

Muscle Contraction

H&SP! Medical Anatomy & Physiology 09b
Lab Activity

Background

Muscle Cell Structure

Muscle cells are specialized to contract. An individual muscle is actually a bundle of hundreds to thousands of long cylindrical muscle fibers or cells. The cell membrane of muscle cells is called the sarcolemma, the cytoplasm is the sarcoplasm, and the endoplasmic reticulum is modified into the sarcoplasmic reticulum (SR). Channels from the sarcolemma into the sarcoplasm and SR are called transverse (T) tubules. The T tubules allow for electrical impulses from motor neurons to be channeled directly to the SR, causing it to release calcium ions and initiate a contraction. Muscle cells are made up of bundles of myofibrils that contain the contracting units, called sarcomeres, made up of two main proteins - myosin and actin.

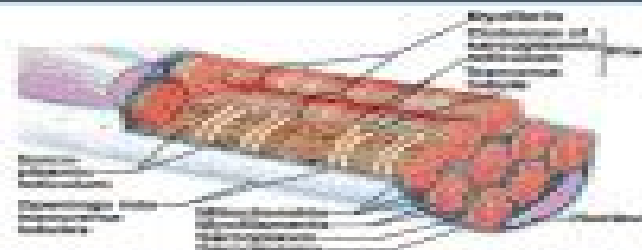


Figure 35.10 The structure of skeletal muscle fibers. © 2011 Sinauer Associates, Inc. and W. H. Freeman & Co.



The Motor Unit

Motor neurons connect to skeletal muscles to control movement. Each motor neuron actually controls a group of muscle cells called a motor unit. All of the cells in the motor unit will be stimulated by the motor neuron at the same time. Movements that need fine motor skills, like writing with a pencil, have only a few muscle cells for each motor unit, which allows for precision. Larger movements, like picking up a bag, have many muscle cells for each motor unit.

Muscle Contraction

A muscle contraction is a complicated cycle and can differ according to the type of contraction and the type of muscle tissue. The following chart describes and diagrams the steps of a muscle contraction according to the sliding filament theory.

Steps of a Muscle Contraction

1	The brain or spinal cord sends an impulse to the muscle.	A diagram of a neuromuscular junction. It shows a cross-section of a motor neuron (labeled 'Motor neuron') with its axon terminal (labeled 'Axon terminal') meeting a muscle fiber (labeled 'Muscle fiber'). The space between them is the synaptic cleft. Labels also include 'Neurotransmitter' and 'Synaptic cleft'.
2	The impulse travels down the motor neuron and reaches a neuromuscular junction where it releases acetylcholine, which triggers the impulse in the muscle.	
3	The impulse travels through the plasma membrane (sarcolemma) and down T tubules surrounding the myofibrils.	A diagram of a muscle fiber showing the path of an electrical impulse. The impulse travels along the sarcolemma (labeled 'Sarcolemma') and down the transverse tubules (labeled 'Transverse tubule'). The diagram also shows the myofibrils (labeled 'Myofibril') and the sarcoplasm (labeled 'Sarcoplasm').
4	As the impulse passes through the T tubules, it causes the sarcoplasmic reticulum (SR) surrounding the T tubule to release calcium ions (Ca^{2+}) into the sarcoplasm, eventually reaching the sarcomere.	

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Mechanism of Muscular Contraction Jack A. Rall, 2014-10-21 This book describes the evolution of ideas relating to the mechanism of muscular contraction since the discovery of sliding filaments in 1954. An amazing variety of experimental techniques have been employed to investigate the mechanism of muscular contraction and relaxation. Some background of these various techniques is presented in order to gain a fuller appreciation of their strengths and weaknesses. Controversies in the muscle field are discussed along with some missed opportunities and false trails. The pathway to ATP and the high energy phosphate bond will be discussed as well as the discovery of myosin contraction coupling and the emergence of cell and molecular biology in the muscle field. Numerous figures from original papers are also included for readers to see the data that led to important conclusions. This book is published on behalf of the American Physiological Society by Springer. Access to APS books published with Springer is free to APS members. *Molecular and Cellular Aspects of Muscle Contraction* Haruo Sugi, 2012-12-06 This volume presents the proceedings of a muscle symposium which was supported by the grant from the Fujihara Foundation of Science to be held as the Fourth Fujihara Seminar on October 28 November 1 2002 at Hakone Japan. The Fujihara Seminar covers all fields of natural science while only one proposal is granted every year. It is therefore a great honor for me to be able to organize this meeting. Before this symposium I have organized muscle symposia five times and published the proceedings. Cross bridge Mechanism in Muscle Contraction University of Tokyo Press 1978. Contractile Mechanisms in Muscle plenum 1984. Molecular Mechanisms of Muscle Contraction plenum 1988. Mechanism of Myofibrillar Sliding in Muscle contraction plenum 1993. Mechanisms of Work Production and Work Absorption in Muscle plenum 1998. As with these proceedings this volume contains records of discussions made not only after each presentation but also during the periods of General Discussion in order that general readers may properly evaluate each presentation and the up to date situation of this research field. It was my great pleasure to have Dr Hugh Huxley a principal discoverer of the sliding filament mechanism in muscle contraction in this meeting. On my request Dr Huxley kindly gave a special lecture on his monumental discovery of myofibrillar lattice structure by X ray diffraction of living skeletal muscle. I hope general readers to learn how a breakthrough in a specific research field can be achieved. *Muscle Contraction* Clive R. Bagshaw, 1982-10-21 The student of biological science in his final years as an undergraduate and his first years as a graduate is expected to gain some familiarity with current research at the frontiers of his discipline. New research work is published in a perplexing diversity of publications and is inevitably concerned with the minutiae of the subject. The sheer number of research journals and papers also causes confusion and difficulties of assimilation. Review articles usually presuppose a background knowledge of the field and are inevitably rather restricted in scope. There is thus a need for short but authoritative introductions to those areas of modern biological research which are either not dealt with in standard introductory textbooks or are not dealt with in sufficient detail to enable the student to go on from them to read scholarly reviews with profit. This series of books is

designed to satisfy this need The authors have been asked to produce a brief outline of their subject assuming that their readers will have read and remembered much of a standard introductory textbook of biology This outline then sets out to provide by building on this basis the conceptual framework within which modern research work is progressing and aims to give the reader an indication of the problems both conceptual and practical which must be overcome if progress is to be maintained

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Regulation of Smooth Muscle Contraction Robert S. Moreland, 2012-12-06 Sixth Annual Graduate Hospital Research Symposium REGULATION OF SMOOTH MUSCLE PROGRESS IN SOLVING THE PUZZLE Every so often a scientific conference comes at a time when everyone has new and exciting information when old dogmas do not seem to be as well established and when speakers and participants alike are ready to challenge interpretations of old and new experimental data This was such a conference What turns on a smooth muscle cell The precise answer to this question has eluded scientists for much longer than I have been involved in the field We know that an increase in cytosolic calcium is necessary and we know that phosphorylation of the 20 kDa myosin light chain is an important step in the process We do not know if other processes are necessary for the initiation and maintenance of a smooth muscle contraction nor do we know if other processes modulate the regulation of contraction The goal of the symposium on which this volume is based was to explore the most current hypotheses for the answers to these questions I believe that after reading the chapters included in this volume you will agree that this goal was achieved The importance of calcium and calmodulin dependent myosin light chain phosphorylation in the regulation of smooth muscle contraction was reinforced by many presentations However the status of myosin light chain phosphorylation as a simple calcium dependent switch came under serious suspicion

Muscle Contraction and Cell Motility Haruo Sugi, 2016-11-03 This book provides a comprehensive overview of the current progress in muscle contraction and cell motility research It discusses structural mechanical and biochemical characteristics of skeletal cardiac and smooth muscles and cell motility The experimental objects of the studies described in this volume extend from humans to molecules A distinct feature of this volume is that in some chapters evidence against the textbook view is presented showing how well established dogma can be denied by an unexpected discovery This book is as interesting as it is informative for general readers and young scientists alike and it is sure to inspire both to challenge the enticing mysteries that still remain in this exciting research field

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