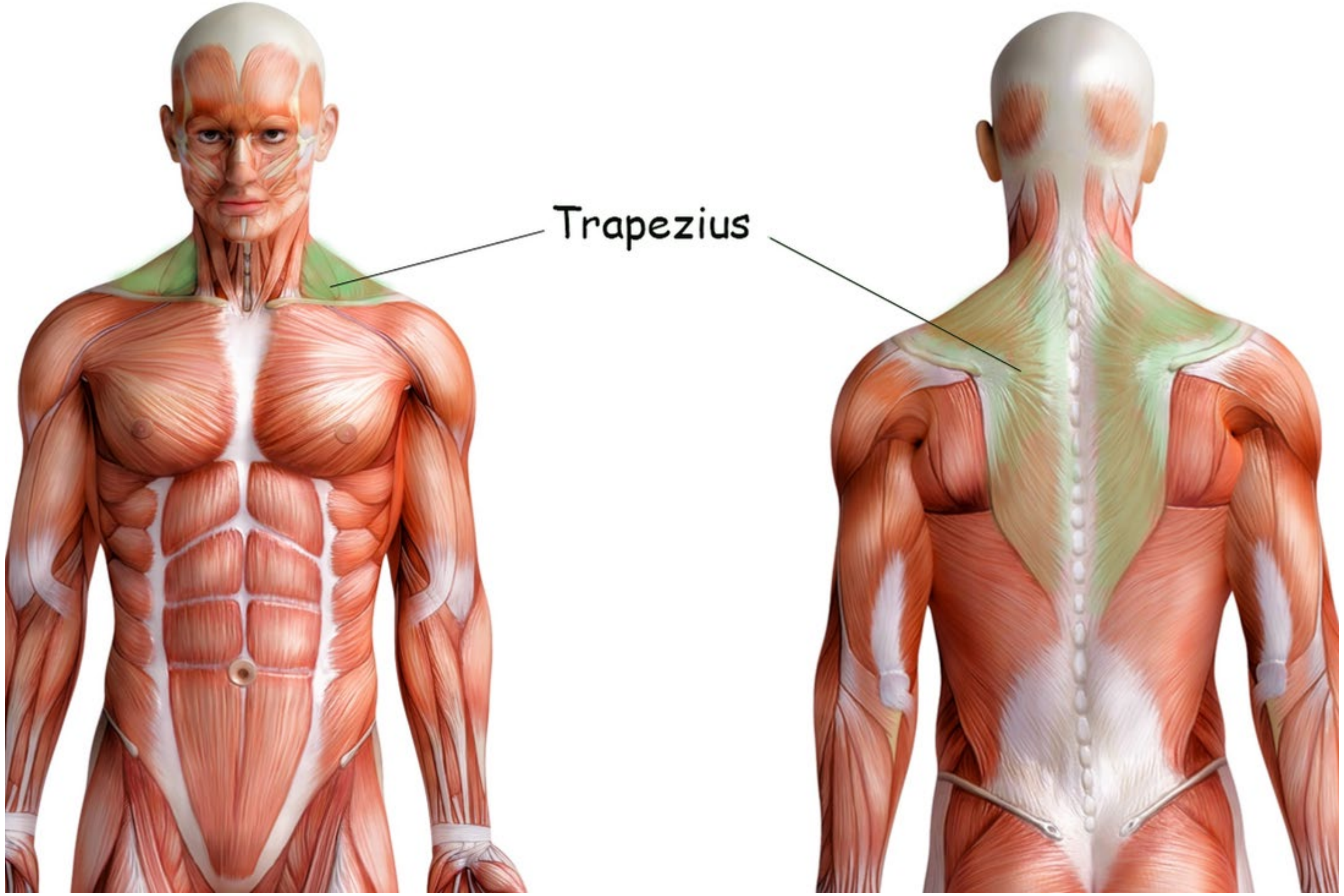
- The Superficial Muscles of the Thorax Include the Trapezius, the Pectoralis (Major and Minor), the Deltoid and the Latissimus Dorsi



# Trapezius Muscles

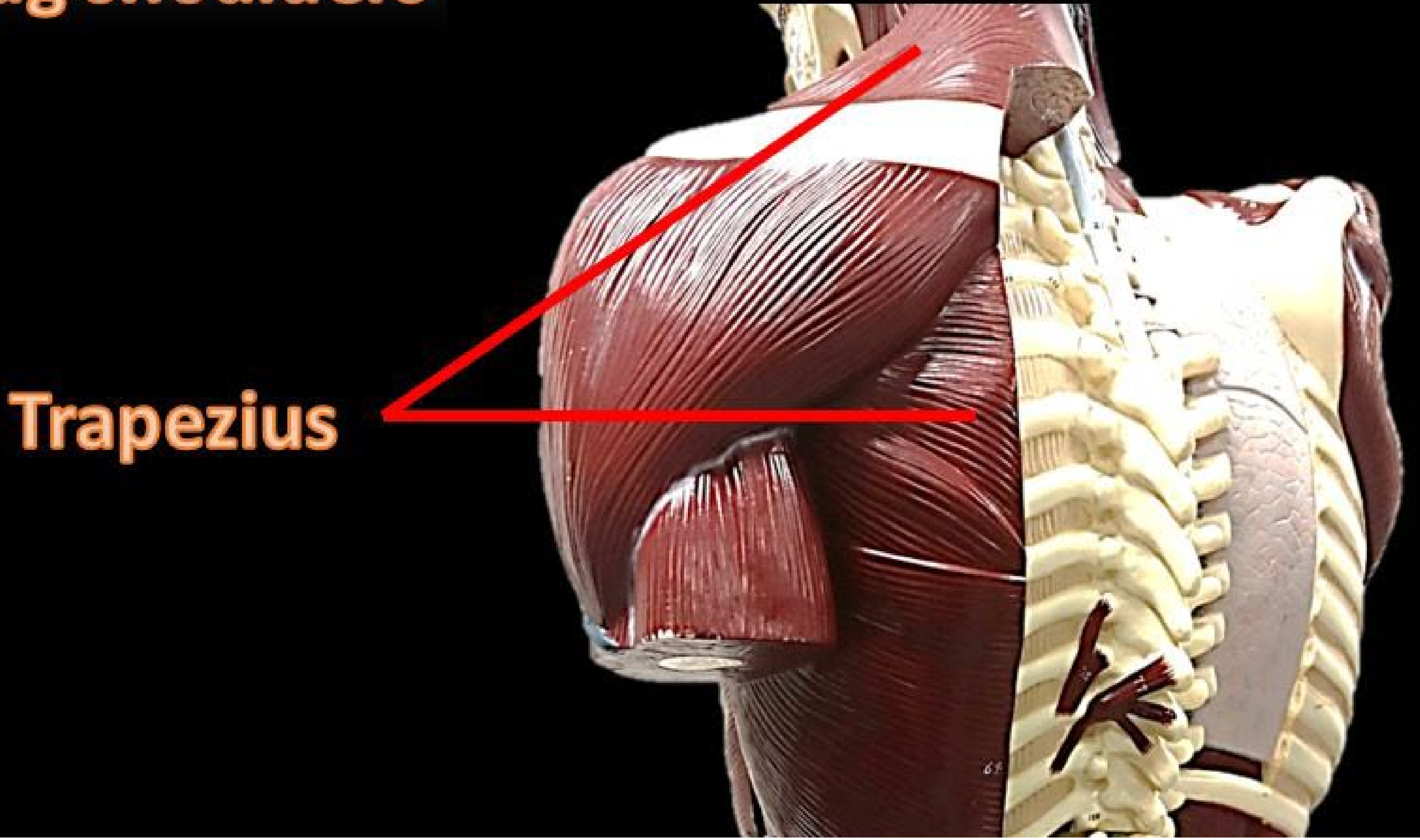
Function: Shrugs Shoulders

# Trapezius Muscles



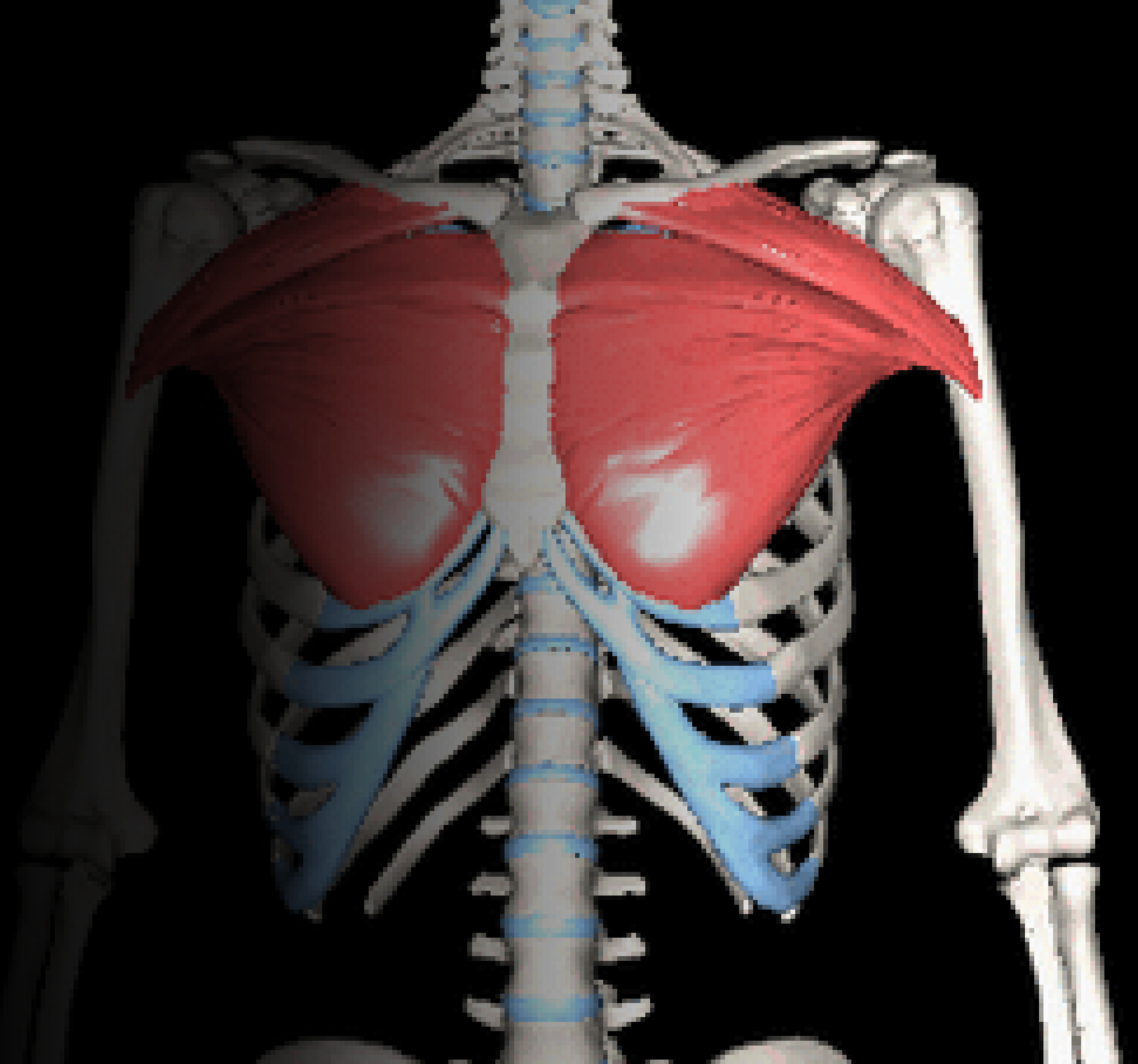

- The trapezius muscles are the large major muscles of the upper back. The trapezius muscles function to move, rotate and stabilize the scapula (shoulder blade).

# FXN – shrug shoulders



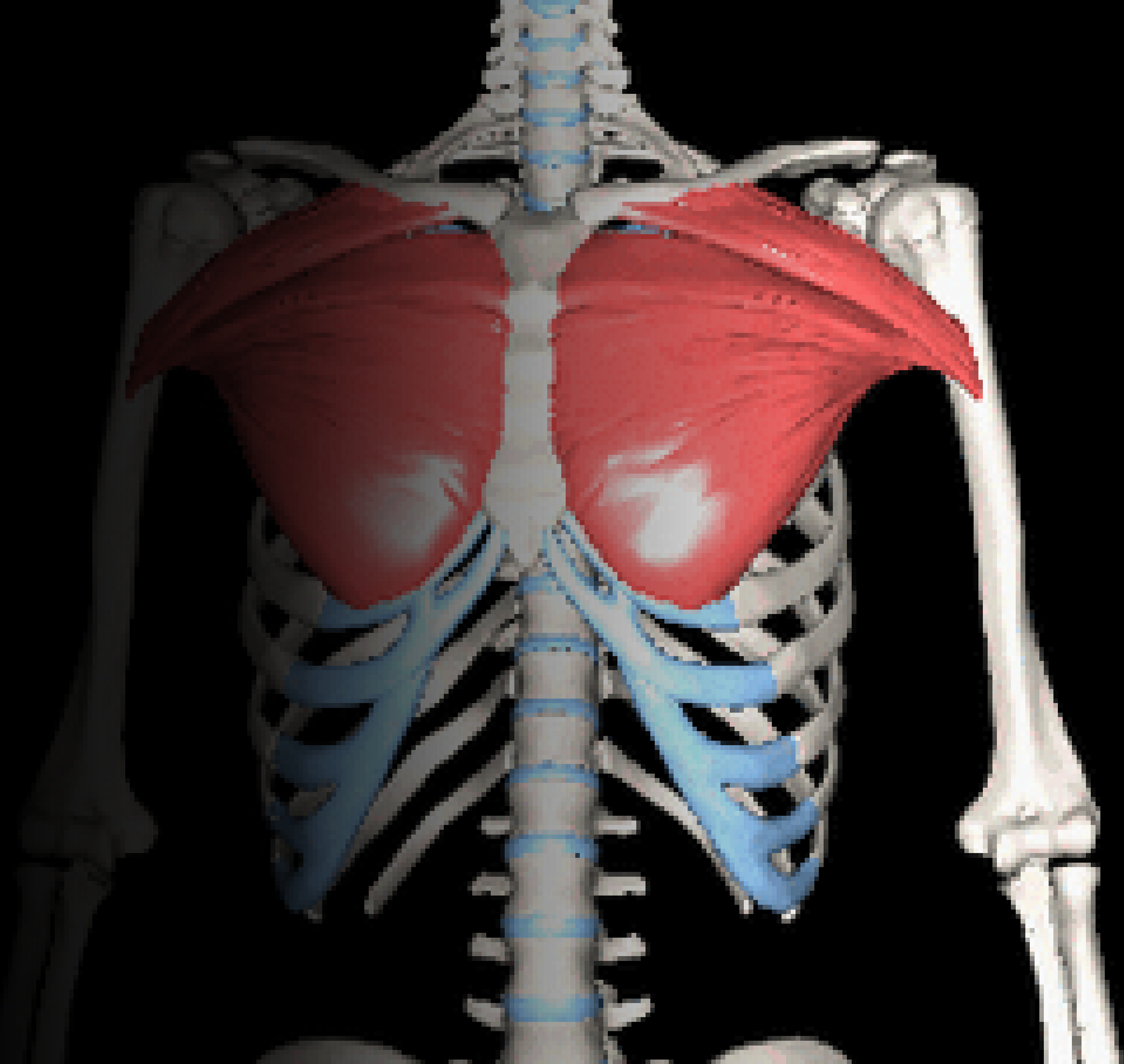
# Pectoralis Major and Minor Muscles

- **Function: Flexion, rotation and adduction of the arm.**



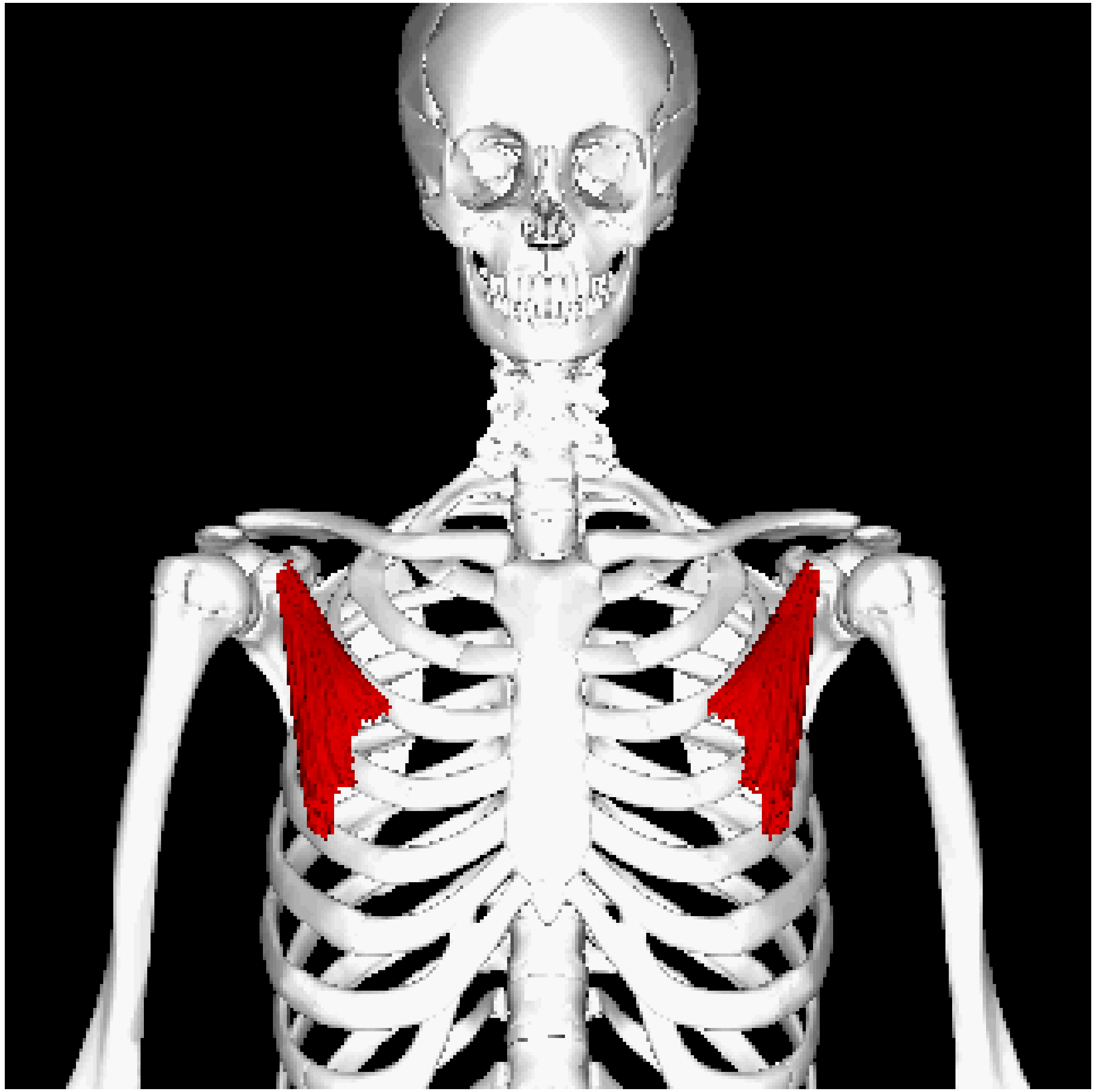
# Pectoralis Major Muscles

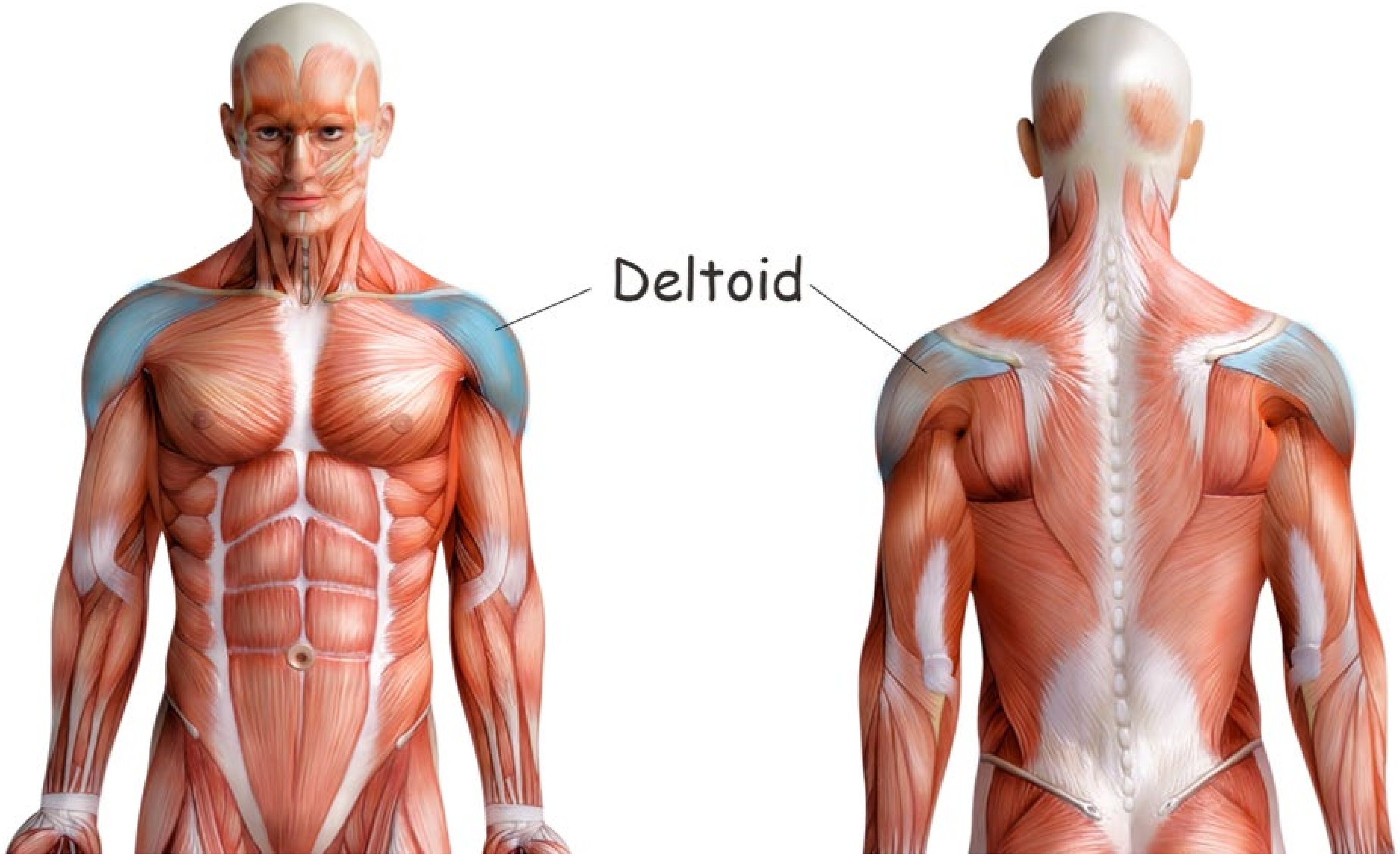
- The **pectoralis major** is a large muscle of the upper chest region (thoracic region). It connects the bones of the chest to the shoulders and upper arms.
- The pectoralis major muscle allows you to move your arm across the body.



# Pectoralis Minor Muscles

- The **pectoralis minor** muscles lie underneath the pectoralis major muscles closer to the axillary region (region of the armpit).
- The pectoralis minor and are considerably smaller.
- It is smaller of the two sets of muscles that connect the bones of the chest to the shoulder and upper arm.





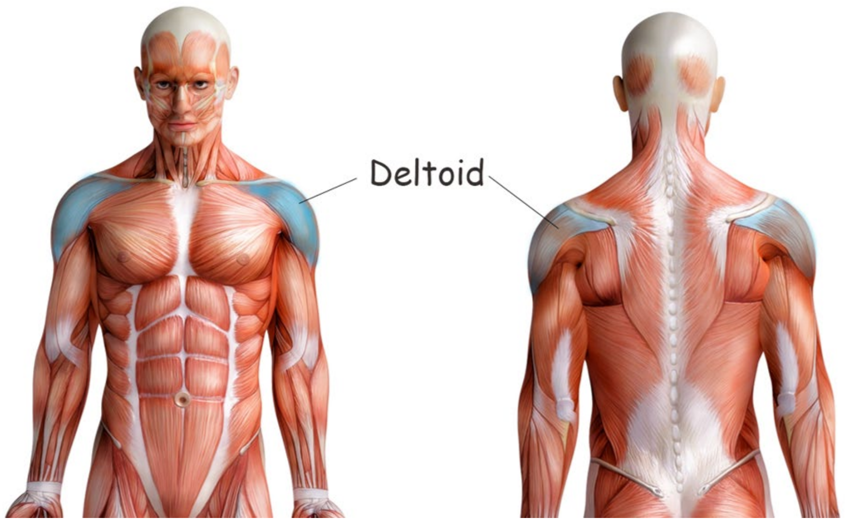

# Deltoid Muscles

- The **deltoid muscle** is the rounded muscle of the shoulder and upper arm. The deltoid muscle is named after the Greek letter "delta", because it has a similar triangular shape. The deltoid is attaches to clavicle (collarbone), the scapula (shoulder blade), and the humerus (upper arm bone).
  Contraction of the deltoid muscle results in a wide range of movement of the arm at the shoulder due to its location and the wide separation of its muscle fibers.

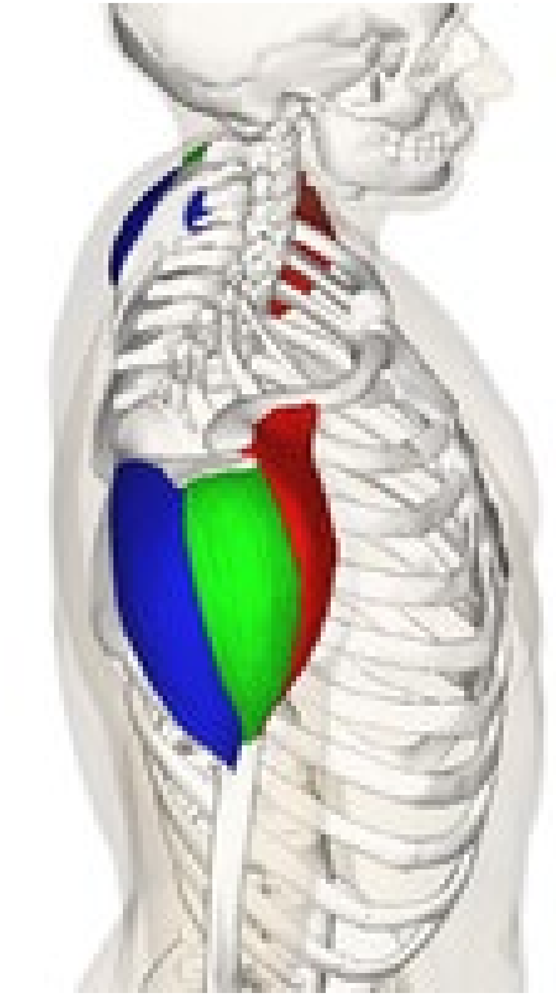
δΔ

Delta

# Deltoid Muscles

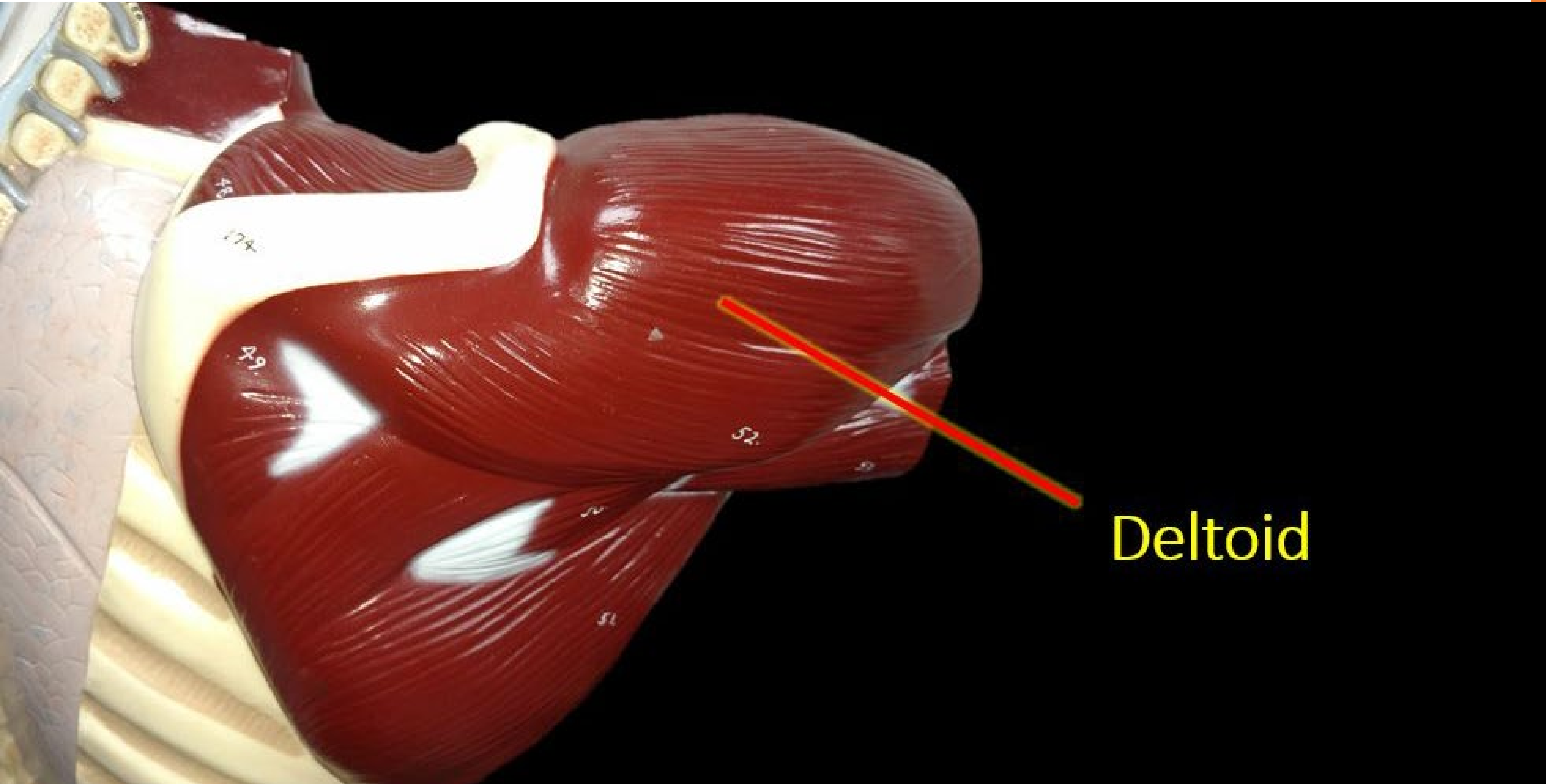



- The **deltoid muscle** is the rounded muscle of the shoulder and upper arm. The deltoid is attaches to clavicle (collarbone), the scapula (shoulder blade), and the humerus (upper arm bone).
  Contraction of the deltoid muscle results in a wide range of movement of the arm at the shoulder due to its location and the wide separation of its muscle fibers.

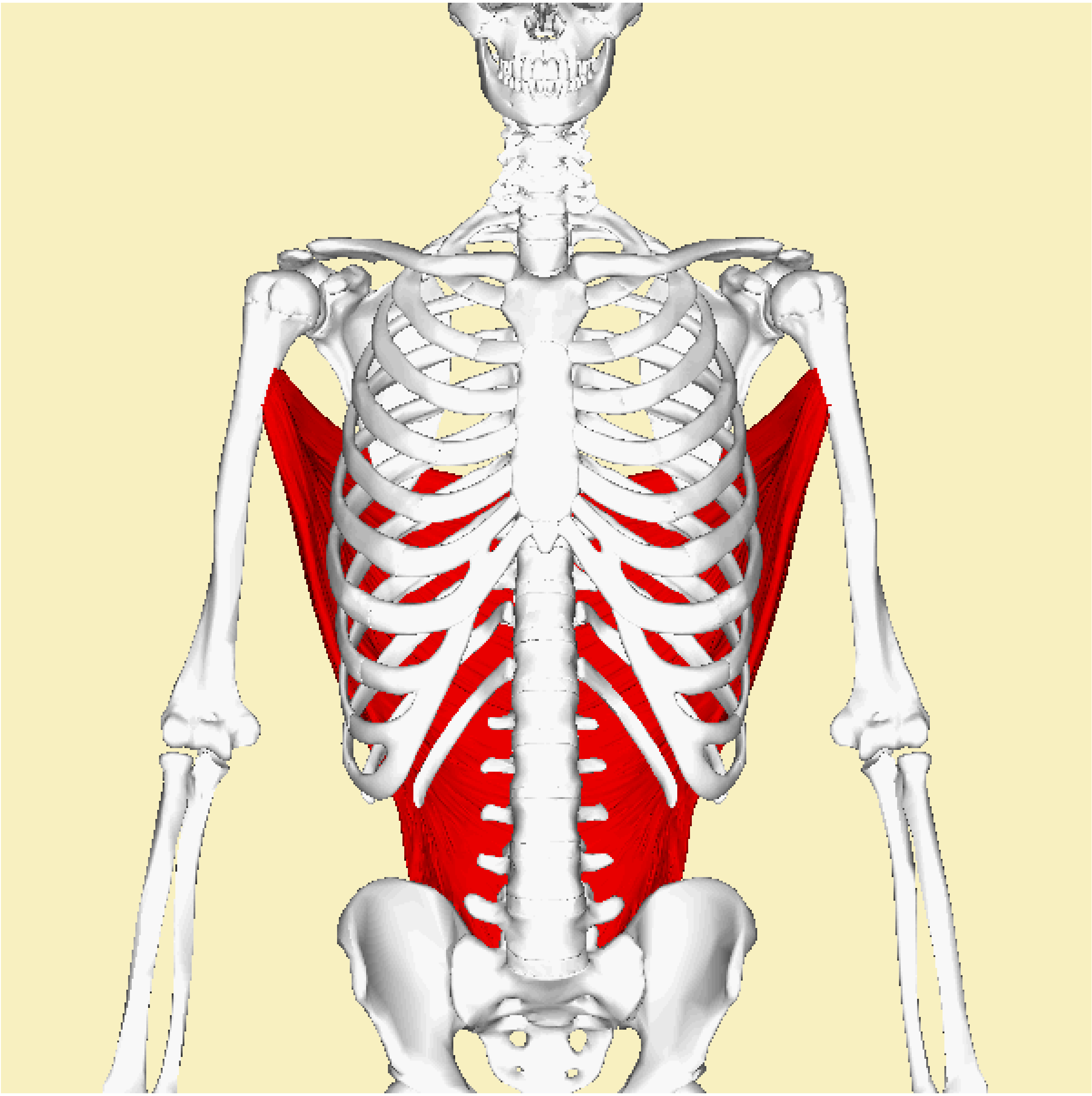


# Deltoid Muscles

- The deltoid muscle is named after the Greek letter "delta", because it has a similar triangular shape.


Deltoid

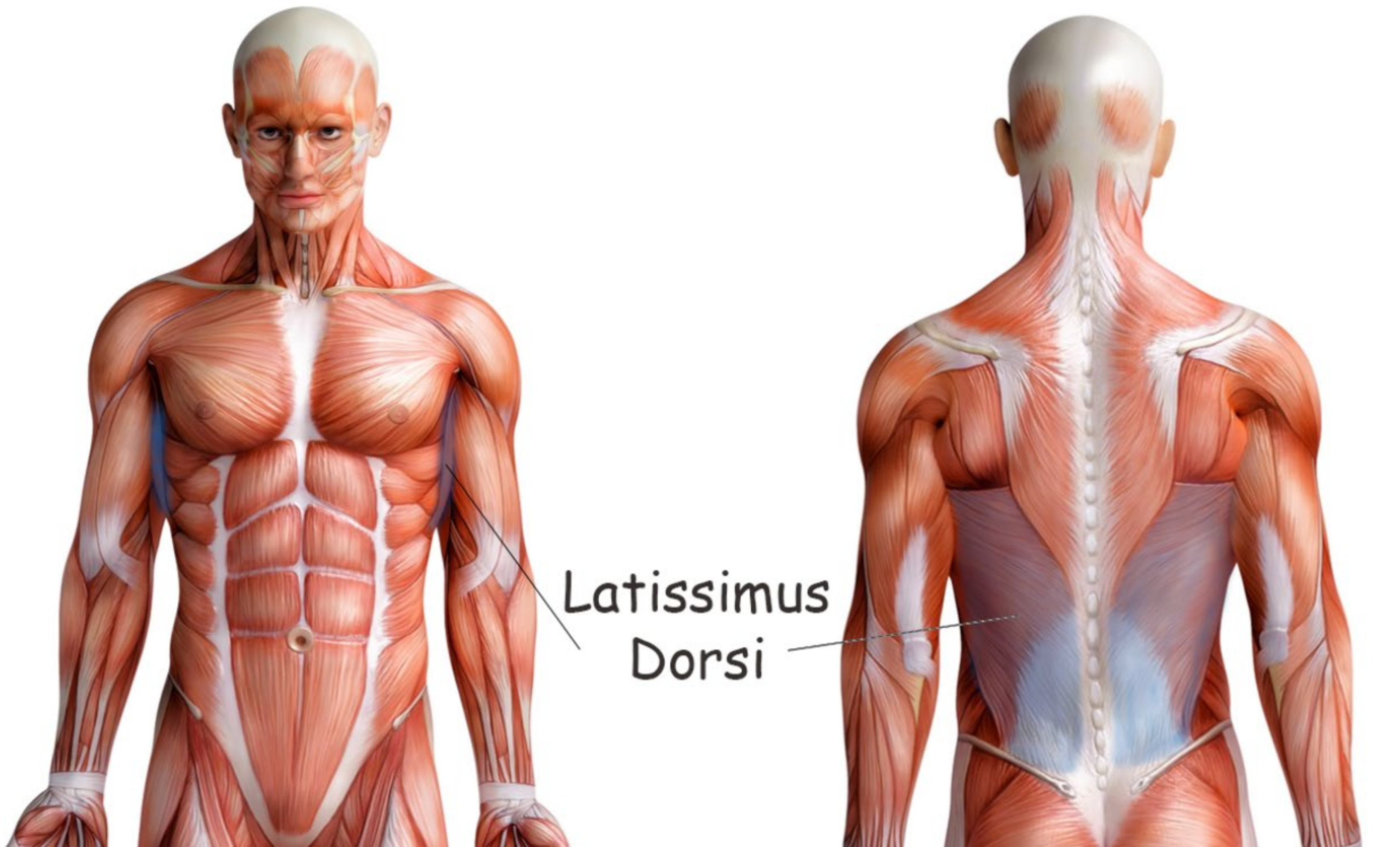
# *Latissimus Dorsi*

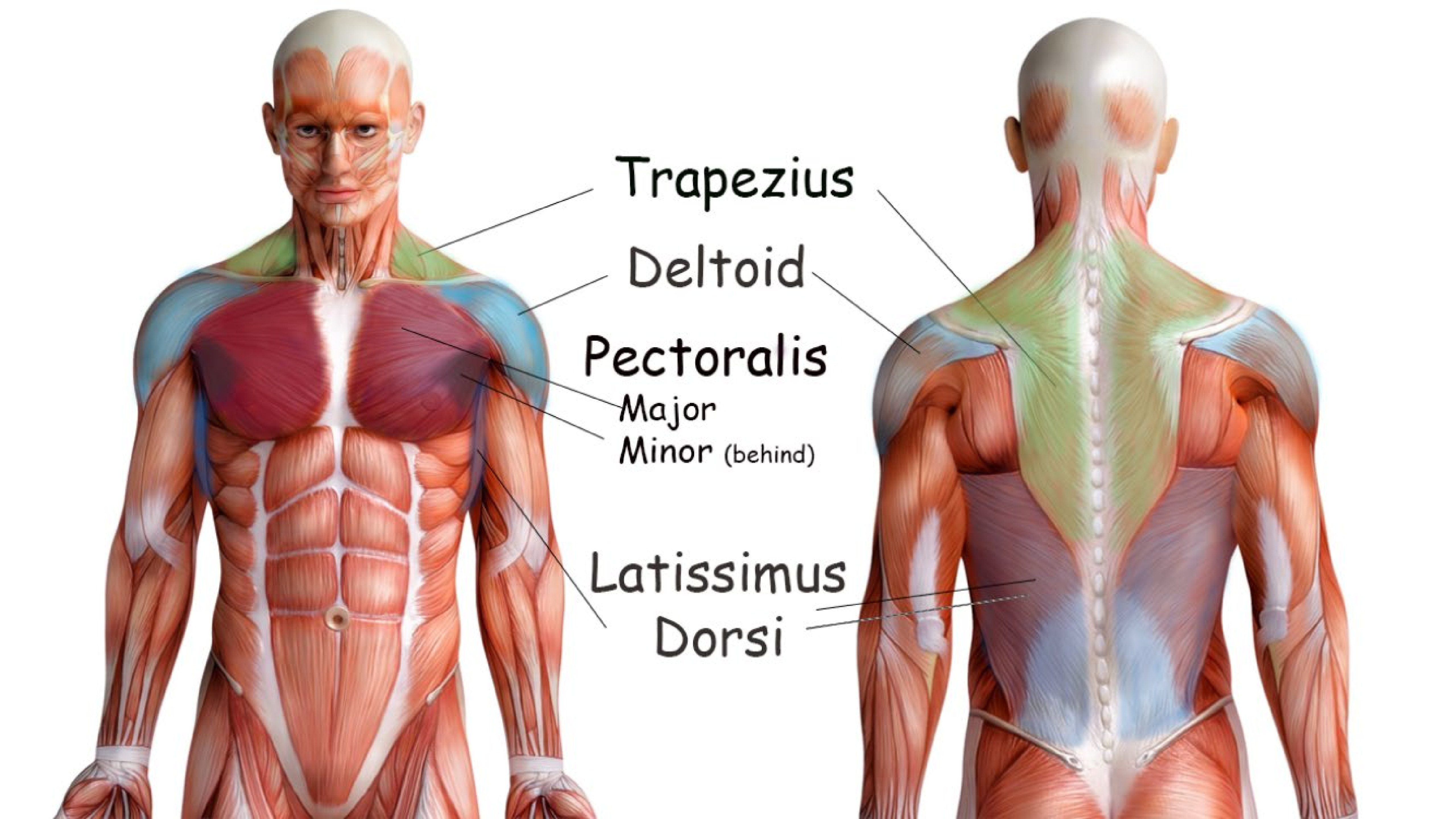


**FUNCTION : Major muscle for arm extension, adduction and medial rotation of arm.**

**Other functions –**
**Bringing the arm down forcefully (hammering)**
**Swimming**
**Reaching overhead**
**Chin-ups**

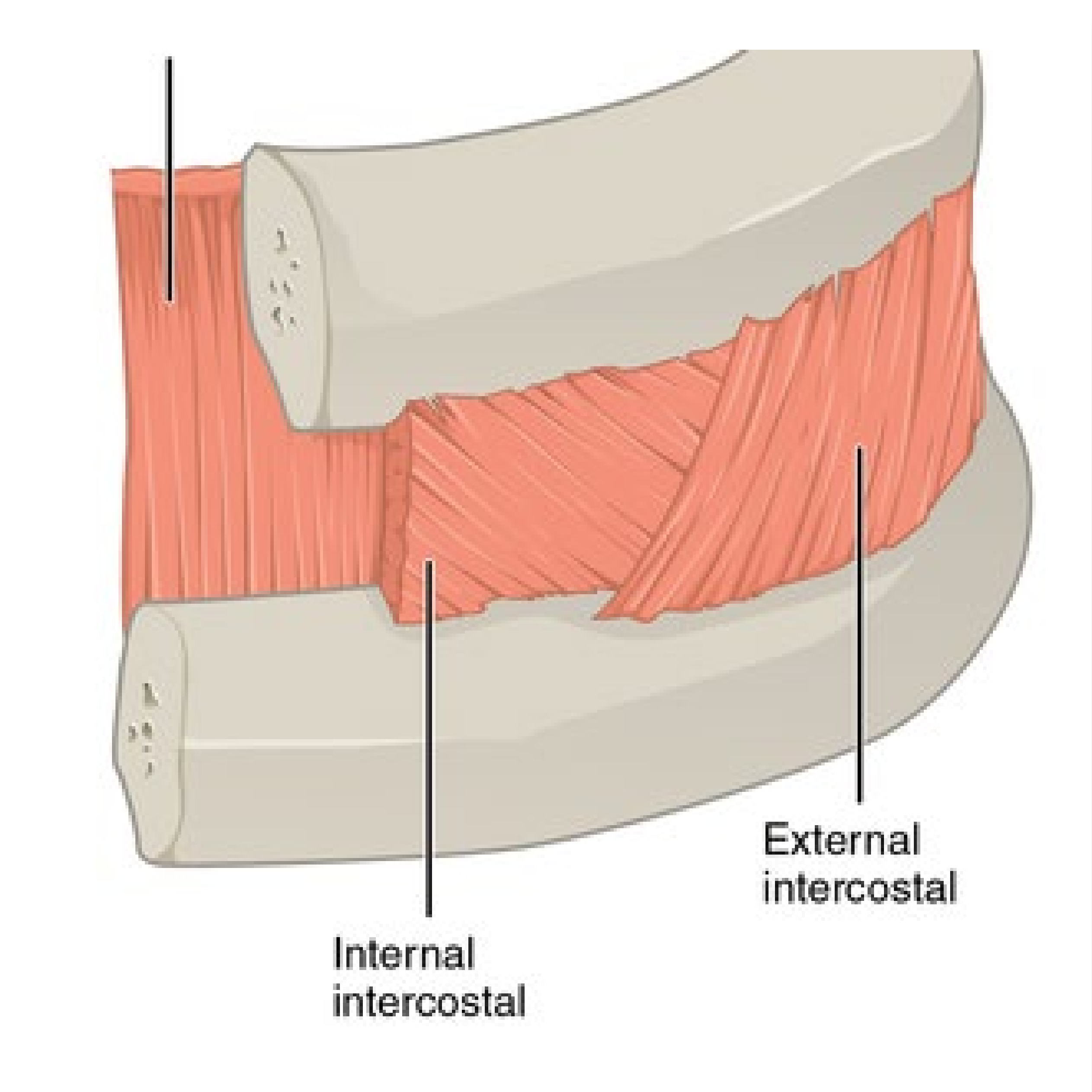
# Latissimus dorsi comes from the words ‘latissimus’ = widest and ‘dorsi’ = back




Trapezius
Deltoid
Pectoralis
Major
Minor (behind)
Latissimus
Dorsi

# Deep Muscles of the Torso

- The Deep Muscles of the Torso Include the Internal and External Intercostal Muscles and the Muscles of the Rotator Cuff
  (the **supraspinatus muscle**, the **infraspinatus** muscle, the **teres minor muscle** and the **subscapularis muscle**)




# Internal and External Intercostal Muscles

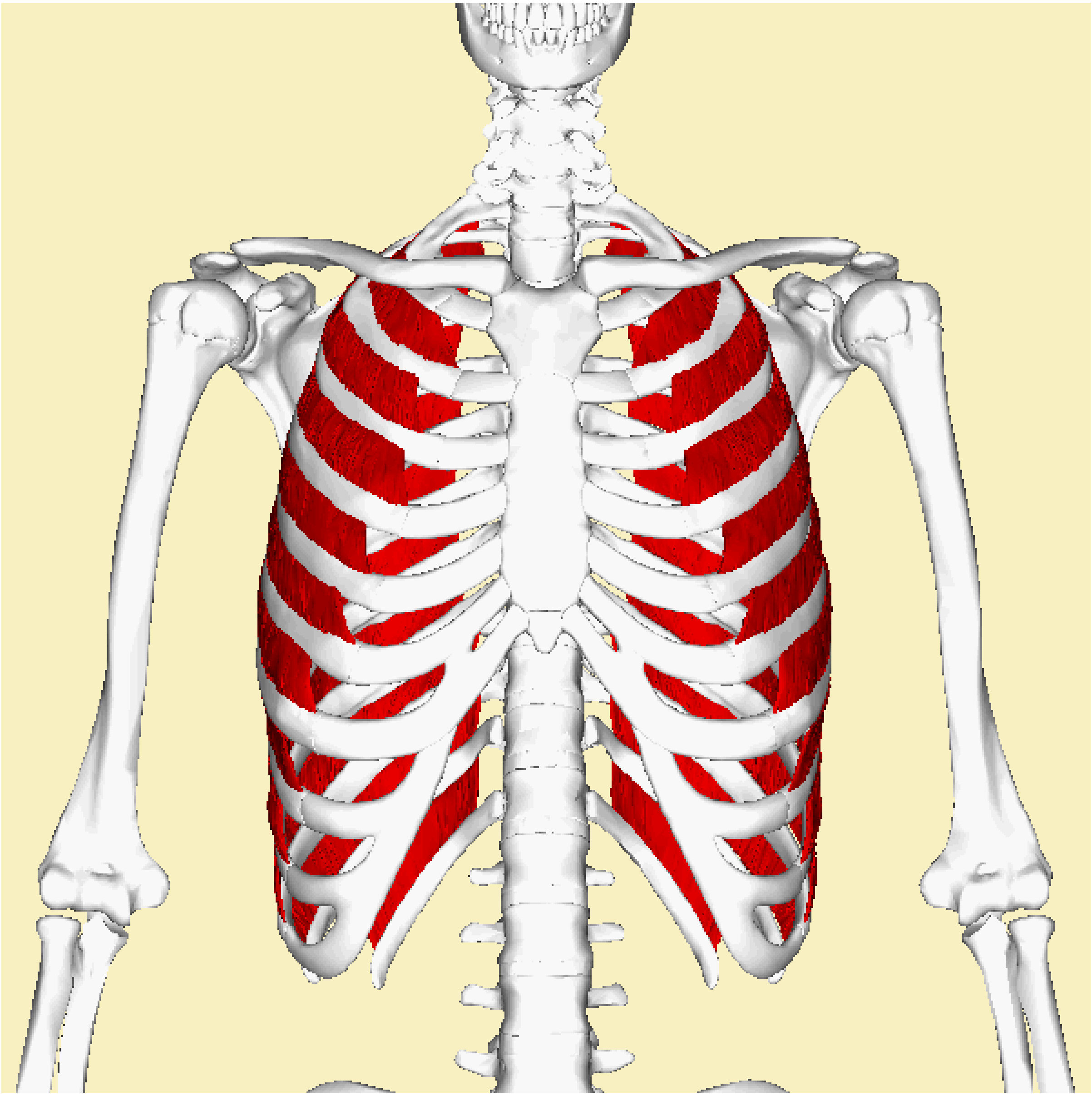
# Internal and External Intercostal Muscles

**The function of the deep muscles of the thorax is to assist in respiration (breathing).**

**The medical term for inhalation (or breathing inwardly) is inspiration and the medical term for exhalation (or breathing outwardly) is expiration.**

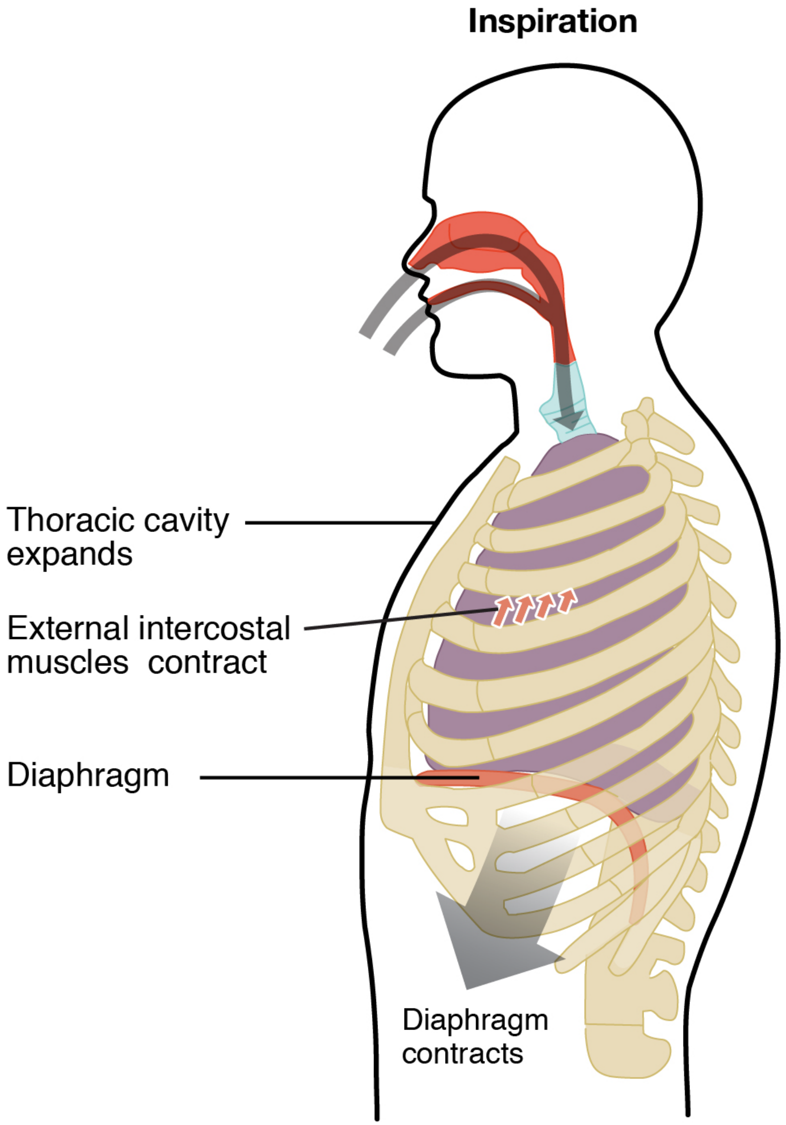
# External Intercostals

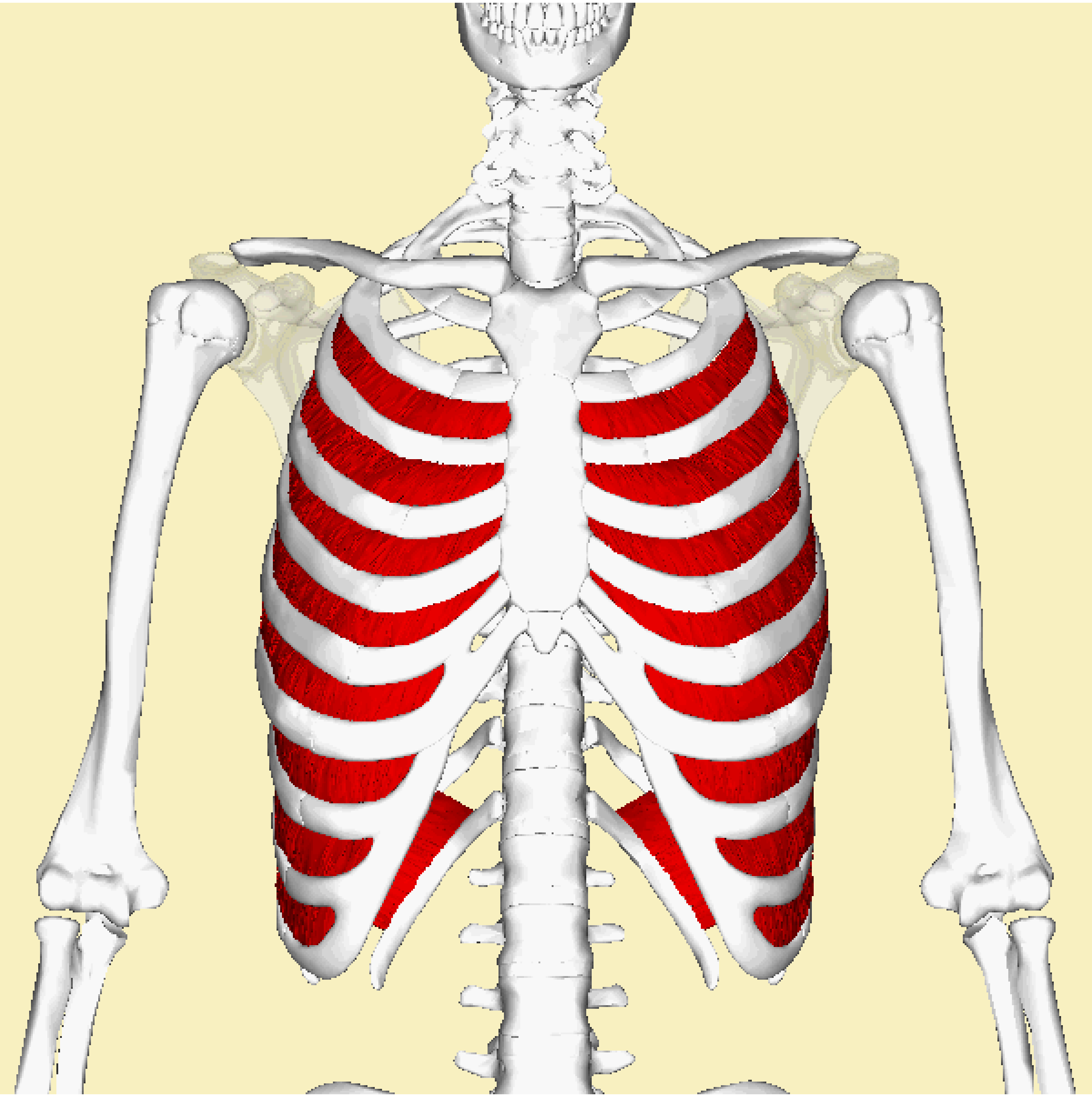
- **The external intercostal muscles make up the most superficial of the 3 layers of intercostals.**



# The external intercostal muscles

- **In order for inspiration to occur, the thoracic cavity (which includes the pleural cavities) must expand (or increase in volume).**
- **The external intercostal muscles function to expand the thoracic cavity upon inspiration (inhalation) by acting to lift the rib cage.**



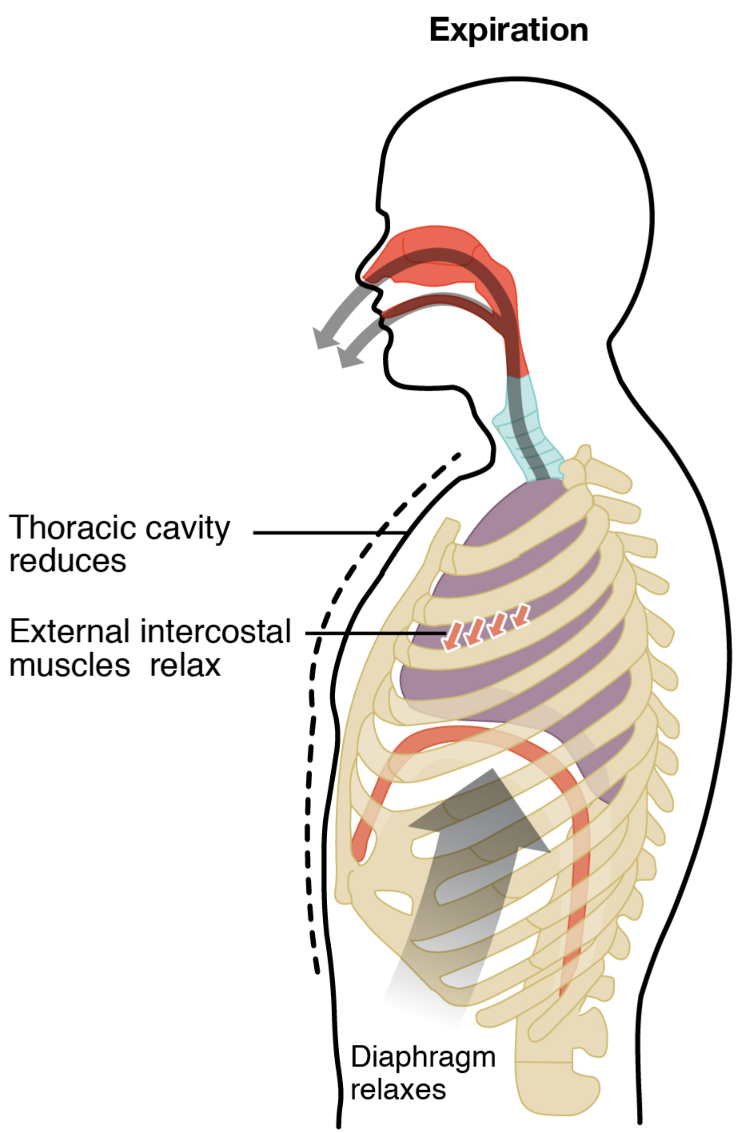


# Internal Intercostals

- The internal intercostals form the intermediate intercostal muscle layer.

# The internal intercostal muscles

- In order for expiration (exhalation) to occur, the thoracic cavity must collapse (or decrease in volume).
- The internal intercostal muscles pull the rib cage down to allow for expiration (or exhalation).



*Just FYI - The deepest muscle layer of the thoracic wall attaches to the internal surfaces of the ribs.*

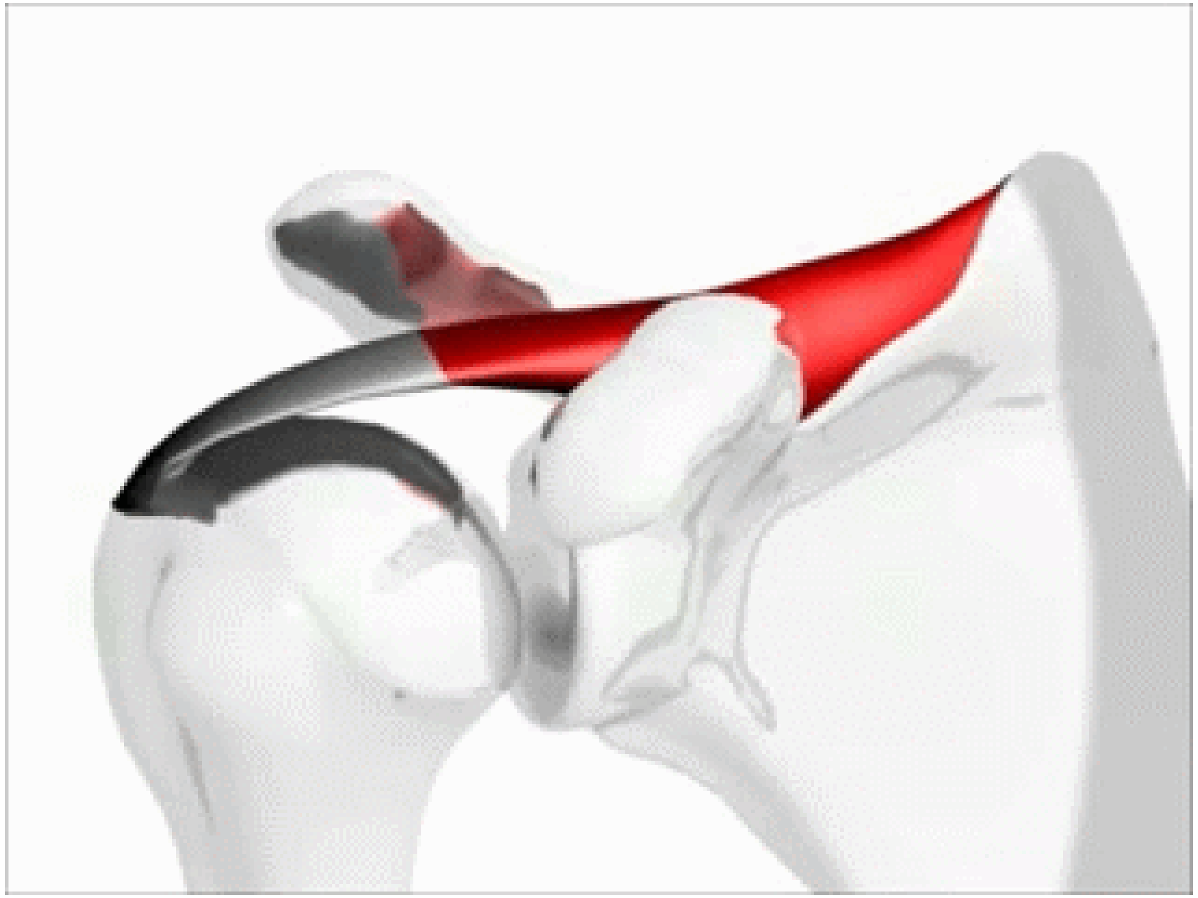
*The function of the deepest layer is unknown.*

# The Rotator Cuff Muscles

- Four muscles make up the rotator cuff that encircles the shoulder joint.
    - The rotator cuff muscles include the following:
      1) The Subscapularis (Pink)
      2) The Supraspinatus (Violet)
      3) The Infraspinatus (Blue)
      4) The Teres Minor (Red)

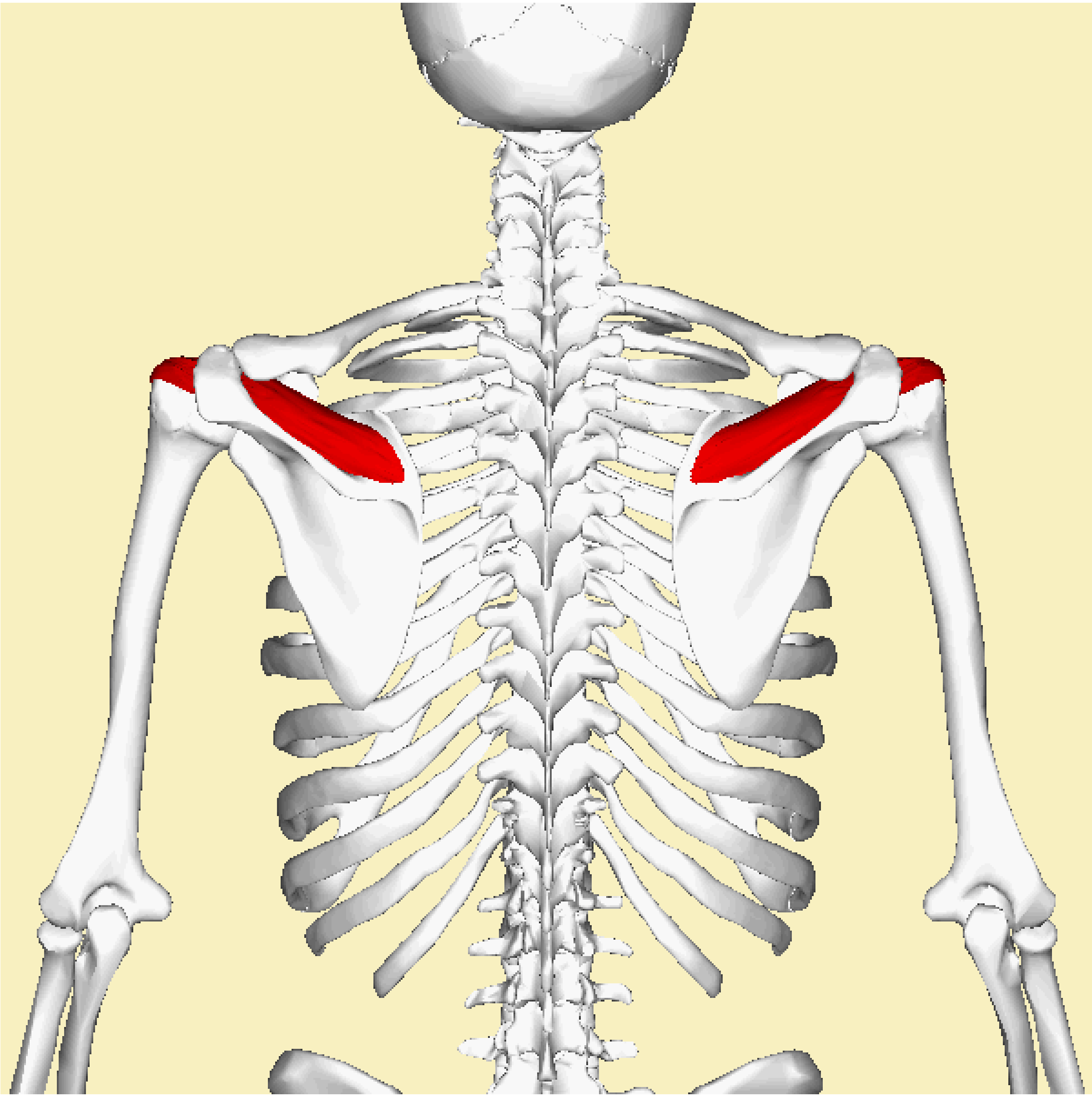
## Supraspinatus

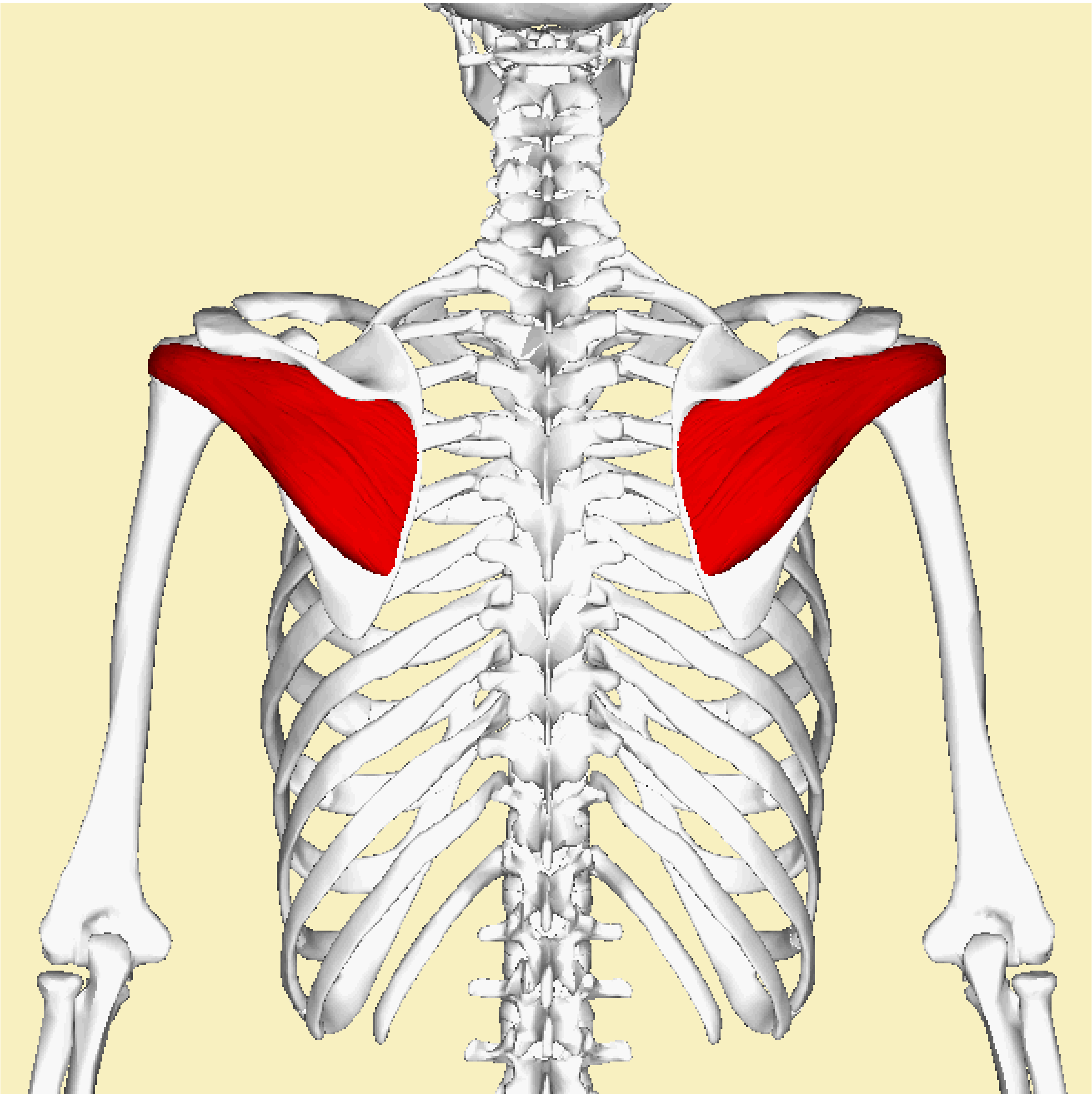
- **Function = initiates abduction of arm**
- **The supraspinatus muscles originate at the supraspinatus fossa (which lies just above the spinous process of the scapulae and inserts at the greater tubercle of the humerus.**
- **The supraspinatus muscles function to abduct the arm and to stabilize the shoulder.**
- **It is located superiorly at the posterior aspect of the scapulae.**



# *Supraspinatus*

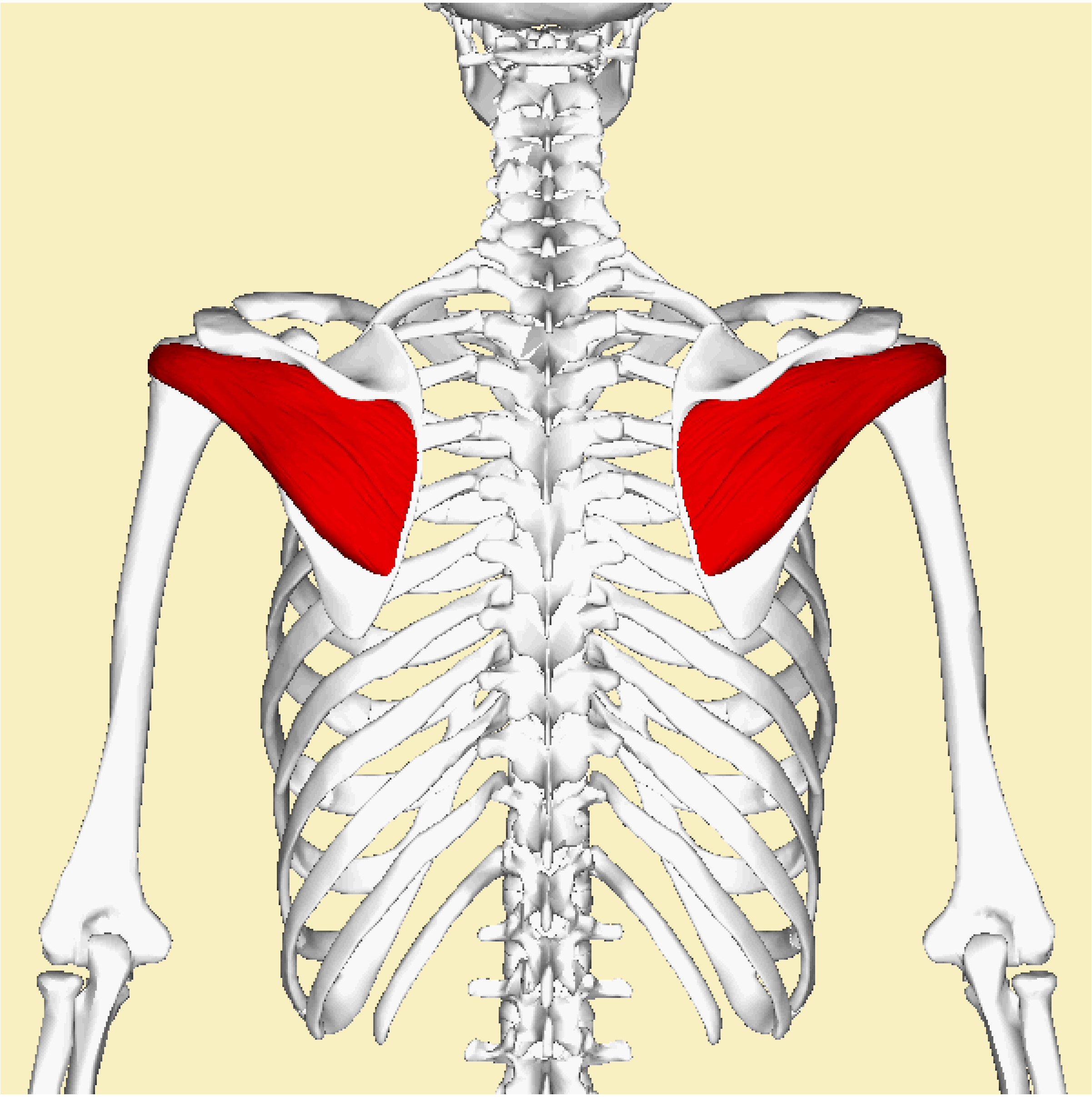
- Function = initiates abduction of arm
- The supraspinatus muscles originate at
  the supraspinatus fossa (which lies just above the spinous process of the scapulae and inserts at the greater tubercle of the humerus.





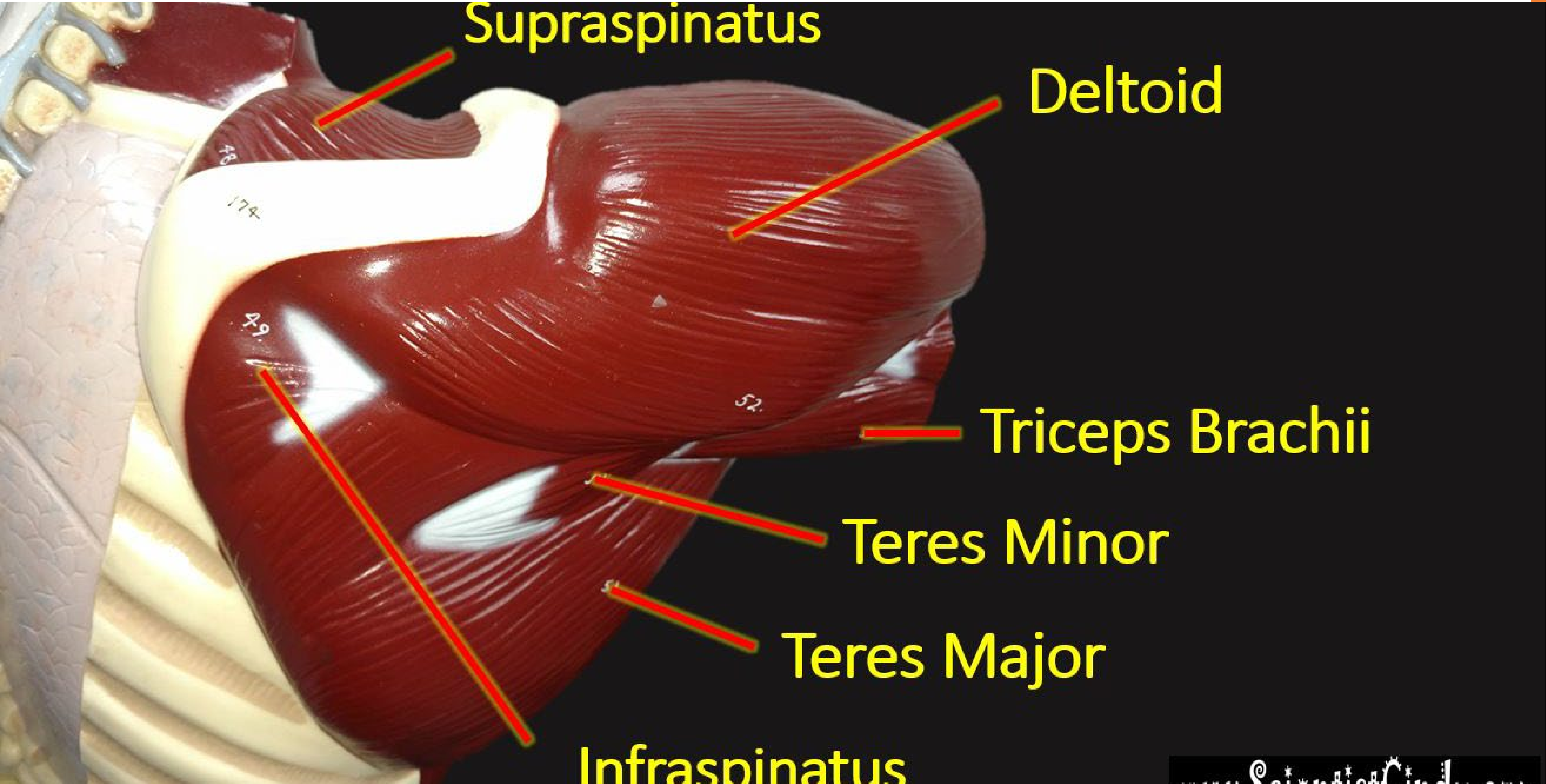
# *Infraspinatus*

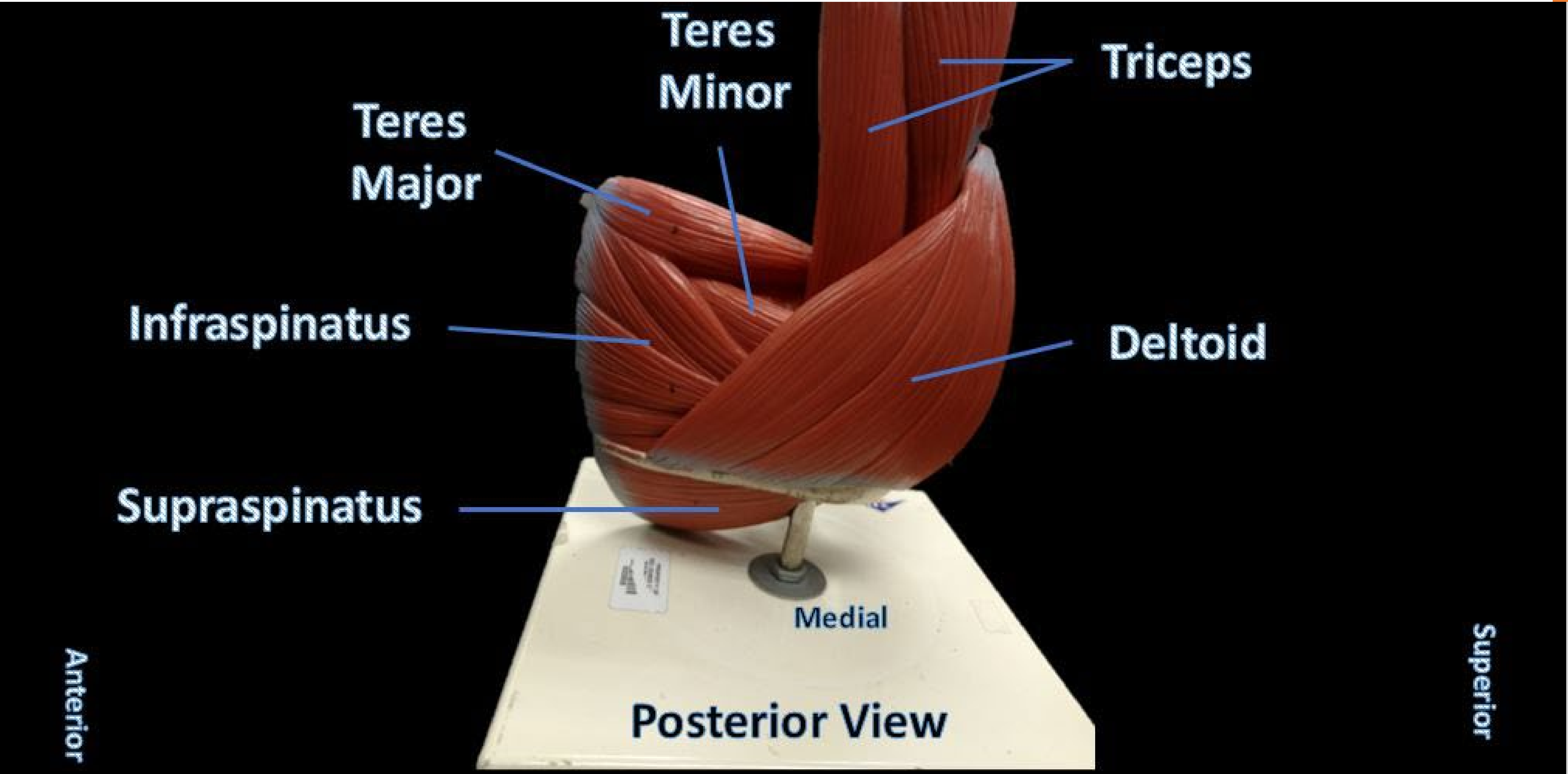
- <u>**Function = laterally rotates the arm; helps stabilize the shoulder**</u>
- **The infraspinatus muscles connect the scapulae and the humerus as one of the rotator cuff muscles.**
- **It lies at the posterior aspect of the scapulae and is below (inferior to) the supraspinatus.**



# *Infraspinatus*

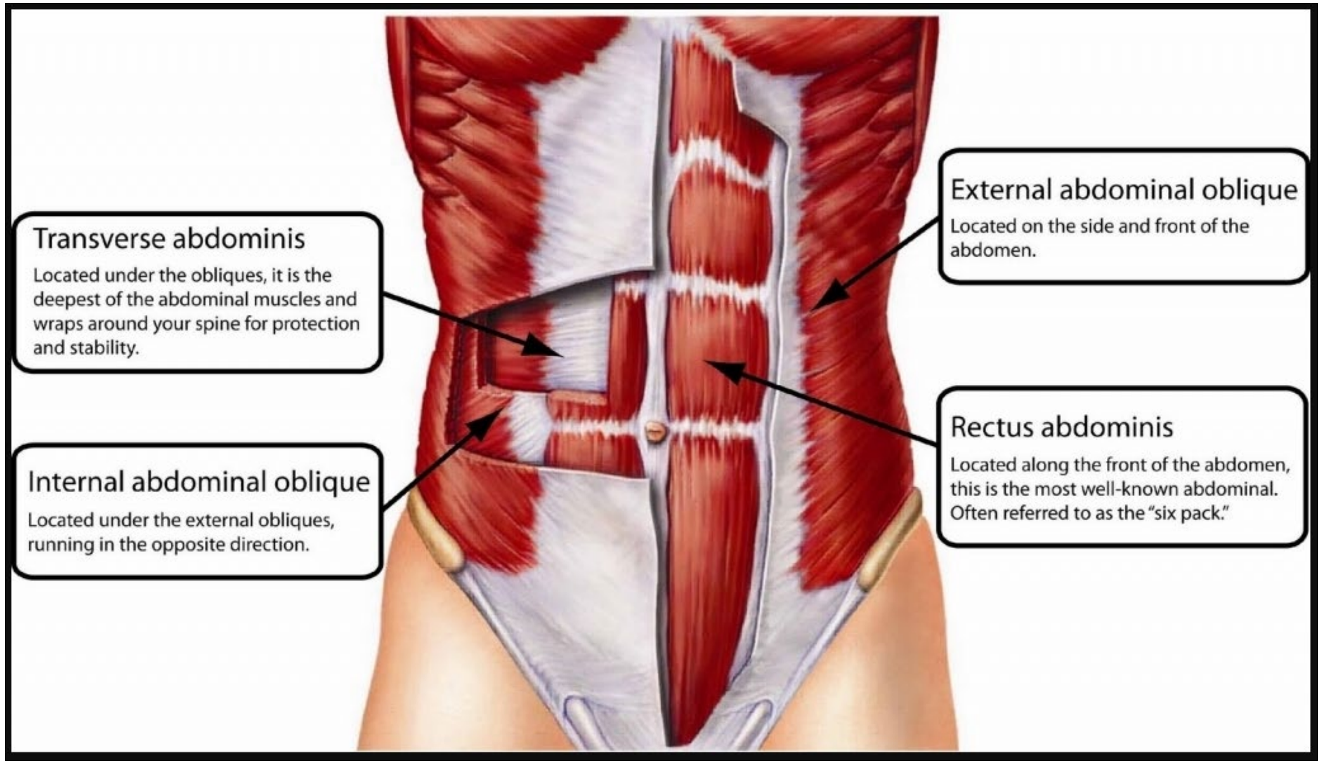
- The literal translation for infraspinatus in "below spine" which refers to its origin beneath the spine of the scapulae.
- The infraspinatus functions to laterally rotate the arm and it helps stabilize the shoulder by drawing the humerus toward the glenoid fossa of the scapula.


Supraspinatus
Deltoid
Triceps Brachii
Teres Minor
Teres Major
Infraspinatus


Teres Minor
Triceps
Teres Major
Infraspinatus
Deltoid
Supraspinatus
Medial
Posterior View
Anterior
Superior

# Muscles of the Abdomen

- The abdominal muscles include the following:
  - External oblique
  - Internal oblique
  - Transversus abdominus
  - Rectus abdominis

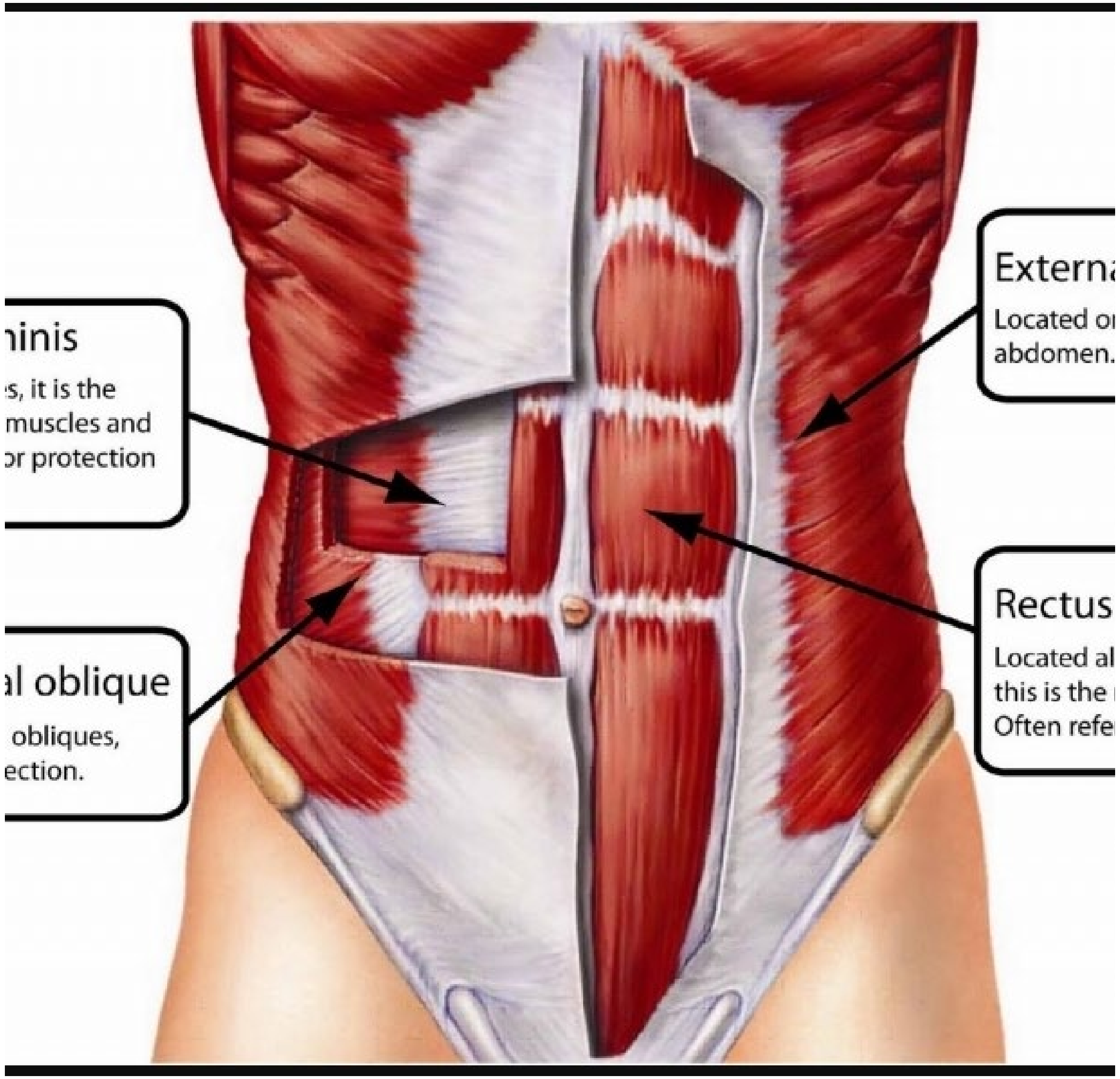


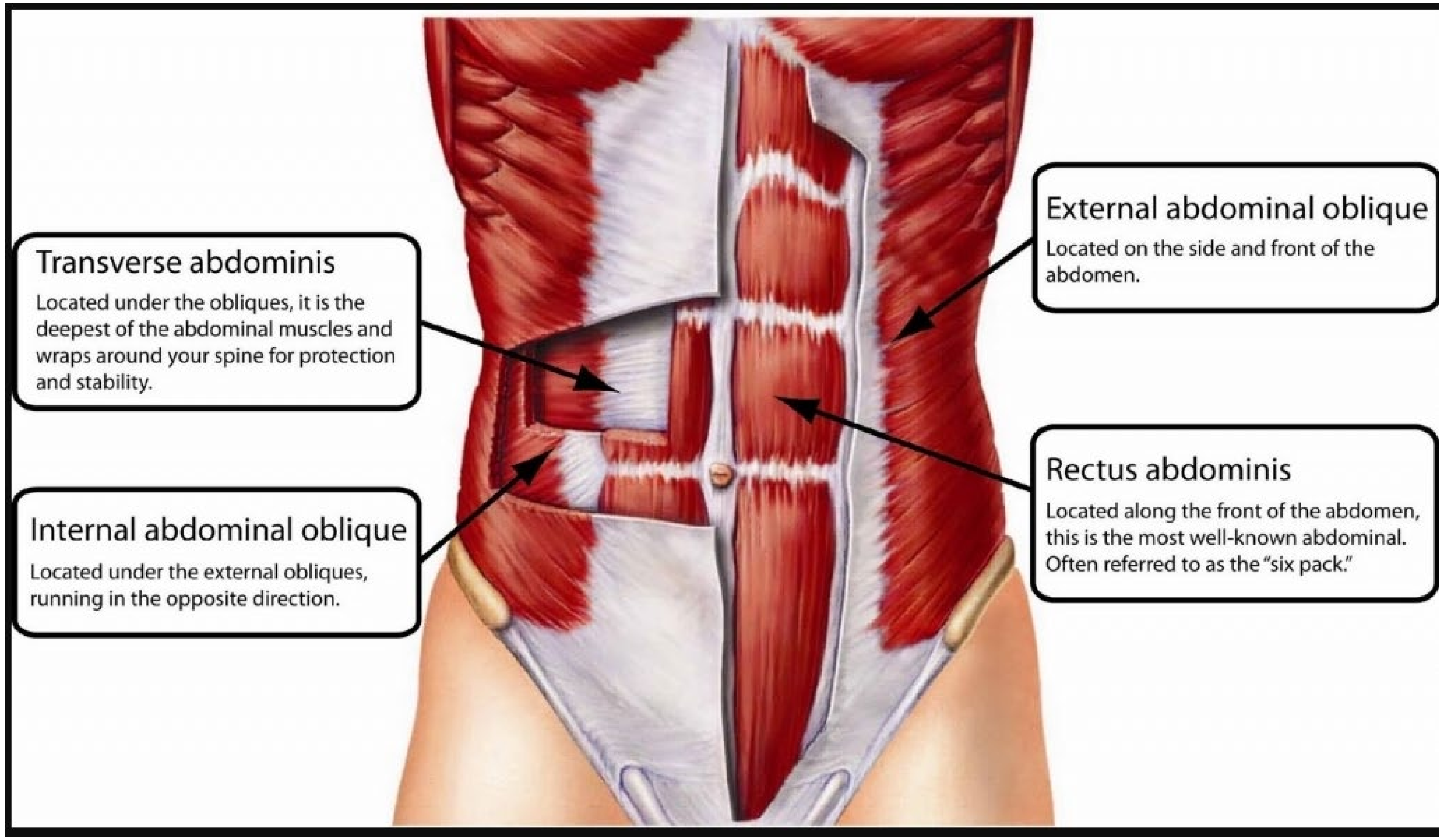

# Muscles of the Abdomen

- **The walls of the abdomen do not have bones protecting it.**
- **This allows for the abdomen to be more flexible, but it leaves the area more vulnerable to injury.**
- **For this reason, your abdominal wall contains strong, broad, sheet-like muscles.**

# Muscles of the Abdomen

- **The anterior and lateral portions of the abdominal wall are composed of three broad, flat sheets of muscle.**
- **These are the external obliques, the internal obliques, and the transverse abdominis.**



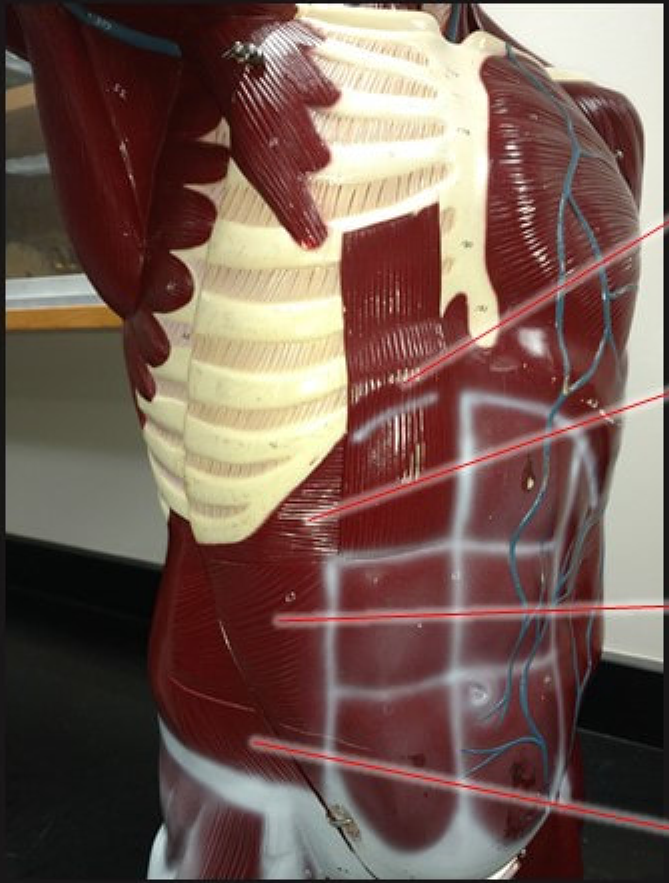


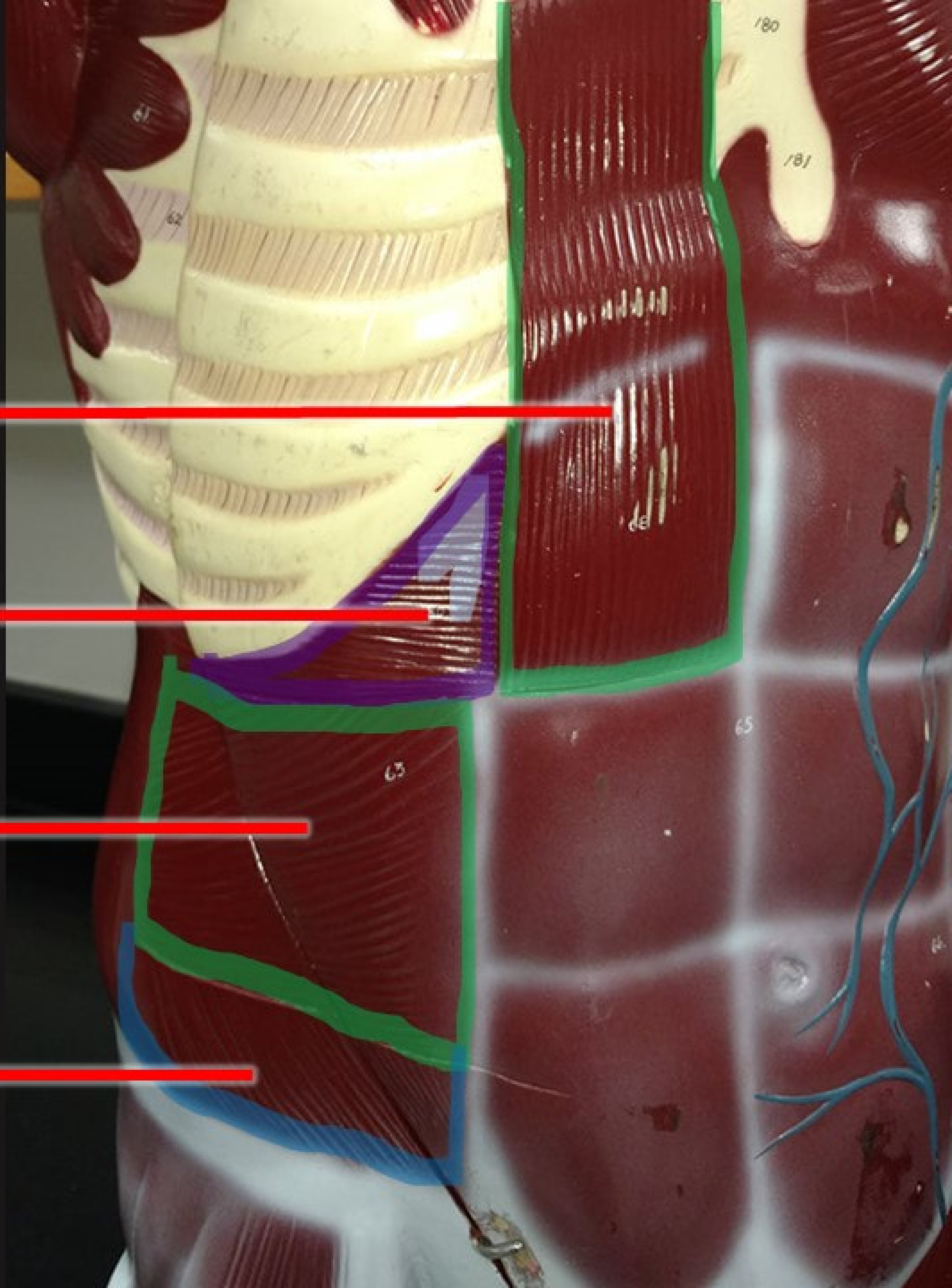

# STRIATIONS OF THE ABDOMINAL MUSCLES

*How the striations of the muscle you are looking at, will an important clue that tells you what abdominal muscle it is.*

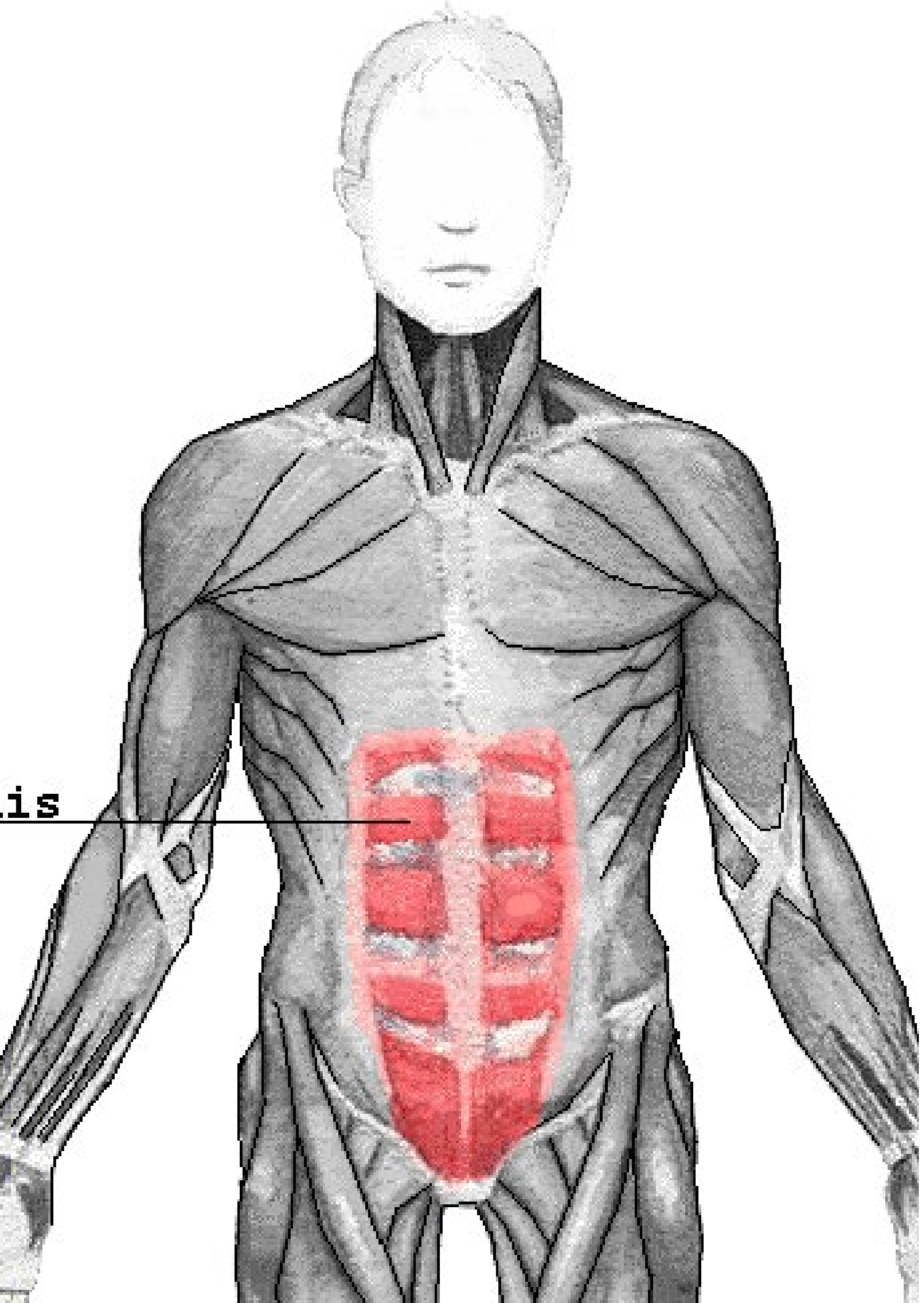
- **RECTUS ABDOMINIS - striations are oriented VERTICALLY (up and down)**
- **TRANSVERSE ABDOMINIS - striations are oriented HORIZONTALLY (on the transverse plane)**
- **EXTERNAL OBLIQUES - striations are oriented DIAGONALLY DOWNWARD**
- **INTERNAL OBLIQUES - striations are oriented DIAGONALLY UPWARD**

# ABDOMINAL MUSCLES



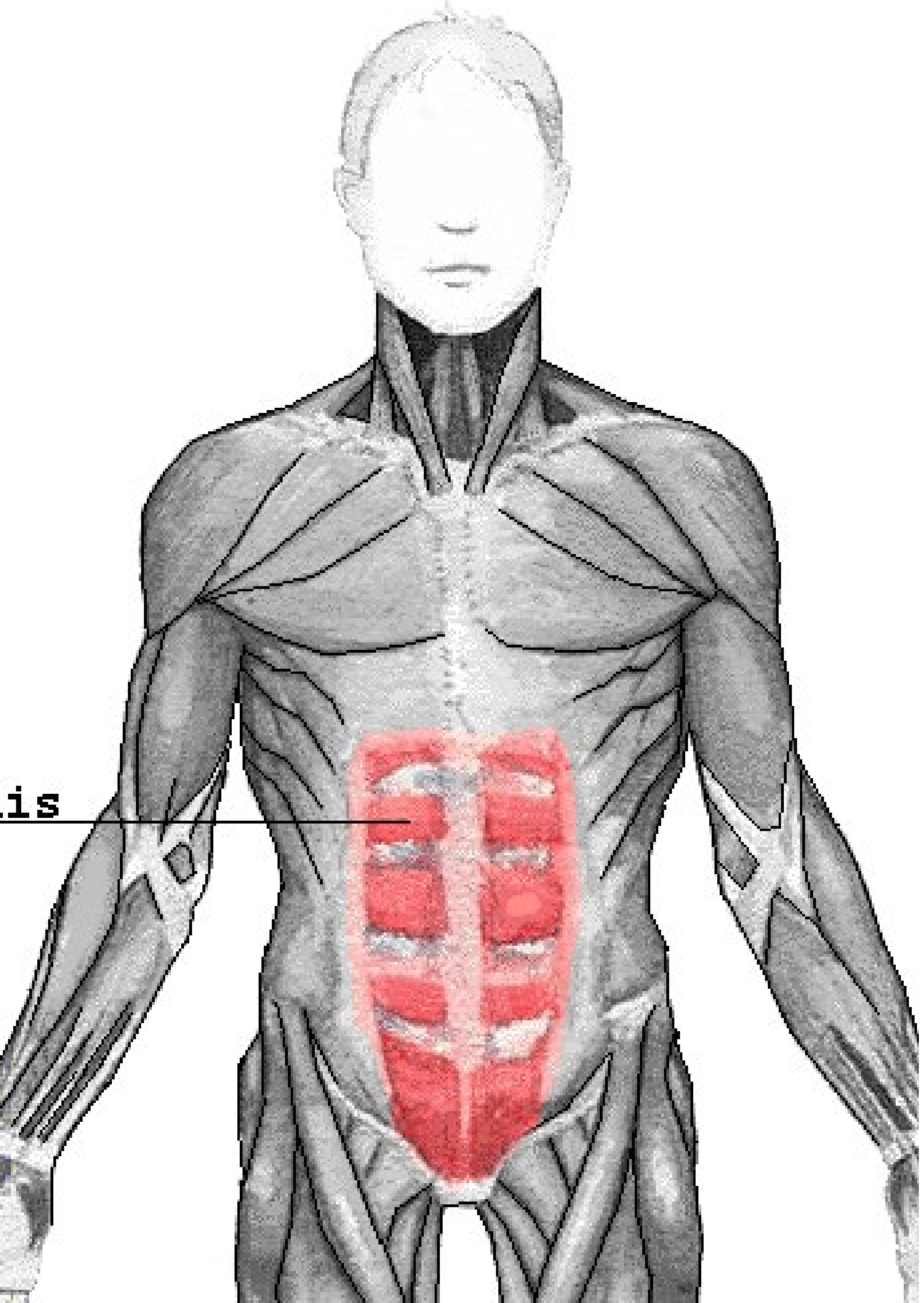



www.ScientistCindy.com



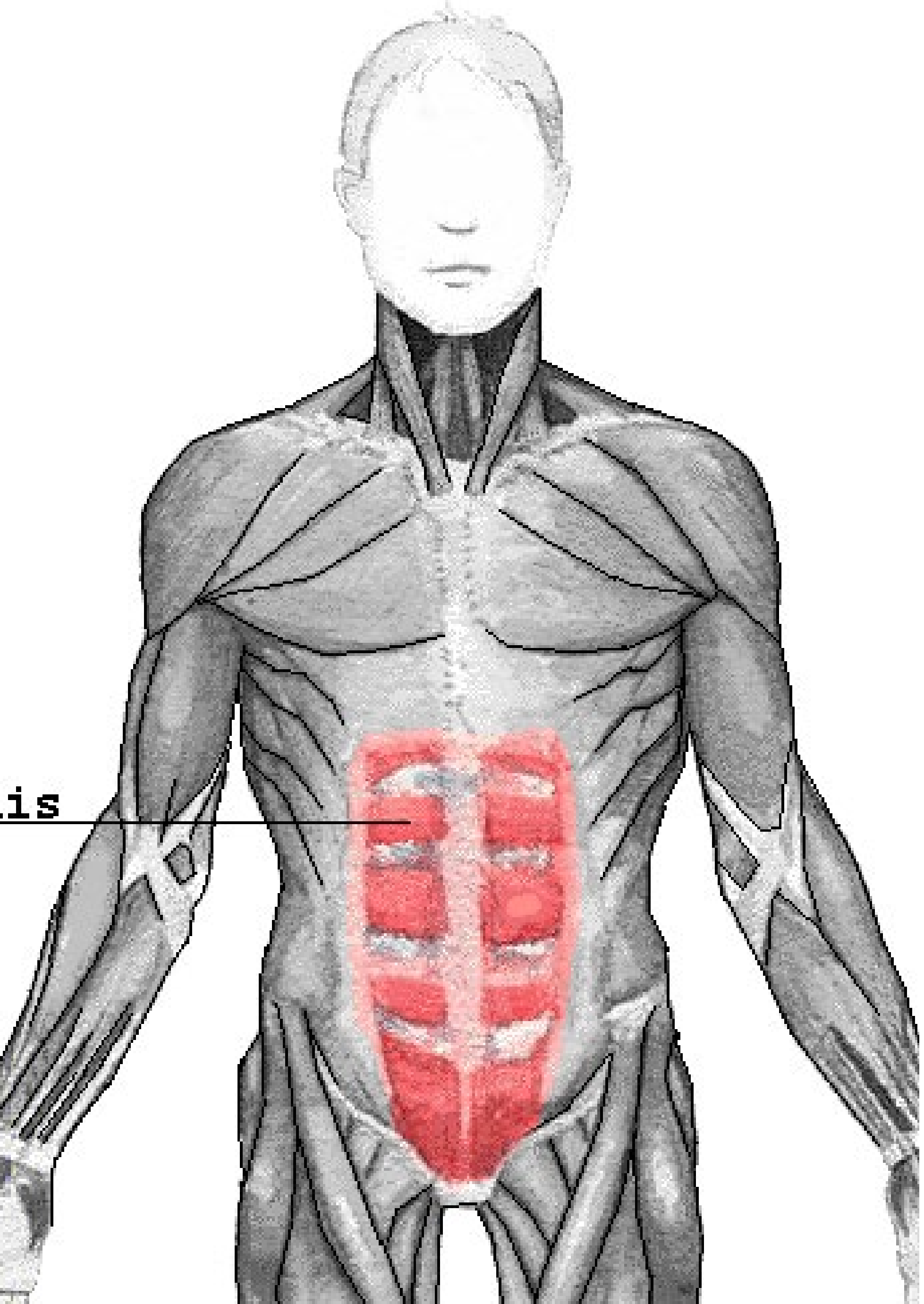

# The **rectus abdominis muscles**

- The **rectus abdominis muscles** are what is commonly referred to as your "abs" or your "six-pack".
- These are the muscles that run vertically on each side of the anterior wall of the abdomen.
- The "six pack" appearance of the rectus abdominis muscles is due to bands of connective tissue, called the tendinous intersections.



# The **rectus abdominis muscles**

- There two parallel muscles are separated by the linea alba, which is a vertical band of connective tissue that runs down the midline.
- The rectus abdominis runs from the pevis to the anterior portions of the lower ribs and the xiphoid process of the sternum.




# The **rectus abdominis muscles**

- The rectus abdominis connects the lower ribs to the pubic bone which is located at the front of the pelvis.
- The main function of the rectus abdominis is to move the body between the ribcage and the pelvis

# External Obliques

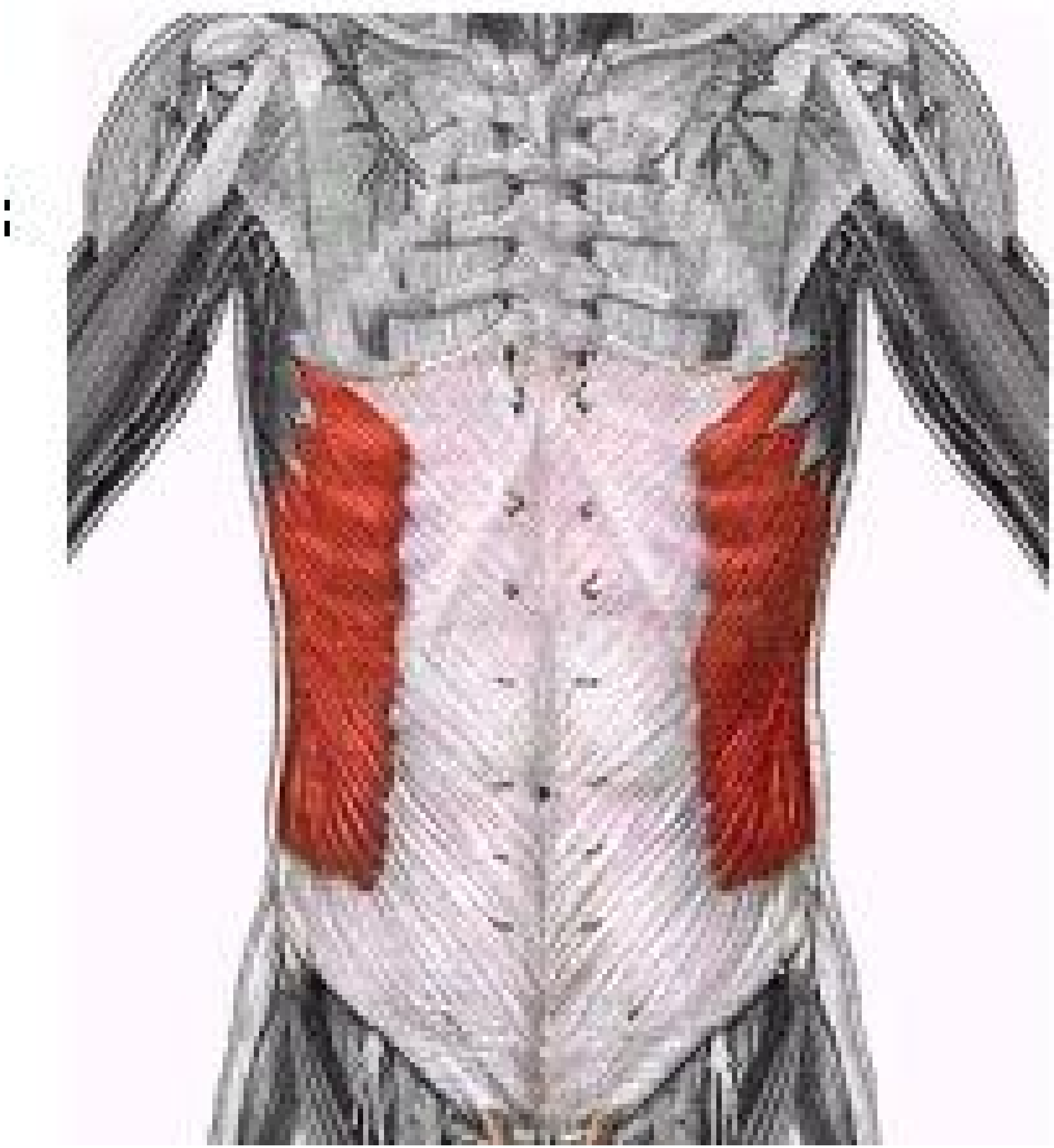
- Function = Assists is trunk rotation and flexion of the vertebral column.

# External Obliques

- The external oblique muscles are named according to their location.
- The word 'oblique' means 'to run at an angle'.
- The external obliques originate by the lower ribs and insert at a few locations within the pelvis.
- The external obliques function to flex the vertebral column and to compress the abdominal wall.

# External Obliques

- The external obliques lie on either side of the rectus abdominis muscles.
- The function of the external oblique muscles is to allow the trunk to twist to the opposite side of whichever external oblique is contracting.
- For example, the right external oblique contracts to turn the body to the left.
- They also function in trunk rotation and lateral flexion.

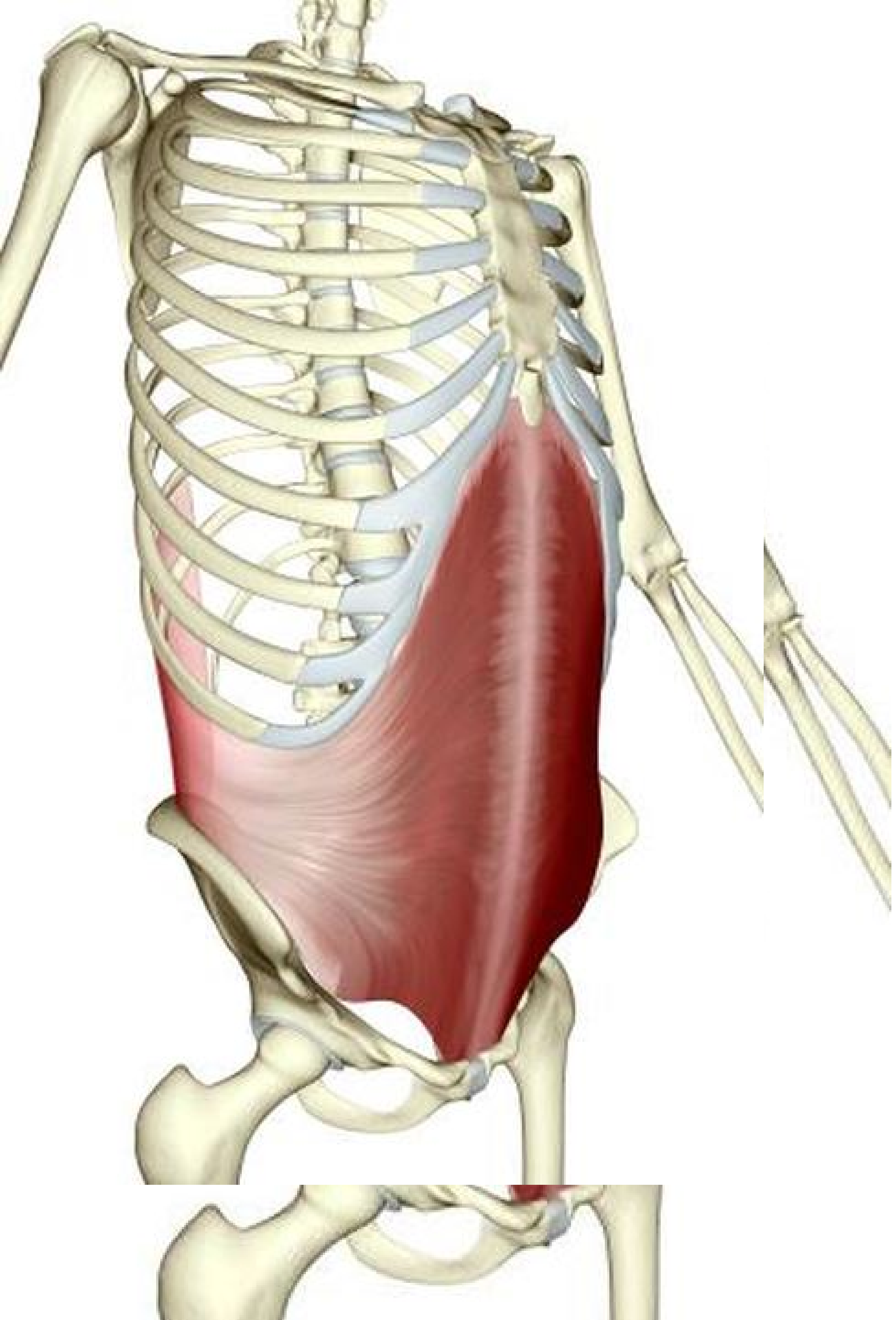


# Internal Obliques

- Function = Assists is trunk rotation and flexion of the vertebral column.
- The internal oblique muscles lie underneath (deep) to the external obliques. These muscles attach to the area of the rectus abdominis muscles that is located just inside of the hip (coxal) bones

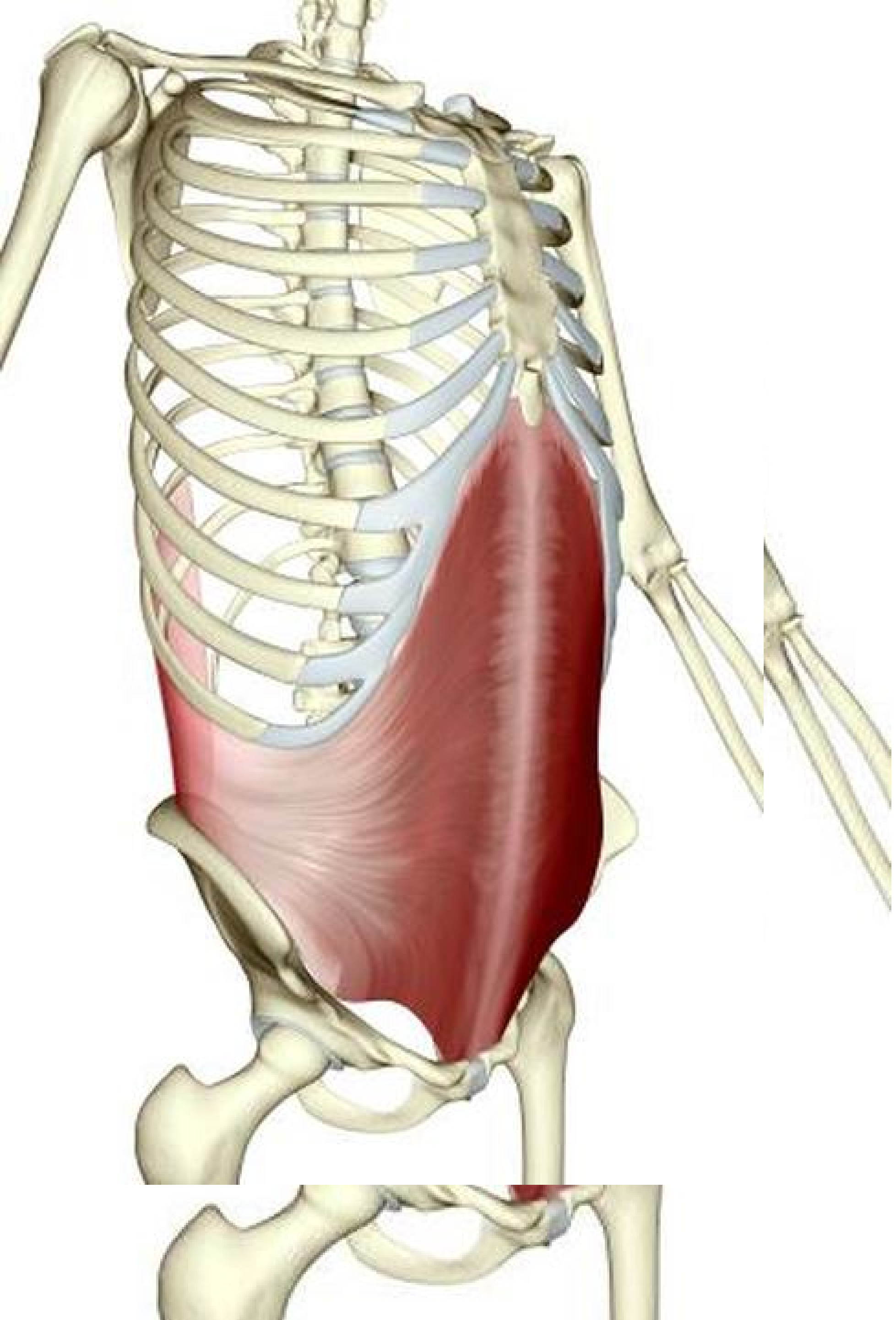
# The Eternal and Internal Obliques

- The internal oblique muscles operate in the opposite direction to the external oblique muscles.
  - For example, twisting the trunk to the left requires the left side internal oblique and the right side external oblique to contract together.



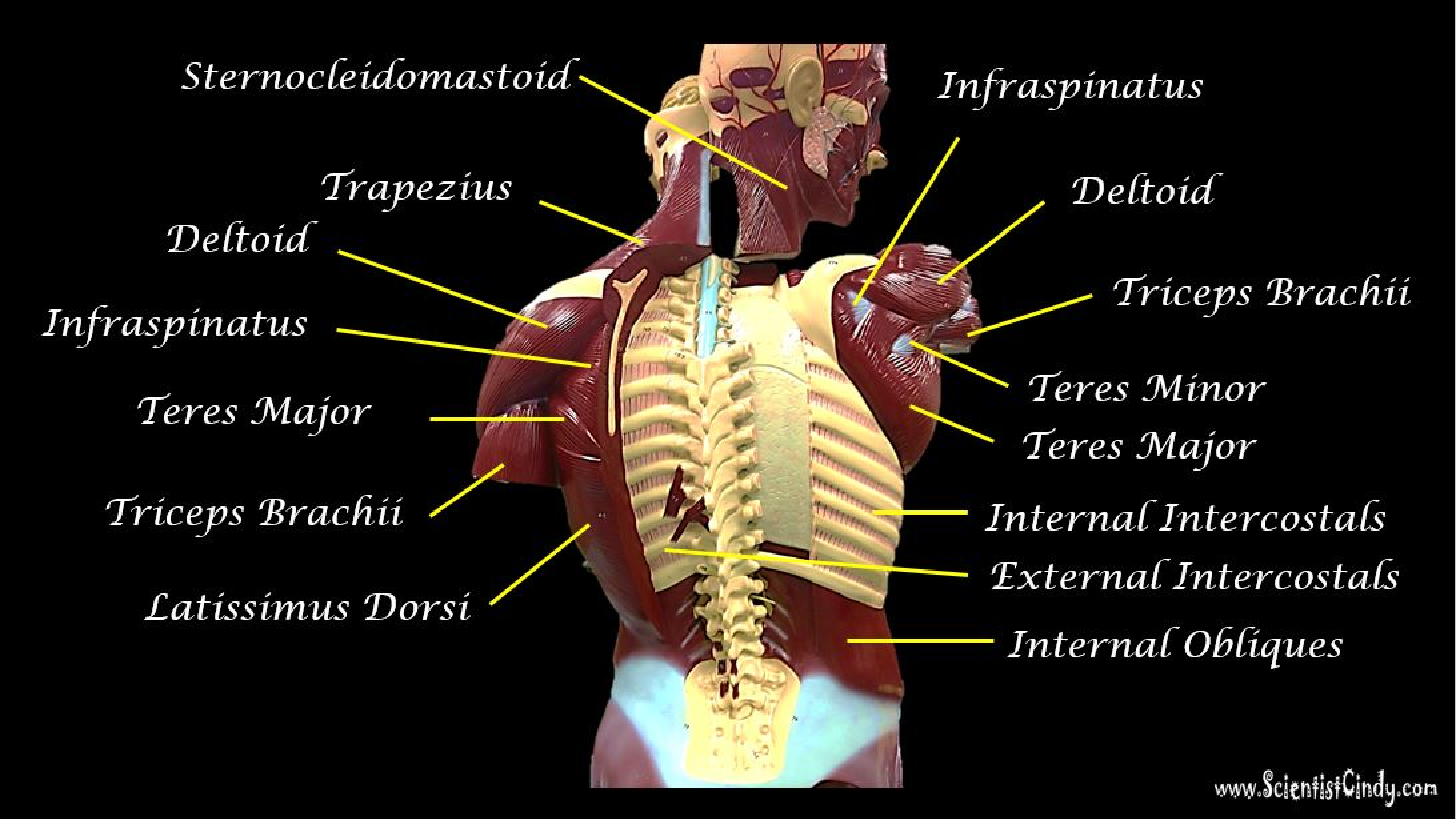
# Transverse Abdominis

- Function = Compresses abdomen inwards
- The word 'transverse' means 'horizontal' and 'abdominis' means 'of the abdomen’.
- Therefore the 'transverse abdominis' translates literally to mean 'horizontal muscles of the abdomen’.

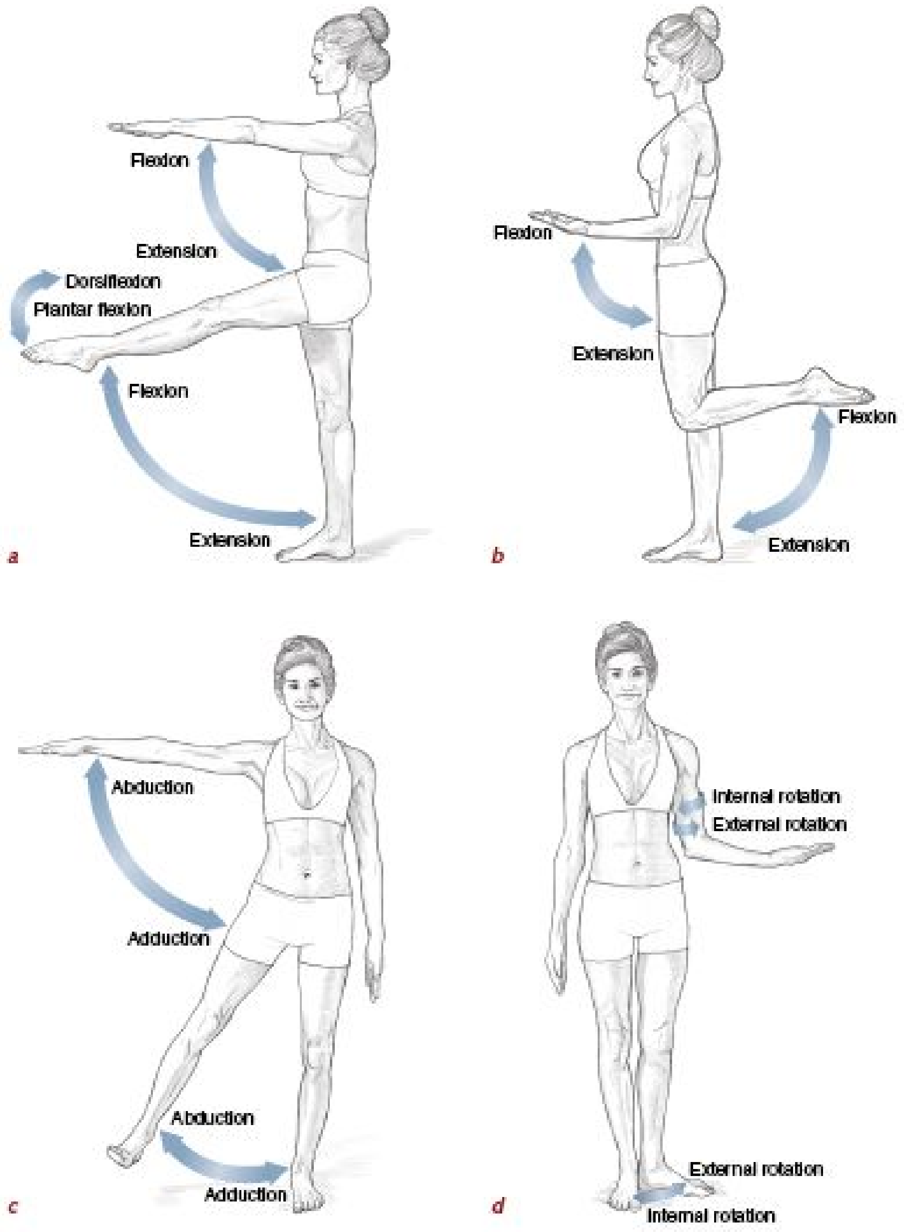


# Transverse Abdominis

- The traverse abdominis muscles are the deepest (innermost) muscles of the abdominal wall.
- The fibers of this muscle run horizontally.
- It functions to compress the abdomen and assists in child delivery in females.

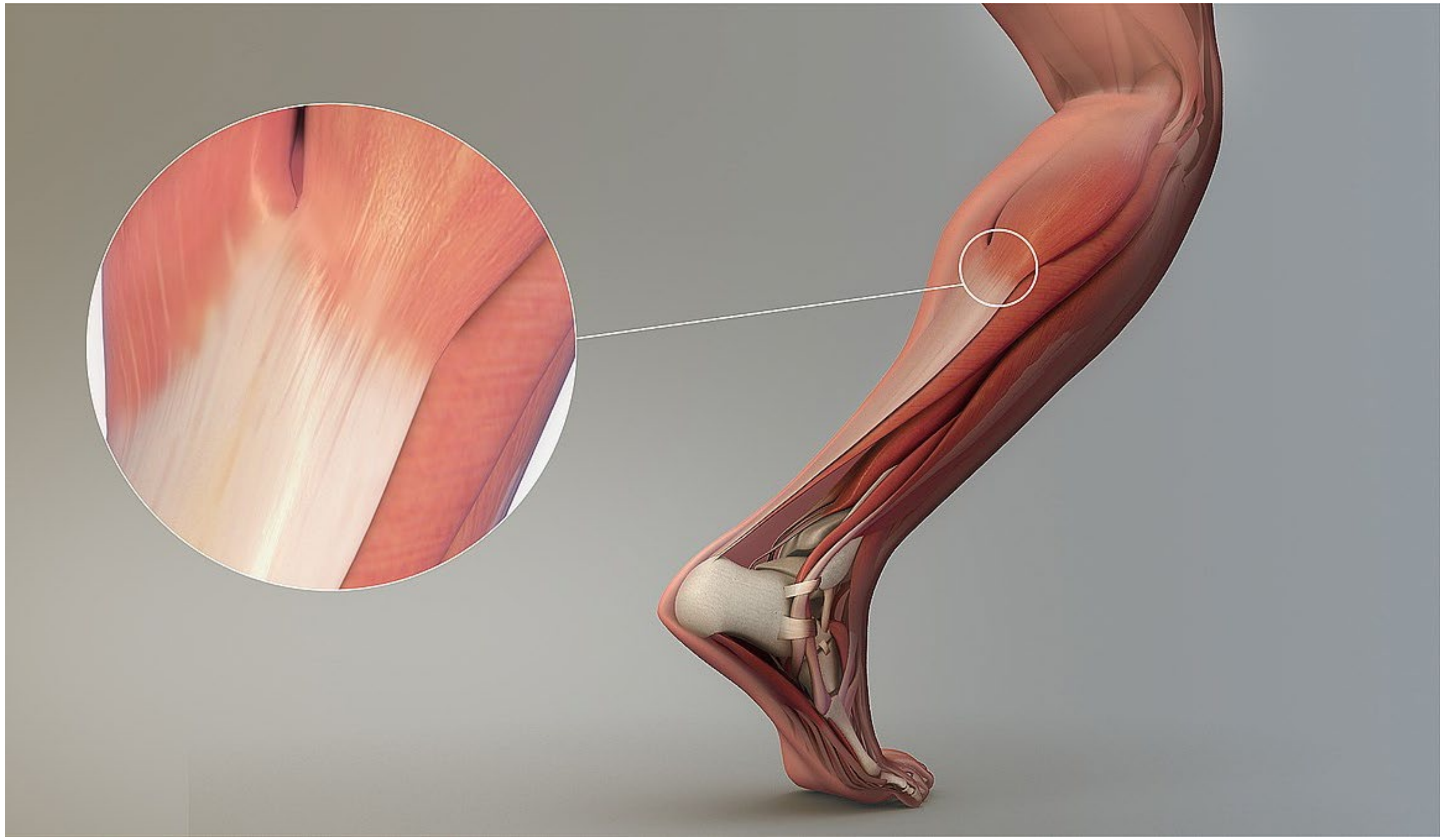

Sternocleidomastoid
Infraspinatus
Trapezius
Deltoid
Deltoid
Triceps Brachii
Infraspinatus
Teres Minor
Teres Major
Teres Major
Triceps Brachii
Internal Intercostals
External Intercostals
Latissimus Dorsi
Internal Obliques
www.ScientistCindy.com

# Muscle Actions



## Muscle Movements

- ***Muscles (skeletal muscles) usually connect to at least 2 bones and span 1 movable joint.***
- ***In this way, skeletal muscle moves the bones to allow for movement of the body.***
- ***Without skeletal muscles, there would NO conscious, purposeful movement!***

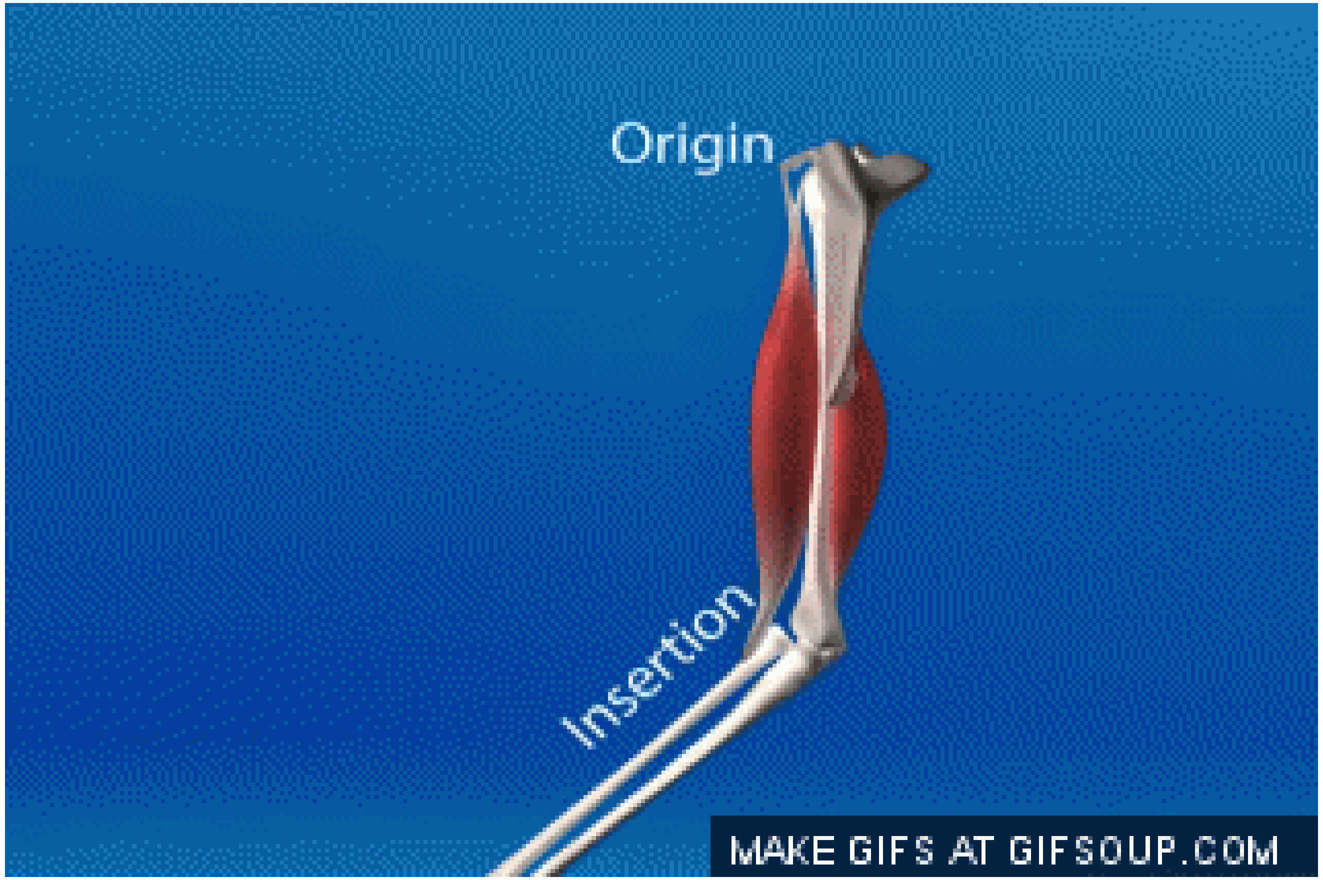


# TENDONS

- Skeletal muscles attach to at least 2 bones, and span one movable joint.
- The way that these muscles attach to the bones of your body, is through TENDONS.

# Origins and Insertions

- The origin is the attachment site that remains relatively "fixed in space" during muscle contraction
- The insertion is the attachment site that moves quite a bit during muscle contraction.
- The insertion moves toward the origin during muscle contraction.



# Origins and Insertions

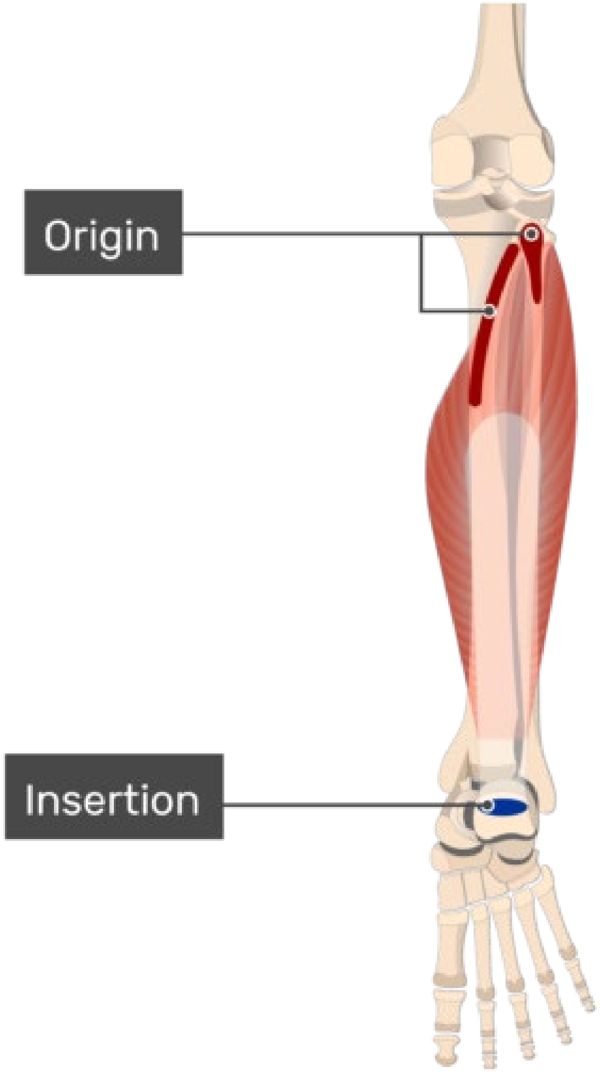
When a muscle contracts, it pulls the bones it connects to closer to one another, by decreasing the angle of the movable joint that is spans.

Knowing the insertion and origin helps us identify the action of the muscle.

The way in which these bones are able to move closer to each other is dictated by the type of joint that the muscle spans.

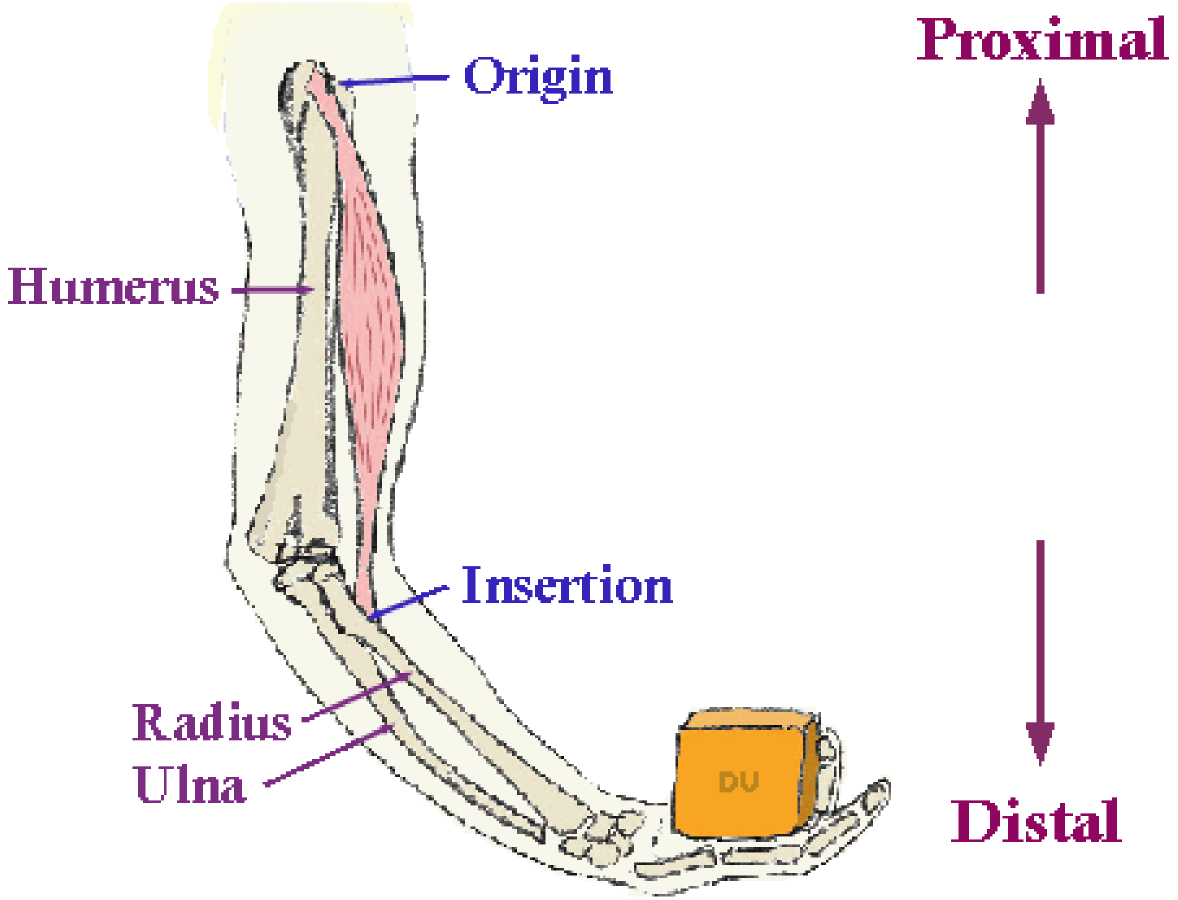
# Origins and Insertions

- Typically, when we contract a muscle, one of the bones the muscle attaches to moves a lot, while the other bone(s) the muscle attaches to remains relatively "fixed" in space.
- The **origin** is the attachment site that remains relatively ***"fixed in space"*** during muscle contraction
- The **insertion** is the attachment site that moves quite a bit during muscle contraction.



# Origins and Insertions

- The insertion is usually at the **distal end**, or the end that is further away from the body's center of mass (or the heart), of the muscle.
- The origin is usually at the more **proximal**, or closer to the body's center of mass, relative to the insertion.



# Circumduction

Circumduction can be defined as a **conical movement of a limb** extending from the joint at which the movement is controlled.

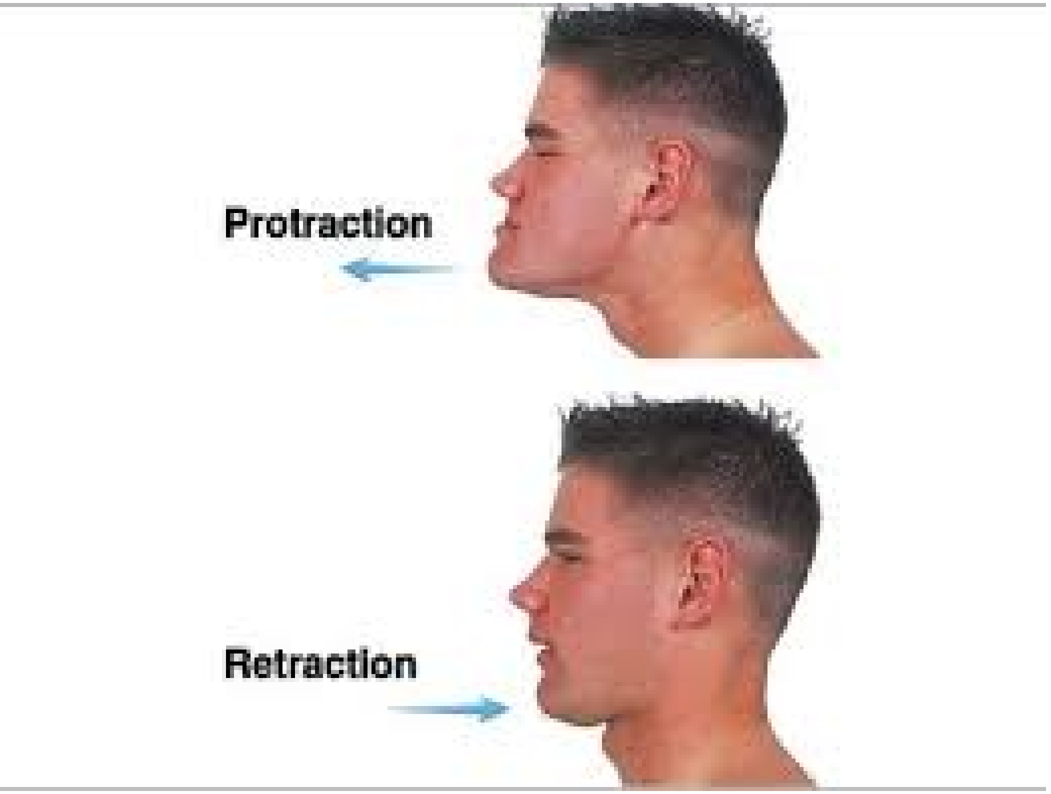
# Circumduction

Circumduction can be defined as a **conical movement of a limb** extending from the joint at which the movement is controlled.

# Elevation and Depression

- **Elevation** refers to movement in a superior direction
- **Depression** refers to movement in an inferior direction

# Protraction and Retraction

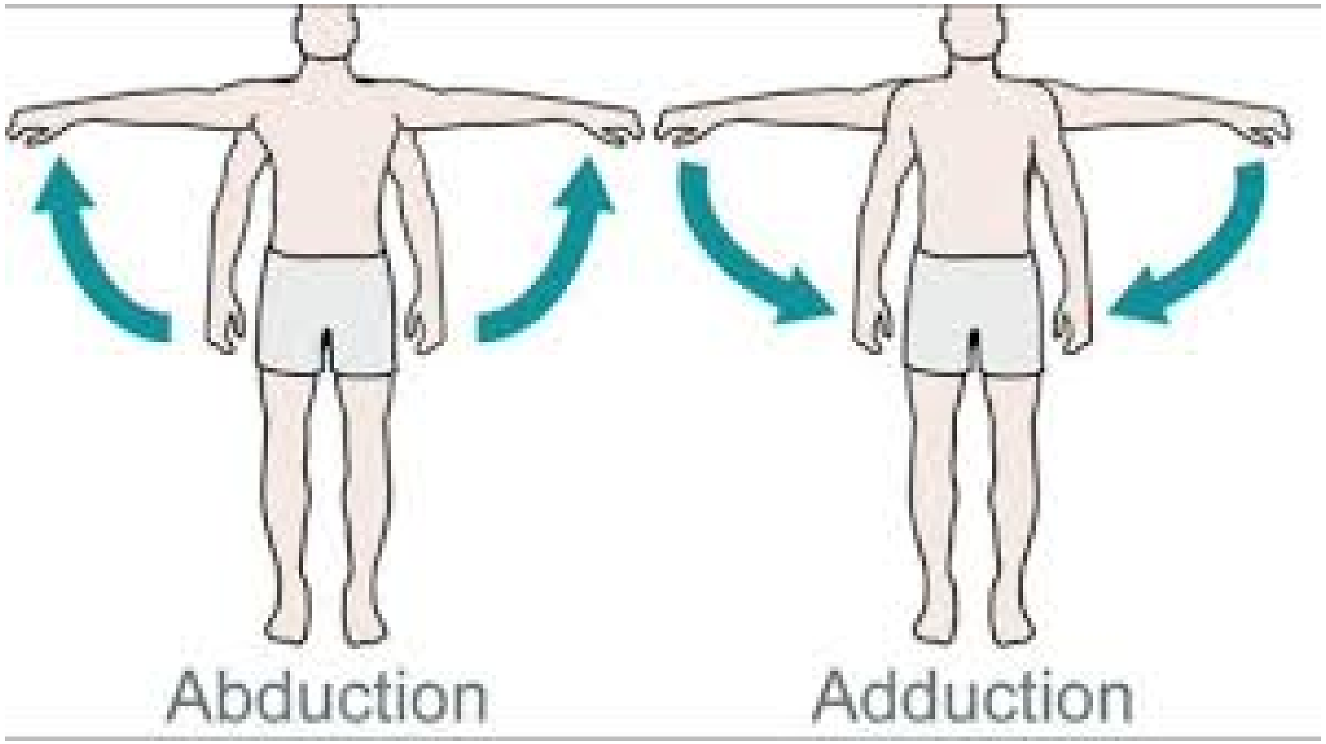



- **Protraction** describes an anterior movement occurring in the transverse plane (anterolateral movements).
- **Retraction** describes a posterior movement occurring in the transverse plane (anteroposterior movements).

# Abduction and Adduction

Abduction and adduction are two terms that are used to describe movements towards or away from the midline of the body.

- **Abduction** is a movement away from the midline
- **Adduction** is a movement towards the midline.



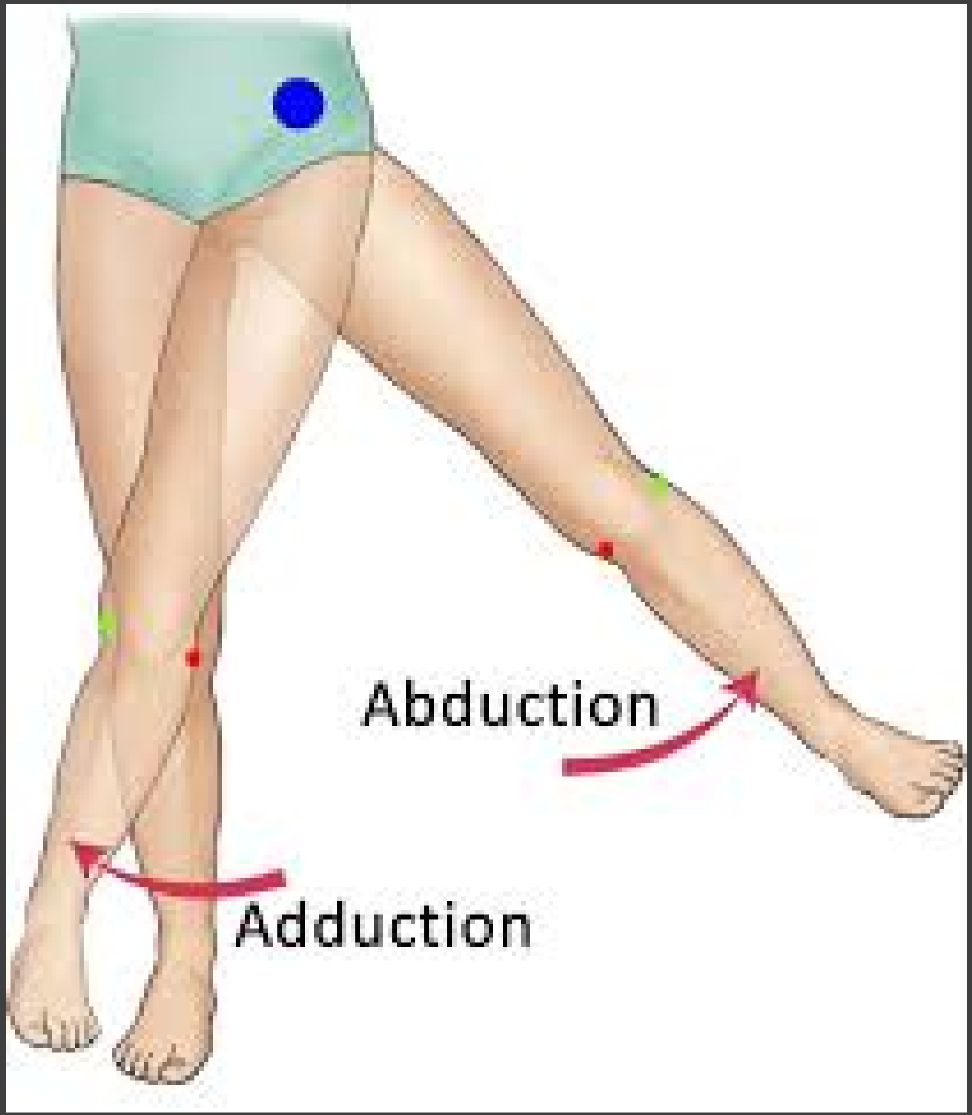
# Abduction and Adduction

Abduction and adduction are two terms that are used to describe movements towards or away from the midline of the body.

- **Abduction** is a movement away from the midline
- **Adduction** is a movement towards the midline.

## Abduction and Adduction

- Adduction of the hip squeezes the legs together.
- Abduction of the legs brings the legs apart.



# Abduction and Adduction

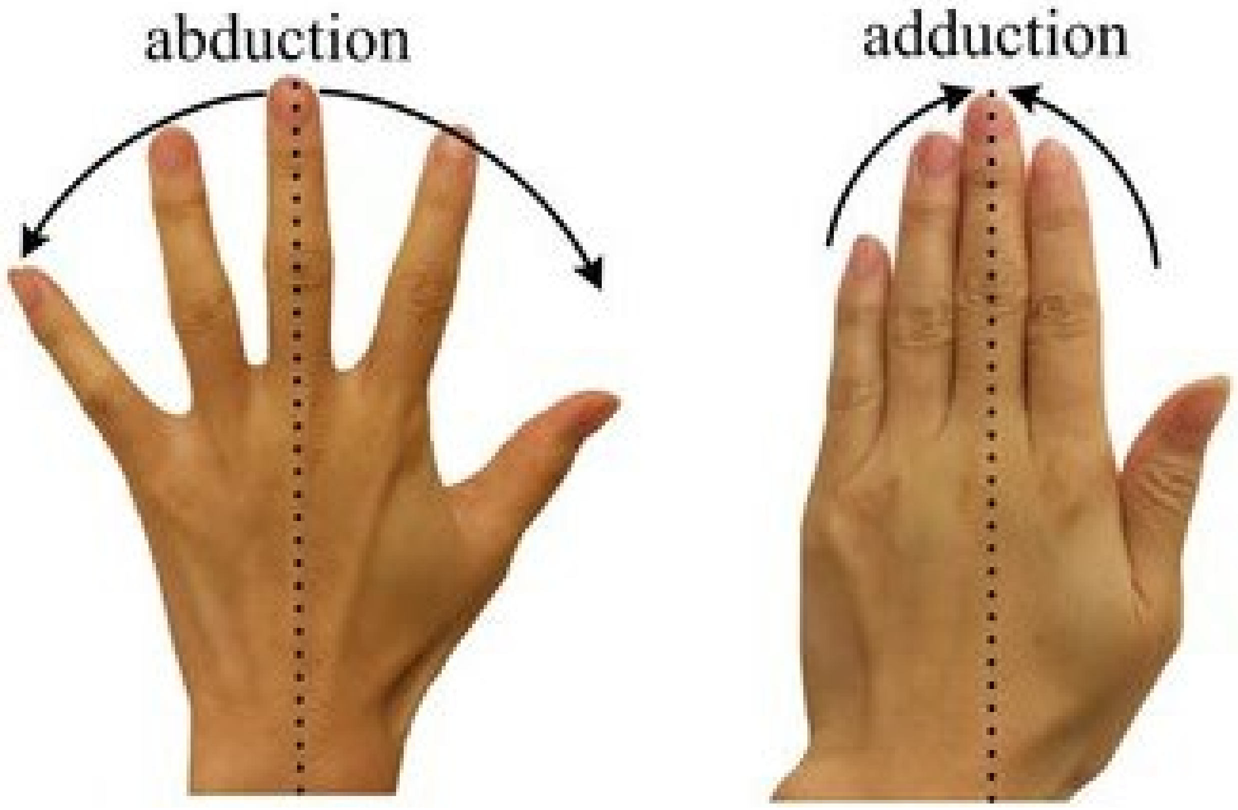
- Adduction of the hip squeezes the legs together.
- Abduction of the legs brings the legs apart.

# Shoulder Adduction

# Abduction and Adduction of the digits

In fingers and toes, the midline used is not the midline of the body, but of the hand and foot respectively.

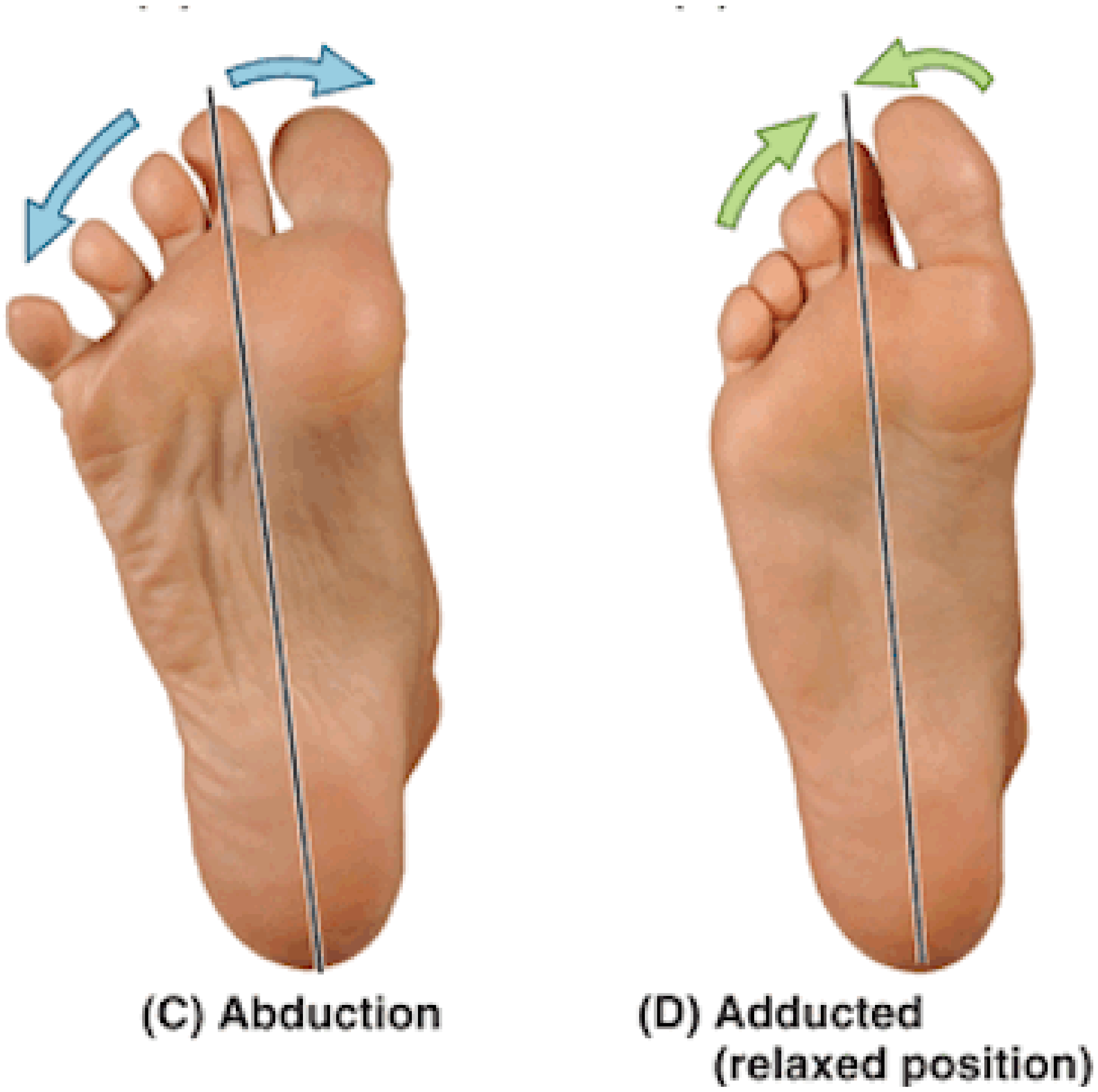
Therefore, abducting the fingers spreads them out, while adducting brings them together.



# Abduction and Adduction of the digits

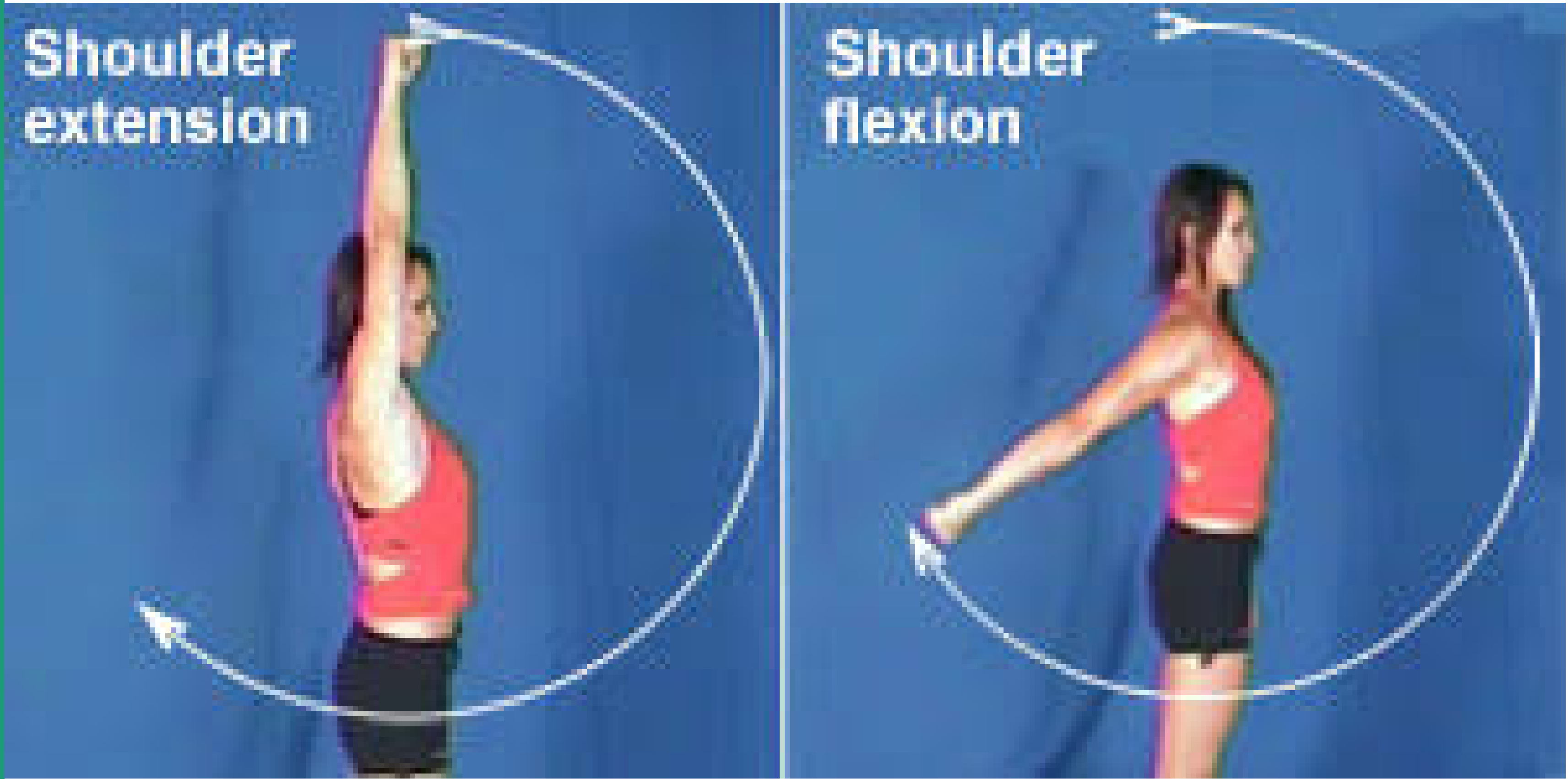
In fingers and toes, the midline used is not the midline of the body, but of the hand and foot respectively.

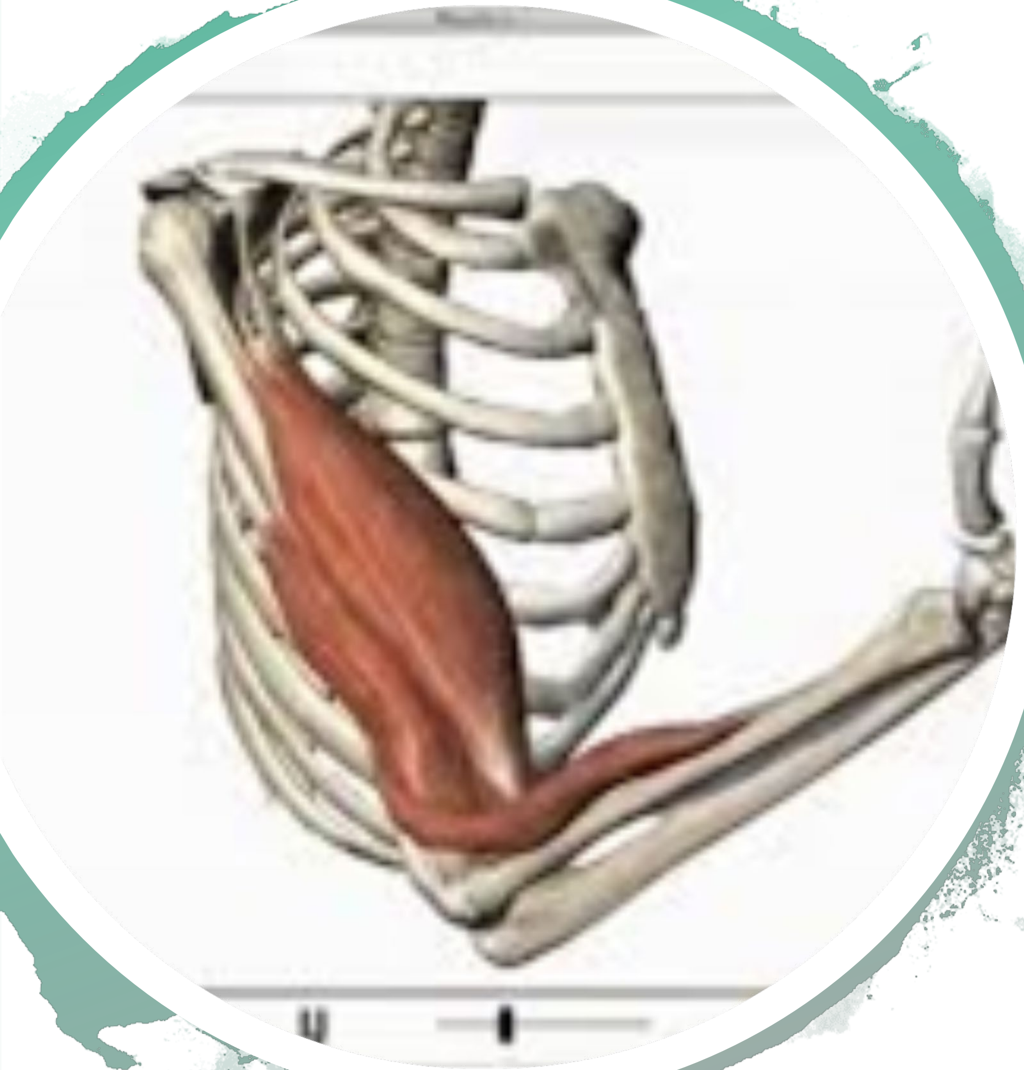
Therefore, abducting the fingers spreads them out, while adducting brings them together.



# Flexion and Extension

- Flexion and extension are movements that occur in the sagittal plane. They refer to increasing and decreasing the angle between two body parts:
- **Flexion** refers to a movement that decreases the angle between two body parts.
- Flexion at the elbow is decreasing the angle between the ulna and the humerus. When the knee flexes, the ankle moves closer to the buttock, and the angle between the femur and tibia gets smaller.



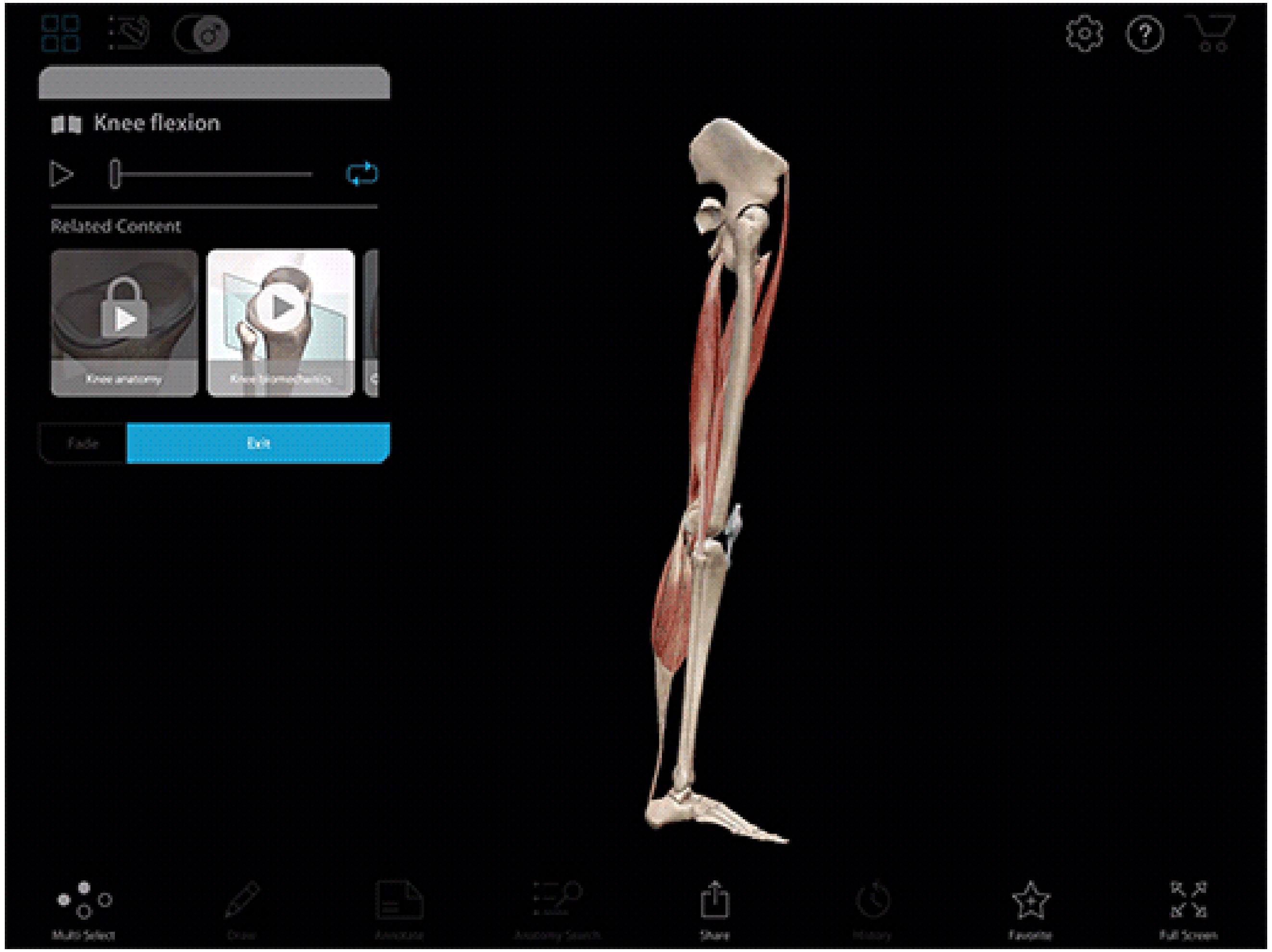


# Flexion and Extension

- Flexion at the elbow is decreasing the angle between the ulna and the humerus.

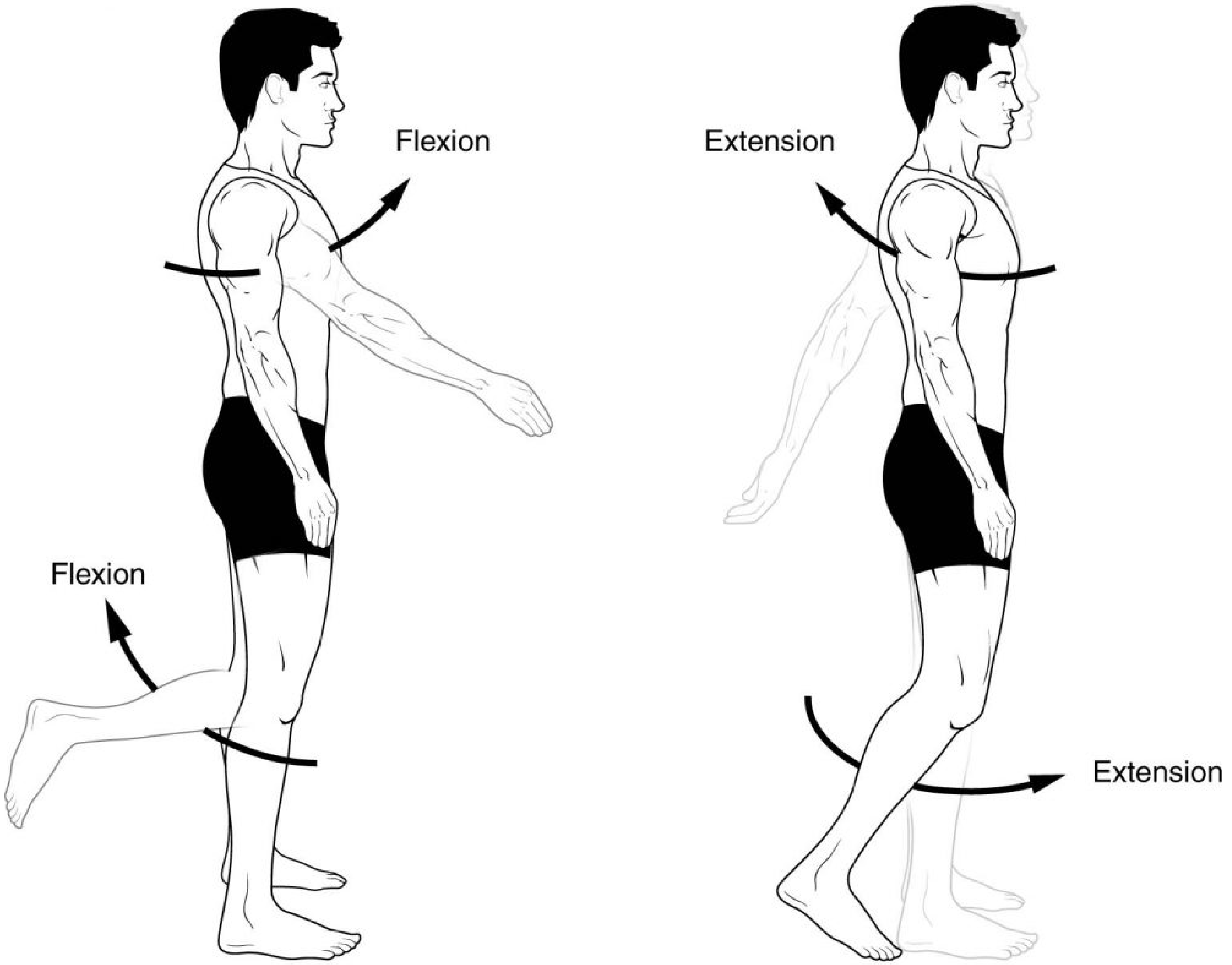
# Knee Flexion

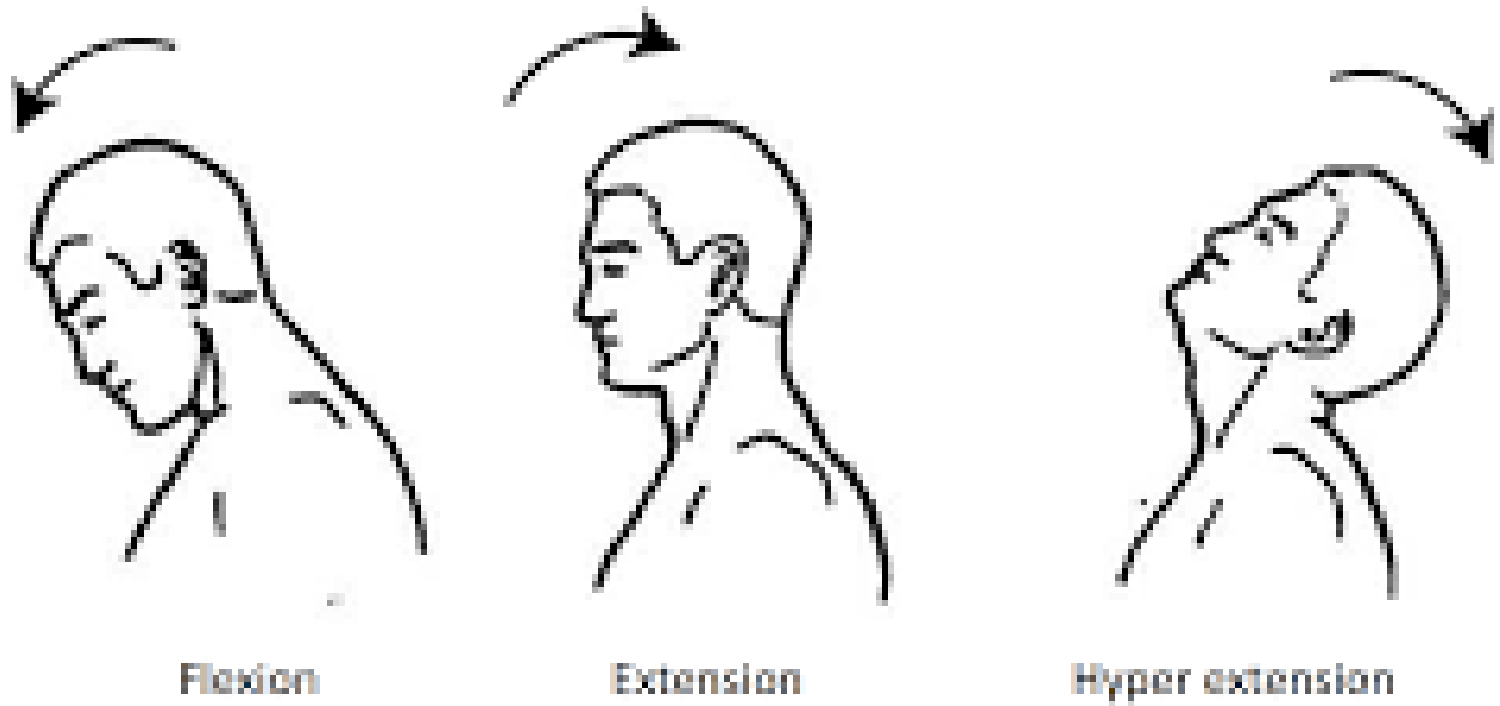
- When the knee flexes, the ankle moves closer to the buttock, and the angle between the femur and tibia gets smaller.



# Flexion and Extension

- **Extension** refers to a movement that increases the angle between two body parts.
- Extension at the elbow is increasing the angle between the ulna and the humerus.
- Extension of the knee straightens the lower limb.

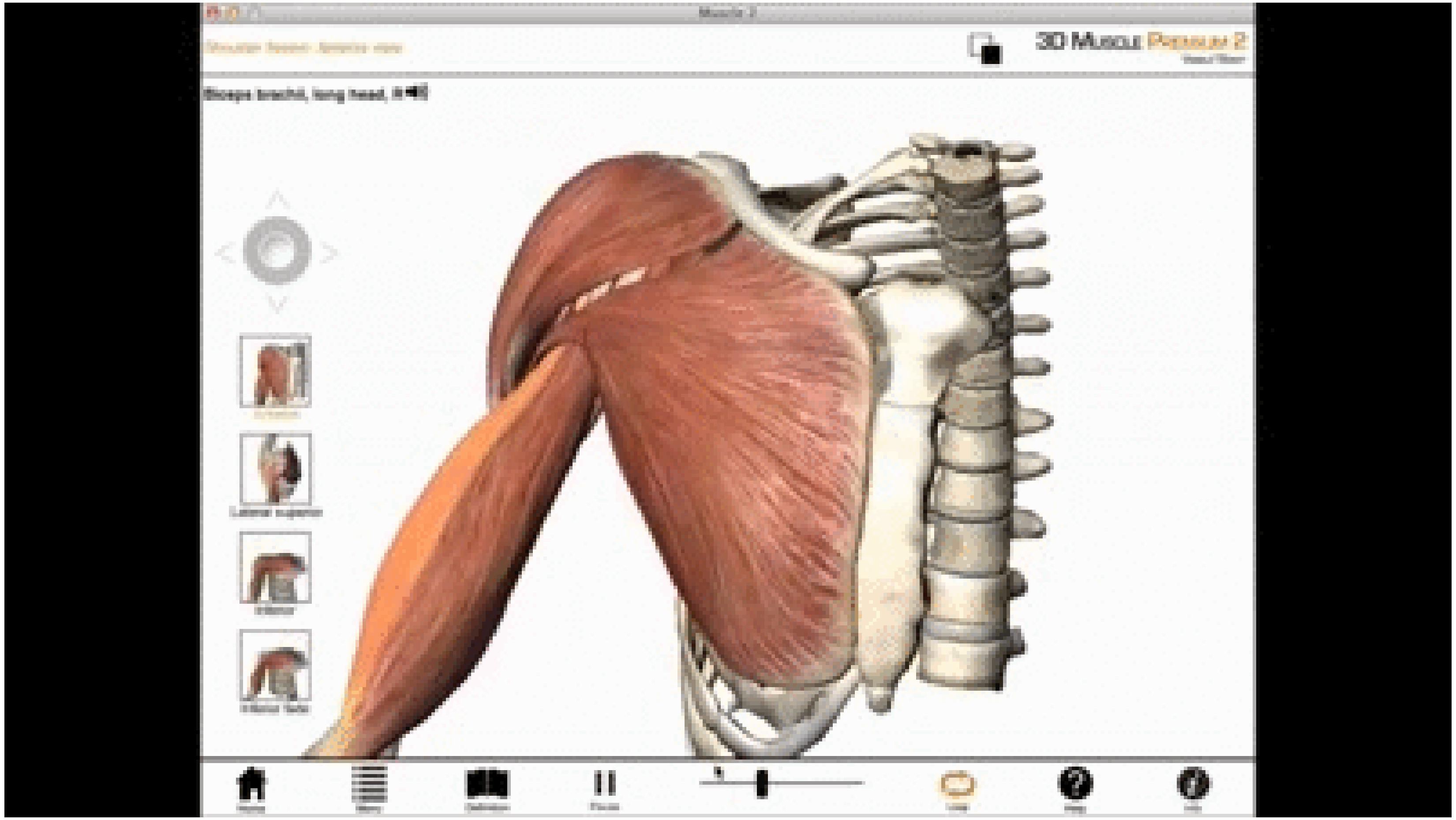





# Flexion and Extension of the Head

- Head Flexion – the movement of the neck that moves the head posteriorly in anatomical position.
- Wrist Extension – the movement of the neck that moves the head anteriorly in anatomical position.

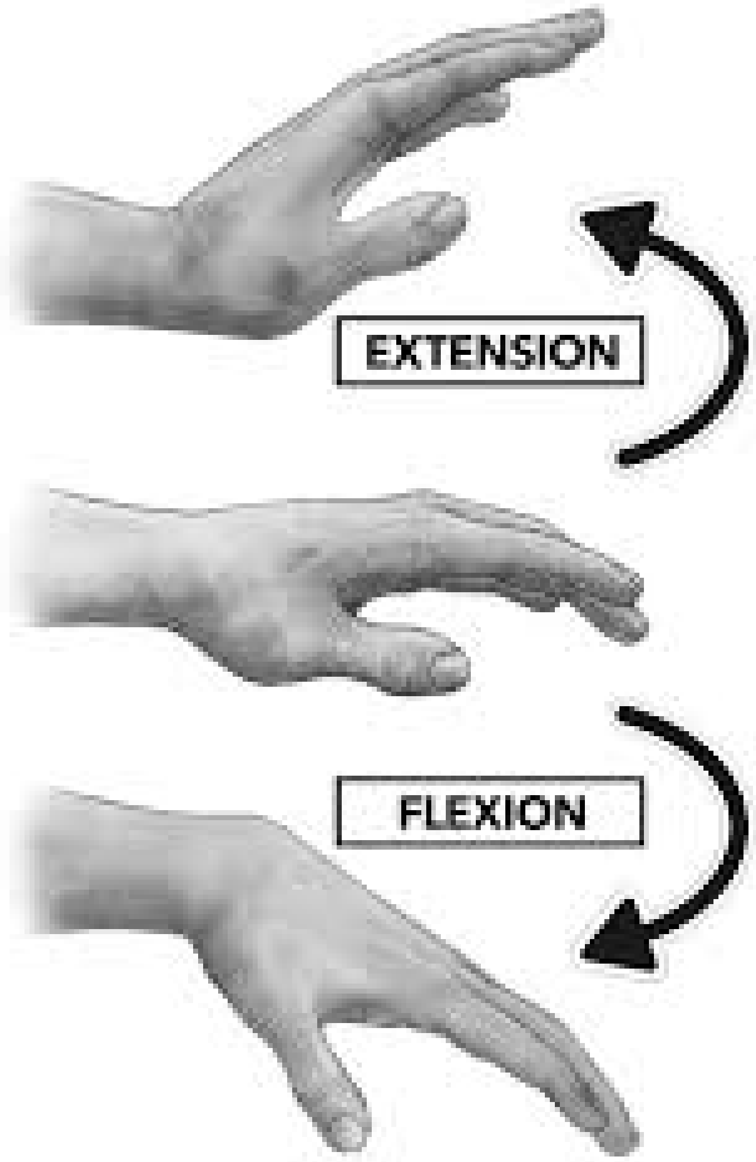
# Shoulder Flexion and Extension



# Flexion and Extension of the Wrist

- Wrist Flexion – the movement of the wrist that moves the hand posteriorly in anatomical position.

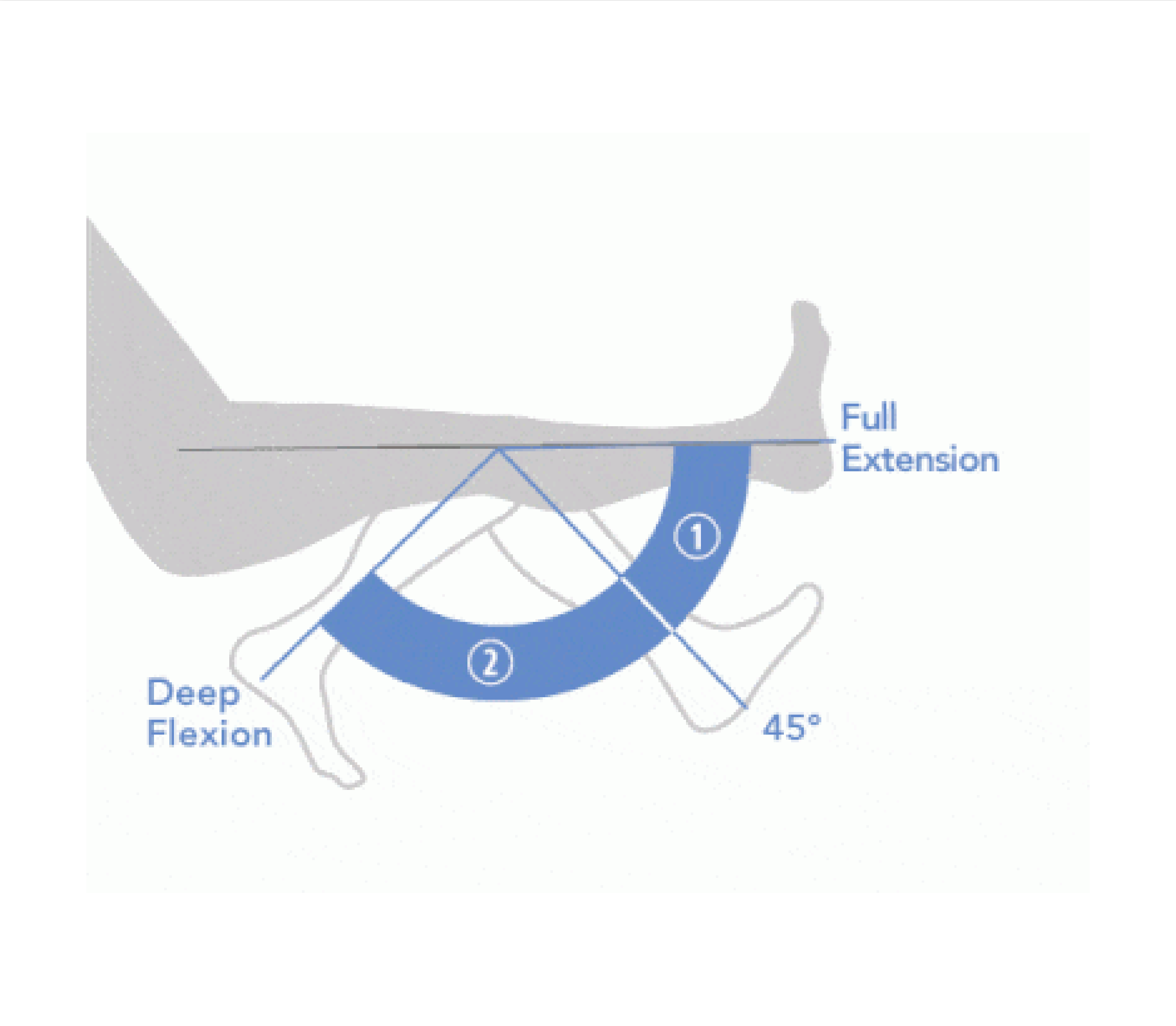
- Wrist Extension – the movement of the wrist that moves the hand anteriorly in anatomical position.



# Flexion and Extension

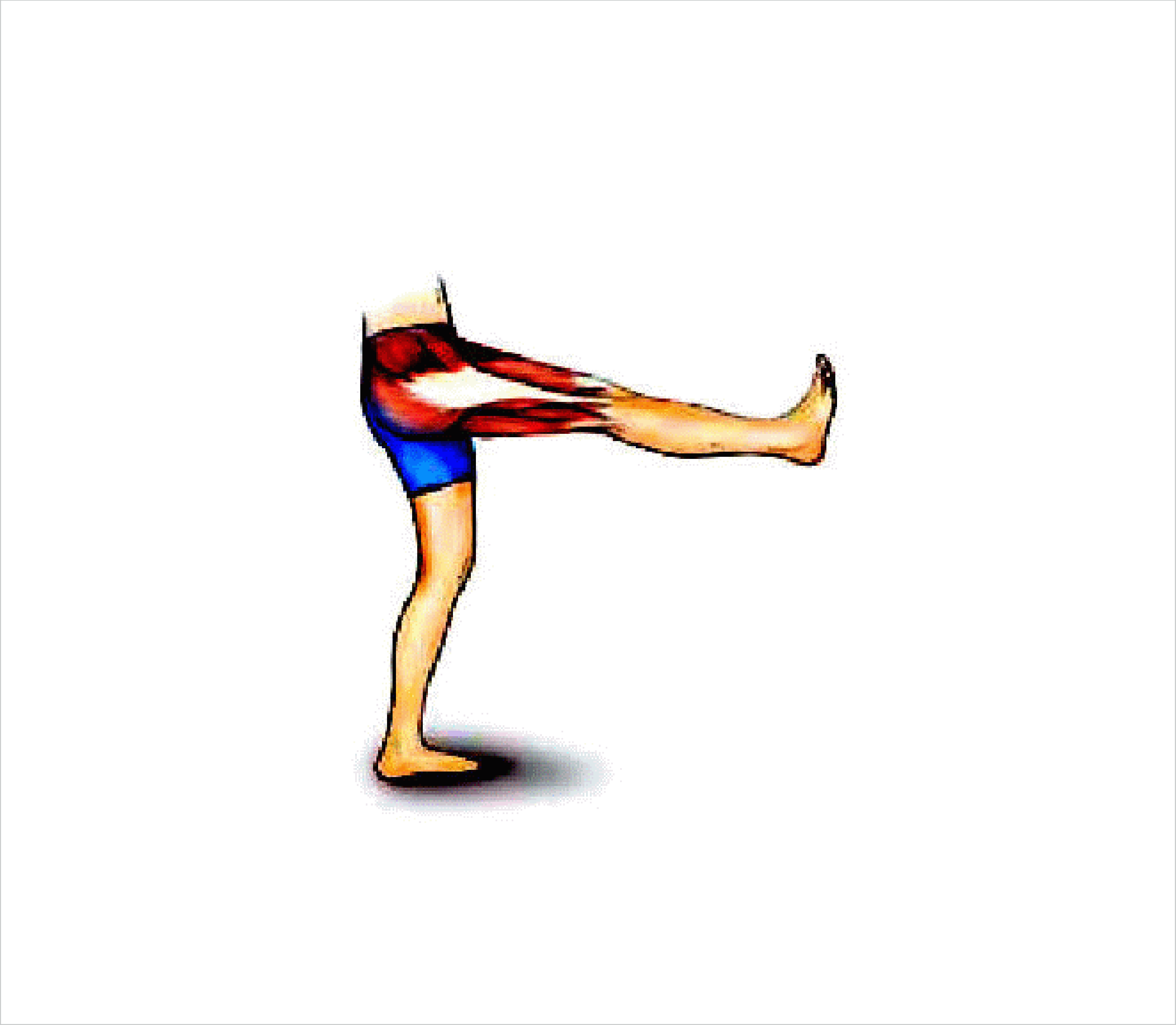
- **Flexion** is the action of decreasing the angle of a joint

- **Extension** is the action of increasing the angle of the joint



# Flexion and Extension

Hip extension is when the leg is moved posteriorly. This motion increases the angle of the joint relative to the anterior surface of the body in anatomical position.



# Flexion and Extension

HIP FLEXION - when the leg is moved anterior to the body, this action decreases the angle of the hip joint relative to the anterior surface of the body in anatomical position. This action flexes the hip joint.

# Flexion and Extension

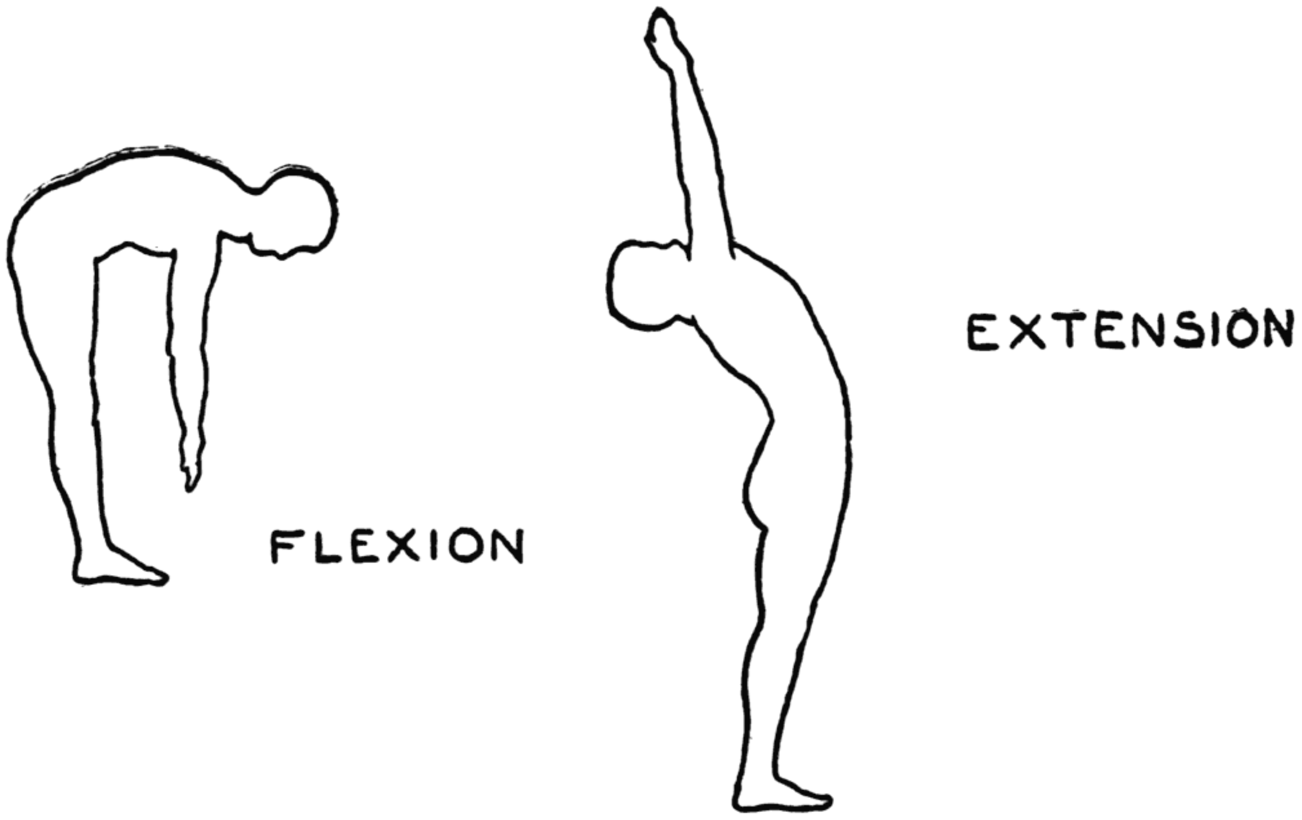
HIP EXTENSION - Hip extension is when the leg is moved posteriorly. This motion increases the angle of the joint relative to the anterior surface of the body in anatomical position.

# Flexion and Extension

Shoulder Flexion -
FLEXION - when the arm is moved anterior to the body, this action decreases the angle of the shoulder joint relative to the anterior surface of the body in anatomical position. This action flexes the shoulder joint.

# Flexion and Extension of the Trunk

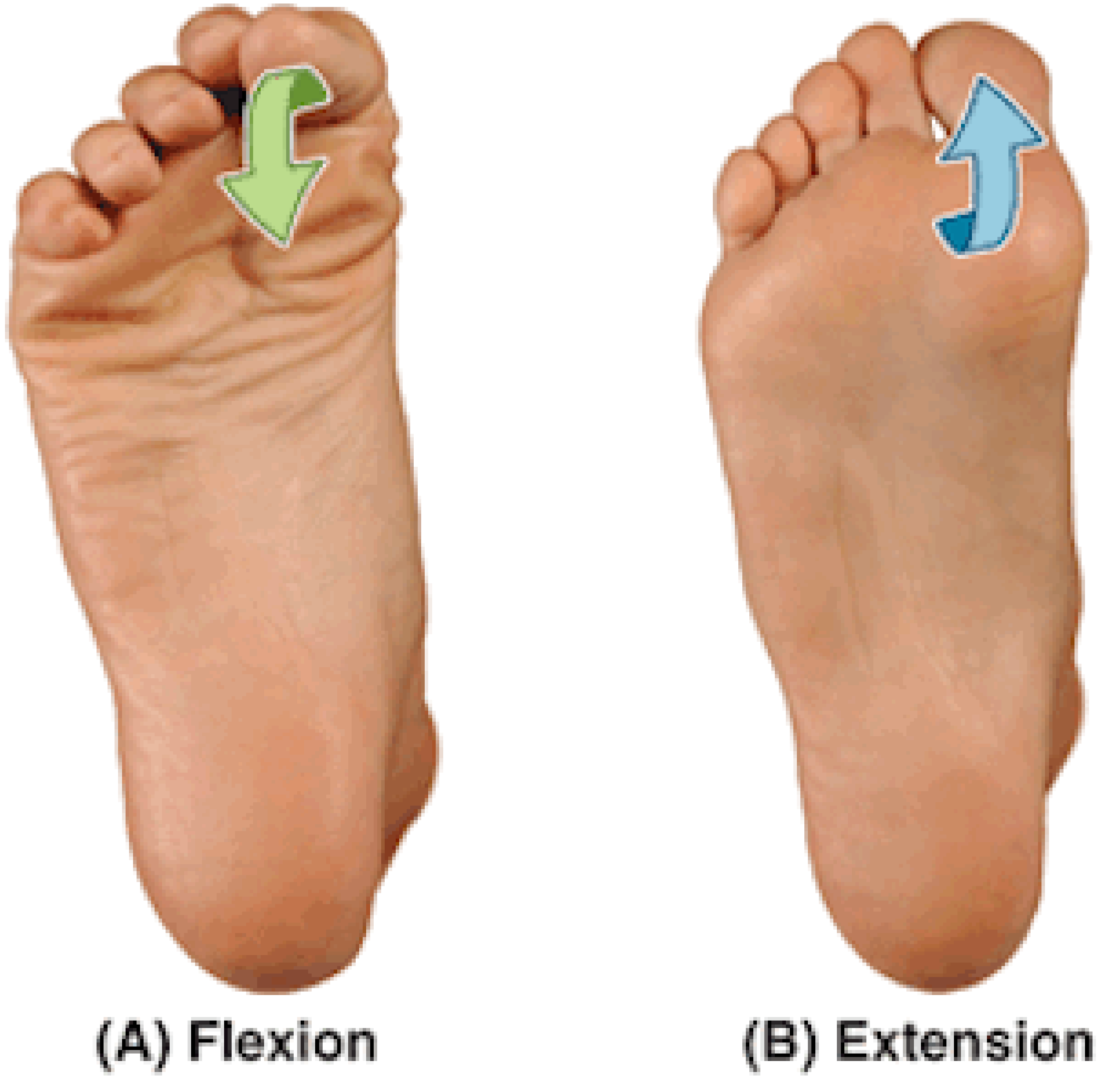
- Leaning forward to touch the toes, is considered flexion of the torso or trunk. Leaning backward is considered extension of the torso or trunk.




MOVEMENTS OF THE TRUNK.

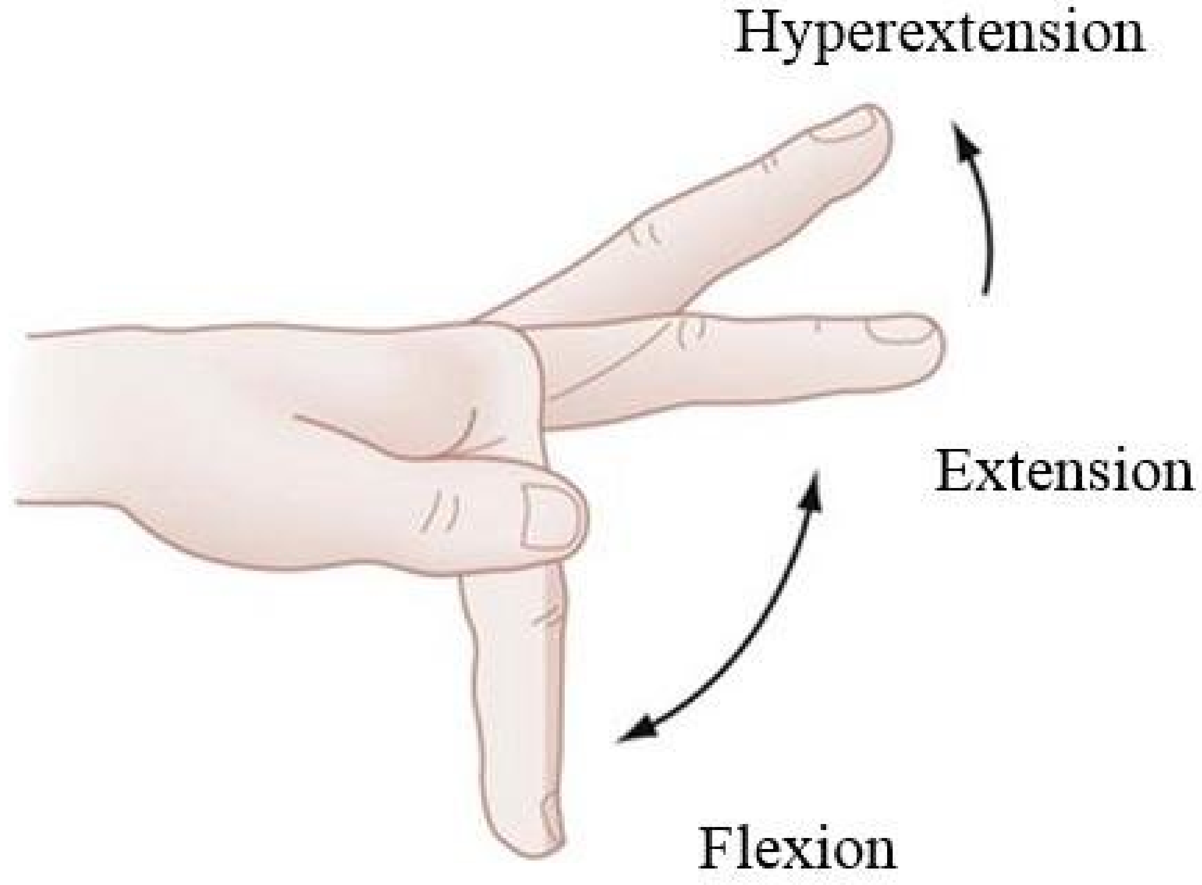
# Flexion and Extension of the Toes

- Toe Flexion – curling of the toes
- Toe Extension – pulling the toes back toward the tibia



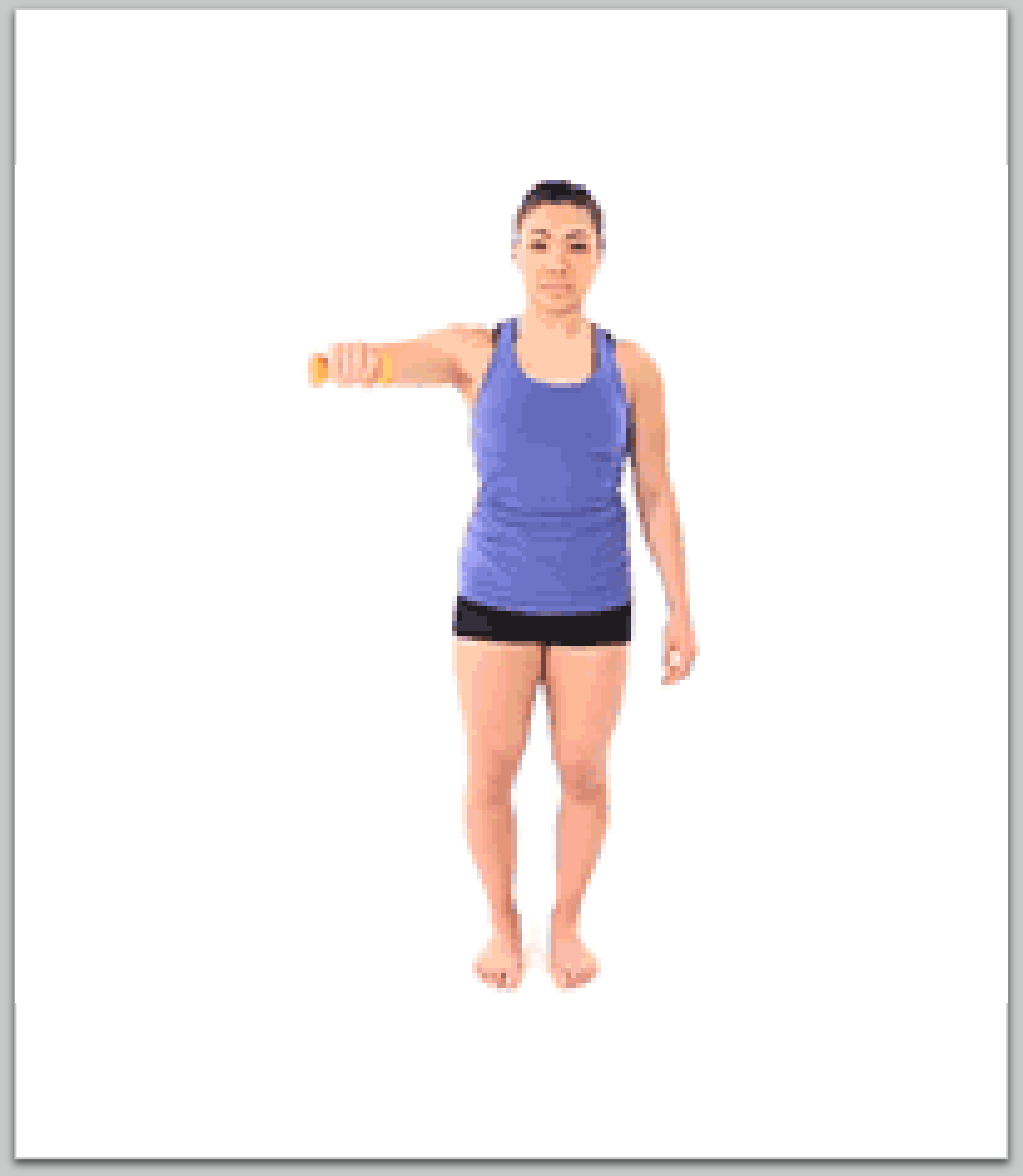
# Flexion and Extension of the Fingers

- Finger Flexion – movement of the fingers that moves the finger in the ANTERIOR direction from anatomical position.
- Finger Extension – movement of the fingers that moves the finger in the POSTERIOR direction from anatomical position.



# Flexion and Extension of the Fingers

**Forming a fist, or bending the fingers is considered flexion of the digits.**



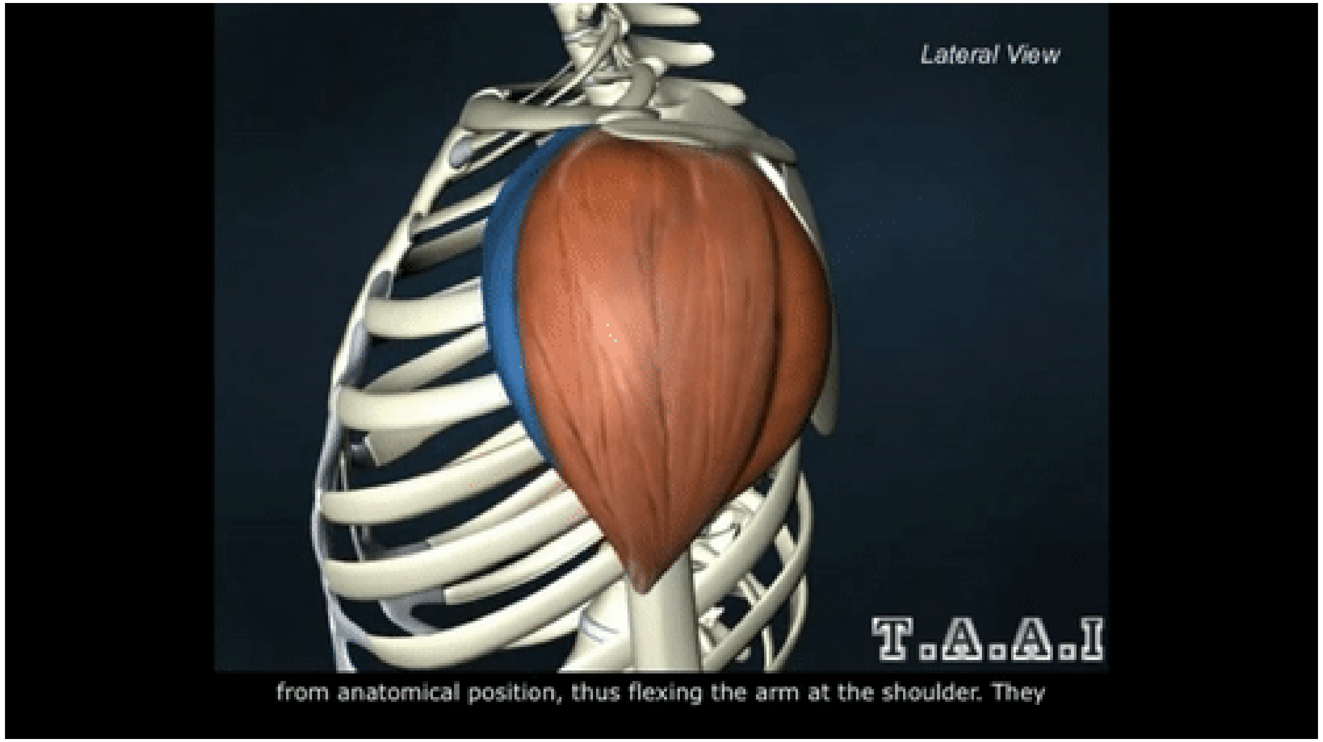
# Rotation

Rotational motion may occur at a number of different types of joints.

# Rotation

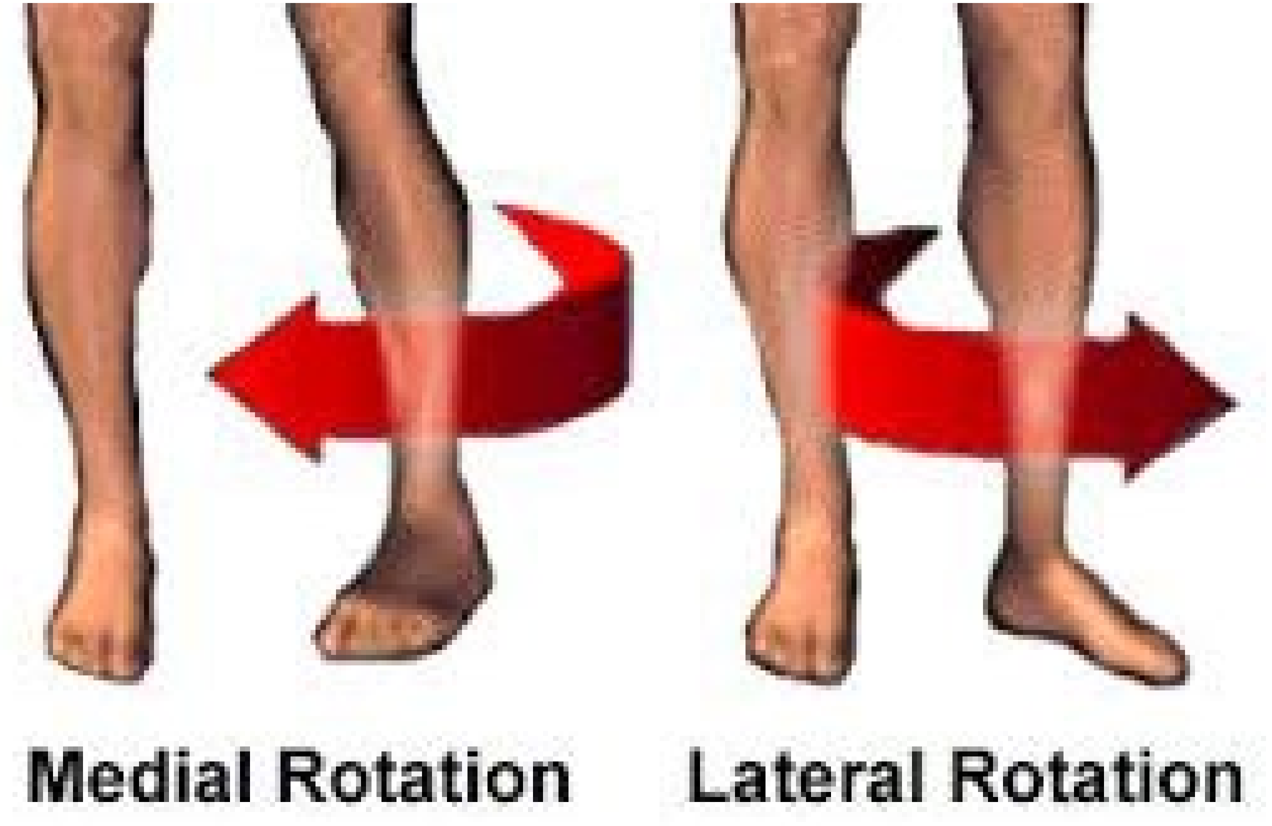
- When rotational motion occurs at a ball-and-socket joint, such as the hip or shoulder joint, the rotational movement can be described as internal rotation or external rotation.

- Internal rotation would be the rotational motion of a limb that is directed TOWARD the midline of the body
- External rotation would be the rotational motion of a limb that is directed AWAY FROM the midline of the body.



# Medial and Lateral Rotation

- Medial and lateral rotation describe movement of the limbs around their long axis:
  - **Medial rotation** is a rotational movement towards the midline. It is sometimes referred to as internal rotation.
  - **Lateral rotation** is a rotating movement away from the midline. This is in the opposite direction to the movements described above.

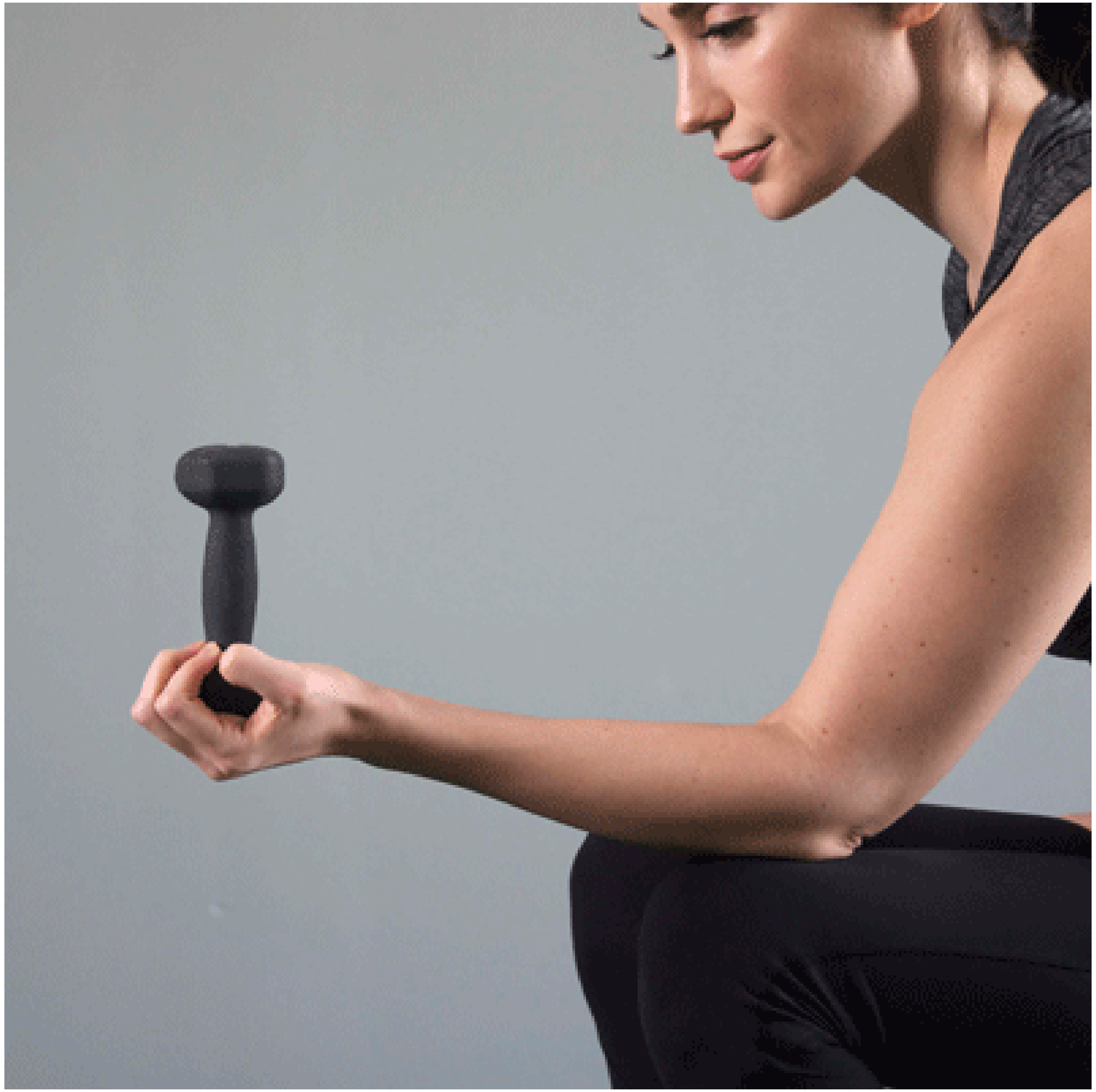


# Rotation

Rotational motion may occur at a number of different types of joints.

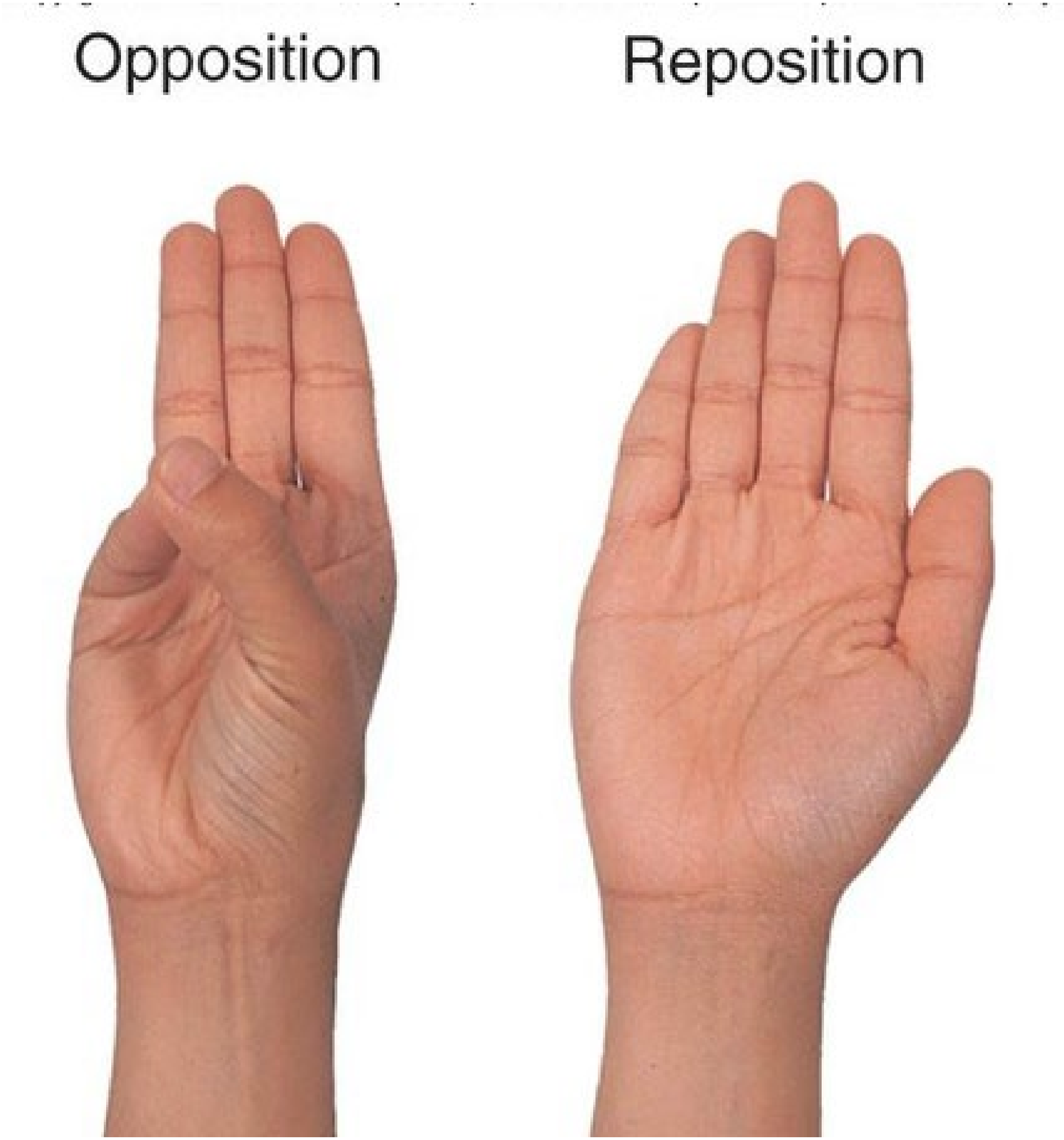
# Rotation

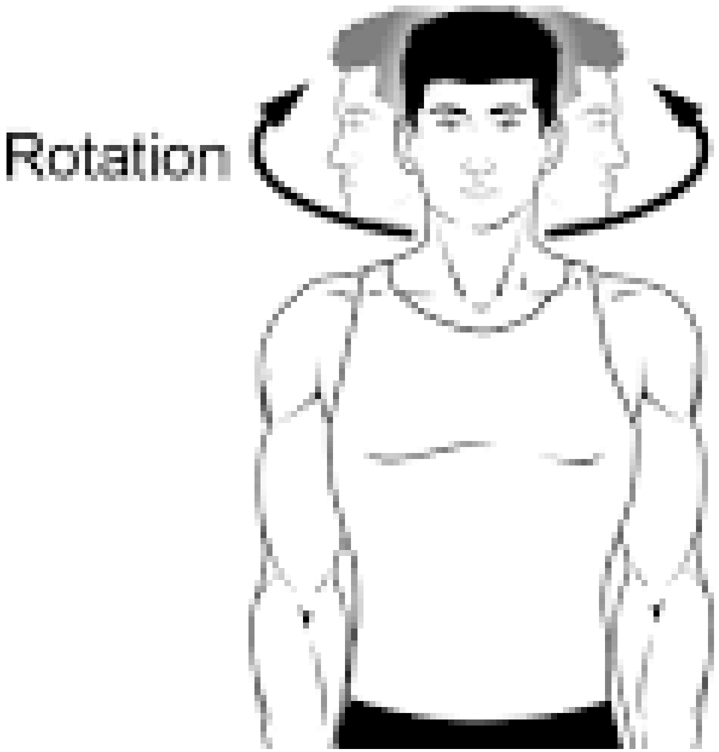
Rotational motion may occur at a number of different types of joints.



# Opposition and Reposition

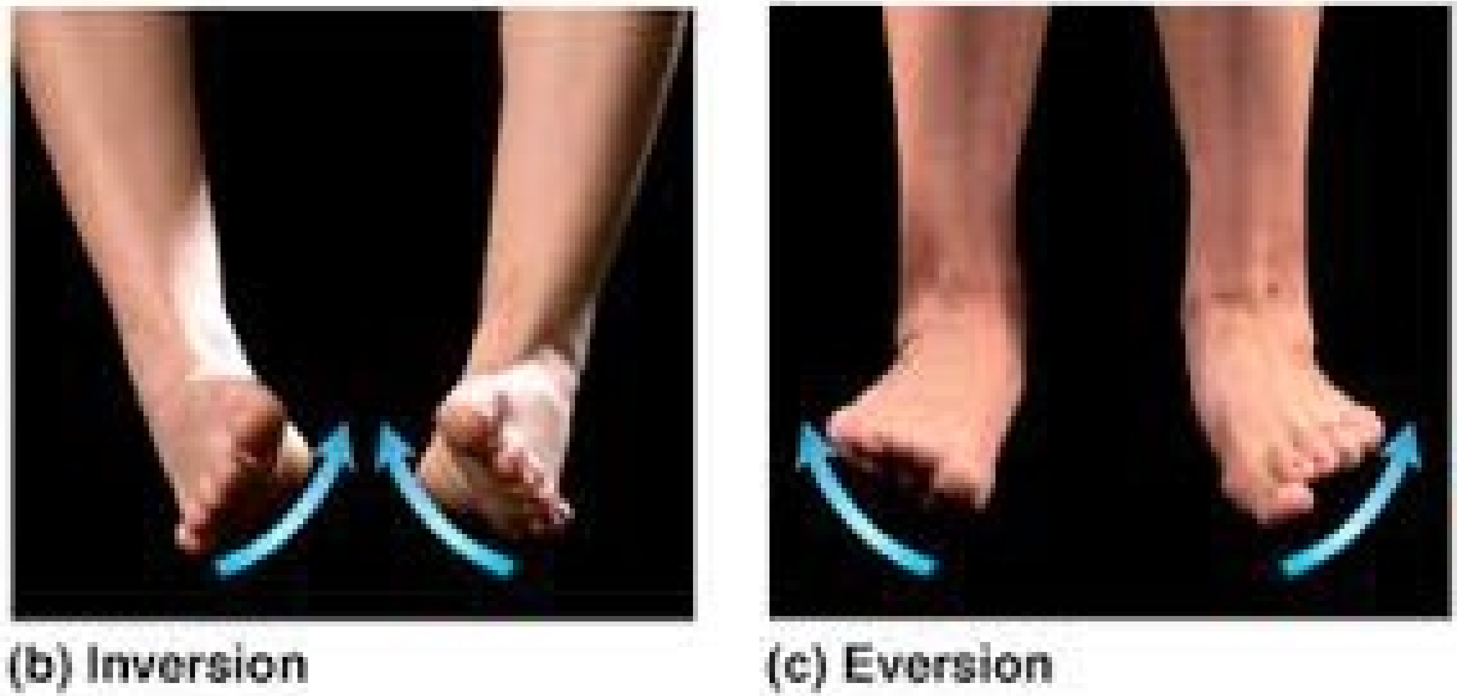
- **Opposition** brings the thumb and little finger together.
- **Reposition** is a movement that moves the thumb and the little finger away from each other, effectively reversing opposition.






# Rotation

- Rotation of the head and neck or torso, is not considered to be either medial or lateral rotation.

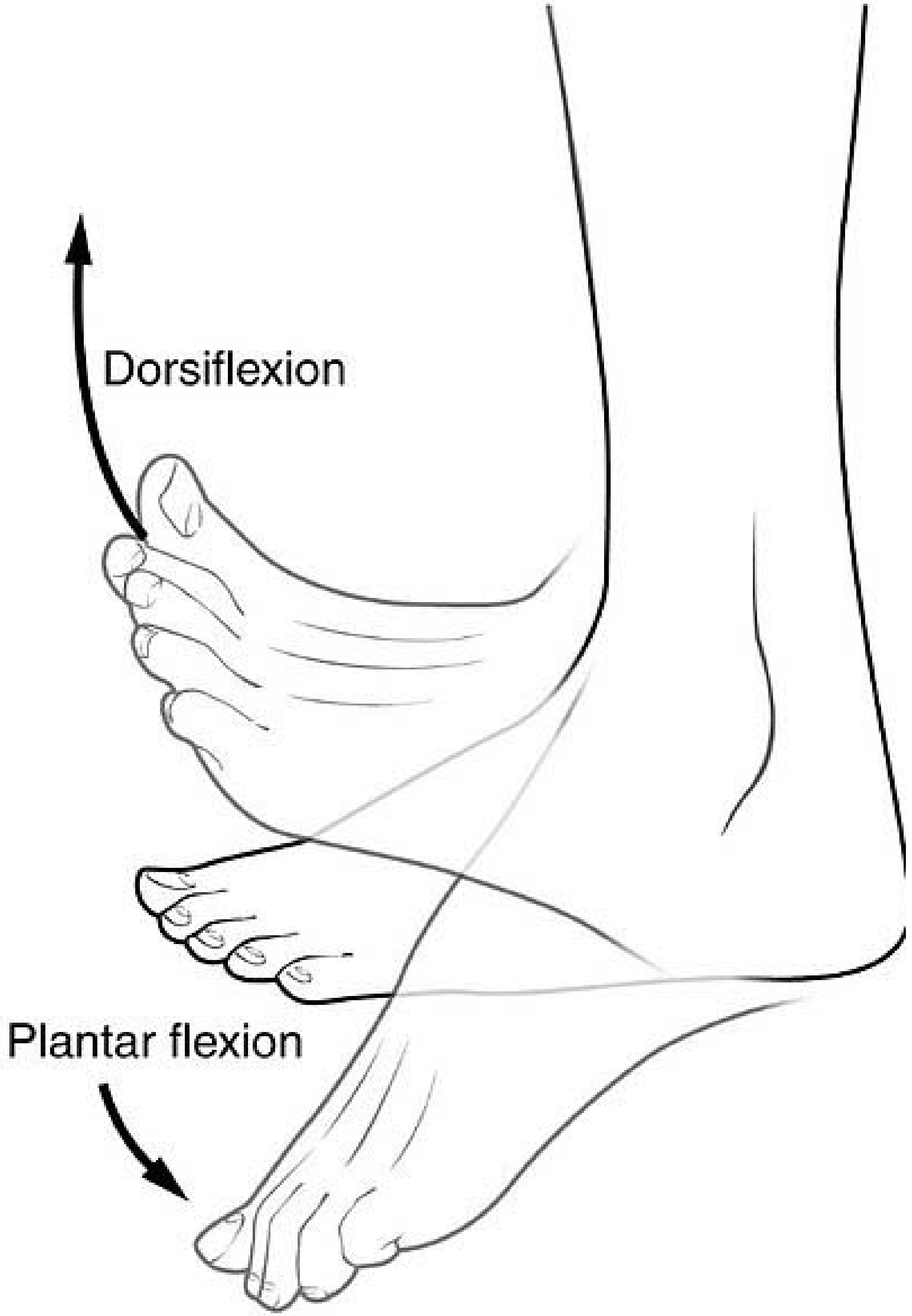



# Inversion and Eversion

**Inversion** and **eversion** are movements which occur at the ankle joint, referring to the rotation of the foot around its long axis.

**Inversion** involves the movement of the sole towards the median plane – so that the sole faces in a medial direction.

**Eversion** involves the movement of the sole away from the median plane – so that the sole faces in a lateral direction.




# Dorsiflexion and Plantarflexion

Dorsiflexion and plantarflexion are terms used to describe movements at the ankle.

- **Dorsiflexion** refers to flexion at the ankle, so that the foot points more superiorly.
- **Plantarflexion** refers extension at the ankle, so that the foot points inferiorly. Similarly there is a term for the hand, which is palmar flexion.

# Pronation and Supination

**Pronation and supination** are a pair of unique movements possible only in the forearms and hands, allowing the human body to flip the palm either face up or face down.

## Supination and Pronation


**Supination**

- Supinator muscle
- Palm facing anteriorly

**Pronation**

- Pronator teres and Pronator quadratus mm.
- Palm faces posteriorly


# Pronation and Supination

**Pronation and supination** are a pair of unique movements possible only in the forearms and hands, allowing the human body to flip the palm either face up or face down.

# Functional groups

**Muscles can be classified into three functional groups:**

Prime Mover or Agonist - A muscle that has the major responsibility for producing a specific movement is a prime mover, or agonist, of that movement.

Antagonist - Muscles that oppose, or reverse, a particular movement are antagonists

Synergist - Synergists help prime movers or agonists by

- adding additional force to the same movement or
- Inhibiting oppositional movements

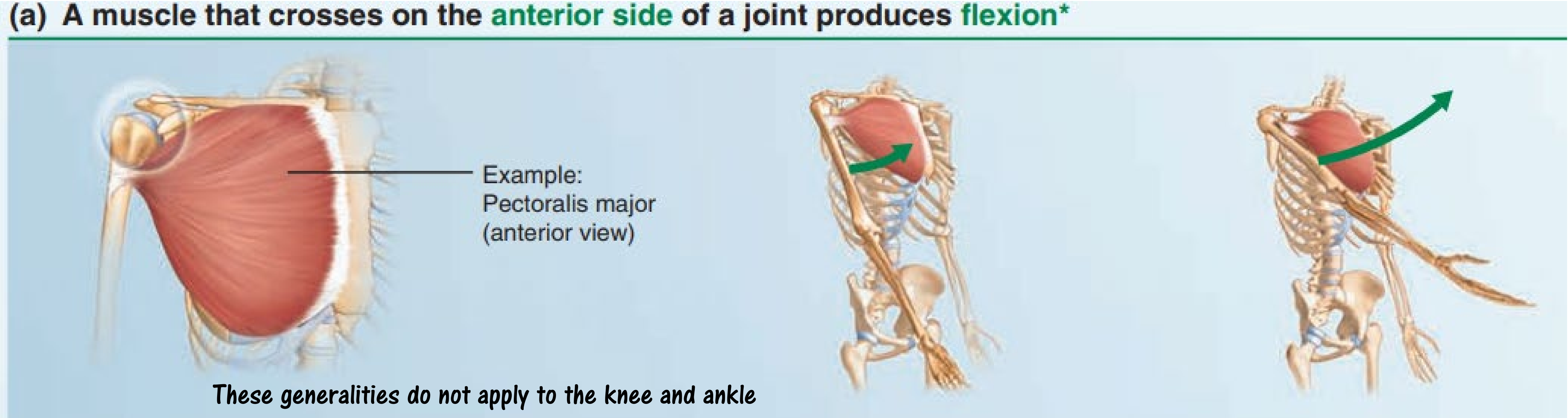
## Muscle action

- Sometimes muscles are named for the movement they produce.
- For example, you may see action words such as
  - Flexor
  - Extensor
  - Adductor

# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the anterior side of a joint produces flexion.

Marieb Human Anatomy & Physiology: Tenth Edition

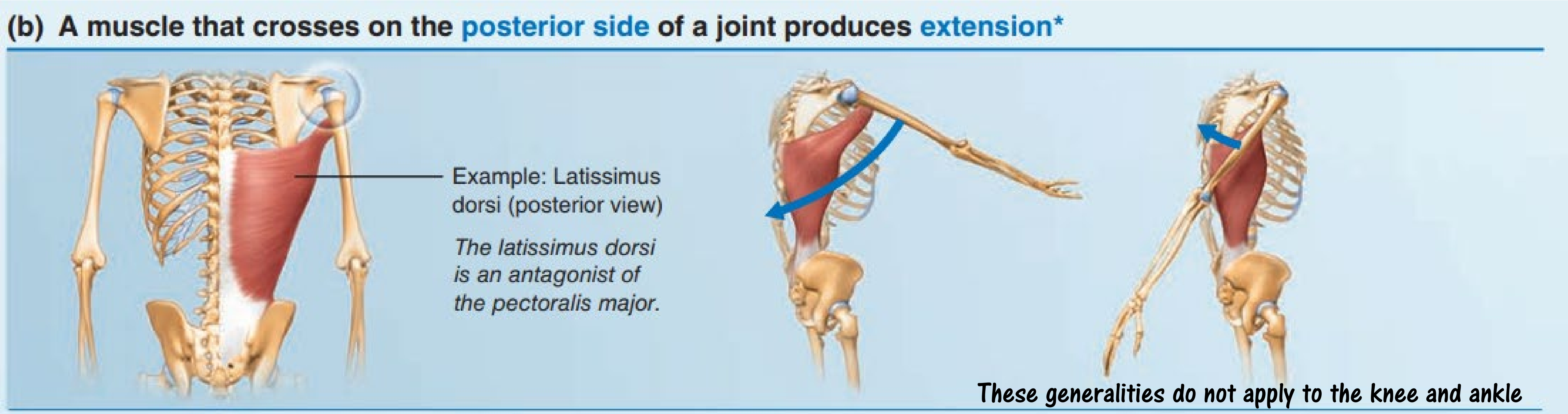



These generalities do not apply to the knee and ankle

# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the posterior side of a joint produces extension.

Marieb Human Anatomy & Physiology: Tenth Edition

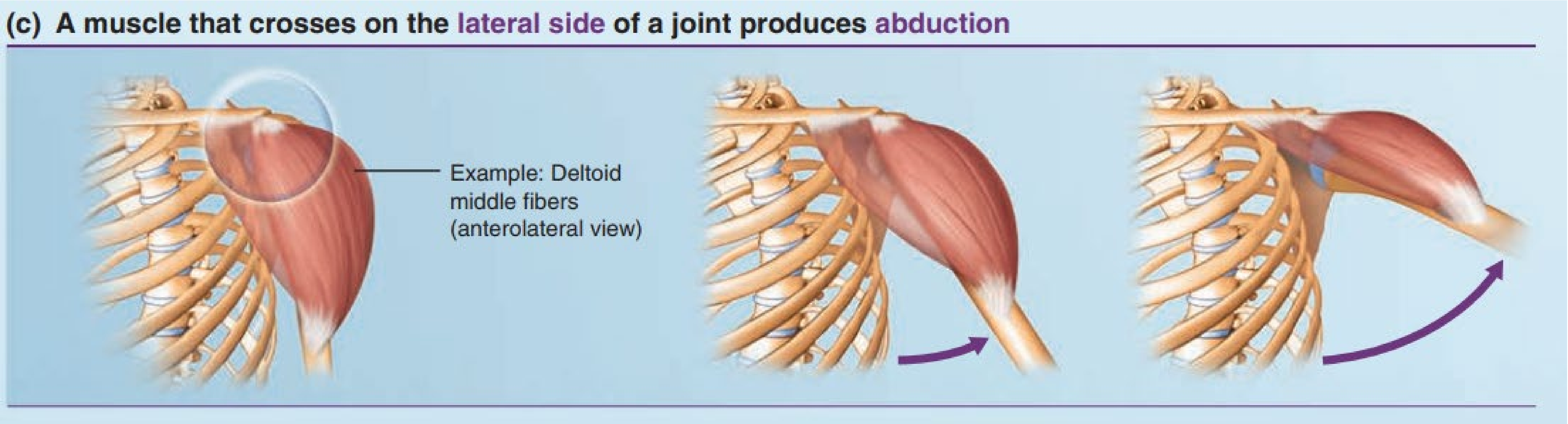


# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the lateral side of a joint produces abduction.

These generalities do not apply to the knee and ankle

Marieb Human Anatomy & Physiology: Tenth Edition

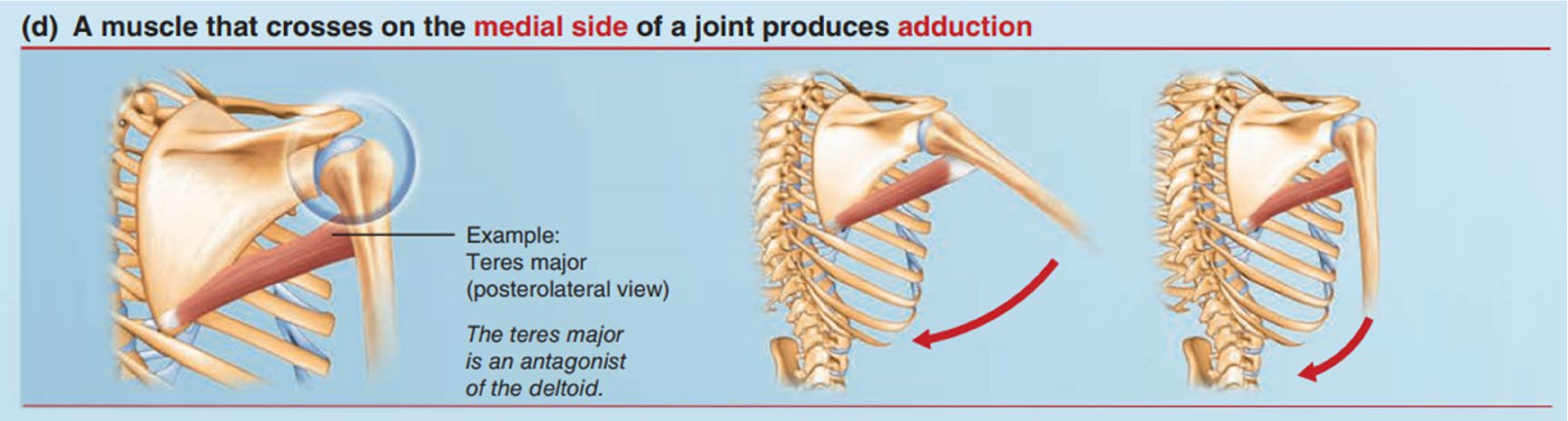


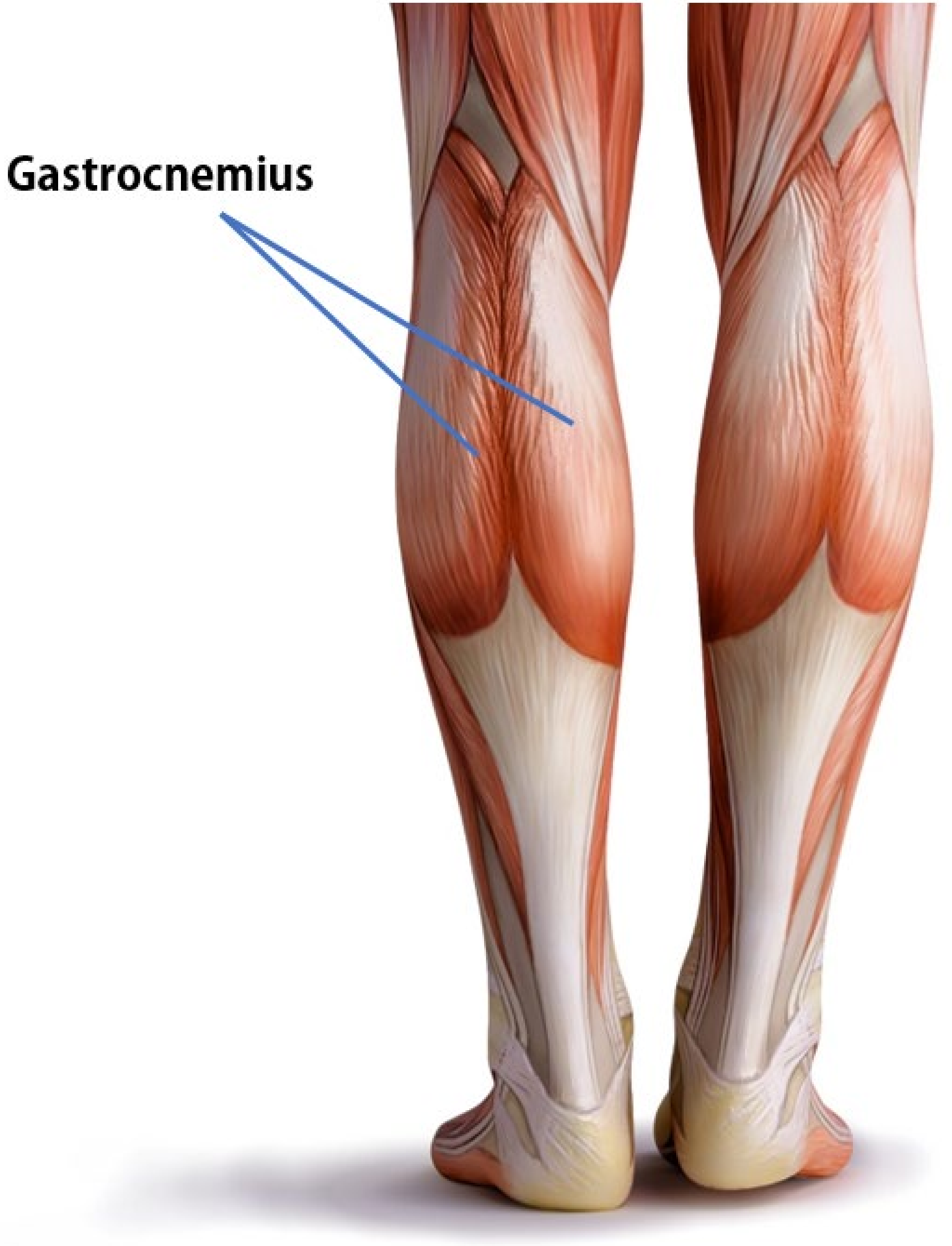
# The action of a Muscle

- The action of a muscle can be inferred by the position of the muscle relative to the joint it crosses.
- A muscle that crosses on the medial side of a joint produces adduction.

These generalities do not apply to the knee and ankle

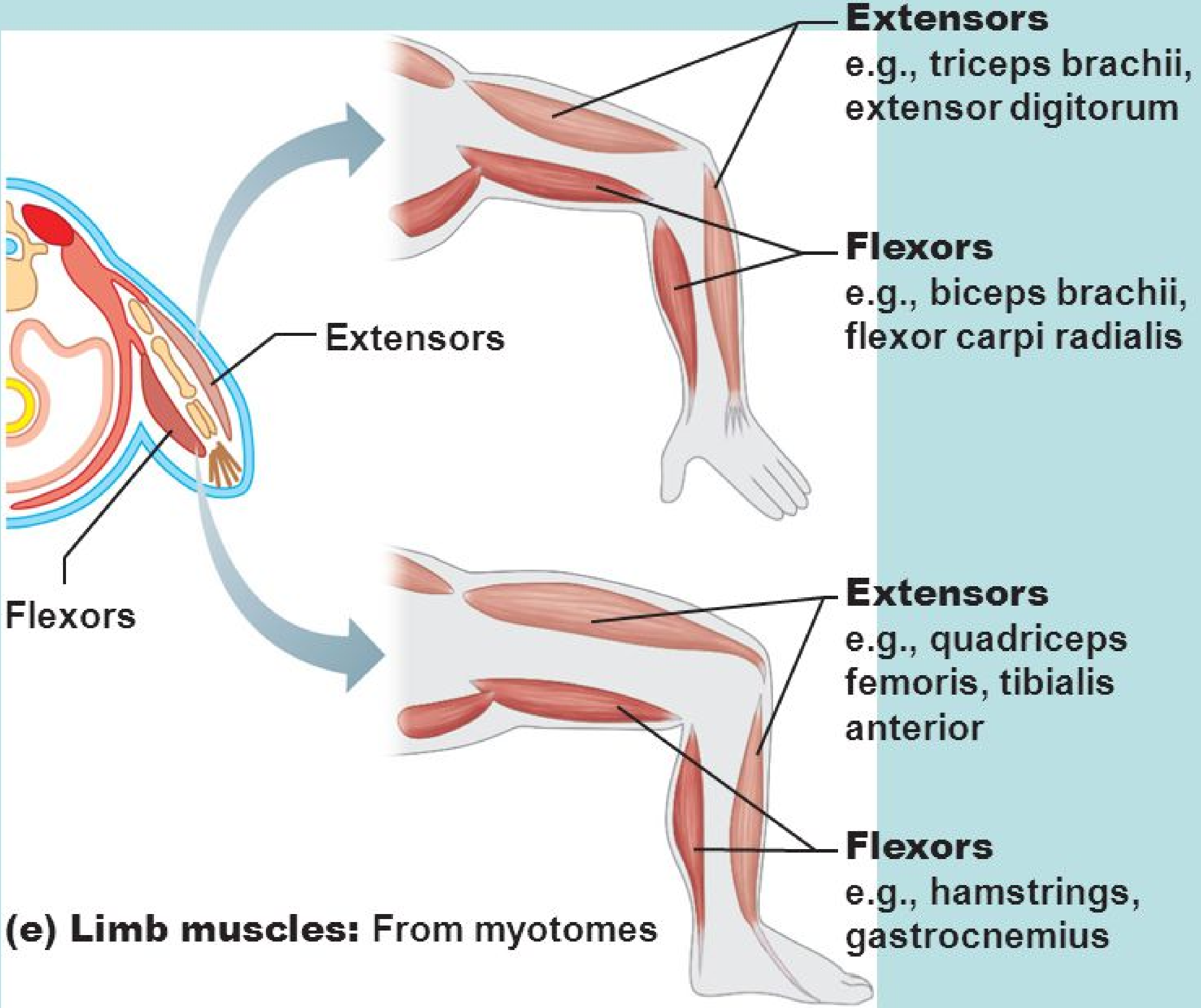
Marieb Human Anatomy & Physiology: Tenth Edition



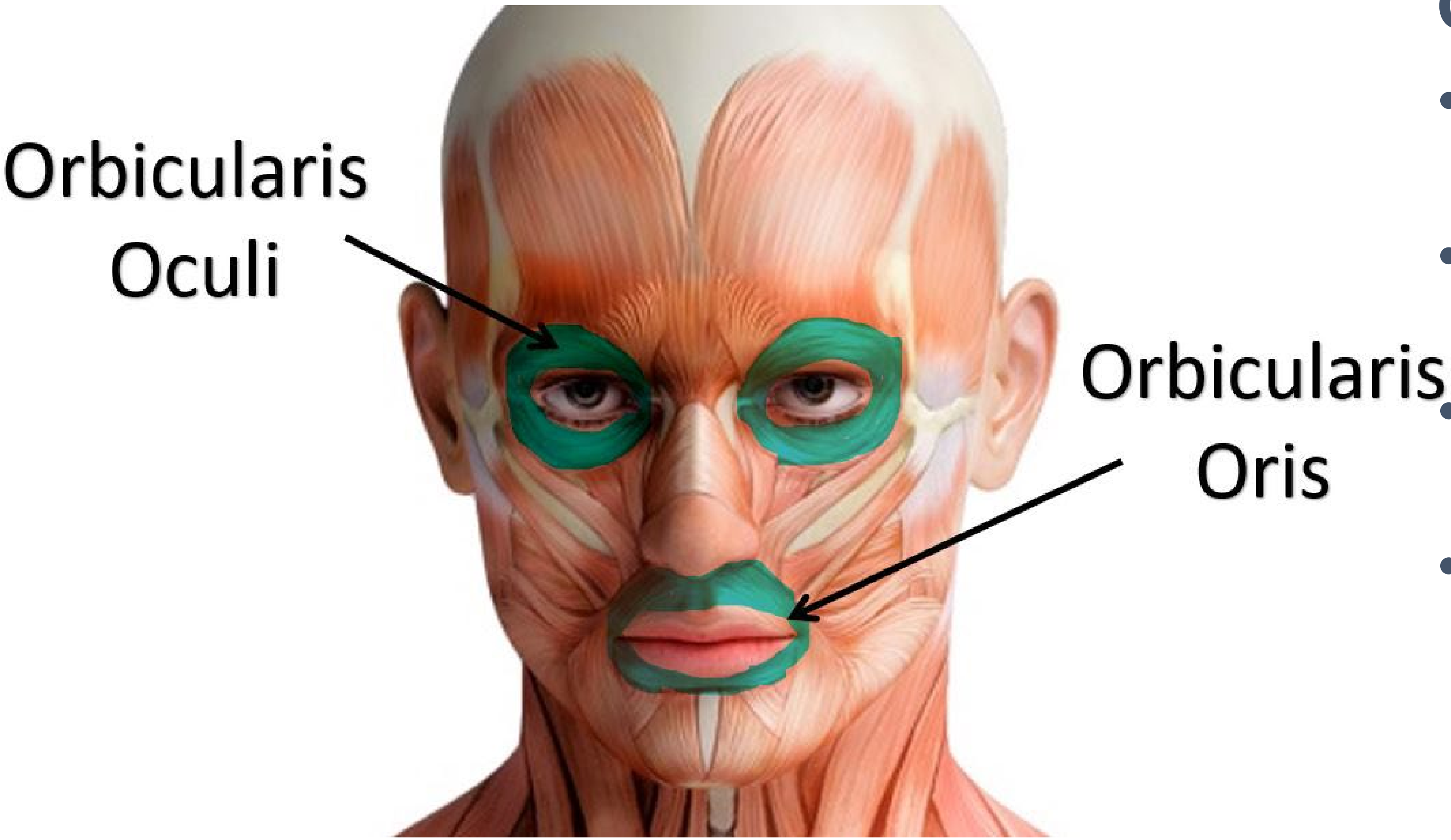



- These generalities do not apply to the knee and ankle because the lower limb is rotated during development.
- The muscles that cross these joints posteriorly produce flexion, and those that cross anteriorly produce extension.

# Limb Muscles




**(e) Limb muscles:** From myotomes

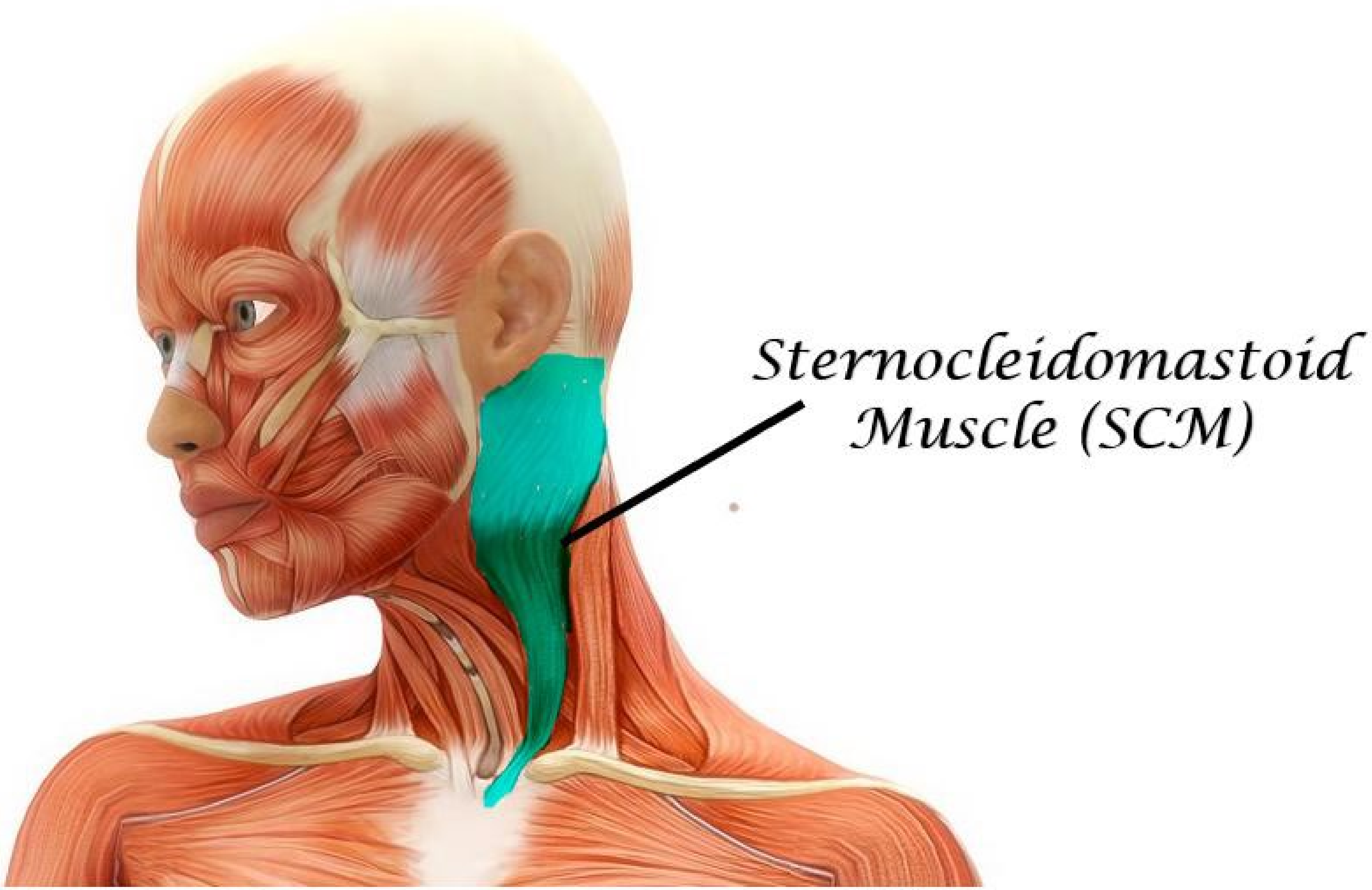



## Circular

- found at external body openings
- When muscle contracts, it closes.
- Known as sphincters which means (“squeezers”).
- Examples are the orbicularis muscles surrounding the eyes and the mouth.

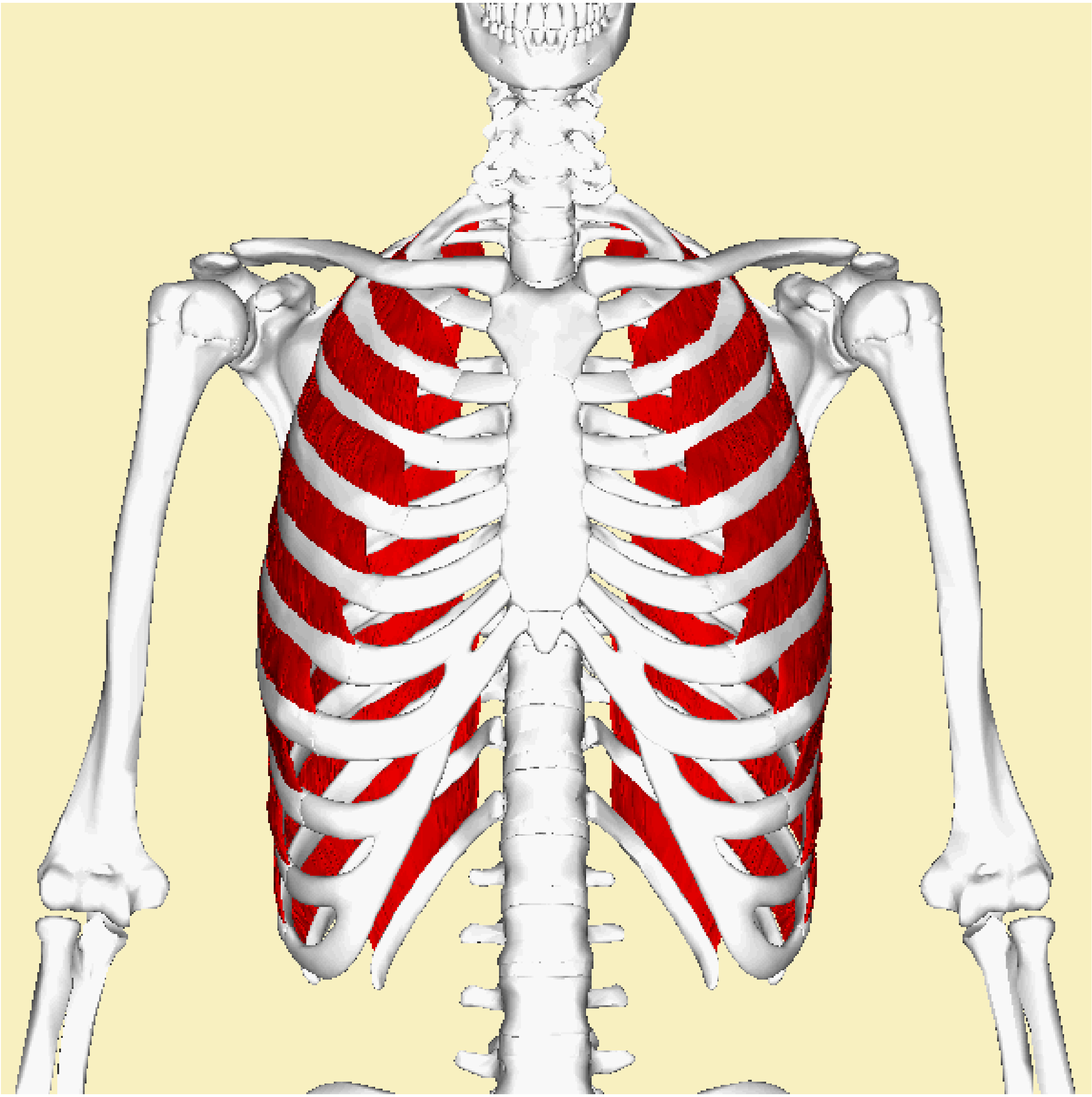
# Action of the SCM

- Flexes and laterally rotates the head



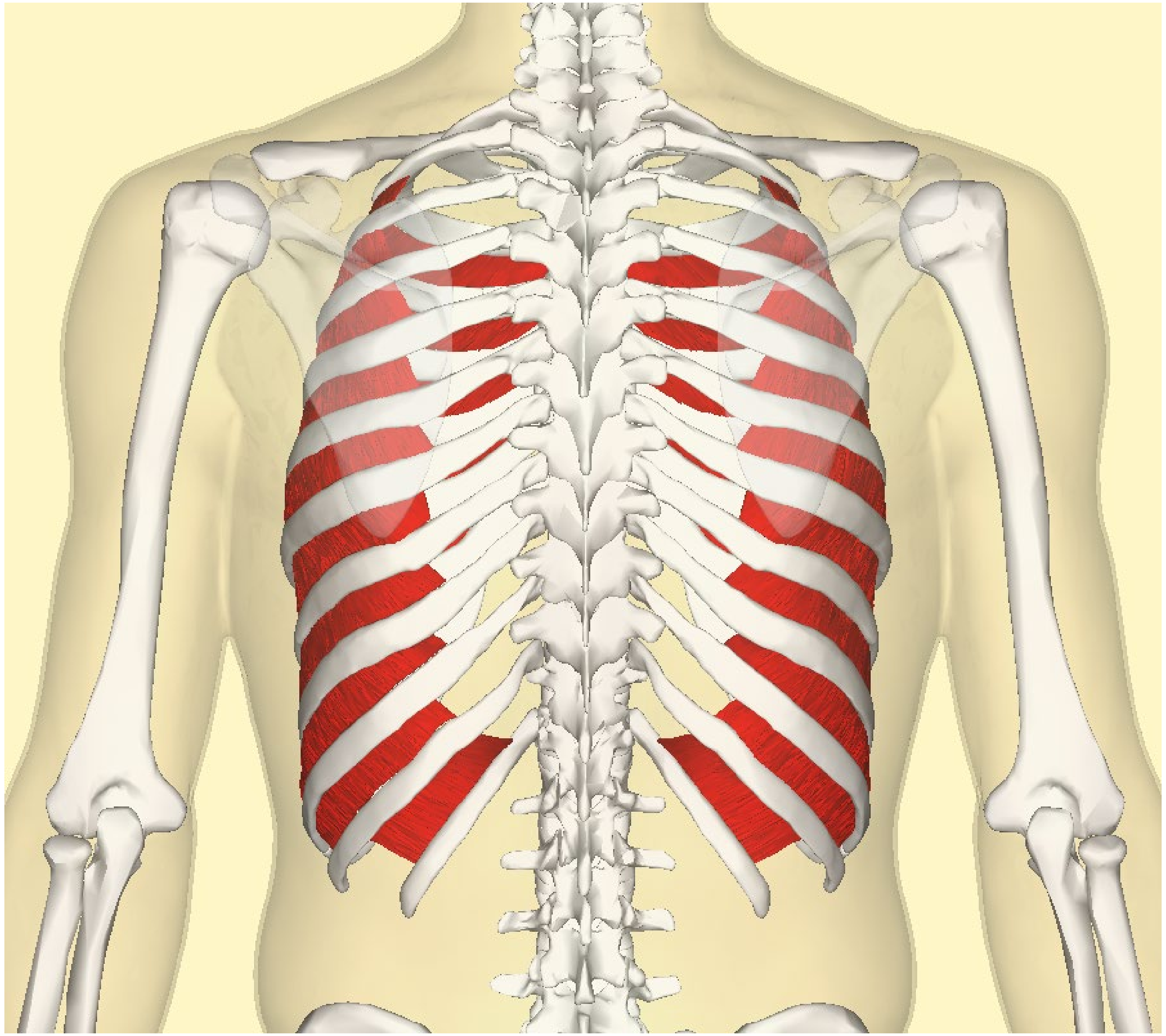
# Action of the External intercostals

- pull ribs toward one another to elevate rib cage; aid in inspiration; synergists of diaphragm



# Internal intercostals

- draw ribs together and depress rib cage; aid forced expiration; antagonistic to external intercostals




# Diaphragm

Prime mover of inspiration; flattens on contraction,