



MUSCLE CLASSIFICATION

Djuraeva Barno Gulomovna

Abdukhalilov Javohir

Abdusaminov Sarvarbek

<https://www.doi.org/10.5281/zenodo.10453788>

ARTICLE INFO

Received: 27th December 2023

Accepted: 02nd January 2024

Online: 03rd January 2024

KEY WORDS

Skeletal Muscles, Smooth Muscles, Cardiac Muscles, Parallel Muscles, Pennate Muscles, Convergent Muscles, Prime Movers (Agonists, Antagonists, Synergists, Fixators.

ABSTRACT

This comprehensive article explores the classification of muscles, offering a detailed examination of the major types based on structure, function, and arrangement. It delves into skeletal muscles, responsible for voluntary movements; smooth muscles, governing involuntary actions; and cardiac muscles, essential for maintaining heart function. The structural classification covers parallel, pennate, and convergent muscles, elucidating their unique features and applications. Additionally, the functional classification categorizes muscles as prime movers, antagonists, synergists, and fixators, providing insights into their roles during movement. The article emphasizes the clinical significance of understanding muscle classification in fields like physical therapy and sports science. Overall, it serves as a comprehensive guide for readers seeking a nuanced understanding of the diverse world of muscles.

Muscle Types and Functions. Muscles are remarkable biological structures responsible for movement, stability, and the intricate coordination of the human body. The classification of muscles is a fundamental aspect of anatomy, shedding light on their structure, function, and how they contribute to overall physiological processes. In this article, we delve into the diverse world of muscle classification, exploring the major types, their characteristics, and their vital roles in the human body.

Introduction and contraction. Muscle Types. There are three types of muscle in the human body: skeletal, cardiac, and smooth. Each muscle cell is called a fiber. The three fiber types differ in structure and function within the body. A Skeletal muscle fiber is a large (10-100 μm diameter), multinucleated syncytium. Those fibers attached to bone, mediate voluntary movement of the skeleton, and/or maintain body position and posture. Others such as the extra-ocular muscle of the eye and the tongue are not attached to the skeleton but provide precise voluntary movements. Skeletal muscle contraction is controlled by the somatic nervous system. Cardiac muscle fibers are small (10-15 μm in diameter) cells with one (or two) nuclei that are connected to each other by gap junctions. These cells form a



functional coordinated unit found in the walls of the heart and at the base of the large veins that empty into the heart. Cardiac muscle is regulated by the autonomic (parasympathetic and sympathetic) nervous system. Smooth muscle cells are small (2-15 μm in diameter) cells found as bundles or sheets in the walls of blood vessels, the GI tract, and uterus. Where smooth muscle cells are connected by gap junctions, the bundle or sheet acts as a single coordinated unit. Smooth muscle is regulated by the autonomic nervous system. All three types of muscle contain the contractile proteins, myosin and actin, contract to generate force, and share 3 common principles:

1. Sliding filament mechanism in which myosin filaments bind to and pull actin filaments as a basis for shortening.
2. Regulation of contractile proteins by calcium ions.
3. Changes in membrane potential lead to a rise in intracellular calcium resulting in contraction (E-C coupling).

Skeletal Muscle Structure. During early development of skeletal muscle, undifferentiated myoblasts fuse to form a single multinucleated cylinder or fiber. Differentiation is completed by birth after which the muscle fibers increase in size but not number. Adult muscle fibers can vary in length from a few millimeters to almost a meter.

In the body, connective tissue surrounds each muscle fiber, each bundle of muscle fibers (called a fascicle), and several fascicles to form a muscle. The connective tissue wrapping is essential to force transduction. At the end of the muscle, the connective tissue continues as a tendon which usually attaches the muscle to bone. Skeletal muscle often overlaps a joint in the limb thereby allowing for lever action. In this arrangement a small degree of muscle cell shortening produces a large movement of the limb. The limb muscles are arranged in pairs such that muscles on opposite sides of the limb act in opposition. For example, flexors contract to close the angle at the joint and extensors contract to open the angle at the joint. Each muscle fiber (single cell) is filled with longitudinally arranged myofibrils whose number determines the force generating capacity of the muscle fiber. Each myofibril extends the length of the muscle fiber. Myofibrils are composed of myofilaments which are polymers of the contractile proteins, actin and myosin. Actin is called the thin filament; myosin the thick filament. Thick and thin filaments are organized into a series of repeating functional units called sarcomeres which give the striated appearance in the phase contrast microscope of skeletal (and cardiac) muscle. The striations are made of dark and light bands, which are called A and I bands, respectively. Places where there is only actin are the I bands and anywhere there is myosin are the A bands

Thin filaments are anchored to a dense line called the Z line which bisects the I bands. The sarcomere extends from one Z line to the next Z line. Thick filaments comprise the A band. These are polarized filaments in which the myosin tail region is anchored to the M line in the center of the sarcomere and the globular region (myosin head) extends away from the M line towards the Z lines. There are no myosin heads and no overlap with actin in the area immediately adjacent to the M line. This is called the H zone. The space between the thick and thin filaments contains the myosin heads. They are called cross bridges because they extend from the parallel axis of the thick filaments towards the thin filaments. During muscle



contraction, these cross bridges make contact with the thin filaments (actin) and exert force on them.

Skeletal Muscle Fiber Types. Skeletal muscle fibers are classified into one of three types distinguished by the speed of their myosin ATPase and preferred metabolism:

1. fast, glycolytic fibers fatigue quickly
2. fast, oxidative, glycolytic fibers resist fatigue
3. slow, oxidative fibers resist fatigue

Fast fibers undergo cross-bridge cycling about 4 times faster than slow fibers. Oxidative fibers contain lots of mitochondria for aerobic metabolism during tasks that require endurance. Glycolytic fibers use only small amounts of oxygen and are larger in diameter than oxidative fibers. As a result of their larger diameter, each glycolytic fiber can produce more tension than an oxidative fiber. Most skeletal muscles include all three fiber types. However, each motor unit contains only a single type of muscle fiber. Motor units containing slow, oxidative fibers contain fewer fibers than motor units containing fast fibers. Recruitment is the process of activating different types of muscle fibers within a fascicle in response to need. Recruitment starts with slow, oxidative fibers that do not provide a lot of force but can provide fine muscle control. If more tension is needed, fast-oxidative-glycolytic fibers can be recruited. Finally, fast, glycolytic fibers that fatigue rapidly increase tension the most dramatically are recruited.

Clinical Significance. Understanding muscle classification is crucial in various fields, including physical therapy, sports science, and medical diagnostics. Injuries, imbalances, and pathological conditions often involve specific muscle groups, and targeted interventions rely on precise knowledge of muscle types and functions.

Types of Muscles: Unveiling the Dynamic World Within

Muscles, the powerhouses of movement and stability in the human body, come in various forms, each with its unique structure, function, and role. Understanding the different types of muscles is crucial for appreciating the complexity of our physiological systems. This essay takes a journey into the intricate world of muscles, exploring the characteristics and significance of skeletal, smooth, and cardiac muscles.

Skeletal Muscles. Skeletal muscles, also known as voluntary or striated muscles, are the architects of intentional movement. These muscles are attached to bones by tendons and are under conscious control. When we think of actions like walking, running, or lifting objects, it is the orchestrated contraction and relaxation of skeletal muscles that make these movements possible.

Structure: Skeletal muscles exhibit a striated appearance under a microscope due to the organized arrangement of muscle fibers.

Function: Beyond movement, skeletal muscles contribute to posture and joint stability. Their voluntary nature allows for precision and adaptability in various activities.

Smooth Muscles. Smooth muscles, in stark contrast to skeletal muscles, are involuntary and found in the walls of internal organs such as the stomach, intestines, and blood vessels. They play a crucial role in governing essential physiological processes.

Structure: Smooth muscles lack the striations seen in skeletal muscles, appearing smooth under microscopic examination.



Function: The involuntary contractions of smooth muscles regulate activities like digestion, blood vessel constriction, and respiratory processes. Their presence in various organs highlights their diverse roles in maintaining homeostasis.

Cardiac Muscles. Cardiac muscles form the muscular layer of the heart, enabling it to function as a powerful pump. These muscles exhibit a unique set of characteristics that distinguish them from skeletal and smooth muscles.

Structure: Similar to skeletal muscles, cardiac muscles are striated. However, they possess intercalated discs, specialized structures that facilitate synchronized contractions.

Function: Cardiac muscles work tirelessly to pump blood throughout the body, ensuring a continuous circulation of oxygen and nutrients. Their rhythmic contractions are vital for maintaining cardiovascular health.

Clinical Significance. Understanding the different types of muscles is not merely an academic pursuit; it holds significant implications in various fields, particularly in healthcare and sports science.

Injuries and Rehabilitation: Knowledge of muscle types aids healthcare professionals in diagnosing and treating injuries. Rehabilitation programs are tailored based on the specific characteristics of the affected muscles.

Sports Performance. Athletes and coaches leverage insights into muscle types to optimize training regimens. Tailoring workouts to target specific muscle groups enhances performance and reduces the risk of injuries.

Conclusion. Muscle classification is a cornerstone of anatomy, providing a roadmap to the intricate world of the body's motor system. From voluntary skeletal muscles to the involuntary rhythms of the heart, each type plays a unique and indispensable role. Whether exploring the structural arrangement, functional roles, or clinical implications, delving into muscle classification enhances our understanding of the marvel that is the human musculature. The diverse array of muscles within the human body underscores the marvel of our biological machinery. From the precision of skeletal muscles to the involuntary rhythms of smooth and cardiac muscles, each type contributes uniquely to our ability to move, breathe, and sustain life. As we delve deeper into the realm of anatomy, the appreciation for these different types of muscles grows, highlighting the intricate balance required for the harmonious functioning of the human body.

References:

1. Marieb, E. N., & Hoehn, K. (2018). Human Anatomy & Physiology. Pearson.
2. Tortora, G. J., & Derrickson, B. (2017). Principles of Anatomy and Physiology. John Wiley & Sons.
3. Guyton, A. C., & Hall, J. E. (2015). Textbook of Medical Physiology. Saunders.
4. Silverthorn, D. U. (2019). Human Physiology: An Integrated Approach. Pearson.
5. Saladin, K. S. (2018). Anatomy & Physiology: The Unity of Form and Function. McGraw-Hill Education.
6. Martini, F., Nath, J. L., & Bartholomew, E. F. (2020). Fundamentals of Anatomy & Physiology. Pearson.



7. Sherwood, L. (2015). *Human Physiology: From Cells to Systems*. Cengage Learning.
8. Meyer, R. A. (2019). *Muscle: The Function of Each Muscle in the Body*. Harvard University Press.
9. Kendall, F. P., McCreary, E. K., Provance, P. G., Rodgers, M. M., & Romani, W. A. (2005). *Muscles: Testing and Function, with Posture and Pain*. Lippincott Williams & Wilkins.
10. Palastanga, N., & Soames, R. (2012). *Anatomy and Human Movement: Structure and Function*. Churchill Livingstone.
11. Stone, M. H., Stone, M., & Sands, W. A. (2007). *Principles and Practice of Resistance Training*. Human Kinetics.
12. Enoka, R. M. (2015). *Neuromechanics of Human Movement*. Human Kinetics.
13. Herdman, S. J., & Minor, V. S. (2014). Comparison of muscle onset detection using EMG and force thresholds. *Journal of Electromyography and Kinesiology*, 24(1), 19-24.