



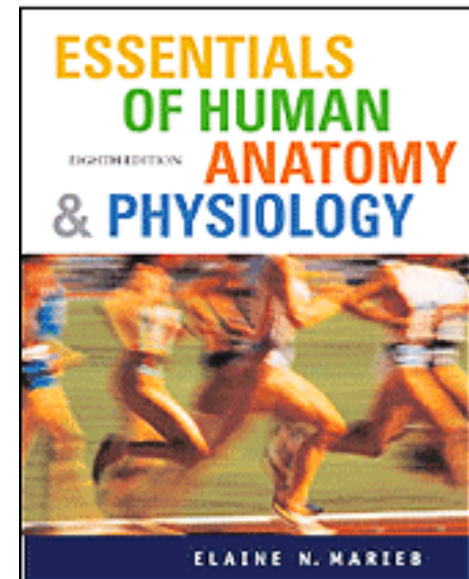
# Human Anatomy and Physiology

CLS 224

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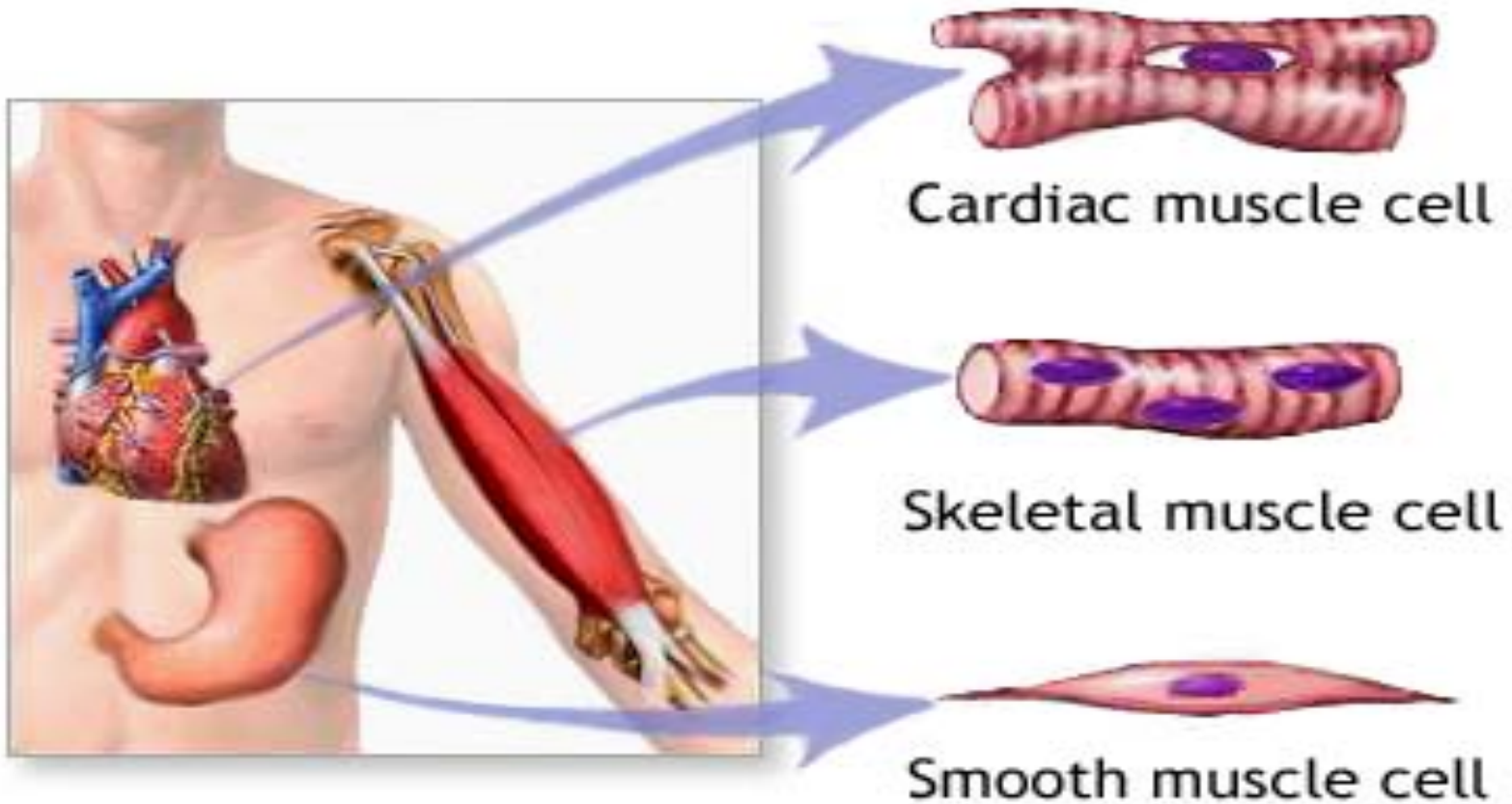


# **Muscular system**

# The Muscular System

- The only body tissue able to *contract*. As a result, muscles are responsible for all body movement.
- “The machine of the body”
- There are three basic types of muscle
  - *Skeletal*
  - *Cardiac*
  - *Smooth*

# 3 Types of Muscles



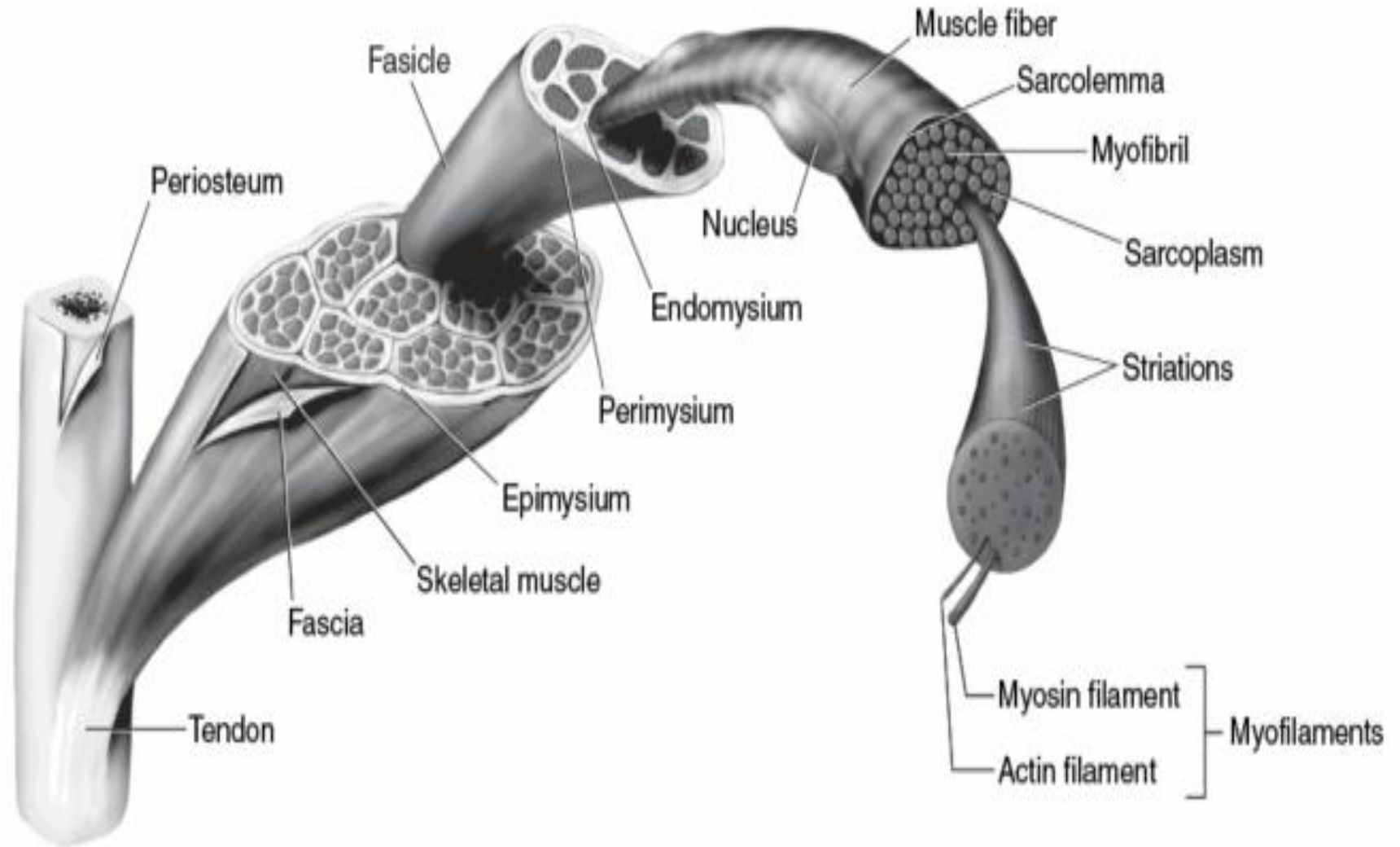
# Classification of Muscle

<p><b>Skeletal- (muscle fiber)</b> found attach to the body's Skeleton.</p>	<p><b>Cardiac- (x)</b> found in heart.</p>	<p><b>Smooth- (muscle fiber)</b> Found in viscera (stomach, urinary bladder, large arteries..)</p>
Striated, multi- nucleated	Striated, 1nucleus	Not striated, 1 nucleus
Controlled by CNS	Regulated by ANS	Controlled by ANS
voluntary	involuntary	involuntary
move, maintain posture and generate heat	Heart beating	Peristalsis
Slow to fast	slow	Very slow

# Skeletal Muscles

Skeletal muscles are sheathed by a tough layer of connective tissue called the **epimysium**. The epimysium joins muscle tissue to tendons at each end, It also protects muscles from friction against other muscles and bones.

- Within the epimysium are multiple bundles of muscle fibers called **fascicles**, each of which contains 10 to 100 or more muscle fibers collectively protected by a **perimysium**. The perimysium is a pathway for nerves and the flow of blood within the muscle.
- The thread like muscle fibers are the individual muscle cells (myocytes), and each cell is encased within its own **endomysium** of delicate connective tissue.

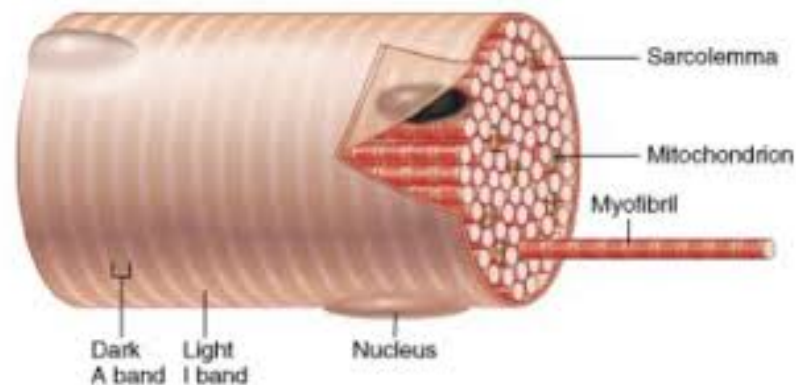


**Figure 2.2** Organization of skeletal muscle.

Reprinted, by permission, from W. Whiting and S. Rugg, 2005, *Dynatomy* (Champaign, IL: Human Kinetics).

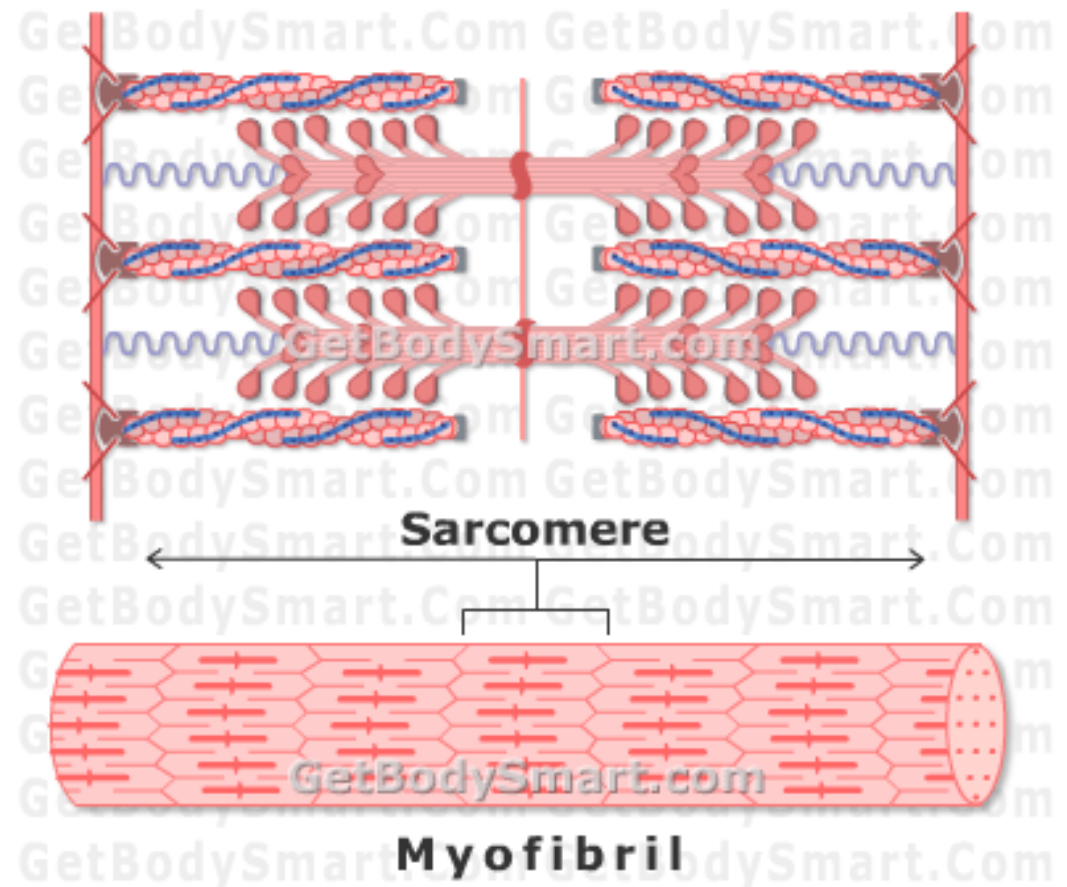
# Microanatomy of **Skeletal Muscles**

- An individual muscle cell is called a muscle fiber
- A muscle fiber is enclosed by a plasma membrane called the **sarcolemma**.
- The cytoplasm of a muscle fiber is called a **sarcoplasm**.
- Nuclei pushed aside by organelles called **myofibrils** that fill the cytoplasm,





- Myofibrils are chains of tiny contractile units called **sarcomeres**.
- sarcomeres are the smallest functional units of a muscle.
- A sarcomere is composed of two types of threadlike protein filaments : **Myosin** and **Actin**, which are responsible for muscle contraction. Myosin is a thick filament, Actin is a thin filament.



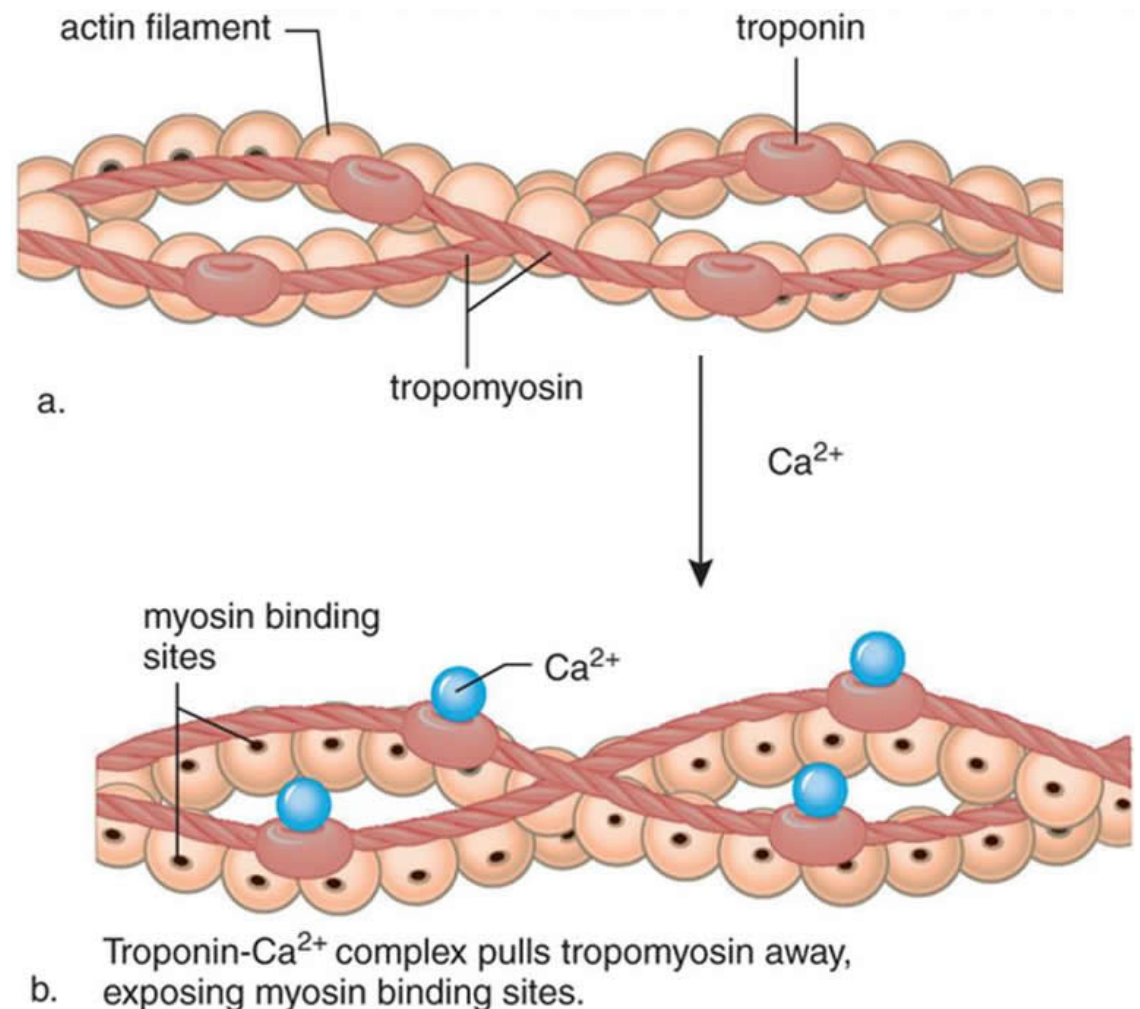
# Another important muscle fiber organelle

- The **sarcoplasmic reticulum (SR)**, is smooth ER. It releases calcium ions during contraction and absorbs them during relaxation.
- Within the sarcoplasm, there are **T-tubules** that allow transport of substances throughout the muscle fiber.

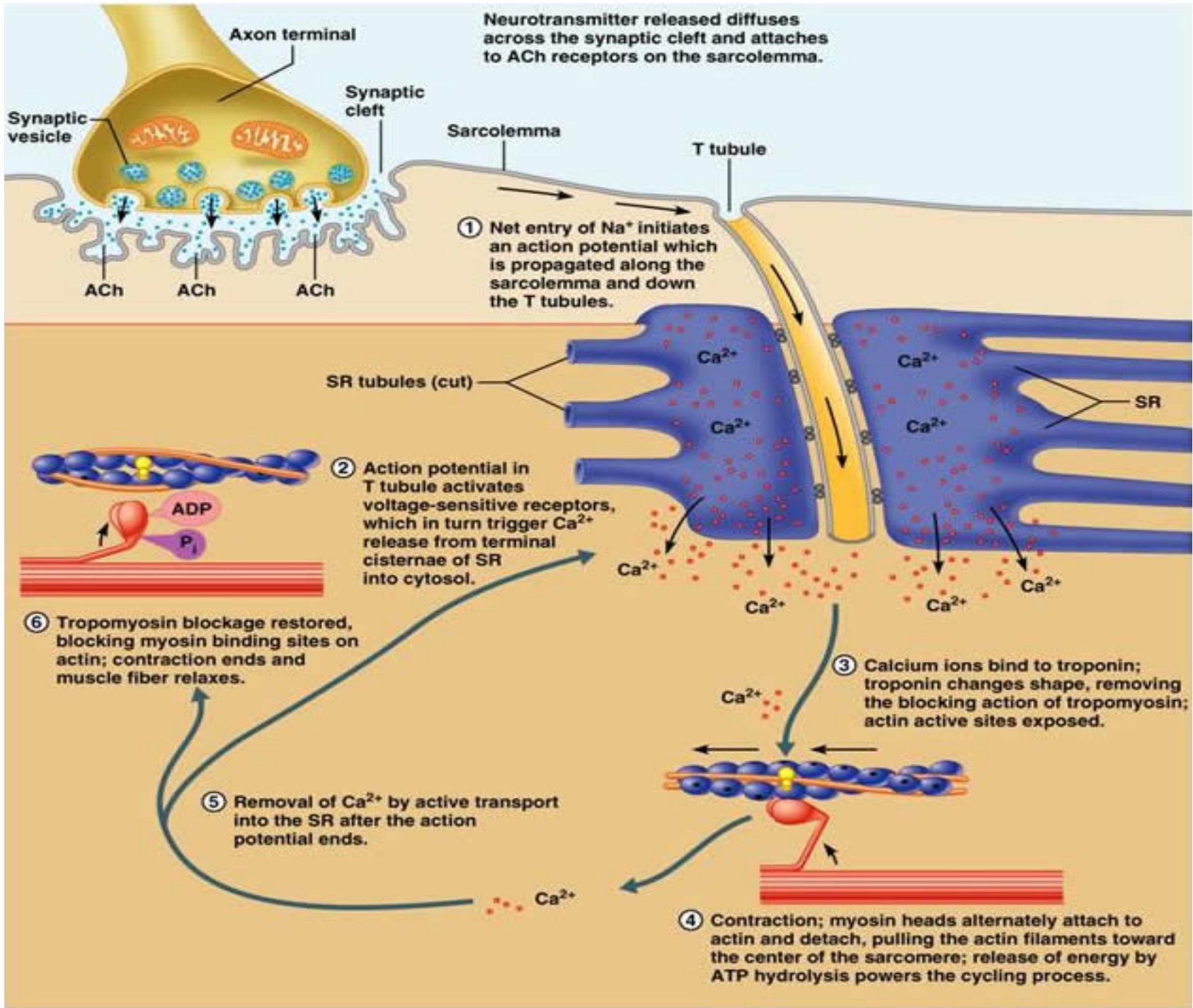
# Troponin and Tropomyosin

- Troponin and tropomyosin are regulatory proteins complexes involved in muscle contraction.

Lies within the actin filaments.

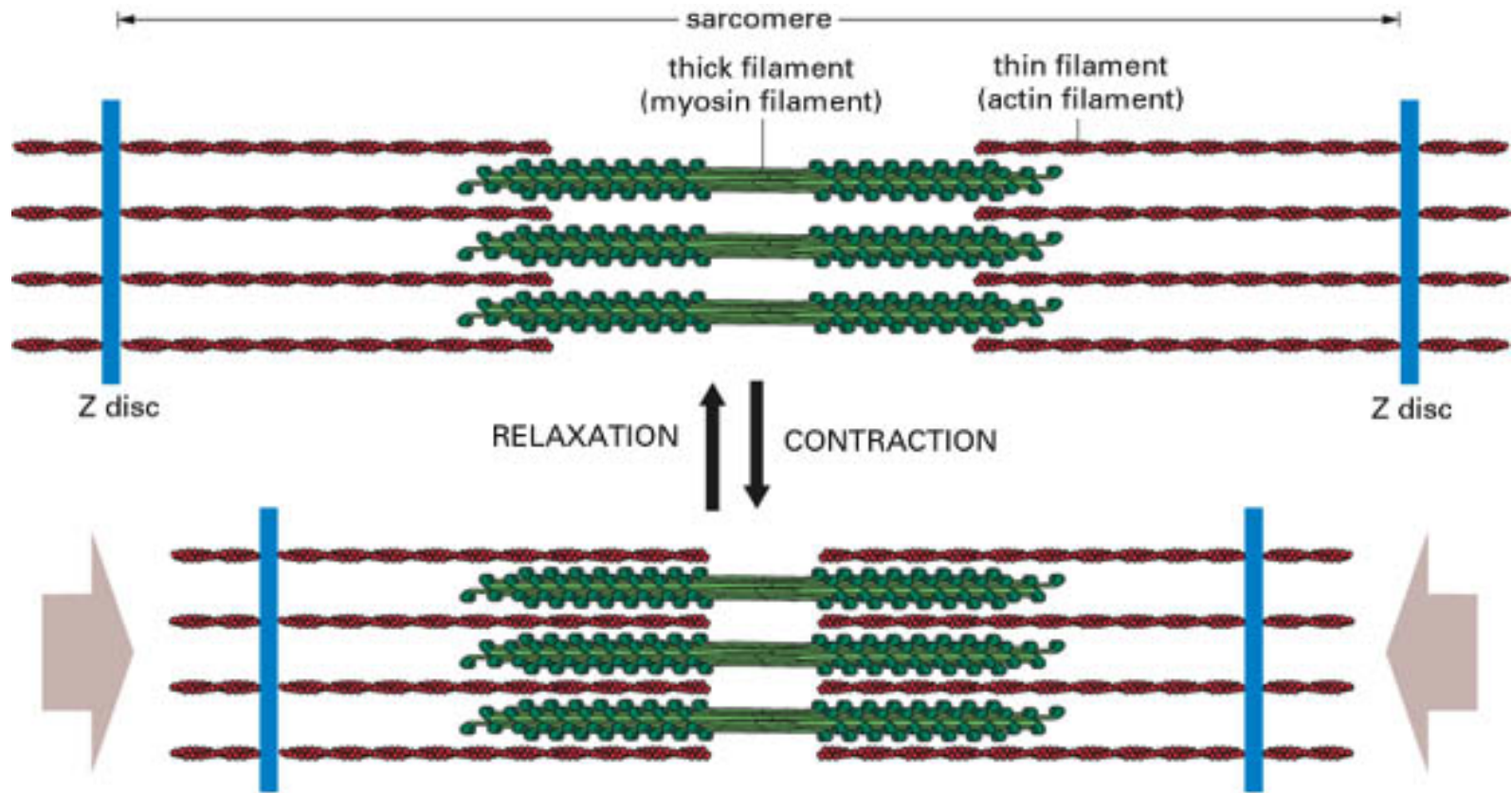


# Muscle Fiber Contraction



- All skeletal muscle fibers are stimulated by motor neurons.
- These neurons release acetylcholine Ach (neurotransmitter) that binds to receptors on the sarcolemma
- The permeability of the sarcolemma changes allowing sodium ions to enter the muscle cell through the T tubules.
- An electrical current (action potential) that flows across the entire sarcolemma is generated
- Calcium ions are released from SR. Calcium ions are the final trigger for muscle fiber contraction.

- The Ca<sup>2+</sup> binds to troponin present on the thin filaments (actin) and exposes myosin binding sites. myosin heads on the thick filament can now attach to the actin filament.
- Contraction occurs



- ATP provides the energy for the sliding process

- Muscle contraction ends when calcium is pumped out of the sarcoplasm to the sarcoplasmic reticulum for storage.