



# Physiology Team 432



## **(7) + (8) Lectures: Muscle Contraction**

**DONE BY:**

**Othman Al-Mutairi & Eman Al-Bediea**

**REVIEWED BY:**

**Khulood Al-Raddadi & Mohammad Jameel**

**1433- 2012**

## Molecular basis of muscle contraction

### In skeletal muscle:

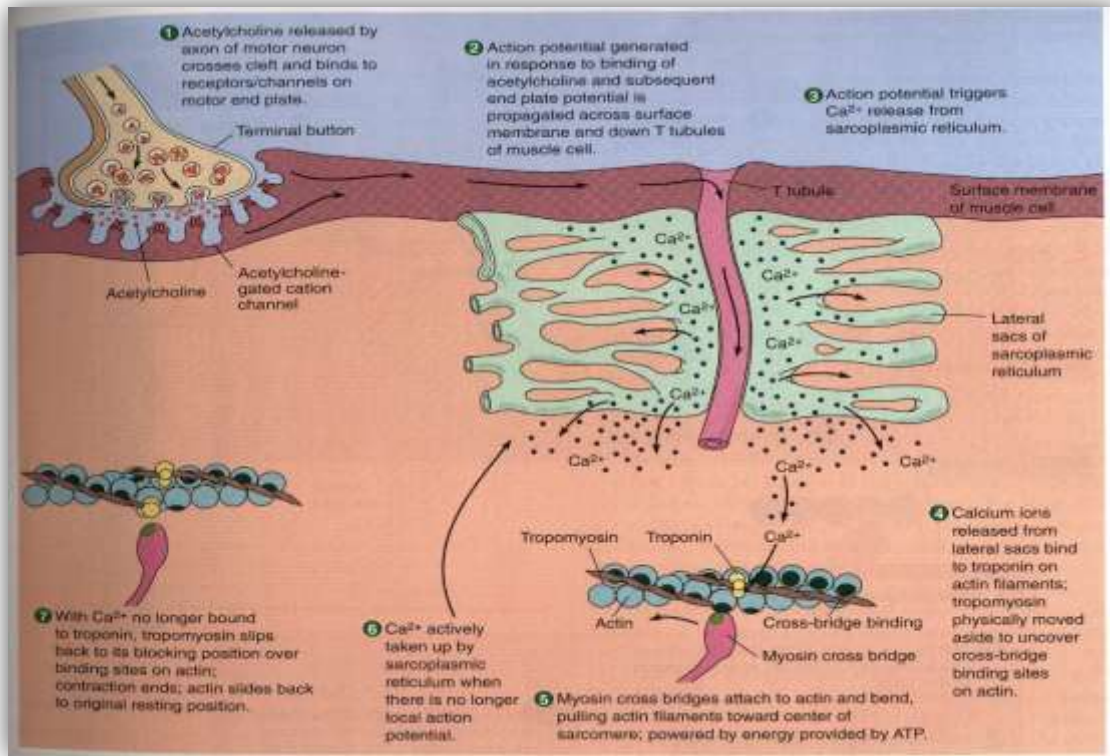
Resting membrane potential (RMP) = -90 mV and the duration of action potential (AP) is 1-5 MS and the conduction velocity (CV)= 3-5 m/s

- Anatomical consideration:
  - Muscle fibre
  - Sarcomere : the building block ( unit ) of muscle
  - Myosin (thick filament): has 2 active sites on the head , one for ATP ,, the other for the actin molecule.
    - Cross-bridge (actin molecule + myosin head)
  - Actin (thin filament)
    - Regulatory protein: (Troponin,Tropomyosin)  
Troponin: calcium binding sit.  
Tropomyosin: covering the active sit in the actin molecule.
    - Actin molecule: has myosin binding site.

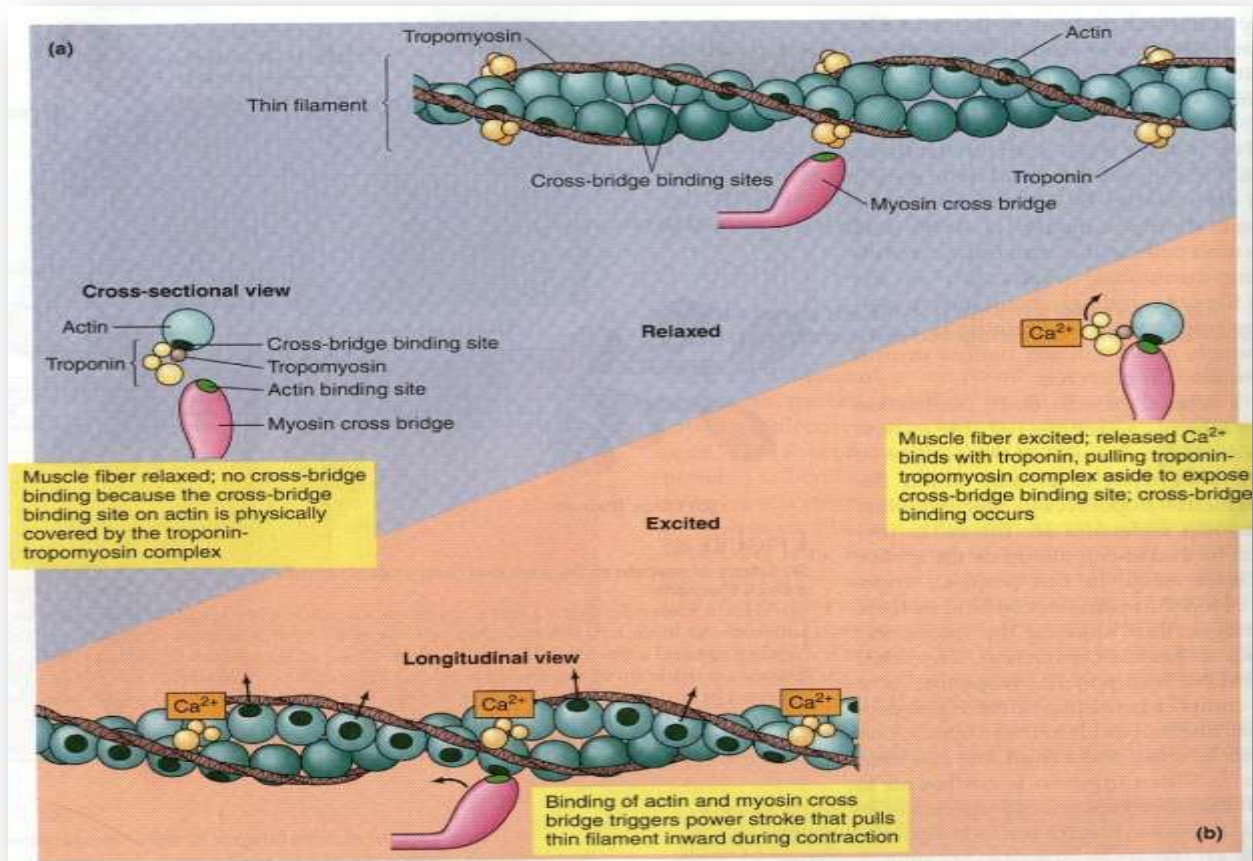
### Events of muscle contraction:

- Acetylcholine released by motor nerve »»»» EPP »»»» depolarization of CM (muscle AP).
- Spread of AP into sarcoplasmic reticulum »»»»release of Ca into the cytoplasm
- Ca combines with troponin »»»» troponin pull tropomyosin sideway »»»» exposing the active site on actin »»»» myosin heads with ATP on them, attached to actin active site
- Resulting in formation of high energy actin-myosin complex »»»» activation of ATP ase (on myosin heads) »»»» energy released, which is used for sliding of actin & myosin

الـ AP ينتقل عن طريق T-tubule عشان يوصل للـ SR و يطلع منها الكالسيوم و يرتبط بالـ Troponin و إذا ارتبط يتحرك الـ Tropomyosin يصير الـ active sit مكشوف و يجي الـ myosin ويرتبط فيه .



**T-tubule of muscle is a deep invagination of the sarcolemma which is the plasma membrane, only found in skeletal and cardiac muscle cells**

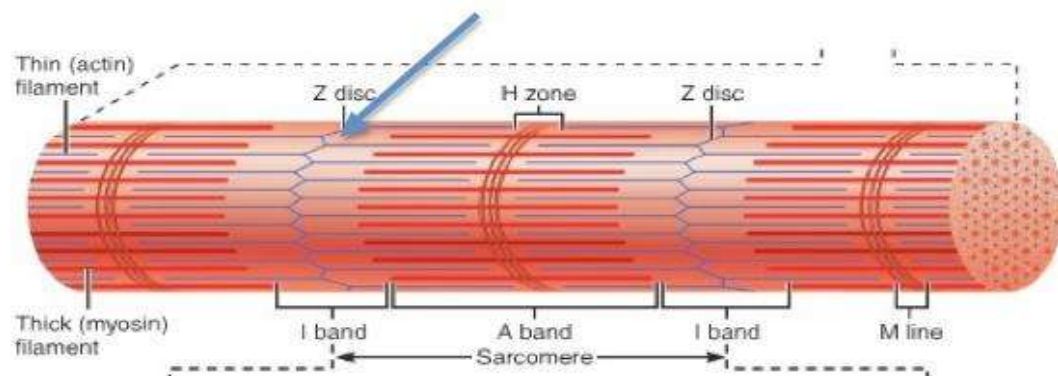


-Cylindrical, multinucleated muscle fibers (10-100 micron in diameter, hundreds of cm long).

-Cell membrane: **sarcolemma**.

-Each Cell contains hundreds to few thousands of striated myofibrils made up of 3000 actin and 1500 myosin filaments.

-Myofibrils.



**Sarcomere limited:**

- **By two Z-lines, A bands consist mainly of thick Myosin, I bands consist of thin actin (end of actin are of Z-lines).**
- **During contraction the sarcomere shorten in size and I band shorten and might disappear but A band still not affected.**

- When a new ATP occupies the vacant site on the myosin head, this triggers detachment of myosin from actin.
- The free myosin swings back to its original position, & attached to another actin & the cycle repeat its self.

- When Ca is pumped back into sarcoplasmic reticulum
- Ca detached from troponin »»»» tropomyosin return to its original position
- covering active sit on actin »»»» prevent formation of cross bridge »»»» relaxation

<http://www.youtube.com/watch?v=f0mDFP7qn1Y> فيديو يوضح الـ ٦ خطوات:



سؤال من الدكتور عن تناسق التركيب والوظيفة :

### ATP Is needed for:

- (1) Actin and myosin attachment.
- (2) Detachment of myosin from actin active site.
- (3) Pumping  $Ca^{++}$  back into the Sarcoplasmic reticulum.

- Which one is better, the contraction of all –or- some fibers in the muscle?

The contraction of some fibers is better.

### In muscle contraction:

#### ■ 1- simple muscle twitch:

The mechanical response (contraction) to **single AP** (single stimulus)

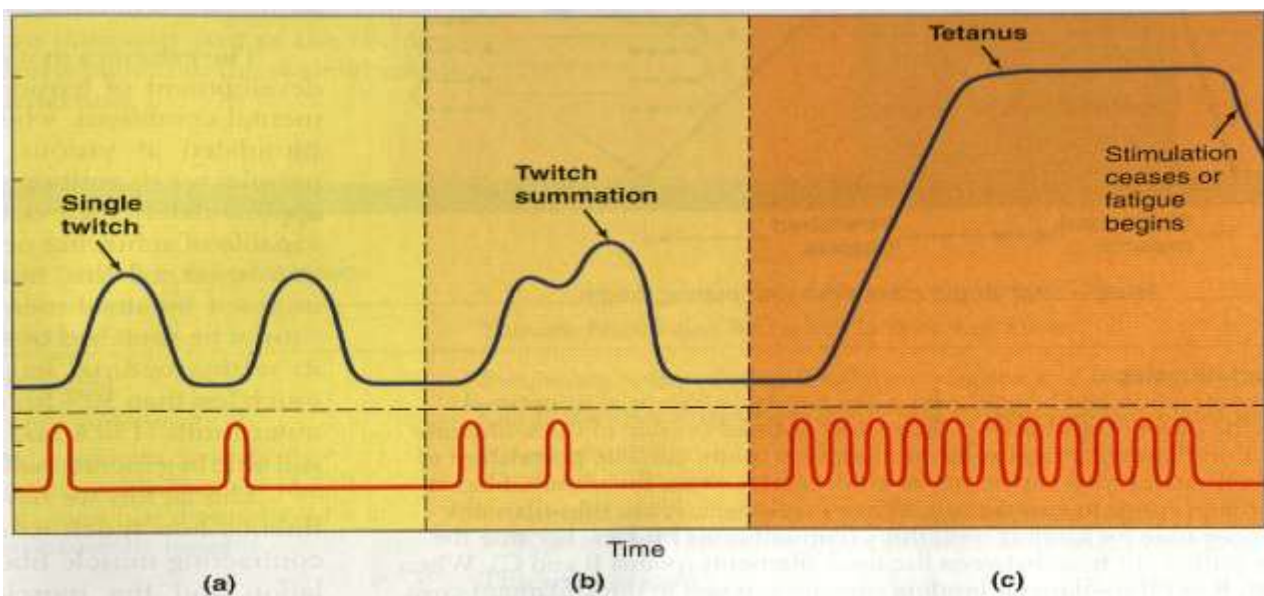
#### ■ 2- Summation of contraction:

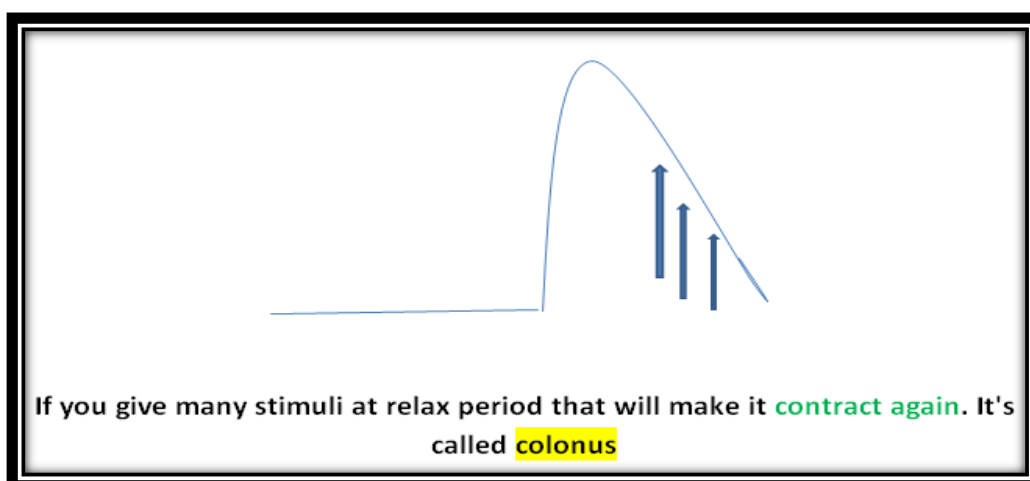
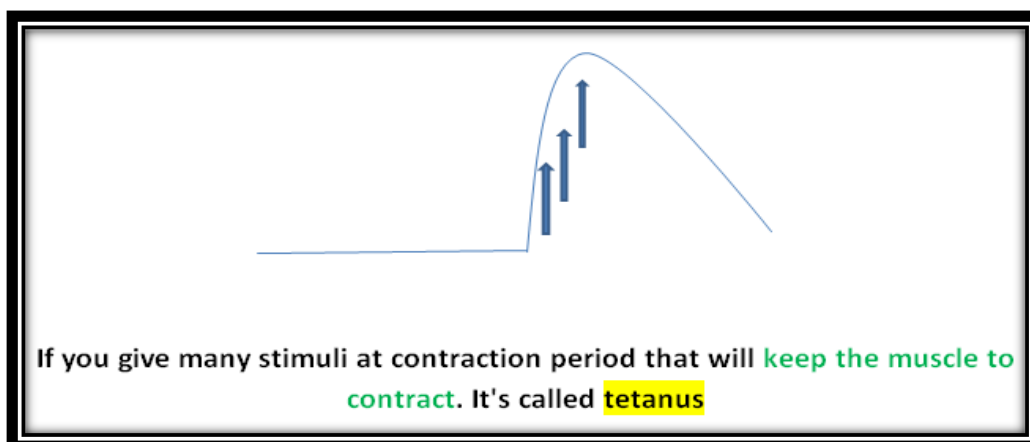
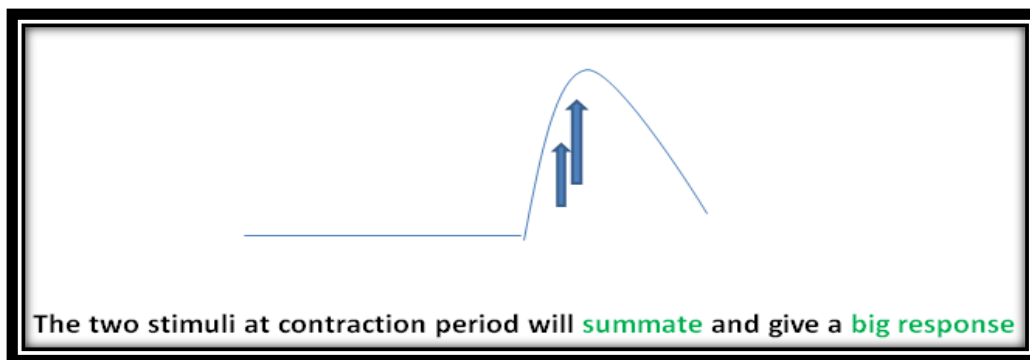
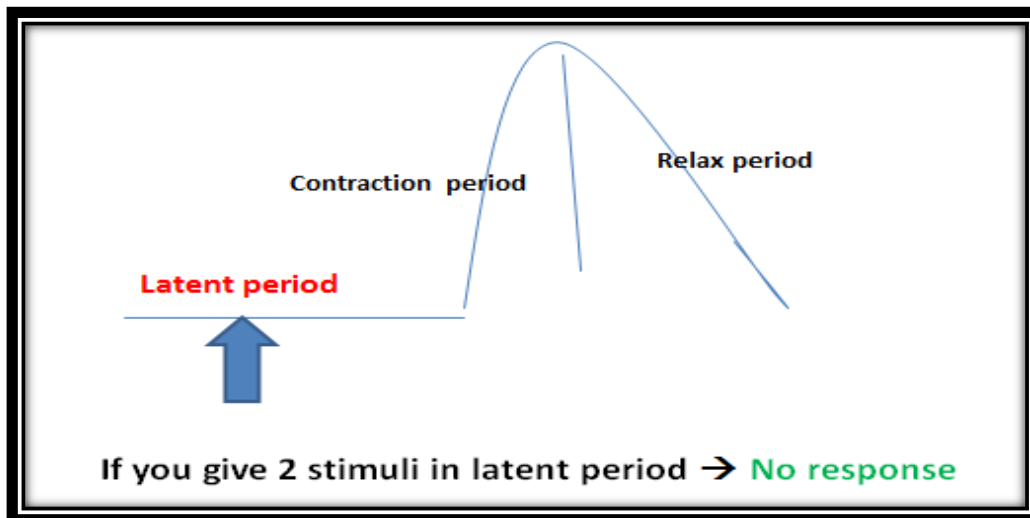
##### -Spatial (متوزع) summation:

The response of different motor unites are added together to produce a strong muscle contraction.

##### -Temporal summation:

When frequency of stimulation increased (on the same motor unite), the degree of summation increased, producing stronger contraction.





## Types of muscle contraction:

- **1- Isometric contraction:** (iso=same ,, matric=length)
  - **No change in muscle length, but increase in muscle tension** (e.g. standing)
  
- **2- Isotonic contraction:** (tonic=the same tone of muscle)
  - **Constant tension, with change in muscle length** (e.g. lifting a loud)

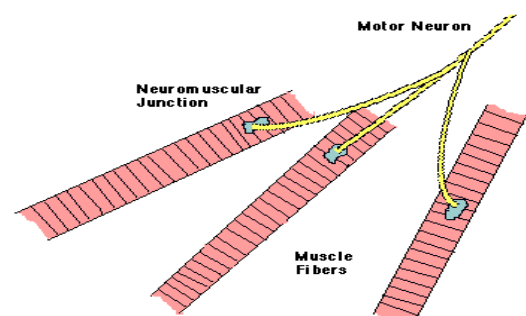
## Rigor Mortis:

When the person die while the muscle was doing contraction.

(Maintained muscle contraction so the detachment can't happen due to lacking of ATP )

## ELECTROMYOGRAPHY (EMG)

- It's a recording of electrical activity of the muscle by inserting needle electrode in the belly of the muscles or by applying the surface electrodes.
- The potentials recorded on volitional effort are derived from motor units of the muscle, hence known as motor unit potentials (MUPs).
  - Electromyography (EMG) is a technique for evaluating and recording physiologic properties of muscles at rest and while contractin.
  - (A motor unit is defined as one motor neuron and all of the muscle fibers it innervates)



Video: 😊 😊

[http://www.youtube.com/watch?feature=player\\_embedded&v=k7WN9MpZw8g#at=161](http://www.youtube.com/watch?feature=player_embedded&v=k7WN9MpZw8g#at=161)

GOOD LUCK