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# Book Review

**Biomechanics: Functional Adaptation and Remodeling**, edited by K. Hayashi, A. Kamiya, and K. Ono. Tokyo: Springer, 1996, 314 pp., ISBN 4-431-70173-7, $149.00.

This book serves as a companion volume to *Computational Biomechanics* and the *Data Book on Mechanical Properties of Living Cells, Tissues, and Organs.* These volumes discuss research focused on the classic doctrine ''function dictates structure.'' Whether this doctrine holds true for the cardiovascular system and connective tissues is a central question in the field of biomechanics. The research discussed in this book takes a multidisciplinary approach to this question to produce ''new insights into the sensors, signals, and activators that produce remodeling and functional adaptation in cardiac muscle, blood vessels, and bone.'' Included in this book are findings on the response of vascular endothelial cells to shear stress and the extent of remodeling and adaptation processes in tendons, ligaments, and intervertebral disks. *Biomechanics: Functional Adaptation and Remodeling* was produced to document ''the unique and important results'' obtained from a research project entitled Biomechanics of Structure and Function of Living Cells, Tissues, and Organs. In addition, it offers information on the phenomena of functional adaptation and optimal remodeling observed in living organs and components for biomedical engineers, medical scientists, clinicians, and other biomechanics-related engineers and scientists.

This book contains a total of 12 chapters divided into three sections: Response of Endothelial Cells to Mechanical Stress, Functional Adaptation and Optimal Control of the Heart and Blood Vessels, and Tissue Remodeling and Biomechanical Response in Orthopedics and Orthodontics. The third section is the largest, containing seven chapters, each written as an independent scientific research paper.

The two chapters contained in Sec. 1 (26 pages) provide a vast amount of information relating to the mechanical properties of endothelial cells. The first, ''Response of Vascular Endothelial Cells to Flow Shear Stress: Phenomenological Aspect,'' concentrates on endothelial cell response to shear stress as related to a change in morphology and function of the cells. Complex flow patterns such as reverse, secondary, and pulsatile commonly found *in vivo* are also investigated. The second chapter, ''Responses of Vascular Endothelial Cells to Fluid Shear Stress: Mechanism,'' discusses the response of mRNA levels of proteins and cytoplasmic $Ca^{2+}$ as related to shear-dependent endothelial cell activities.

Section 2 (33 pages) contains three chapters. The first, ''Responses of the Heart to Mechanical Stress,'' focuses on the immediate and chronic effects of mechanical overload on the structure and function of the heart. Expanding this topic, ''Residual Stress in the Left Ventricle'' proposes a mathematical model for stress on the left-ventricular wall taking into consideration the effect of residual stress. This mathematical model was tested using excised canine hearts. ''Response of Arterial Wall to Hypertension and Residual Stress'' reviews the effects of hypertension on the mechanical properties of the arterial wall and recent studies on residual stress in the arteries.

Section 3 (160 pages) contains seven chapters. The first explains research titled ''Mechanical Stresses and Bone Formation.'' In this chapter the quantitative relation between bone formation and mechanical stimuli were studied using rabbits and three-dimensional finite-element analysis. ''Fatigue Fracture Mechanism of Cancellous Bone'' explains predictions related to the progression of osteoporosis and the fatigue life of bone using both a theoretical analysis and an experimental study. The authors of the third chapter, ''Residual Stress in Bone Structure: Experimental Observation and Model Study with Uniform Stress Hypothesis,'' provide information on residual stress in normal bone structure observed in leporine (rabbit) and bovine bone. The fourth chapter, ''Response of Knee Joint Tendons and Ligaments to Mechanical Stress,'' is primarily concerned with the experimental findings observed in the changes of the biomechanical characteristics of rabbit and canine knee joint tendons and ligaments induced by a wide variety of techniques. The next chapter, ''Remodeling of Tendon Autograft in Ligament Reconstruction,'' continues a discussion of ligament mechanics, focusing on the remodeling of tendon autografts related to anterior cruciate ligament (ACL) reconstruction. ''Instability of the Spinal System with Focus on Degeneration of the Intervertebral Disk'' describes studies related to disk degeneration paired with excessive extension-flexion of the head and neck. In addition, the chapter discusses the ''potential conflict between the biological properties and functional demands of the intervertebral disk.'' The final chapter, ''Biological Response in Orthodontics,'' provides a biomechanical description of periodontal tissue change in felines caused by orthodontic force.

One of the most positive aspects of this book is that the information contained provides up-to-date (1996) information about three specific areas of research in the field of biomechanics.

This book provides a large amount of reference material on theoretical and applied biomechanics related to endothelial cell response to shear stress, and the adaptation of connective tissue and the circulatory system to mechanical stress. Although some of the topics are complex, the authors are careful to provide extensive background information and make the book fairly readable. Each chapter contains many clear pictures, charts, and tables relevant to the text. This book would be of interest to a biomedical engineering student or researcher interested in the specific topics covered, or in a general overview of selected areas of biomechanics research.

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