Department of Anesthesia Techniques
Title of the lecture:-Excitation Contraction Coupling
Dr.Sura A. Awadh
sura.abdailahalek@mustaqbal-college.edu.iq

Excitation Contraction Coupling

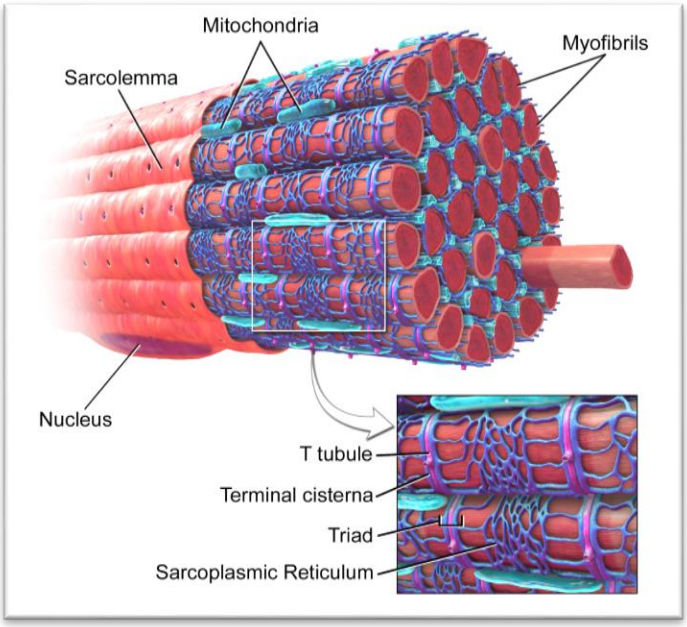
Skeletal Muscle Structure

- **Muscle** is composed of **muscle cells** "muscle fibers". The cell membrane called **Sarcolemma**, the cytoplasm called **Sarcoplasm**. Within the cells are myofibrils which contain **sarcomeres** which composed of thin filament (Actin, Troponin and Tropomyosin & thick filament (Myosin).

Sarcolemma & T-tubule

- **Sarcolemma** : also called the myolemma, is the cell membrane of a muscle cell

- **T-tubules** (transverse tubules) are extensions of the cell membrane that penetrate into the centre of skeletal and cardiac muscle cells



Striation pattern of skeletal muscles

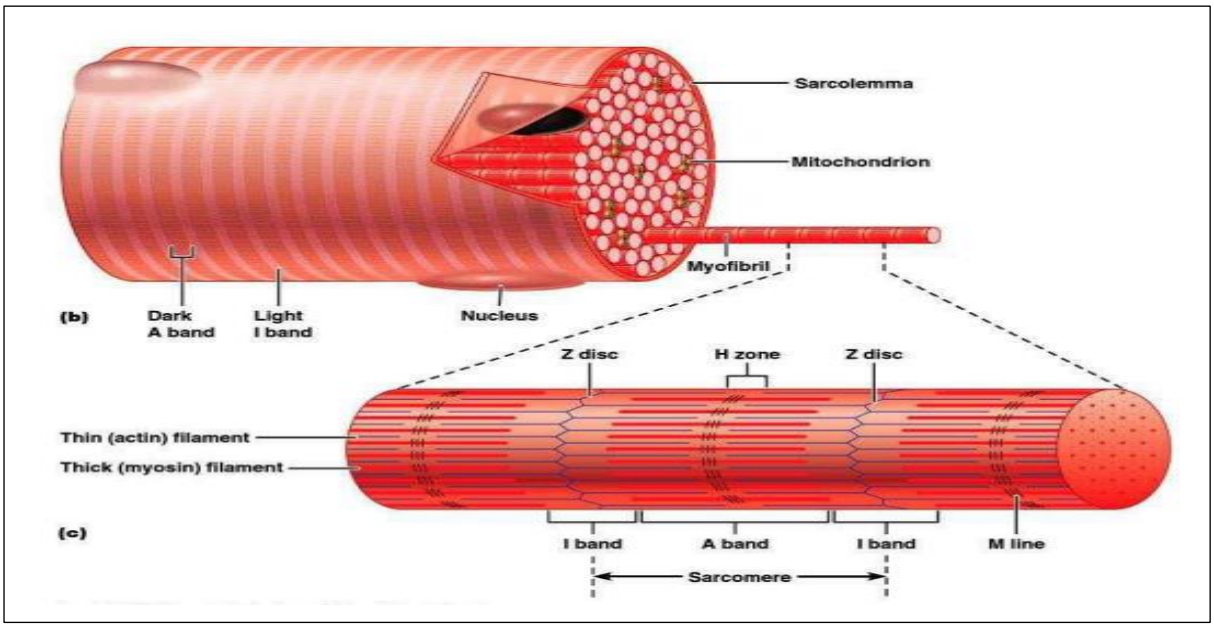
1. The I (light) bands - Composed of thin actin filaments. Extends from the edge of one stack of thick filaments to the edge of next stack.

2. The A (dark) bands– composed of thick myosin filaments overlapping thin filaments (actin).

3. Z lines : Myosin filaments are held together by Z lines .

4. H zone : Central region , consisting of only thick filaments without overlapping between thick and thin filaments.

5. M line: A dark band In the center of A band



Definitions

- **Sarcomere** :

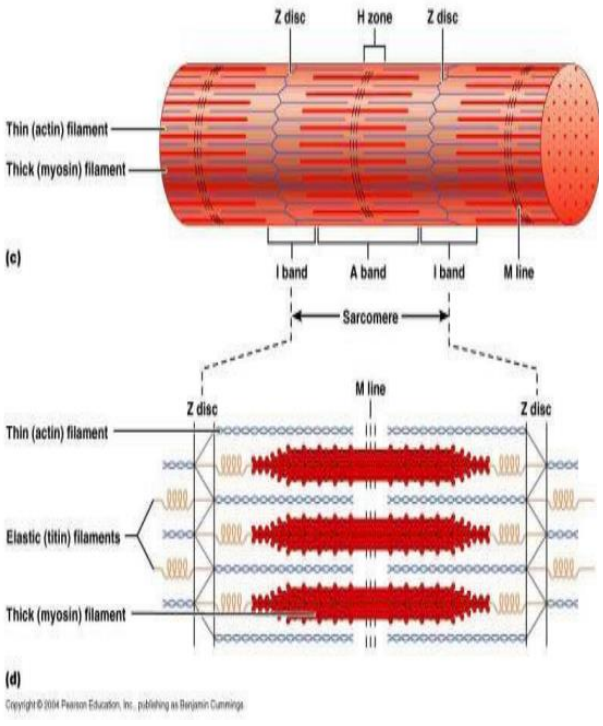
The segment of myofibrils that extends from one Z line to the next Z line.

- **Cross bridge Attachment**:

The activated myosin heads are attracted to the exposed binding sites on actin and cross bridge attachment occurs.

- **Power stroke** :

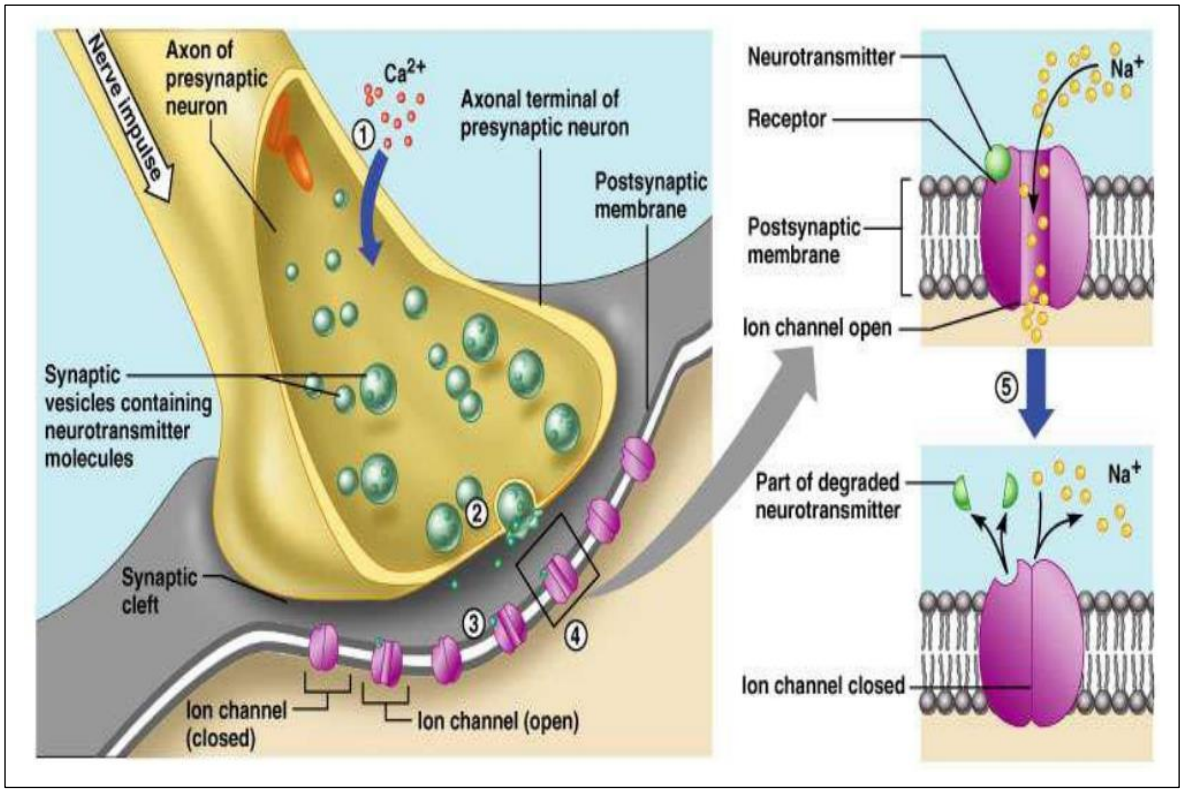
The sliding action which occurs at the same time for thousands of actin and myosin molecules is referred to as the power stroke



Department of Anesthesia Techniques
Title of the lecture:-Excitation Contraction Coupling
Dr.Sura A. Awadh
sura.abdailahalek@mustaqbal-college.edu.iq

Contraction and Relaxation

- A motor nerve and a myofibril form a neuromuscular junction called synapse.
- Upon the stimulation of a nerve, impulse from motor nerve, neurotransmitter (Acetylcholine) will release from synaptic vesicles binding with the receptors & creating action potentials along the cell membrane.



Steps of a skeletal muscle contraction

1. An action potential reaches the axon of the motor neuron.

2. The action potential activates voltage gated calcium ion channels on the axon, and calcium rushes in.

3. The calcium causes acetylcholine vesicles to release neurotransmitter (Acetylcholine) which diffuse across the synapse, opening channels in the membrane for sodium to rushes in and potassium rushes out.

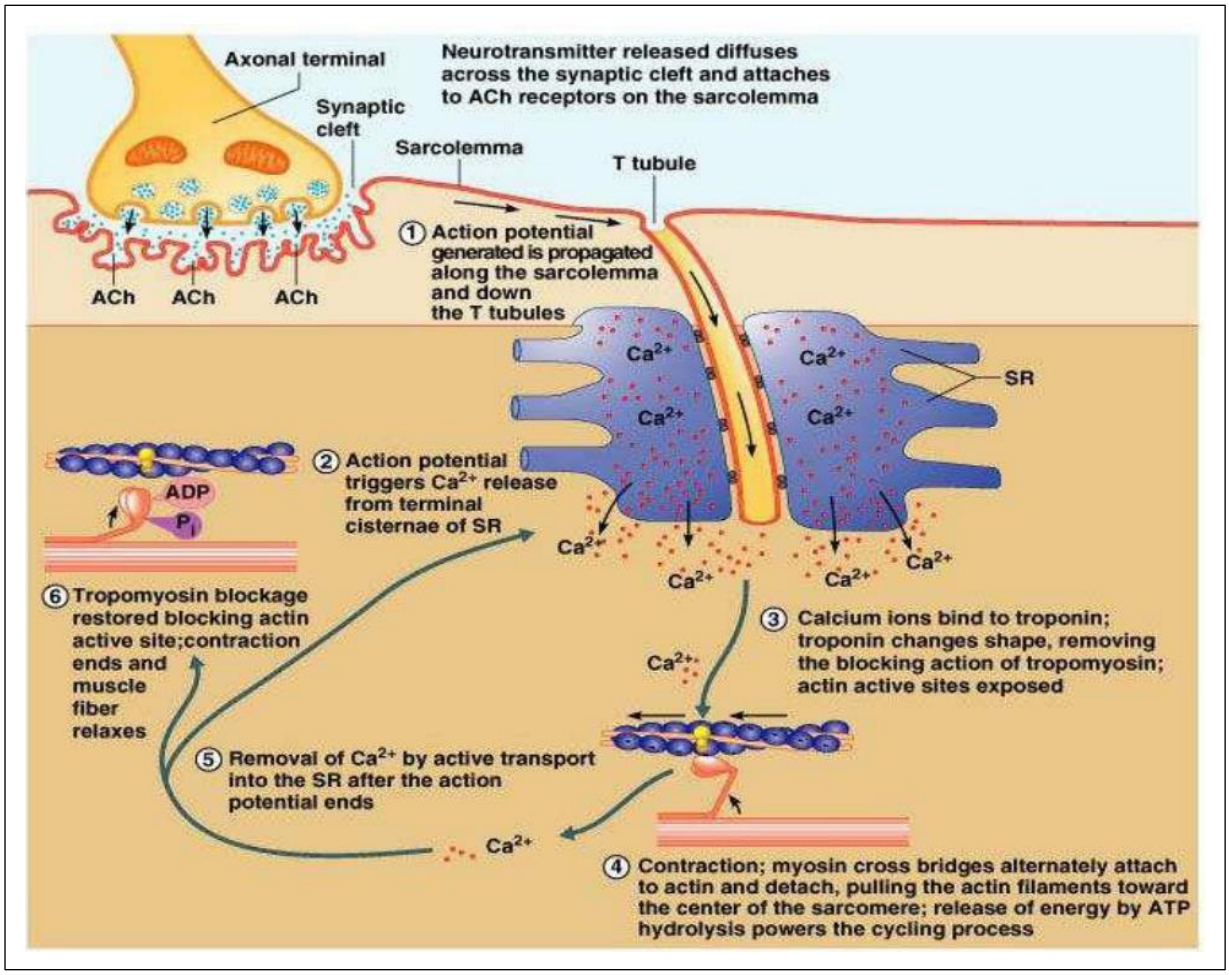
4. The sarcolemma stimulated by the action potential, and a muscle impulse travels through the transverse tubules and reaches the sarcoplasmic reticulum.

5. Ca2+ ions diffuse from the sarcoplasmic reticulum into the sarcoplasm bind to troponin molecules.

6. Tropomyosin molecules move and expose specific sites on actin filament.

7. Actin and myosin filaments form linkages and actin filaments are pulled inward by myosin cross bridges.

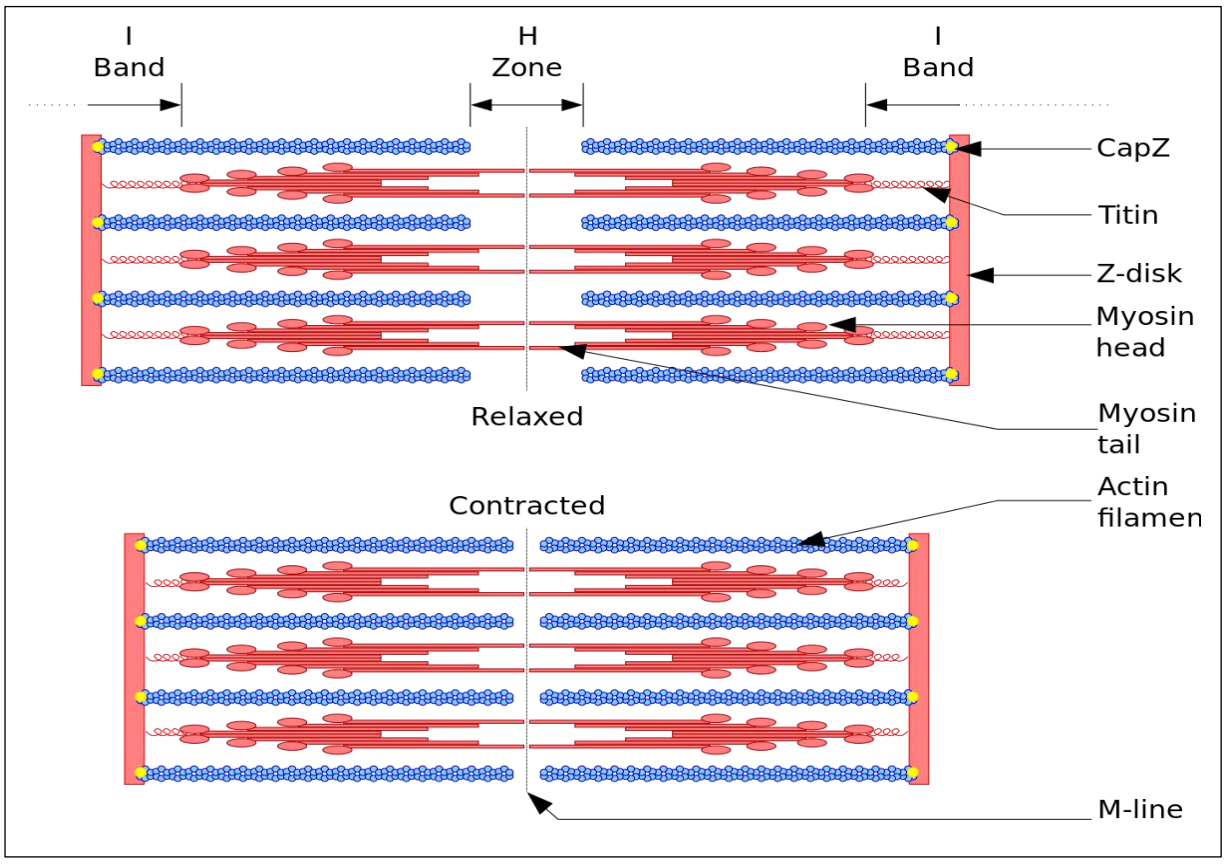
8. Muscle fiber shortens as a contraction occurs



Dr.Sura A. Awadh
sura.abdailahalek@mustaqbal-college.edu.iq

Sliding Filament Theory

- When a muscle contracts, the actin is pulled along myosin toward the center of the sarcomere until the actin and myosin filaments are completely overlapped.
- The H zone becomes smaller and smaller due to the increasing overlap of actin and myosin filaments, and the muscle shortens.
- Thus when the muscle is fully contracted, the H zone is no longer visible.
- The actin and myosin filaments themselves do not actually change length, but instead slide past each other.



Dr.Sura A. Awadh
sura.abdailahalek@mustaqbal-college.edu.iq

Major events of muscle relaxation :

1. Acetylcholinestrase decomposes acetylcholine , and the muscle fiber & membrane is no longer stimulated .
2. Ca2+ ions are actively transported into the sarcoplasmic reticulum .
3. ATP causes linkage between actin and myosin filaments to break .
4. Cross–bridges re–open .
5. Troponin & tropomysin molecules inhibit the interaction between myosin and actin filaments .
6. Muscle fiber remain relaxed , yet ready until stimulated again

Neuromuscular Blocking Agents (Muscle Relaxants)

- Drugs that block transmission at the neuromuscular junctions causing paralysis of the affected skeletal muscles. This is accomplished via their action on the post-synaptic acetylcholine (Nm) receptors.

  Types:

1. Depolarizing muscle relaxants act as Acetylcholine (ACh) receptor agonists
2. Non-depolarizing muscle relaxants function as competitive antagonists