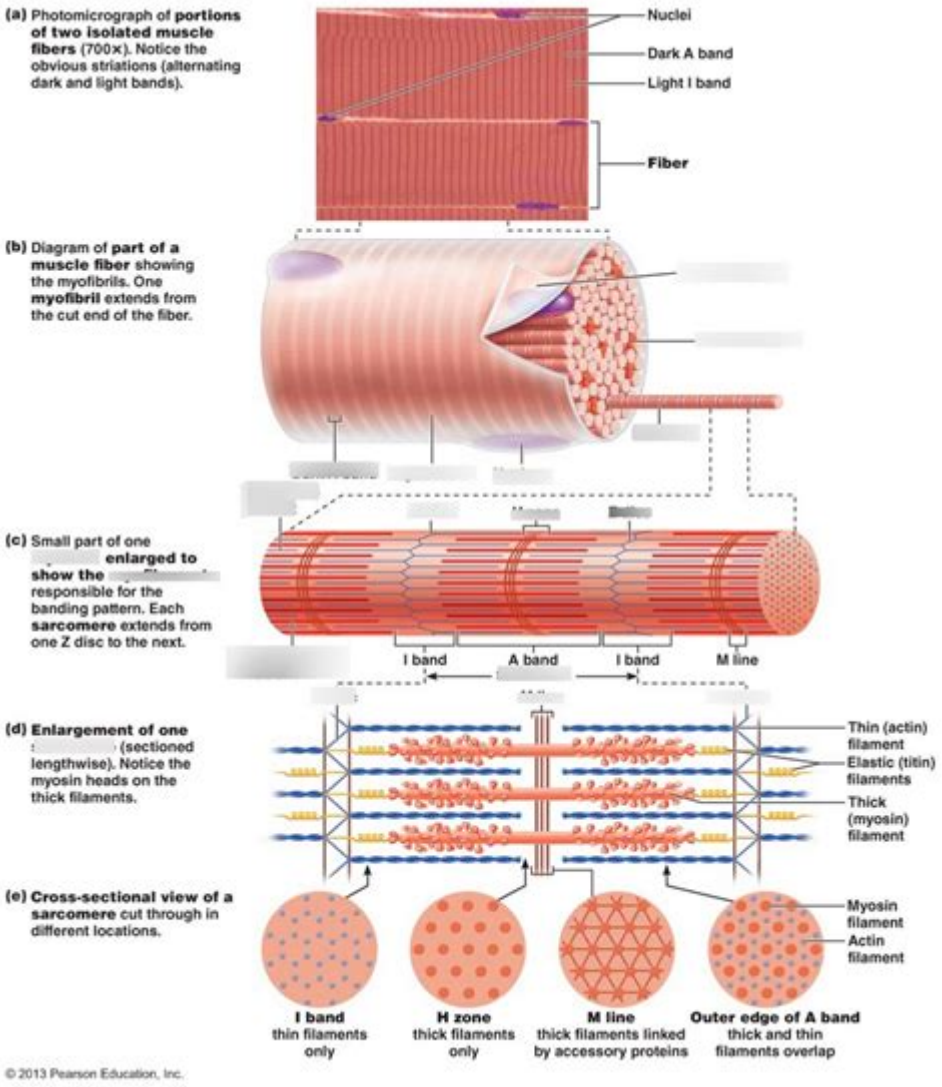
Microscopic Anatomy And Organization Of Skeletal Muscle



Microscopic Anatomy and Organization of Skeletal Muscle: A Deep Dive

Introduction:

Ever wondered what makes your body move? The answer lies within the intricate world of skeletal muscle tissue. This seemingly simple tissue, responsible for everything from walking to smiling, boasts a complex microscopic structure optimized for generating powerful, coordinated contractions. This comprehensive guide delves into the microscopic anatomy and organization of skeletal muscle, exploring its cellular components and the fascinating interplay between them. We'll unpack the intricacies of muscle fibers, myofibrils, sarcomeres, and the crucial role of connective

tissues, providing you with a thorough understanding of this fundamental component of the musculoskeletal system. Prepare to journey into the fascinating miniature world of muscle!

Understanding the Skeletal Muscle Fiber: The Building Block

Skeletal muscle, unlike smooth or cardiac muscle, is characterized by its striated appearance. This striation is a direct result of the highly organized arrangement of its constituent components. The basic functional unit of skeletal muscle is the muscle fiber, also known as a muscle cell. These cylindrical, multinucleated cells are incredibly long, sometimes spanning the entire length of a muscle. Their size is directly proportional to the power they can generate; larger fibers generally produce more force.

The Myofibrils: The Powerhouses within

Each muscle fiber is densely packed with numerous myofibrils, long cylindrical structures running parallel to the fiber's length. These myofibrils are the true contractile elements of the muscle, responsible for generating the force needed for movement. Their organized structure, visible under a microscope as repeating units, is essential for efficient muscle contraction.

The Sarcomere: The Functional Unit of Contraction

The repeating units within myofibrils are called sarcomeres. These are the fundamental functional units of muscle contraction. Each sarcomere is bounded by Z-lines (or Z-discs), protein structures that anchor the thin filaments (primarily actin). The sarcomere's organized arrangement of thick (myosin) and thin (actin) filaments, along with other proteins like troponin and tropomyosin, allows for the sliding filament mechanism of muscle contraction.

The Sliding Filament Theory in Action:

The sliding filament theory explains how muscle contraction occurs. Myosin heads bind to actin filaments, using ATP (adenosine triphosphate) as an energy source to pull the thin filaments towards the center of the sarcomere. This shortening of the sarcomeres leads to the overall contraction of the muscle fiber, and ultimately, the entire muscle.

Connective Tissue: Providing Structure and Support

The organization of skeletal muscle extends beyond the individual muscle fibers. Connective tissue

plays a crucial role in providing structural support and transmitting the force generated by muscle fibers to the bones. This connective tissue includes:

Endomysium: A delicate layer of connective tissue surrounding each individual muscle fiber.
Perimysium: A thicker layer of connective tissue that groups muscle fibers into fascicles (bundles).
Epimysium: The outermost layer of connective tissue that encloses the entire muscle.

These layers of connective tissue merge at the ends of the muscle to form tendons, which connect the muscle to bone. This sophisticated arrangement ensures efficient force transmission and overall muscle integrity.

Neuromuscular Junction: The Communication Hub

Muscle contraction is initiated by signals from the nervous system. The neuromuscular junction is the specialized synapse where a motor neuron's axon terminal meets a muscle fiber. Acetylcholine, a neurotransmitter, is released at the neuromuscular junction, triggering depolarization of the muscle fiber membrane and initiating the chain of events leading to contraction.

Microscopic Variations and Muscle Fiber Types

While the basic structure remains consistent, there are variations in the microscopic anatomy of skeletal muscle fibers. These variations reflect differences in the speed and endurance of muscle contraction. Different muscle fiber types—Type I (slow-twitch), Type IIa (fast-twitch oxidative), and Type IIb (fast-twitch glycolytic)— exhibit distinct metabolic characteristics and contractile properties. Understanding these variations is crucial for comprehending the diverse functions of skeletal muscle throughout the body.

Conclusion:

The microscopic anatomy and organization of skeletal muscle are incredibly complex yet elegantly efficient. The coordinated interplay of muscle fibers, myofibrils, sarcomeres, and connective tissues, orchestrated by the nervous system, allows for the precise and powerful movements that define our daily lives. From the cellular level to the whole muscle, understanding this intricate structure reveals the remarkable engineering of the human body. This knowledge is fundamental to appreciating the mechanics of movement, understanding muscle-related disorders, and developing effective strategies for exercise and rehabilitation.

FAQs:

1. What is the role of ATP in muscle contraction? ATP provides the energy required for the myosin heads to bind to actin and pull the thin filaments, leading to sarcomere shortening and muscle contraction.

2. How do different muscle fiber types contribute to overall muscle function? Different fiber types offer a range of contractile speeds and endurance capacities, allowing for both powerful, short bursts of activity and sustained, less intense movements.

3. What happens during muscle fatigue? Muscle fatigue is a complex process involving depletion of energy stores (ATP), accumulation of metabolic byproducts (lactate), and changes in ion concentrations within muscle fibers, leading to reduced contractile ability.

4. What are some common microscopic changes seen in muscle diseases? Muscle diseases can exhibit various microscopic changes, including muscle fiber atrophy, necrosis, inflammation, and abnormalities in the organization of myofibrils and sarcomeres.

5. How does aging affect the microscopic structure of skeletal muscle? Aging leads to a gradual decline in muscle mass (sarcopenia) and changes in muscle fiber composition, characterized by a reduction in Type II fibers and an increase in the proportion of connective tissue.

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microscopic anatomy and organization of skeletal muscle: *Skeletal Muscle Circulation* Ronald J. Korthuis, 2011 The aim of this treatise is to summarize the current understanding of the mechanisms for blood flow control to skeletal muscle under resting conditions, how perfusion is elevated (exercise hyperemia) to meet the increased demand for oxygen and other substrates during exercise, mechanisms underlying the beneficial effects of regular physical activity on cardiovascular health, the regulation of transcapillary fluid filtration and protein flux across the microvascular exchange vessels, and the role of changes in the skeletal muscle circulation in pathologic states. Skeletal muscle is unique among organs in that its blood flow can change over a remarkably large range. Compared to blood flow at rest, muscle blood flow can increase by more than 20-fold on average during intense exercise, while perfusion of certain individual white muscles or portions of those muscles can increase by as much as 80-fold. This is compared to maximal increases of 4- to 6-fold in the coronary circulation during exercise. These increases in muscle perfusion are required to meet the enormous demands for oxygen and nutrients by the active muscles. Because of its large mass and the fact that skeletal muscles receive 25% of the cardiac output at rest, sympathetically mediated vasoconstriction in vessels supplying this tissue allows central hemodynamic variables (e.g., blood pressure) to be spared during stresses such as hypovolemic shock. Sympathetic vasoconstriction in skeletal muscle in such pathologic conditions also effectively shunts blood flow away from muscles to tissues that are more sensitive to reductions in their blood supply that might otherwise occur. Again, because of its large mass and percentage of cardiac output directed to skeletal muscle, alterations in blood vessel structure and function with chronic disease (e.g., hypertension) contribute significantly to the pathology of such disorders. Alterations in skeletal muscle vascular resistance and/or in the exchange properties of this vascular bed also modify transcapillary fluid filtration and solute movement across the microvascular barrier to influence muscle function and contribute to disease pathology. Finally, it is clear that exercise training induces an adaptive transformation to a protected phenotype in the vasculature supplying skeletal muscle and other tissues to promote overall cardiovascular health. Table of Contents: Introduction / Anatomy of Skeletal Muscle and Its Vascular Supply / Regulation of Vascular Tone in Skeletal Muscle / Exercise Hyperemia and Regulation of Tissue Oxygenation During Muscular Activity / Microvascular Fluid and Solute Exchange in Skeletal Muscle / Skeletal Muscle Circulation in Aging and Disease States: Protective Effects of Exercise / References

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Gaspar, Rakesh Kumar Vasishta, Bishan Dass Radotra, 2018-09-24 This book covers all aspects of basic, essential, recent advances and controversies in myopathology. The major emphasis is on diagnostic myopathology of muscular dystrophies, inflammatory myopathies, mitochondrial myopathies, metabolic myopathies, congenital myopathies, myopathies of miscellaneous etiology, neurogenic and neuromuscular junction disorders, the goal being to broaden readers' understanding of individual disease subgroups. The book also contains all the essential details needed to establish a neuromuscular lab, making it especially relevant for laboratory technical staff and research scholars.

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bridging the gap between foundational biomechanics texts and scientific literature. With the information found in this text, readers can prepare themselves to better understand the latest in cutting-edge research. Biomechanics of Skeletal Muscles is the third volume in the Biomechanics of Human Motion series. Advanced readers in human movement science gain a comprehensive understanding of the biomechanics of human motion as presented by one of the world's foremost researchers on the subject, Dr. Vladimir Zatsiorsky. The series begins with Kinematics of Human Motion, which details human body positioning and movement in three dimensions; continues with Kinetics of Human Motion, which examines the forces that create body motion and their effects; and concludes with Biomechanics of Skeletal Muscles, which explains the action of the biological motors that exert force and produce mechanical work during human movement.

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particular help to readers new to the subject area, those returning to study after a period of absence, and for anyone whose first language isn't English. - Latest edition of the world's most popular textbook on basic human anatomy and physiology with over 1.5 million copies sold worldwide - Clear, no nonsense writing style helps make learning easy - Accompanying website contains animations, audio-glossary, case studies and other self-assessment material, the unique Body Spectrum© online colouring and self-test software, and helpful weblinks - Includes basic pathology and pathophysiology of important diseases and disorders - Contains helpful learning features such as Learning Outcomes boxes, colour coding and design icons together with a stunning illustration and photography collection - Contains clear explanations of common prefixes, suffixes and roots, with helpful examples from the text, plus a glossary and an appendix of normal biological values. - Particularly valuable for students who are completely new to the subject, or returning to study after a period of absence, and for anyone whose first language is not English - All new illustration programme brings the book right up-to-date for today's student - Helpful 'Spot Check' questions at the end of each topic to monitor progress - Fully updated throughout with the latest information on common and/or life threatening diseases and disorders - Review and Revise end-of-chapter exercises assist with reader understanding and recall - Over 120 animations – many of them newly created – help clarify underlying scientific and physiological principles and make learning fun

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with a 90% science and 10% clinical focus. A needed resource for researchers, clinical professionals, postdocs, and graduate students, this publication will further discuss basic biology development and physiology, how processes go awry in disease states, and how the defective pathways are targeted for therapy. This book will assist both the new and experienced clinician's and researcher's need for science translation of background research into clinical applications, bridging the gap between research and clinical knowledge.

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public. The 1990s were declared the Decade of the Brain by former President Bush, and the neuroscience community responded with a host of new investigations and conferences. Discovering the Brain is based on the Institute of Medicine conference, Decade of the Brain: Frontiers in Neuroscience and Brain Research. Discovering the Brain is a field guide to the brainâ€an easy-to-read discussion of the brain's physical structure and where functions such as language and music appreciation lie. Ackerman examines: How electrical and chemical signals are conveyed in the brain. The mechanisms by which we see, hear, think, and pay attentionâ€and how a gut feeling actually originates in the brain. Learning and memory retention, including parallels to computer memory and what they might tell us about our own mental capacity. Development of the brain throughout the life span, with a look at the aging brain. Ackerman provides an enlightening chapter on the connection between the brain's physical condition and various mental disorders and notes what progress can realistically be made toward the prevention and treatment of stroke and other ailments. Finally, she explores the potential for major advances during the Decade of the Brain, with a look at medical imaging techniquesâ€what various technologies can and cannot tell usâ€and how the public and private sectors can contribute to continued advances in neuroscience. This highly readable volume will provide the public and policymakersâ€and many scientists as wellâ€with a helpful guide to understanding the many discoveries that are sure to be announced throughout the Decade of the Brain.

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microscopic anatomy and organization of skeletal muscle: The NeuroMuscular System: From Earth to Space Life Science Dieter Blottner, Michele Salanova, 2014-11-25 The book provides fundamental new insights in the structure and function of the healthy NeuroMuscular system. Recent findings suggest that the musculoskeletal system that supports movement control on Earth is controlled by unique principles of structural, biochemical and molecular characteristics. Mechanical loading by working against normal gravity helps to support principal structures in bone, muscle and associated subcellular scaffold components. Disuse or immobilization of the body in bed rest on Earth or in microgravity in Space result in considerable loss of bone, muscle and force with downregulation of neuromuscular activity resulting in impaired performance control. The goal is to develop exercise prescriptions to maintain postural control in normal life, aging and rehabilitation on Earth as well as for an adequate human performance management in Space.

microscopic anatomy and organization of skeletal muscle: *Cellular Organelles* Edward Bittar, 1995-12-08 The purpose of this volume is to provide a synopsis of present knowledge of the structure, organisation, and function of cellular organelles with an emphasis on the examination of important but unsolved problems, and the directions in which molecular and cell biology are moving. Though designed primarily to meet the needs of the first-year medical student, particularly in schools where the traditional curriculum has been partly or wholly replaced by a multi-disciplinary core curriculum, the mass of information made available here should prove useful to students of biochemistry, physiology, biology, bioengineering, dentistry, and nursing.It is not yet possible to give a complete account of the relations between the organelles of two compartments and of the mechanisms by which some degree of order is maintained in the cell as a whole. However, a new breed of scientists, known as molecular cell biologists, have already contributed in some measure to our understanding of several biological phenomena notably interorganelle communication. Take, for example, intracellular membrane transport: it can now be expressed in terms of the sorting, targeting, and transport of protein from the endoplasmic reticulum to another compartment. This volume contains the first ten chapters on the subject of organelles. The remaining four are in Volume 3, to which sections on organelle disorders and the extracellular matrix have been added.

microscopic anatomy and organization of skeletal muscle: Fascia: The Tensional Network of the Human Body Robert Schleip, Peter Huijing, Thomas W. Findley, 2013-02-26 This book is the product of an important collaboration between clinicians of the manual therapies and scientists in several disciplines that grew out of the three recent International Fascia Research Congresses (Boston, Amsterdam, and Vancouver). The book editors, Thomas Findley MD PhD, Robert Schleip PhD, Peter Huijing PhD and Leon Chaitow DO, were major organizers of these congresses and used their extensive experience to select chapters and contributors for this book. This volume therefore brings together contributors from diverse backgrounds who share the desire to bridge the gap between theory and practice in our current knowledge of the fascia and goes beyond the 2007, 2009 and 2012 congresses to define the state-of-the-art, from both the clinical and scientific perspective. Prepared by over 100 specialists and researchers from throughout the world, Fascia: The Tensional Network of the Human Body will be ideal for all professionals who have an interest in fascia and human movement - physiotherapists, osteopathic physicians, osteopaths, chiropractors, structural integration practitioners, manual therapists, massage therapists,

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microscopic anatomy and organization of skeletal muscle: The Peripheral Nervous System John Hubbard, 2012-12-06 The peripheral nervous system is usually defined as the cranial nerves, spinal nerves, and peripheral ganglia which lie outside the brain and spinal cord. To describe the structure and function of this system in one book may have been possible last century. Today, only a judicious selection is possible. It may be fairly claimed that the title of this book is not misleading, for in keeping the text within bounds only accounts of olfaction, vision, audition, and vestibular function have been omitted, and as popularly understood these topics fall into the category of special senses. This book contains a comprehensive treatment of the structure and function of peripheral nerves (including axoplasmic flow and trophic func tions); junctional regions in the autonomic and somatic divisions of the peripheral nervous system; receptors in skin, tongue, and deeper tissues; and the integrative role of ganglia. It is thus a handbook of the peripheral nervous system as it is usually understood for teaching purposes. The convenience of having this material inside one set of covers is already proven, for my colleagues were borrowing parts of the text even while the book was in manuscript. It is my belief that lecturers will find here the information they need, while graduate students will be able to get a sound yet easily read account of results of research in their area. JOHN 1. HUBBARD vii Contents SECTION I-PERIPHERAL NERVE Chapter 1 Peripheral Nerve Structure 3 Henry deF. Webster 3 1. Introduction .

microscopic anatomy and organization of skeletal muscle: *Muscle Homeostasis and Regeneration* Antonio Musarò, 2020-11-20 The book is a collection of original research and review articles addressing the intriguing field of the cellular and molecular players involved in muscle homeostasis and regeneration. One of the most ambitious aspirations of modern medical science is the possibility of regenerating any damaged part of the body, including skeletal muscle. This desire has prompted clinicians and researchers to search for innovative technologies aimed at replacing organs and tissues that are compromised. In this context, the papers, collected in this book, addressing a specific aspects of muscle homeostasis and regeneration under physiopathologic conditions, will help us to better understand the underlying mechanisms of muscle healing and will help to design more appropriate therapeutic approaches to improve muscle regeneration and to counteract muscle diseases.

microscopic anatomy and organization of skeletal muscle: *Essential Applications of Musculoskeletal Ultrasound in Rheumatology E-Book* Richard J. Wakefield, Maria Antonietta D'Agostino, 2010-07-15 Essential Applications of Musculoskeletal Ultrasound in Rheumatology, by Richard Wakefield & Maria Antonietta D’Agostino, assists you in most effectively using musculoskeletal ultrasound to diagnose and monitor the progression of rheumatoid arthritis, vasculitis, and other rheumatic and soft tissue disorders. Sponsored by the European League against Rheumatism (EULAR), it is the first reference that attempts to set rigorous guidelines for how and

when to use musculoskeletal ultrasound in the evaluation of these cases. At expertconsult.com you can reference the complete contents online, along with an image gallery, supplemental video stills and clips, and clinical cases with companion assessment questions. Detect rheumatic diseases much earlier using musculoskeletal ultrasound, and monitor their progression more accurately, with reliable, expert guidance from internationally renowned authorities. Visualize the imaging presentation of a full range of rheumatic diseases with a wealth of full-color illustrations. Apply rigorous, consistent guidelines on how and when to use musculoskeletal ultrasound. Access the complete contents online at expertconsult.com, along with an image gallery, supplemental video stills and clips, and clinical cases with companion assessment questions.

microscopic anatomy and organization of skeletal muscle: *The Thorax: Applied physiology* Charis Roussos, 1995 This book provides a comprehensive, authoritative, and contemporary discussion of the physiology and pathophysiology of the chest wall as well as an overview of the diagnostic and therapeutic modalities. It is an invaluable aid to clinical investigators.

microscopic anatomy and organization of skeletal muscle: Respiratory Muscle Training Alison McConnell, 2013-04-18 Respiratory Muscle Training: theory and practice is the world's first book to provide an everything-you-need-to-know guide to respiratory muscle training (RMT). Authored by an internationally-acclaimed expert, it is an evidence-based resource, built upon current scientific knowledge, as well as experience at the cutting-edge of respiratory training in a wide range of settings. The aim of the book is to give readers: 1) an introduction to respiratory physiology and exercise physiology, as well as training theory; 2) an understanding of how disease affects the respiratory muscles and the mechanics of breathing; 3) an insight into the disease-specific, evidence-based benefits of RMT; 4) advice on the application of RMT as a standalone treatment, and as part of a rehabilitation programme; and finally, 5) guidance on the application of functional training techniques to RMT. The book is divided into two parts – theory and practice. Part I provides readers with access to the theoretical building blocks that support practice. It explores the evidence base for RMT as well as the different methods of training respiratory muscles and their respective efficacy. Part II guides the reader through the practical implementation of the most widely validated form of RMT, namely inspiratory muscle resistance training. Finally, over 150 Functional RMT exercises are described, which incorporate a stability and/or postural challenge – and address specific movements that provoke dyspnoea. Respiratory Muscle Training: theory and practice is supported by a dedicated website (www.physiobreathe.com), which provides access to the latest information on RMT, as well as video clips of all exercises described in the book. Purchasers will also receive a three-month free trial of the Physiotec software platform (via www.physiotec.ca), which allows clinicians to create bespoke training programmes (including video clips) that can be printed or emailed to patients. - Introductory overviews of respiratory and exercise physiology, as well as training theory - Comprehensive, up-to-date review of respiratory muscle function, breathing mechanics and RMT - Analysis of the interaction between disease and respiratory mechanics, as well as their independent and combined influence upon exercise tolerance - Analysis of the rationale and application of RMT to over 20 clinical conditions, e.g., COPD, heart failure, obesity, mechanical ventilation - Evidence-based guidance on the implementation of inspiratory muscle resistance training - Over 150 functional exercises that incorporate a breathing challenge - www.physiobreathe.com - access up-to-date information, video clips of exercises and a three-month free trial of Physiotec's RMT exercise module (via www.physiotec.ca)

microscopic anatomy and organization of skeletal muscle: Pathology of Skeletal Muscle Stirling Carpenter, George Karpati, 1984 This book has been described as the bible of muscle disease, from both a scientific and a clinical point of view. It is a comprehensive work that explains and illustrates in detail all pathological reactions of skeletal muscles that occur in human disease. The microscopic changes are illustrated by histochemistry, immunocytochemistry, resin histology, and electron microscopy. The pathological findings are correlated with the clinical picture whenever possible. The interpretation of the findings is scientifically based. To facilitate this process, the fundamentals of normal histology and biology of the muscle cell are also covered.The book has been

thoroughly revised and expanded for this Second Edition to provide up-to-date coverage of the relevant molecular biology and molecular genetics, as well as extensive references. It has been well organized and richly illustrated by the authors, who have been at the forefront of muscle pathology and neuromuscular research for 35 years. This practical reference work is intended for neuropathologists, neurologists, and general pathologists who look at muscle biopsies. It will also serve as an introduction to muscle disease for neurology and pathology residents.

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microscopic anatomy and organization of skeletal muscle: Biomechanics Daniel J. Schneck, Joseph D. Bronzino, 2002-08-29 Biomechanics: Principles and Applications offers a definitive, comprehensive review of this rapidly growing field, including recent advancements made by biomedical engineers to the understanding of fundamental aspects of physiologic function in health, disease, and environmental extremes. The chapters, each by a recognized leader in the field, addr

microscopic anatomy and organization of skeletal muscle: Muscle Atrophy Junjie Xiao, 2018-11-02 The book addresses the development of muscle atrophy, which can be caused by denervation, disuse, excessive fasting, aging, and a variety of diseases including heart failure, chronic kidney diseases and cancers. Muscle atrophy reduces quality of life and increases morbidity and mortality worldwide. The book is divided into five parts, the first of which describes the general aspects of muscle atrophy including its characteristics, related economic and health burdens, and the current clinical therapy. Secondly, basic aspects of muscle atrophy including the composition, structure and function of skeletal muscle, muscle changes in response to atrophy, and experimental models are summarized. Thirdly, the book reviews the molecular mechanisms of muscle atrophy, including protein degradation and synthesis pathways, noncoding RNAs, inflammatory signaling, oxidative stress, mitochondria signaling, etc. Fourthly, it highlights the pathophysiological mechanisms of muscle atrophy in aging and disease. The book’s fifth and final part covers the diagnosis, treatment strategies, promising agents and future prospects of muscle atrophy. The book will appeal to a broad readership including scientists, undergraduate and graduate students in medicine and cell biology.

microscopic anatomy and organization of skeletal muscle: *IMMS’ General Textbook of Entomology* A.D. Imms, O.W. Richards, R.G. Davies, 2012-12-06 seem as appropriate now as the original balance was when Dr A. D. Imms' textbook was first published over fifty years ago. There are 35 new figures, all based on published illustrations, the sources of which are acknowledged in the captions. We are grateful to the authors concerned and also to Miss K. Priest of Messrs Chapman

& Hall, who saved us from many errors and omissions, and to Mrs R. G. Davies for substantial help in preparing the bibliographies and checking references. London O.W.R. May 1976 R.G.D. Part I ANATOMY AND PHYSIOLOGY Chapter I INTRODUCTION Definition of the Insecta (Hexapoda) The insects are tracheate arthropods in which the body is divided into head, thorax and abdomen. A single pair of antennae (homologous with the anten nules of the Crustacea) is present and the head also bears a pair of mandibles and two pairs of maxillae, the second pair fused medially to form the labium. The thorax carries three pairs of legs and usually one or two pairs of wings. The abdomen is devoid of ambulatory appendages, and the genital opening is situated near the posterior end of the body. Postembryonic development is rarely direct and a metamorphosis usually occurs.

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