

# BIOCHEMICAL MECHANISMS OF MUSCLE CONTRACTION AND RELAXATION, THE IMPORTANCE OF MONOVALENT IONS AND CALCIUM IONS

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**Annotation:** The article provides information on the biochemical mechanisms of muscle contraction and relaxation, the importance of monovalent ions and calcium ions.

**Keywords:** ATP,  $\text{Ca}^{+2}$ - $\text{Mg}^{+2}$ -ATP hase, Energetic, Morphological Biophysical-chemical energy, Nerve impulses

The contraction occurs as a result of the interaction of two different protein fibers in the muscle, consisting of actin and myosin. Due to the successive formation and rupture of the diurnal bridges between the two types of filaments, the generation of forces takes place, which ensures the movement of the actin filaments to the central area of the myosin filaments. Every day, the bridges break and the filaments become loose as a result of the primary condition. This cycle is triggered by the propagation of a depolarization wave in both directions along the length of the muscle fiber from the neuromuscular contact; As the diaphragm waves into the foramen magnum, the excitation process spreads inward and provides  $\text{Ca} + 2$  release from the sarcoplasmic reticulum. Troponin, located in the act of sarcoplasmic reticulum, binds to the C protein, which changes the conformation of this protein. This, in turn, allows the transfer of another protein - tropomyosin, which prevents the formation of diurnal bridges between actin and myosin. The formation of diurnal bubbles activates actin filaments; it is due to the energy released under the action of myosin as a result of hydrolysis of ATP. At the end of the excitatory state, the sarcoplasmic reticulum  $\text{Ca} + 2$ - $\text{Mg} + 2$ -ATPase provides the re-transfer of calcium into this system. When the concentration of  $\text{Ca} + 2$  is low, the diaphragms rupture and the muscle fibers relax.

During muscle contraction, actin filaments are classified as myosin filaments by M-lines:

The problem of muscle contraction includes 3 aspects:

1. Energy
2. Morphological (changes in the micro and submicrostructure of muscle fibers).
3. Biophysical-chemical energy is transformed into mechanical energy.

Myosin has a contractile function and ATPase activity. Actin plays a role in pH shift (optimal degree of reduction reaction in the field of physiological pH levels). In addition, actin performs a supporting function, changes in the structural state of myosin molecules can be seen as a mechanical effect of contraction or contraction. Г. According to Huxley, the interpretation of morphological aspects is widely accepted. When the muscle is contracted, thin protofibrils move along the thickness, area I is shortened, Z discs are drawn closer, that is, the sarcomere is shortened.

ATP is involved in muscle contraction energy. At present, ATP has been shown to be an energy source for muscle contraction and relaxation.

#### *The role of monovalent ion and calcium ion gradient in muscle contraction*

Under the influence of nerve impulses, acetylcholine is released in the myoneural plate, which increases the permeability of the muscle fiber membrane to Na<sup>+</sup> and K<sup>+</sup> ions and ensures their redistribution. This leads to changes in the concentration gradient of Na<sup>+</sup> and K<sup>+</sup> inside and outside the muscle fiber. The muscle first converts chemical energy into electrical and osmotic energy, and as a result, the contraction apparatus becomes active. Changes in the concentration of calcium in the cell play an important role in the formation of muscle contraction. After receiving a nerve impulse, the permeability of the sarcoplasmic reticulum membrane changes rapidly and Ca<sup>2+</sup> ions are released into the sarcoplasm. The muscle contraction that occurs is due to the ability of myofibrils to bind to ATP at a concentration of Ca<sup>2+</sup> at 10<sup>-5</sup> - 10<sup>-6</sup>M. The "sensitivity" of the actomyosin system to Ca<sup>2+</sup> ions is due to the presence of troponin protein in the actin

filaments. Calcium binds to troponin and conformational changes occur in its molecule, which leads to the movement of the troponin-tropomyosin complex in the F-actin transformation, and the active centers of the actin are blocked and have the ability to bind to myosin. According to Huxley and Hanson, when myofibrils contract, the actin filaments slide along the myosin filaments, meaning that the filaments do not contract, but "slide" on each other's faces, which is an important link in the molecular mechanism of muscle contraction.

In the movement of actin filaments along the myosin filaments, diurnal bridges, which are temporarily formed from the heads of the myosin molecule between the filaments, play an important role.

The binding of myosin filaments to actin occurs not only by the rotation of the head of the myosin molecule, but also by the lateral movement of the actin filaments, which are located at a certain distance. Muscle 2-phase function (contraction-relaxation) depends on the dynamics of the amount of  $\text{Ca}^{+2}$  ions. When calcium concentrations decrease, free tropomyosin closes the active center of actin, which prevents the formation of actomyosin. This is the main reason for muscle relaxation.

The concentration of  $\text{Ca}^{+2}$  ions in the sarcoplasm is minimal ( $10^{-7}\text{M}$ ) in the muscle released as a result of binding to the structures of the sarcoplasmic reticulum and T-system, which includes  $\text{Ca}^{+2}$  ions Ca-binding protein - calcicvestin. Intracellular Ca control is associated with an energy-intensive transport system that carries ATP-dependent sarcoplasmic reticulum. It is due to the energy released during the breakdown of ATP by the reticulum  $\text{Mg}^{+2}$ - $\text{Ca}^{+2}$  ATPase. The activity of this enzyme is manifested when the concentration of  $\text{Ca}^{+2}$  ions is  $10^{-8}$ - $10^{-6}\text{M}$ .

The increase in calcium concentration in muscle cells activates the transport through the sarcoplasmic reticulum and the membrane of the T-system and increases the deposition of Ca, inhibits the ATPase activity of the actomyosin complex, and a steady state occurs. In this case, the muscle is released with a new

impulse of excitation, resulting in the release of calcium from the reticulum and activation of the ATP-member of the actomyosin complex.

During hydrolysis, ATPase (molecular weight 100,000) is broken down into two fragments with a molecular weight of 55,000 and 45,000. A fragment with a molecular weight of 55,000 is located on the outside of the sarcoplasmic reticulum, while a fragment with a molecular weight of 45,000 forms a channel through the membrane into the lipid layer of the membrane. In the long-term hydrolysis of ATP, a fragment with a mass of 55,000 moles is broken down into smaller fragments with a molecular weight of 30,000 and 20,000. The fragment, which has a molecular weight of 20,000, acts as a channel "barrier" and controls the entry of  $\text{Ca} + 2$  ions into it. A 30,000-molecular-weight fragment provides energy for the  $\text{Ca}$  ions to move through the channel. Like a sodium pump, this mechanism is called a calcium pump.

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