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The M-band Myomesin Proteins: A Mini Review

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Abstract

The M-band and Z-disc are transversal structural features of cross-striated muscles that anchor and mechanically support the contractile apparatus and its minimum unit, the sarcomere. Proteins' capacity to locate and interact with these structural sarcomeric parts is an unavoidable requirement for proper myofbrillar apparatus construction and function. The M-band, in particular, is a well-known mechanical and signalling hub that deals with active forces during contraction, and its damage causes sickness and death. The assembly and interactions of the three key flamentous proteins in the region, primarily the three myomesin proteins, including their Embryonic Heart (EH) isoform, titin, and obscurin, are the focus of research on the M-band architecture.

Keywords: M-band • Z-disc • Myomesin • Embryonic Heart

Introduction

These proteins interact with one other as well as with other proteins in the region that are engaged in signalling, energy, or mechanosensitive activities to form the M-fundamental band's flamentous network. While myomesin-1, titin, and obscurin are found in every muscle, myomesin-2 (also known as M-protein) and myomesin-3 are tissue specific: myomesin-2 is primarily expressed in cardiac and fast skeletal muscles, whereas myomesin-3 is primarily expressed in intermediate muscles and specific regions of the cardiac muscle. Furthermore, EH-myomesin is found in adults with specific heart disorders, in addition to its role during embryonic stages [1].

Literature Review

Current research in structural, molecular, and cellular biology, as well as animal models, has revealed vital details regarding the assembly of myomesin-1, obscurin, and titin. However, information about myomesin-2 and -3, such as interactions, localization, and structural characteristics, is still scarce. Surprisingly, an increasing number of papers relate all three myomesin proteins, especially myomesin-2, to significant cardiovascular disorders, implying that this protein family may be more important than previously considered. We will discuss the myomesin protein family, myomesin interactions, and structural differences between isoforms in this review, as well as the most recent evidence for why the structurally and biophysically unexplored myomesin-2 and myomesin-3 are emerging as hot targets for understanding muscle function and disease [2].

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Discussion

Muscles contraction

Muscle contraction is crucial for life, as it covers involuntary actions like heartbeat, as well as for the quality of our lives, as it is required for the majority of our everyday activities. Muscles must be able to tolerate significant mechanical stresses while also stretching and reversibly returning to their relaxed state in order to fulfil their purpose [3]. There are two types of muscles: striated muscles, which include the cardiac and skeletal muscles, and smooth muscles. Smooth muscles lack any specific pattern, but striated muscles have ordered and clearly defined contractile blocks known as sarcomeres. In contrast to morphologically identical skeletal muscles, the heart muscle never gets weary under physiological conditions. In that respect, the cardiac muscle is a unique type of muscle and possibly the most important tissue in the human body, given that cardiovascular diseases are still the leading cause of mortality worldwide, accounting for 32% of all deaths [4].

The contractile elements of skeletal and cardiac muscles are organised sarcomeric units. During contraction, sarcomeres are split into compartments with specific roles. The Z-discs, which look denser on electron micrographs than the rest of the sarcomere, define the sarcomere boundaries. Z-discs serve as anchors for thin (or actin) filaments. The I-bands, which exclusively contain thin filaments, and the A-band, which includes both thin and thick (or myosin) filaments, are the two primary compartments of the sarcomere. The myosin filaments interconnect and run antiparallel to both sides of the sarcomere at the centre region of the sarcomere, known as the M-band. The thick filaments form a regular hexagonal lattice on the transverse sarcomere portions [5,6]. The Z-discs and M-bands, in particular, contain dense networks of proteins that perform different functions: while the Z-discs are stable and maintain their structural integrity during contraction, the M-bands undergo massive conformational changes and nearly vanish before returning to their original regular pattern during muscle rest.

The Z-discs and M-bands contain a complex network of filamentous proteins that support the contractile apparatus. These proteins include arrays of immunoglobulin like (Ig) and fibronectin type III (Fn) domains, as well as additional proteins involved in metabolic processes and signalling, such as -actinin-2, a spectrin-like repeat dimeric protein that interconnects actin filaments in the Z-disc. These proteins are involved in a range of interactions with one other, the thick and thin filaments, as well as adaptor and other proteins involved in signalling and metabolic

activities. The primary protein is titin, which is also the world's largest single polypeptide, with a slack length of 1 m and a slack length of 1 m, spanning the half sarcomere from the Z-disc to the central M-band. In addition to the Ig and Fn domains, titin has various unstructured areas, such as the PEVK motifs in the I-band, which give the molecule its elasticity. Several other proteins found in the M-band and Z-disc of the sarcomere has a domain arrangement similar to titin, however they are considerably smaller.

Myomesin protein

All myomesin family proteins have the same 13-domain structure: a unique N-terminal domain, two immunoglobulin-like (Ig) domains, five Fibronectin type III (Fn) domains, and five immunoglobulin domains (referred in the text as My1 to My13 for myomesin-1, Mp1 to Mp13 for myomesin-2 and My3-1 to My3-13 for myomesin-3). They have a 50% sequence similarity, with roughly 40% identity, primarily in the Ig and Fn domains. The N-terminal domain of myomesin-1, which is around 100 amino acids longer than the other two isoforms, shows the most differences. Minor differences are also visible at the three proteins' very C-termini, implying that both termini are important in the assembly and function of all proteins. Each protein and its interactions will be discussed separately [7].

Conclusion

The architecture and function of the Te M-band have always been a key problem for structural and cell biologists, with early research focusing on the region's ultrastructural organisation. The M-band, in contrast to other sections of the muscular sarcomere, is the most active and exhibits massive conformational changes. Because of this peculiar behaviour, electron microscopy studies are limited to tissues with well-organized M-bands. Such tissues are often found in a few numbers of animals and are generated under extremely specific conditions that may not be representative of normal M-bands in mice or humans. Parallel to the discovery of the M-major band's molecular components, such as the M-protein (myomesin-2), myomesin-1, MM-CK, titin, and then obscurin, there has been a surge in interest in the region's architectural and functional composition, initially through epitope labelling and biochemical characterization of specific components, and later through high-resolution structural biology approaches.

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Conflict of Interest

There is no conflict of interest of author towards this manuscript.

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