

PHYSIOLOGY OF MUSCLE CONTRACTION – A PANCHABHOUTHIK UNDERSTANDING

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ABSTRACT

The individual is an epitome of the universe. All the material & spiritual phenomenon of the universe are present in the individual. Similarly all those present in the individual are also contained in the universe. The body is described as the modified form of *Mahabhutas* hence the description of the identity of the individual & the universe relates to *Mahabhutic* composition only. The multitudes of the human features are ascribed to the proportion of different *Bhutas* each of different nature. The major function of *Prithvi Mahabhuta* is it improves the size by solidifying the body parts, *Jala Mahabhuta* confluences the body tissues, *Agni Mahabhuta* is responsible for metabolic activities, *Vayu Mahabhuta* divides and differentiates the cell and tissues, *Akasha Mahabhuta* increases the quantity by forming cavities. The solid and tough structures like muscle, muscle fibres, nerve and at microscopic level including other cellular components, structural proteins are the attributes of *Prithvi Mahabhuta*. The liquid portion present inside the muscle, nerves i.e. intracellular fluid, secretions from structures which helps in lubrication & moistening can be considered as the attributes of *Jala Mahabhuta*. The *Agni Mahabhuta* can be considered as neurotransmitters that are secreted for the initiation & continuation of muscle contraction, Ionic variations, ATP utilisation that occur for muscle contraction. The process of movement of thick & thin filaments, contraction & relaxation, movement of neurotransmitters across nerve fibre & neuro muscular junction, movement of ions functions of contractile & regulatory proteins in muscle tissue can be considered as the function because of *Vayu Mahabhuta* since the function of *Vayu Mahabhuta* is differentiation, movement & regulation. The space present inside various organs and various channels present for the secretions & other functions can be attributed to *Akasha Mahabhuta*.

Keywords: *Panchamahabhuta*, muscle contraction, *Shareera*, *Kriya*

INTRODUCTION

The individual is an epitome of the universe. All the material & spiritual phenomenon of the universe are

present in the individual. Similarly all those present in the individual are also contained in the universe.¹

Originating in cosmic consciousness, this wisdom was intuitively received in the hearts of the ancient scholars. They perceived that consciousness was energy manifested into the five basic principles or elements. Man is microcosm of the nature and so the five basic elements present in all matter also exists within each individual. Thus out of the womb of the five elements, all matter is born. The five basic elements exist in all matter. Water provides the classic example: - the solids of iced water are manifestation of the *Prithvi Mahabhuta* (earth principle). Latent heat in the ice (*Agni*) liquefies it, manifesting into *Jala Mahabhuta* (water principle). And then eventually it turns into steam expressing the *Vayu Mahabhuta* (air principle) the steam disappears into *Akasha* or space.²*Bhuta* is that which is not born out of something, but out of which something is born. It is the material cause of substances in the world. When we say *Bhuta* we mean that subtle level of existence, where as *Mahabhuta* refers to gross level of existence.³*Panchikarana* is the process through which invisible *Bhutas* combine with each other and form the visible *Mahabhutas* in such a way that all *Bhutas* are present together in each *Drisya Bhuta* in varying degrees of predominance. Thus in the physical world everything is a combination of *Pancha Mahabhutas* & we cannot see them independently.⁴ Thus the five basic elements *Akasha Vayu, Teja, Jala And Prithvi* are present in one substance. This proves that all five elements are present in all matter in the universe.⁵ Visualization of the identity of the individual with the universe paves the way for salvation. The body is described as the modified form of *Mahabhutas* hence the description of the identity of the individual & the universe relates to *Mahabhutic* composition only. The multitudes of the human features are ascribed to the proportion of different *Bhutas* each of different nature.

Myofibrils basic unit of muscle tissue are built from three kinds of proteins: (1) contractile proteins, which generate force during contraction; (2) regulatory proteins, which help switch the contraction process on and off; and (3) structural proteins, which

keep the thick and thin filaments in the proper alignment, give the myofibril elasticity and extensibility, and link the myofibrils to the sarcolemma and extracellular matrix. The two contractile proteins in muscle are myosin and actin, which are the main components of thick and thin filaments, respectively. Myosin functions as a motor protein in all three types of muscle tissue. Motor proteins push or pull various cellular structures to achieve movement by converting the chemical energy in ATP to the mechanical energy of motion or the production of force. In skeletal muscle, about 300 molecules of myosin form a single thick filament. Each myosin molecule is shaped like two golf clubs twisted together. The myosin tail (twisted golf club handles) points toward the M line in the center of the sarcomere. Tails of neighboring myosin molecules lie parallel to one another, forming the shaft of the thick filament. The two projections of each myosin molecule (golf club heads) are called myosin heads. The heads project outward from the shaft in a spiraling fashion, each extending toward one of the six thin filaments that surround each thick filament.

Thin filaments are anchored to Z discs. Their main component is the protein actin. Individual actin molecules join to form an actin filament that is twisted into a helix. On each actin molecule is a myosin-binding site, a myosin head can attach. Smaller amounts of two regulatory proteins—tropomyosin and troponin—are also part of the thin filament. In relaxed muscle, myosin is blocked from binding to actin because strands of tropomyosin cover the myosin-binding sites on actin. The tropomyosin strands in turn are held in place by troponin molecules. when calcium ions (Ca^{2+}) bind to troponin, it undergoes a change in shape; this conformational change moves tropomyosin away from myosin-binding sites on actin and muscle contraction subsequently begins as myosin binds to actin. Besides contractile and regulatory proteins, muscle contains about a dozen structural proteins, which contribute to the alignment, stability, elasticity, and extensibil-

ity of myofibrils. Several key structural proteins are titin, α -actinin, myomesin, nebulin, and dystrophin.⁶ Muscle contraction occurs because myosin heads attach to and “walk” along the thin filaments at both ends of a sarcomere, progressively pulling the thin filaments toward the M line. As a result, the thin filaments slide inward and meet at the center of a sarcomere. They may even move so far inward that their ends overlap. As the thin filaments slide inward, the Z discs come closer together, and the sarcomere shortens. However, the lengths of the individual thick and thin filaments do not change. Shortening of the sarcomeres causes shortening of the whole muscle fiber, which in turn leads to shortening of the entire muscle. The contraction cycle consists of following steps: ATP hydrolysis. The myosin head includes an ATP-binding site and an ATPase, an enzyme that hydrolyzes ATP into ADP (adenosine diphosphate) and a phosphate group. This hydrolysis reaction reorients and energizes the myosin head. Attachment of myosin to actin to form cross-bridges. The energized myosin head attaches to the myosin-binding site actin and releases the previously hydrolyzed phosphate group. When the myosin heads attach to actin during contraction, they are referred to as cross-bridges. Power stroke. After the crossbridges form, the power stroke occurs. During the power stroke, the site on the crossbridge where ADP is still bound opens. As a result, the crossbridge rotates and releases the ADP. The crossbridge generates force as it rotates toward the center of the sarcomere, sliding the thin filament past the thick filament toward the M line. Detachment of myosin from actin. At the end of the power stroke, the crossbridge remains firmly attached to actin until it binds another molecule of ATP. As ATP binds to the ATP binding site on the myosin head, the myosin head detaches from actin.⁷

Excitation-contraction coupling is the process that occurs in between the excitation and contraction of the muscle. This process involves series of activities, which responsible for the contraction of excited muscle. When a muscle is excited (stimulated) by

the impulses passing through motor nerve and neuromuscular junction, action potential is generated in the muscle fiber. Action potential spreads over sarcolemma and also into the muscle fiber through the ‘T’ tubules. The ‘T’ tubules are responsible for the rapid spread of action potential into the muscle fiber. When the action potential reaches the cisternae of ‘L’ tubules, these cisternae are excited. Now, the calcium ions stored in the cisternae are released into the sarcoplasm. The calcium ions from the sarcoplasm move towards the actin filaments to produce the contraction. Thus, the calcium ion forms the link or coupling material between the excitation and the contraction of muscle. Hence, the calcium ions are said to form the basis of excitation-contraction coupling.⁸

AIM & OBJECTIVES

To critically analyze the *Panchabhauthik* understanding of physiology of muscle contraction.

MATERIALS & METHODS

The *Bruhat Trayi* were scrutinised regarding the references for the *Guna* and *Karma* of the *Panchamahabhuta*. Later, physiologico-anatomical aspects of the physiology of muscle contraction were studied from modern physiology books. Later, supportive correlation was done between *Ayurvedic* and modern views to build valid and reliable hypothesis regarding the *Panchabhauthika* relation to the various anatomical and physiological aspects of muscle contraction.

DISCUSSION

The individual *Mahabhutas* will be having *Bhavas*. The *Bhavas* of *Akasha Mahabhuta* is audition, auditory apparatus, lightness, minuteness, separation, face, neck and lips. The *Bhavas* of *Vayu Mahabhuta* are touch, touch senses, dryness, inspiration, tissue configuration, vitality, apana region, motor function of body. *Tejah Mahubhuta Bhavas* are vision, visual apparatus, splendor, pitta, digestive power and heat and growth of body. The *Bhavas Of Jala Mahabhuta*

are taste, taste organ, coldness, softness, confluence, viscous, humidity, *kapha*, *meda*, *rakta*, *mamsa*, *shukra*. The *Bhavas* of *Pritivi Mahabhuta* are smell, olfactory organ, heaviness, stability and statuette.⁹

The major function of *Prithvi Mahabhuta* is it improves the size by solidifying the body parts, *Jala Mahabhuta* confluences the body tissues, *Agni Mahabhuta* is responsible for metabolic activities, *Vayu Mahabhuta* divides and differentiates the cell and tissues, *Akasha Mahabhuta* increases the quantity by forming cavities. These result in complexity, delightedness or richness, energy, movement, cavitations/perforations in the body.¹⁰

Myofibrils basic unit of muscle tissue are built from three kinds of proteins: (1) contractile proteins, which generate force during contraction; (2) regulatory proteins, which help switch the contraction process on and off; and (3) structural proteins, which keep the thick and thin filaments in the proper alignment, give the myofibril elasticity and extensibility, and link the myofibrils to the sarcolemma and extracellular matrix. The solid and tough structures like muscle, muscle fibres, nerve and at microscopic level including other cellular components, structural proteins are the attributes of *Prithvi Mahabhuta* but considering the properties & functions. The liquid portion present inside the muscle, nerves i.e. intracellular fluid, secretions from structures which help in lubrication & moistening can be considered as the attributes of *Jala Mahabhuta*.

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CONCLUSION

The solid and tough structures like muscle, muscle fibres, nerve and at microscopic level including other cellular components, structural proteins are the attributes of *Prithvi Mahabhuta*. The liquid portion present inside the muscle, nerves i.e. intracellular fluid, secretions from structures which helps in lubrication & moistening are the attributes of *Jala Mahabhuta*. The *Agni Mahabhuta* is considered as neurotransmitters that are secreted for the initiation & continuation of muscle contraction, Ionic variations, ATP utilisation that occur for muscle contraction. The process of movement of thick & thin filaments, contraction & relaxation, movement of neurotransmitters across nerve fibre & neuro muscular junction, movement of ions functions of contractile & regulatory proteins in muscle tissue are considered as the function because of *Vayu Mahabhuta* since the function of *Vayu Mahabhuta* is differentiation, movement & regulation. The space present inside various organs and various channels present for the secretions & other functions are attributed to *Akasha Mahabhuta*.

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