The muscular system

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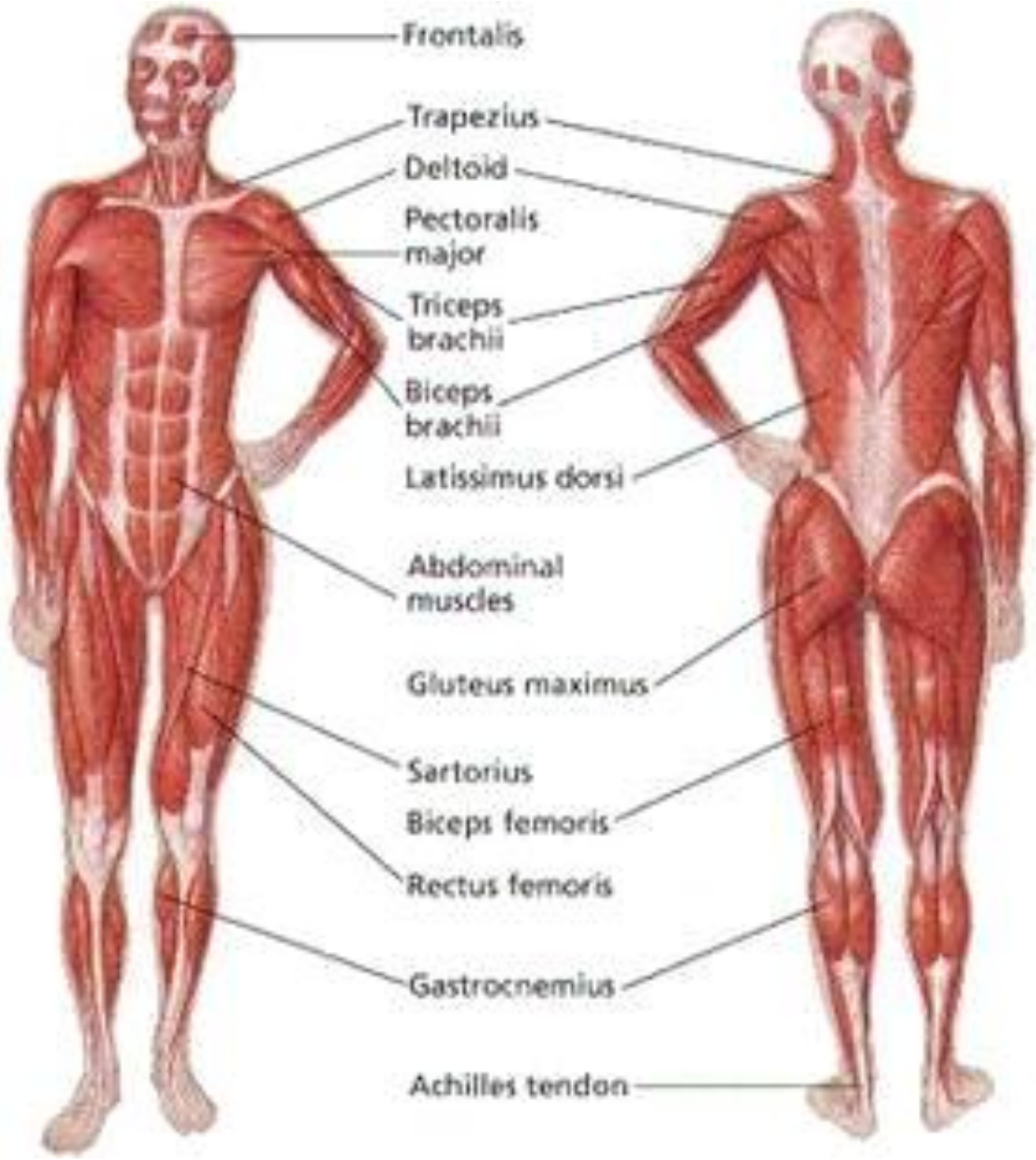
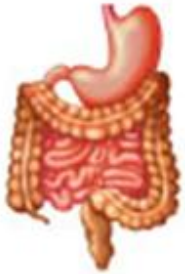
By the end of this lesson we will be able to :

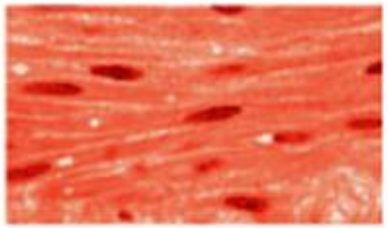
1. Distinguish between the three types of muscle tissue.
2. Describe the structure of skeletal muscle fiber
3. Explain how skeletal muscles contract
4. Describe how muscles move bones
5. Explain the process in which a muscle becomes fatigued

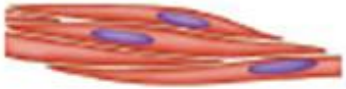

Frontalis
Trapezius
Deltoid
Pectoralis major
Triceps brachii
Biceps brachii
Latissimus dorsi
Abdominal muscles
Gluteus maximus
Sartorius
Biceps femoris
Rectus femoris
Gastrocnemius
Achilles tendon

Muscle types

- A muscle is an organ that contracts in a coordinated fashion and includes muscle tissue, blood vessels, nerves and connective tissue.
- The three types of muscular tissue are : **skeletal, smooth and cardiac muscle.**

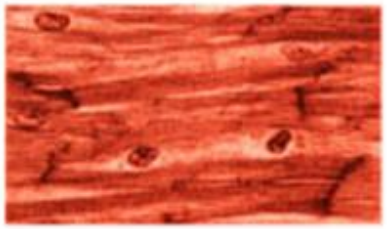






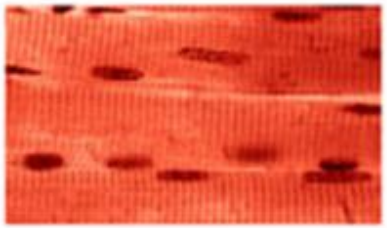
Smooth muscle

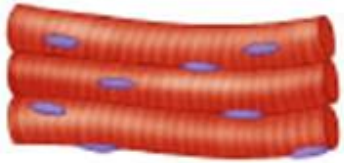
- has spindle-shaped, nonstriated uninucleated fibers.
- occurs in walls of internal organs.
- is involuntary.



Cardiac muscle

- has striated, branched, uninucleated fibers.
- occurs in walls of heart.
- is involuntary.



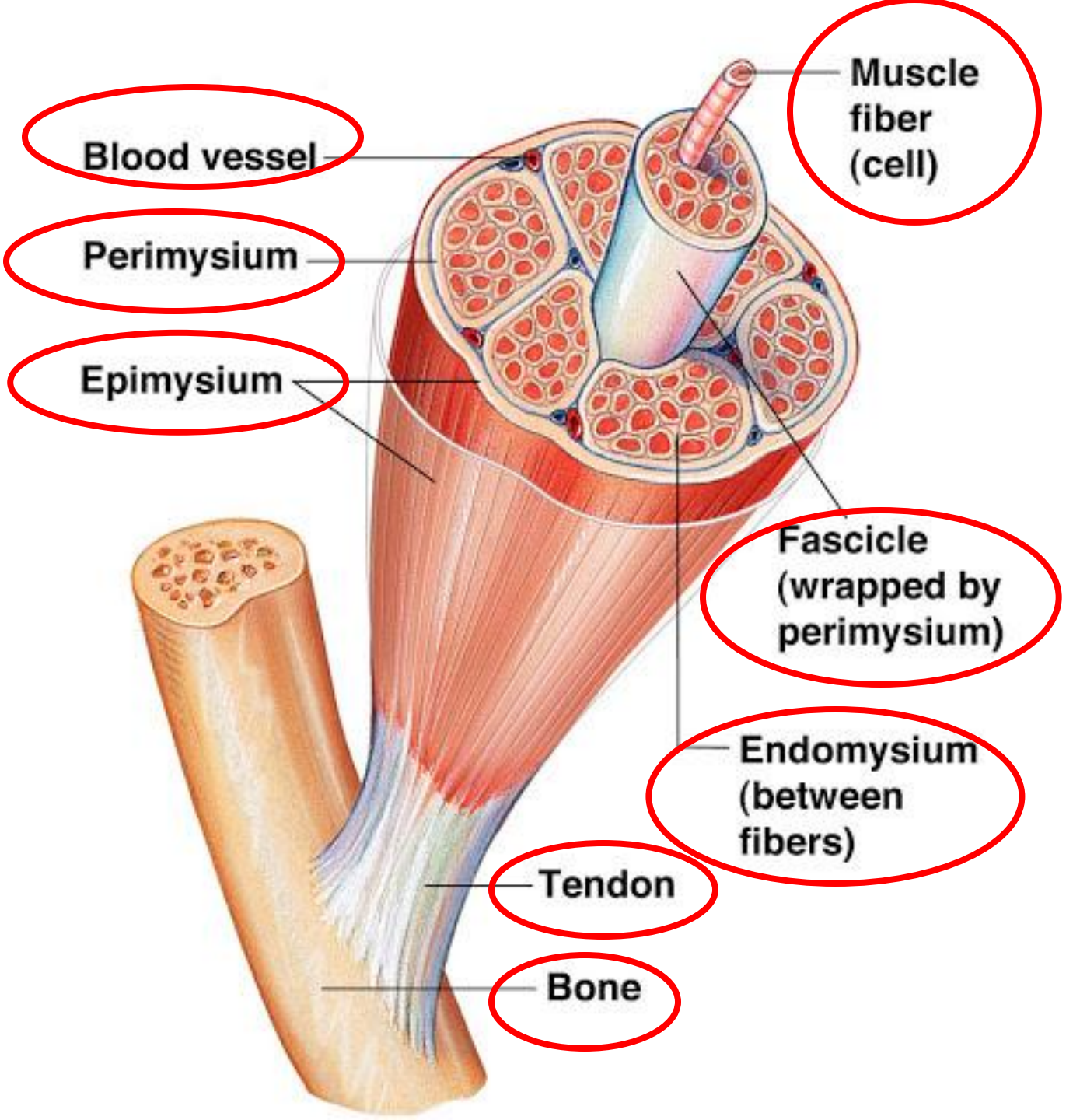


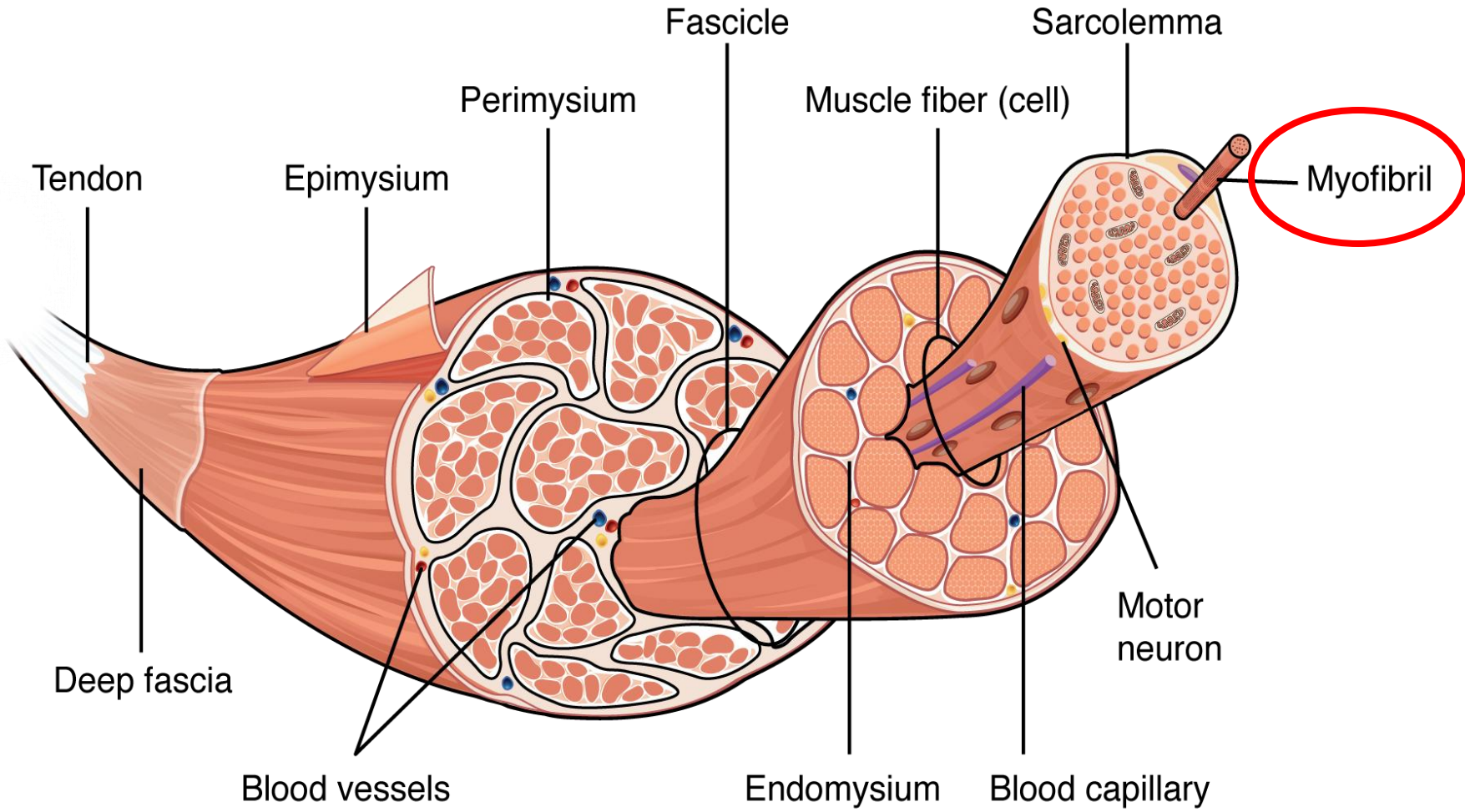
Skeletal muscle

- has striated, tubular, multinucleated fibers.
- is usually attached to skeleton.
- is voluntary.

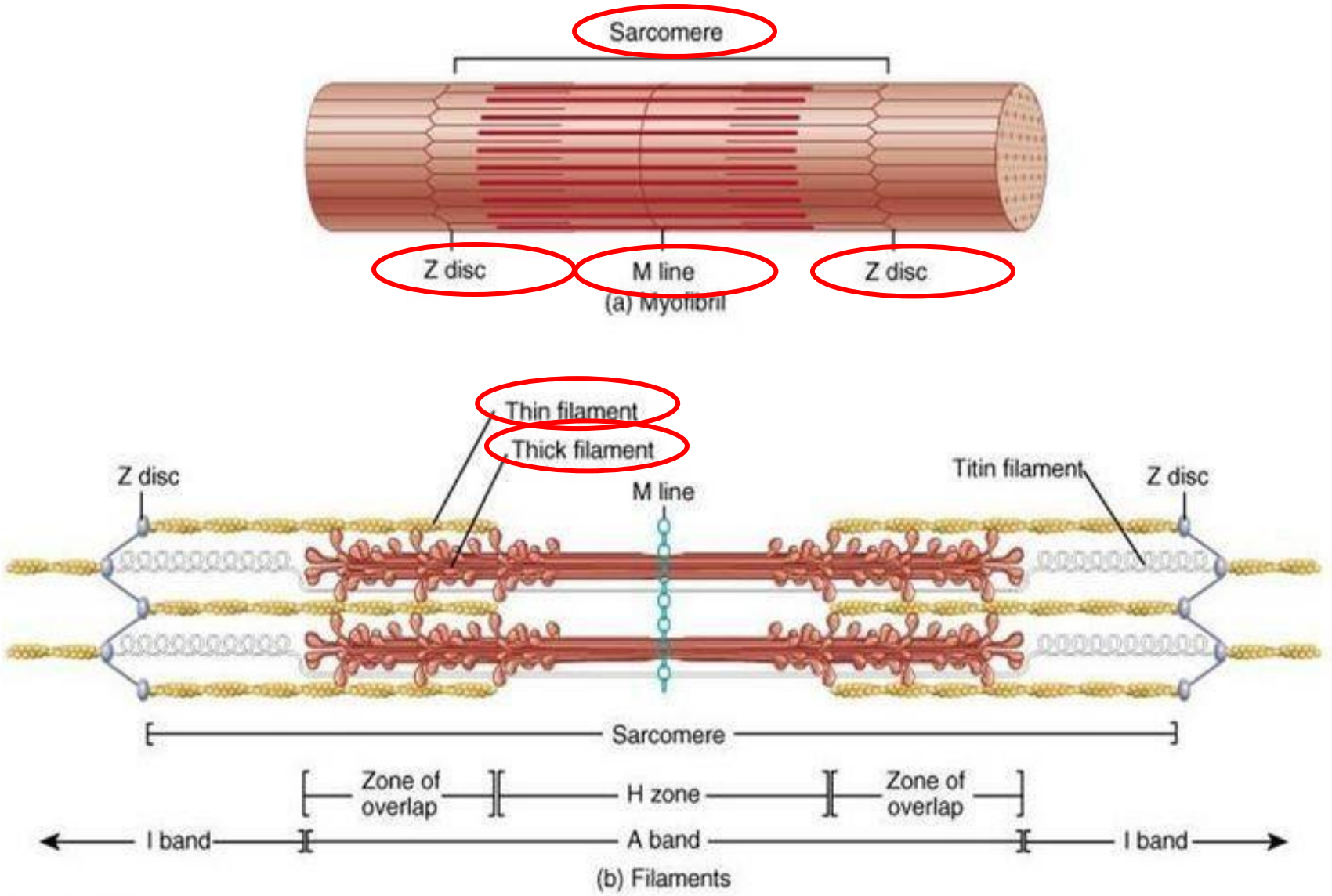
The skeletal muscle

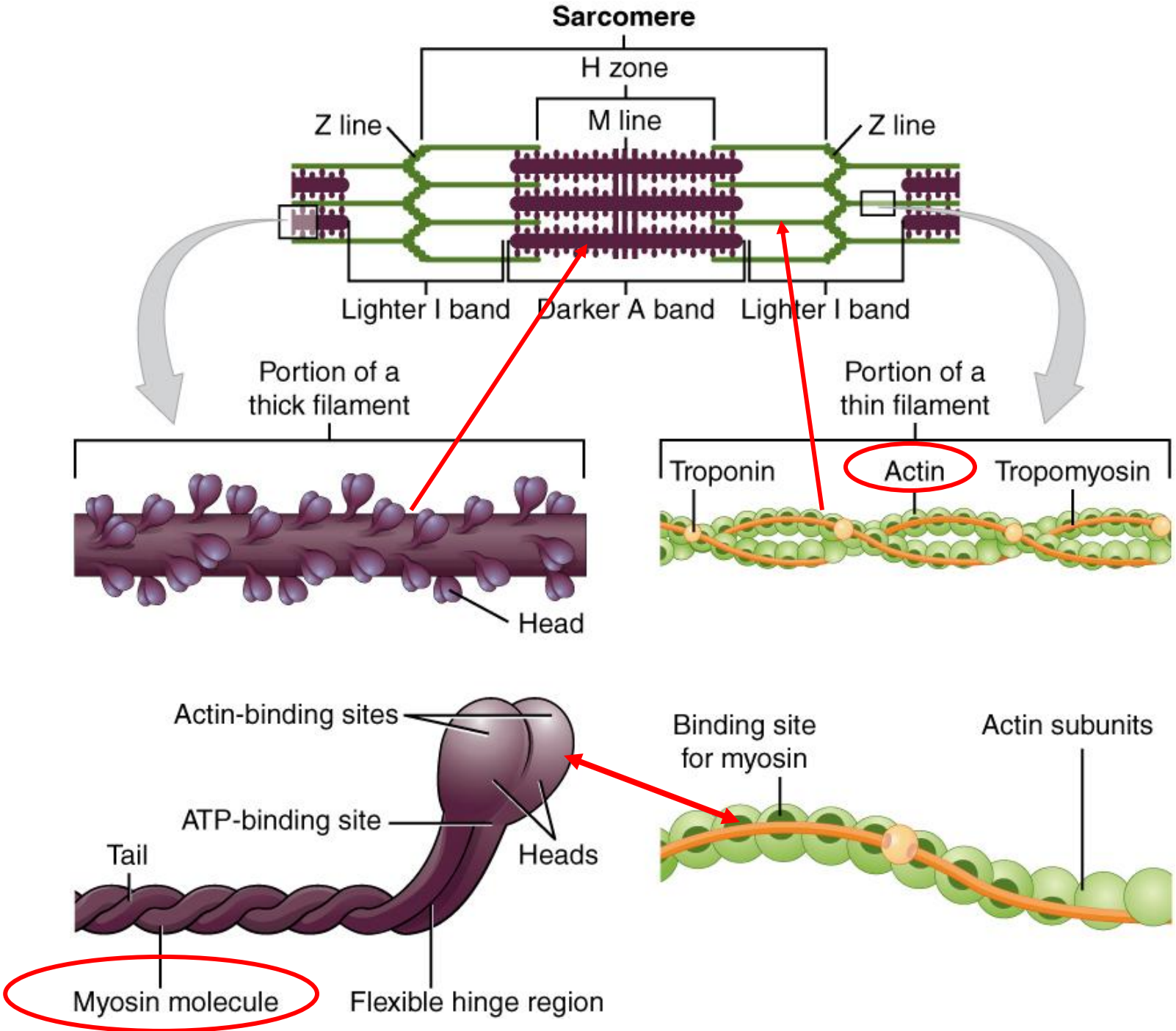
- Is made of **elongated cells called muscle fibers.**
- Each muscle fiber constains many nuclei and is crossed by light and dark stripes called **striations.**

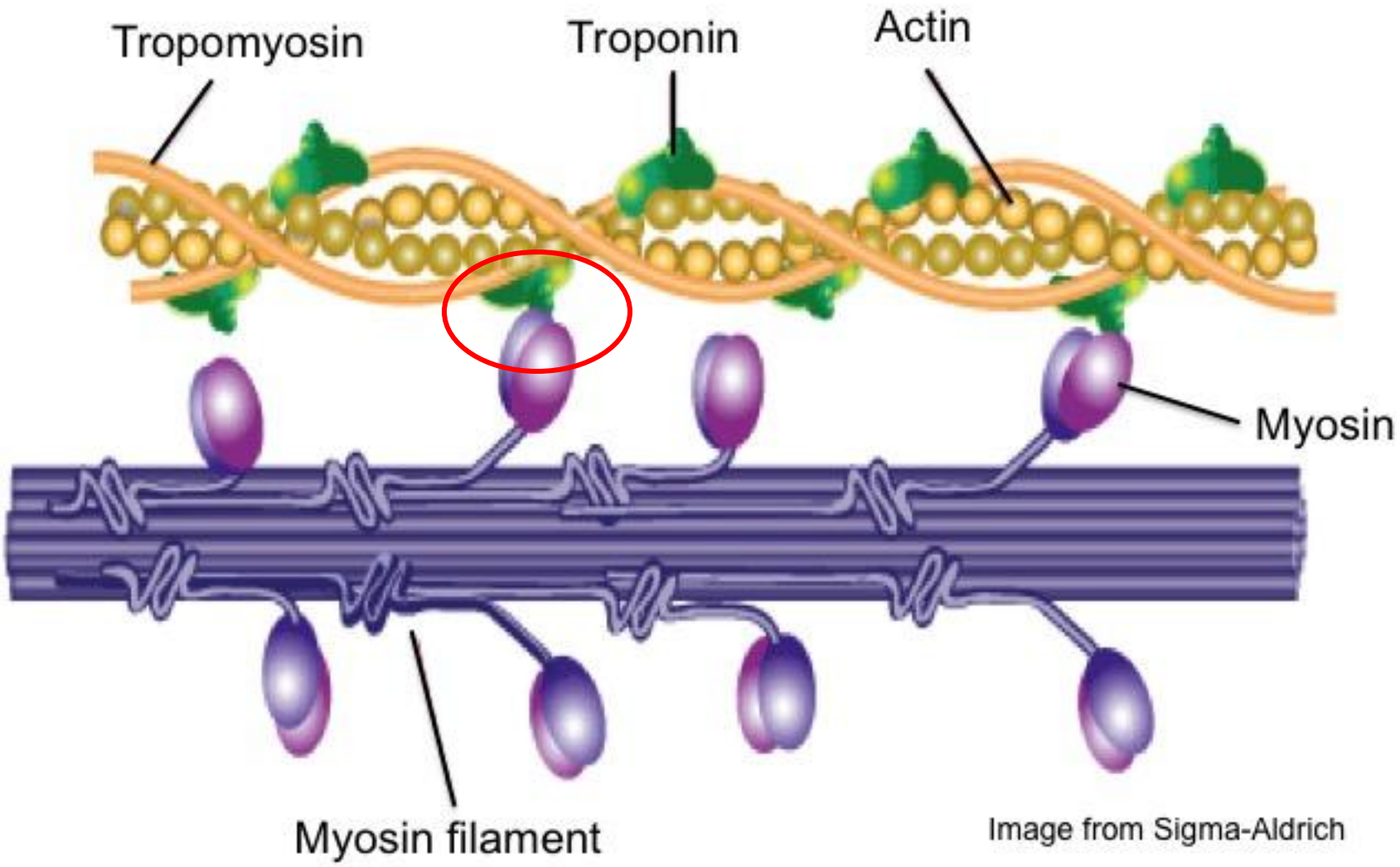

Muscle fiber (cell)
Blood vessel
Perimysium
Epimysium
Fascicle (wrapped by perimysium)
Endomysium (between fibers)
Tendon
Bone


Fascicle
Sarcolemma
Perimysium
Muscle fiber (cell)
Tendon
Epimysium
Myofibril
Motor neuron
Deep fascia
Blood vessels
Endomysium
Blood capillary

The structure of myofibril




Sarcomere
H zone
M line
Z line
Z line
Lighter I band
Darker A band
Lighter I band
Portion of a thick filament
Portion of a thin filament
Troponin
Actin
Tropomyosin
Head
Actin-binding sites
ATP-binding site
Tail
Heads
Myosin molecule
Flexible hinge region
Binding site for myosin
Actin subunits


Tropomyosin
Troponin
Actin
Myosin
Myosin filament
Image from Sigma-Aldrich

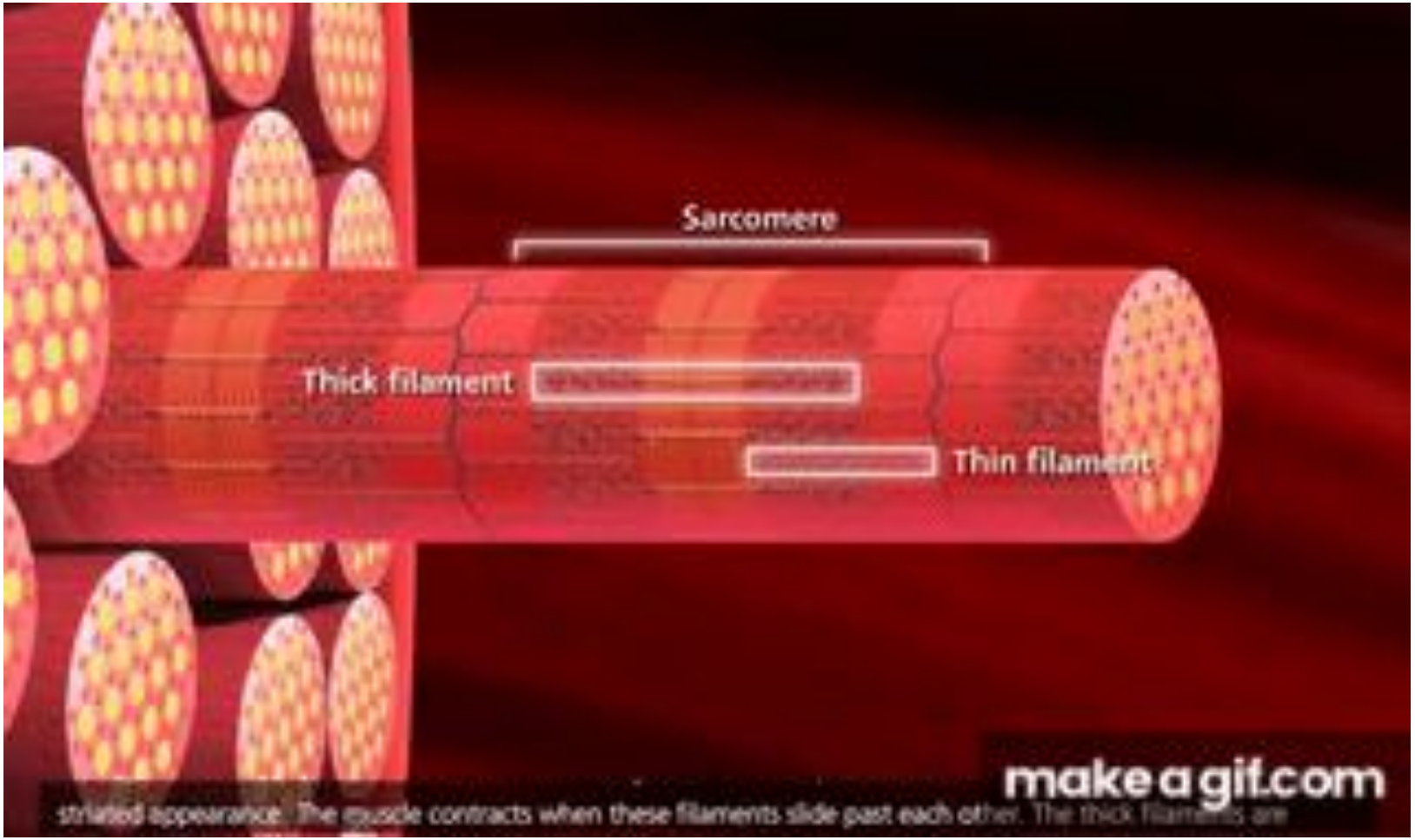
Description of the mechanism

"In the intricate world of muscle contraction, two key players come into focus: **ATP (Adenosine Triphosphate) and calcium ions (Ca^{2+}).** These molecules play pivotal roles in the dynamic interaction between myosin and actin filaments.

ATP serves as the cell's energy currency, and in muscle cells, **it's the 'fuel' that powers the entire contraction process**. When a muscle is stimulated, **ATP is required to energize myosin, allowing it to bind to actin and perform the 'power stroke,' causing muscle fibers to contract**. Without ATP, muscle contraction would come to a grinding halt.

On the other hand, calcium ions are like the 'switch' that initiates the contraction. Normally, calcium is stored in specialized compartments within muscle cells. **When a nerve signal arrives at the muscle, it triggers the release of calcium from these storage sites**. Calcium then binds to a molecule called troponin, which moves tropomyosin aside, exposing the binding sites on actin. This allows myosin to grab onto actin and initiate the contraction.

In summary, ATP provides the energy needed for myosin to do its work, while calcium ions act as the 'starter' for the muscle contraction process. Together, these two molecules orchestrate the synchronized dance of myosin and actin, allowing our muscles to contract and perform essential functions in our bodies."


Sarcomere
Thick filament
Thin filament
striated appearance. The muscle contracts when these filaments slide past each other. The thick filaments are
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Animation

https://www.youtube.com/watch?v=GrHsiHazpsw

Animation

https://www.youtube.com/watch?v=BVcgO4p88AA