# KINESIOLOGY

*Fifth Printing*

# KINESIOLOGY

## OF THE HUMAN BODY

*Under Normal and Pathological Conditions*

*By*

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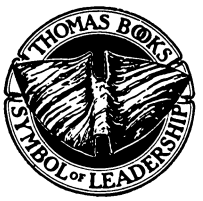


CHARLES C THOMAS · PUBLISHER

*Springfield · Illinois · U.S.A.*

*Published and Distributed Throughout the World by*

CHARLES C THOMAS • PUBLISHER
BANNERSTONE HOUSE
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.


ISBN 0-398-01846-4 (cloth) ISBN 0-398-06442-3 (paper)
Library of Congress Catalog Card Number: 55-6121

*First Printing, 1955*
*Second Printing, 1964*
*Third Printing, 1970*
*Fourth Printing, 1973*
*Fifth Printing, 1977*

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*Printed in the United States of America*

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*To my good Wife and Helpmate*
*Louise Steindler*

# PREFACE

A PREVIOUS publication on the subject of the *Mechanics of Normal and Pathological Locomotion,*[1] has met with what the author believes to be an indifferent reception. There seemed to be two reasons for it. The first problem was that not enough consideration had been accorded to the practical application of rehabilitation and re-education of locomotor deficiencies. With this in mind, the author has endeavored to give the theoretical facts a much wider interpretation in connection with diagnostic and therapeutic questions, fully realizing that the value of the book lies in what help it can offer to clinician and physical educator.

The other criticism was that the analysis of locomotion has ventured too much into the field of general mechanics which made the reading of the book uncomfortable and required much needless concentration. It was argued that practical conclusions could be attained more directly by observation and empiricism without any tedious theoretical preambles. It is with this second argument that the author has to disagree. He is neither willing nor able to reconcile himself to a short cut method based entirely on impressions and to summersault over the hard facts of basic sciences just in order to arrive at quick and usually superficial practical conclusions.

He is convinced that Kinesiology is an indispensable background for the prevention, the treatment, and rehabilitation of locomotor disorders.

On the other hand, it is conceded that mathematical accuracy in the calculation of locomotor events is only too often swallowed up by the stream of physiological and especially of pathological fluctuations; that certain allowances must be made because no two situations, be they normal or abnormal, are so alike that they can be expressed accurately by the same mathematical formula.

After all the analysis of human motion is primarily the job of the biologist, and only secondarily that of the physicist or engineer. The purely mechanical aspect of locomotion, which is the province of kinesiology, is merely a part of the physiology of motion in general.

All motor events are the end result of a long chain of cause and effect, the beginning of which, as in all things, is steeped in mystery. The study of kinetics taps this chain of events at a point just behind the clinical manifestation while the biologist tries to penetrate much farther into the background. In other words, kinetics explains only the physical events which lead immediately to the locomotor performance and it is not concerned with the more remote causes of human motion.

[1] Steindler, A.: Charles C Thomas, Publisher, Springfield, Illinois, 1935.

With these considerations in mind the author has tried to reduce all mathematical calculations to a minimum and has advanced on every occasion the clinical significance and the practical implication of kinetic findings. This, he hopes, should make for more palatable reading.

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## ACKNOWLEDGMENTS

THE author has received most valuable assistance in the preparation of this book. He is particularly grateful for the help extended to him by his associate, Dr. Webster B. Gelman. He not only furnished the illustrative drawings but he also helped with the arrangement of the book and with reading of the text, for which he made many useful suggestions. For the clerical help in typing the text the author is indebted to Mrs. June Clendenin, Mrs. Marian Heilbrun, and Mrs. Margaret Washburn. The photographic work was in the able hands of the Messrs. Kent. Mrs. Thea Wiegand compiled the table of contents and author and subject indices. The publisher, Mr. Charles C Thomas, has bestowed upon this work his highly appreciated painstaking efforts in the examination of the text, its editing and printing. All of this assistance is hereby thankfully acknowledged by the author.

A. STEINDLER

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# KINESIOLOGY

# Part I

# GENERAL KINETICS

## Lecture I

# THE AIMS AND PURPOSES OF KINESIOLOGY

KINESIOLOGY is that part of physiology of motion which describes and analyzes locomotor events so far as they reflect the action of mechanical forces. In other words, it presents bodily motion as a special case in mechanics.

The question is, can it be so represented; can human motion, with its boundless variability and being the product of a multitude of only partially known factors, be forced into the narrow frame of precise and austere mathematical and physical laws?

This is the very point which ultimately decides whether or not there is enough practical value in the undertaking to warrant this line of investigation. It must be admitted that locomotion involves certain unknown and incalculable factors which preclude a strictly mathematical presentation.

Nevertheless, the operation of known physical laws can be clearly recognized and evaluated in properly observed locomotor events. The Newtonian laws are accepted as being fundamental for terrestrial mechanics. We intend to interpret the operation of these laws in terms of human motion. We do not attempt to formulate general mechanical laws from our observation as Newton formulated his law of gravitation from observing the falling apple. In other words, our reasoning is *deductive* from the accepted mechanical laws to their interpretation in terms of our observations; it is not *inductive* from the observation to the formulation of the laws.

If we are in error the quarrel is with the observation and its interpretation and not with the law itself. The danger then lies not in failing to recognize that a mechanical law is operating but rather in overlooking the existence of other laws, not mechanical in nature, which have their share in human locomotion.

A good example is the interpretation of the functional adaptation of bone as formulated by Julius Wolff in 1876. When it was recognized by Culman that the internal structure of the upper end of the femur presents a perfectly calculated construction of a loaded crane, it was believed that the physical laws had absolute and complete control over the form and texture of the human bone and that the lamellar arrangements or trajectories, as they are called, fall strictly in line with tension and pressure stresses. This is no doubt true to a large extent. The only mistake was that the operation of other laws biological in nature had been overlooked because their influence on the structure of the bone was less evident. As a matter of fact, the architectural response of bone to the mechanical forces of stress and strain merely approaches but never completely conforms with the accurate engineering calculation. The reason is that there are other biological laws in operation which, under certain conditions, may become more conspicuous than the mechanical laws themselves. For instance, the organization of bone after fracture may proceed under the laws of transformation on stress and strain resistance. But it would be more