

### **Role of Ca<sup>+</sup> in muscle contraction:**

- 1. promotes neurotransmitter release .
- 2. Triggers Ca<sup>+</sup> release from SR .
- 3. Triggers sliding of my filaments and ATPase activity .
  - 4. promotes glycogen breakdown & ATP synthesis

### **Events of muscle contraction**

1. The distal end of a motor neuron releases **Acetylcholine** .
2. Acetylcholine diffuse across the gap at the **neuromuscular junction** .
3. The **sarcolemma** is stimulated , and a muscle impulse travels over the surface of the muscle fiber and deep into the fiber through the transverse tubules and reaches the sarcoplasmic reticulum .
4. **Ca<sup>2+</sup>** ions diffuse from the sarcoplasmic reticulum into the sarcoplasm bind to **troponin** molecules .
  
5. Tropomyosin molecules move and expose specific sites on actin filament .
6. Actin and myosin filaments form linkages .
7. Actin filaments are pulled inward by myosin cross – bridges .
8. muscle fiber shortens as a contraction occurs

**Smooth muscle**, (so-named because the cells do not have striations) also called **involuntary muscle**. It consists of narrow spindle-shaped cells with a single, centrally located nucleus. It is present in the walls of hollow organs like the urinary bladder, uterus, stomach, intestines, and in the walls of passageways, such as the arteries and veins of the circulatory system, and the tracts of the respiratory, urinary, and

reproductive systems .Smooth muscle is also present in the eyes, where it functions to change the size of the iris and alter the shape of the lens; and in the skin where it causes hair to stand erect in response to cold temperature or fear.

Smooth muscle [tissue](#), unlike [striated muscle](#), contracts slowly and automatically. It [constitutes](#) much of the musculature of internal organs and the digestive system.

## Smooth Muscle Contraction

1. Smooth muscles contain filaments of actin and myosin .
2. Lack transverse tubules and S.R. is not well developed .
3. Display rhythmicity (spontaneous repeated contractions) , responsible for [peristalsis](#) (alternate contraction and relaxation) .
4. Lack troponin (protein that binds to  $Ca^{2+}$ ) , instead [calmodulin](#) binds to  $Ca^{2+}$  .
5. Both Acetylcholine & norepinephrine are neurotransmitters for smooth muscles .
6. Hormones and stretching affect smooth muscle contractions .
7. Can contract for a long period of time .

## Cardiac muscle

a) unique arrangement of actin and myosin filaments produces the cross- striations (an optical illusion the microscope), and rapid contraction with powerful forces involved.

- b) muscle cells are joined by [intercalated disks](#), and allow muscle groups to form branching networks - both features are necessary for cardiac muscle to function as a unit (" syncytium" ).
- c) **SR** and **T** tubules are well developed, so a large amount of [calcium](#) can be released rapidly through the T tubules

- d) contains more mitochondria in each muscle cell than skeletal and smooth muscles, providing more **ATP** energy for continuous contraction

### Muscle Response

- All – or – none response
- a. if a muscle fiber contracts at all , it will contract completely .
- b. motor units respond in an all – or – none manner .
- - **Threshold stimulus** is the minimal stimulus needed to elicit a muscular contraction .
- **Twitch** : single , short contraction reflecting stimulation of some motor units in a muscle .
- - **Latent period** is the time between stimulus and responding muscle contraction .
- - **refractory period** : During his period immediately following contraction , a muscle can not respond

**Summation** : A rapid series of stimuli may produce summation of twitches and a sustained contraction .

- Forceful , sustained contraction without relaxation is a **tetanic contraction** . - Tetany is the result of low **Ca<sup>2+</sup>** concentrations

### Types of Contractions:

- Isotonic : when a muscle contracts and its ends are pulled closer together .
- Isometric : when a muscle contracts but attachments do not move
- Isokinetic : when the force a muscle generates is less than that required to move or lift an object