

PERSPECTIVES IN BIOMECHANICS

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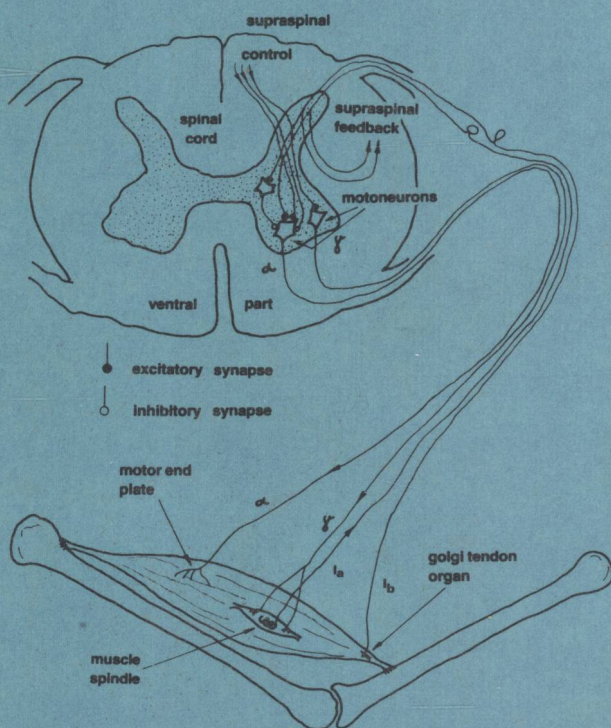
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Volume 1

Part A

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Edited by

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PERSPECTIVES IN BIOMECHANICS

Volume 1

Part A

PERSPECTIVES IN BIOMECHANICS

A series of monographs edited by D. N. Ghista, *Michigan Technological University, Houghton, Michigan*

VOLUME 1 PERSPECTIVES IN BIOMECHANICS, Parts A and B

Edited by H. Reul, D. N. Ghista, and G. Rau

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SERIES PREFACE

Perspectives in Biomechanics series is intended to provide a perspective of the depth and rigor of investigations in Theoretical and Applied Mechanics in diverse problem-oriented arenas, such as Medicine, Biology, Kinesiology, Sociobiology, Agriculture, Ecology, etc. The style and format of the volumes of this series is to make the chapters instructional, so to serve the tri-fold purpose of representing the state-of-the-art, serving as research reference as well as providing useful instructional material.

This first volume has been prepared to commemorate the First International Conference on Mechanics in Medicine and Biology held in August 1978 at Aachen under the auspices of the Helmholtz Institute of RWTH (Aachen); the flavor and orientation of this volume is discussed in the Editors' preface. It is intended to bring out further volumes in conjunction with subsequent conferences in this international series.

Dhanjoo N. Ghista
Series Editor

PREFACE

This book series is intended to provide a perspective on the range and scope of Biomechanics. Although the two parts (A and B) of this Volume 1 cannot by themselves do full justice to the comprehensive nature of the series theme, nevertheless an attempt has been made to select the contents to at least depict the flavor of the series theme. On the one hand, we have chapters dealing with the scope in physiology and medicine of specific mechanics disciplines, such as Solid mechanics, Fluid mechanics, Heat transfer, Systems theory and Compartmental analysis. On the other hand, there are chapters that provide expositions on the input of Biomechanics in some new arenas, such as Agriculture and Societal dynamics. The third category of chapters (principally in Part B) deals with the following topics: mechanics of impact, injury, and rehabilitation; mechanics of cardiovascular compartmental, neurosensory and pulmonary systems; articular joints evaluation and biomaterials considerations for surgical implants selection.

In Part A of this Volume, the first chapter makes a case for, and provides demonstration of the exploitation of Applied Mechanics rigor to purposefully cater to practical applications in medicine through the development of diagnostic indices, monitoring procedures, surgical guidelines, prosthetic and assist systems and devices.

The succeeding chapters, on Solid mechanics, Fluid mechanics, Heat transfer and Systems theory, deal, respectively, with (i) the constitutive relations of hard tissue, structural analysis of bones, and locomotion control, (ii) unsteady flow in branches and curved vessels, collapsible tube flows in veins and sphygmomanometry, inertially dominated flow in heart valves and motion of viscoelastic blood cells in capillaries, (iii) micro heat transfer processes in cells and macro heat transfer applications to cryosurgery, hyperthermia and hypothermia, response to climatic heat and cold, and clothing prescription, and (iv) systems analysis and control in human health and disease characterizations, diagnosis and therapy.

The next category of chapters (of Part A), demonstrating the scope of Biomechanics in some esoteric (non-medical) arenas, are on (i) mechanisms of walking and running, based on stability and energy-expenditure optimization considerations,

(ii) ergonomic models and techniques for achieving safer, more reliable and effective interactions between the medical staff and patients, medical staff and instrument systems, and patients and equipment, (iii) biomechanical formulations of agricultural products' constitutive and flow characteristics based design of products handling equipments, and human factors based design of harvesting and ploughing equipment, and (iv) statistical mechanics methodology in the formulation of the "thermodynamics" of biological groups, societal cultures, and urban societal trade activities.

The first four chapters in Part B are on biomechanics of trauma-injury and its rehabilitation. The treatment of the simulation of dynamic response of a finite (rigid) segment human body model provided with deformable skull and spine, impacted by or on a crushable surface, can (along with controlled experiments) be employed to suitably design car interior protective surfaces and restraint systems; to this end, the "force-acceleration input vs. lesions-pathology output" model of head impact (provided in the following chapter) in terms of quantitative biomechanical processes and phenomena can also assist in the prediction of the nature and mechanism of injuries. For treatment of spinal injuries and deformities, biomechanical analyses of force systems to reduce and stabilize spinal fractures can be employed to develop more effective correction-stabilization devices and associated surgical guidelines. Finally, for facilitating locomotion of patients with neuromuscular disorders, it is shown (in chapter 13) how the modalities of the functional electrical stimulation systems and techniques can be optimized by means of models of neurologically actuated musculoskeletal limb movements.

The next three chapters treat (i) compartmental analysis of transport of dyes and tracers in the circulatory system, to determine cardiac output, transit times through organs and shunt flows, (ii) vestibular system's biomechanical models of transduction of mechanical signals into neuro signals, and (iii) the mechanics of ventilation-perfusion ratio, and the influence of its regional variation on lung function and pulmonary diseases. The final two chapters are on articular joint modelling to simulate joint kinematics (to aid subsequent design of joint prostheses), and on the criteria and selection basis of the use of polymeric materials for tissue substitutes, cardiovascular prostheses, and indwelling catheters.

It has been our intent to provide a perspective of Biomechanics by means of in-depth mechanics formulations and analyses of some anatomical-physiological, agricultural

and social systems, neurological injury and rehabilitative mechanisms. It is hoped that this book will serve as a major state-of-the-art reference book and even a textbook for a graduate Biomechanics course.

Helmut Reul
Dhanjoo N. Ghista
Gunter Rau
March, 1980

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