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BASIC BIOMECHANICS

Ninth Edition

Susan J. Hall

Mc Graw Hill

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NINTH EDITION

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PREFACE

The ninth edition of *Basic Biomechanics* has been significantly revised from the previous edition. As the interdisciplinary field of biomechanics grows in both breadth and depth, it is important that even introductory textbooks reflect the nature of the science. Accordingly, the text has been revised, expanded, and updated, with the objectives being to present relevant information from recent research findings and to prepare students to *analyze* human biomechanics.

The approach remains an integrated balance of qualitative and quantitative examples, applications, and problems designed to illustrate the principles discussed. The ninth edition also retains the important sensitivity to the fact that some beginning students of biomechanics possess weak backgrounds in mathematics. For this reason, it includes numerous sample problems and applications, along with practical advice on approaching quantitative problems.

ORGANIZATION

Each chapter follows a logical and readable format, with the introduction of new concepts consistently accompanied by practical human movement examples and applications from across the lifespan and across sport, clinical, and daily living activities.

NEW CONTENT HIGHLIGHTS

New content has been added to provide updated scientific information on relevant topics. All chapters have been revised to incorporate the latest information from the biomechanics research literature, and numerous new sport and clinical applications and examples are included. Topics added or expanded include articular cartilage repair, electromechanical delay, facet joint structure and function, hamstrings strains, barefoot running, baseball pitching, stand-up paddle boarding, bone health in microgravity, swimming technique, uses of exoskeletons, and careers utilizing biomechanics.

Balanced Coverage

Biomechanics is a field that analyzes the mechanical aspects of biological organisms. In this book focused on human biomechanics, anatomical and mechanical factors, as well as functional applications are covered. The integrated approach to coverage of these areas taken in previous editions is continued in this ninth edition.

Applications Oriented

All chapters in this new edition contain discussion of a broad range of updated human movement applications, many of which are taken from the recent biomechanics research literature. Special emphasis has been placed on examples that span all ages and address

clinical and daily living issues, as well as sport applications.

Laboratory Experiences

The integrated laboratory manual at the end of each chapter includes a number of updates.

PEDAGOGICAL FEATURES

In addition to the sample problems, problem sets, laboratory experiences, end-of-chapter key terms lists, and lists of websites, the book contains other pedagogical features from previous editions. These include **key concepts, marginal definitions, sample problems, chapter summaries, introductory and additional problems, references,** and **appendices.**

ANCILLARIES

Connect

The ninth edition of *Basic Biomechanics* is now available online with Connect, McGraw Hill's integrated assignment and assessment platform. Connect also offers SmartBook 2.0 for the new edition, which is the first adaptive reading experience proven to improve grades and help students study more effectively. All of the title's website and ancillary content is also available through Connect. Connect includes downloadable ancillaries, student quizzing, additional student exercises, and much more.

Resources for instructors and students include:

- Downloadable PowerPoint presentations with annotated lecture notes
- Instructor's manual, originally developed by Darla Smith, faculty emerita, University of Texas at El Paso
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MaxTRAQ™

The ninth edition of *Basic Biomechanics* can be used with MaxTRAQ™ software (for a small

additional price). MaxTRAQ is a downloadable motion analysis software that offers an easy-to-use tool to track data and analyze various motions selected by the authors. The MaxTRAQ software includes video clips of golf swing, gait, and other motions; 2D manual tracking; coverage of distance and angles; and more!

Visit http://www.motionanalysisproducts.com/Motion_Analysis_Store.html to purchase MaxTRAQ software for use with *Basic Biomechanics,* 9e. Each MaxTRAQ access code is unique and not related to any other registration or ID number. Each code is good for one-time registration and is available by download.

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> *"I really liked this app—it made it easy to study when you don't have your textbook in front of you."*
>
> - Jordan Cunningham, Eastern Washington University

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CHAPTER 1

What Is Biomechanics?

After completing this chapter, you will be able to:

Define the terms *biomechanics, statics, dynamics, kinematics*, and *kinetics*, and explain the ways in which they are related.

Describe the scope of scientific inquiry addressed by biomechanists.

Distinguish between qualitative and quantitative approaches for analyzing human movement.

Explain how to formulate questions for qualitative analysis of human movement.

Use the 11 steps identified in the chapter to solve formal problems.

CONNECT RESOURCES

Log on to Connect for access to these additional resources:

- **Online Lab Manual**
- **Chapter lecture PowerPoint presentation**
- **Chapter quizzes**
- **Additional chapter resources**
- **Web links for study and exploration of chapter-related topics**

Why do some golfers slice the ball? How can workers avoid developing low back pain? What cues can a physical education teacher provide to help students learn the underhand volleyball serve? Why do some elderly individuals tend to fall? We have all admired the fluid, graceful movements of highly skilled performers in various sports. We have also observed the awkward first steps of a young child, the slow progress of an injured person with a walking cast, and the hesitant, uneven gait of an elderly person using a cane. Virtually every activity class includes a student who seems to acquire new skills with utmost ease and a student who trips when executing a jump or misses the ball when attempting to catch, strike, or serve. What enables some individuals to execute complex movements so easily, while others appear

to have difficulty with relatively simple movement skills?

Learning to walk is an ambitious task from a biomechanical perspective.

Ariel Skelley/Getty Images

Although the answers to these questions may be rooted in physiological, psychological, or sociological issues, the problems identified are all biomechanical in nature. This book will provide a foundation for identifying, analyzing, and solving problems related to the biomechanics of human movement.

BIOMECHANICS: DEFINITION AND PERSPECTIVE

The term biomechanics combines the prefix *bio,* meaning "life," with the field of *mechanics,* which is the study of the actions of forces. The international community of scientists adopted the term *biomechanics* during the early 1970s to describe the science involving the study of the mechanical aspects of living organisms. Within the fields of kinesiology and exercise science, the living organism most commonly of interest is the human body. The forces studied include both the internal forces produced by muscles and the external forces that act on the body.


Anthropometry is the study of the size, shape, and composition of the body segments. Anthropometric characteristics may predispose an athlete to success in one sport and yet be disadvantageous for participation in another.

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•*Courses in anatomy, physiology, mathematics, physics, and engineering provide background knowledge for biomechanists.*

Biomechanists use the tools of mechanics, the branch of physics involving analysis of the actions of forces, to study the anatomical and functional aspects of living organisms (Figure 1-1). Statics and dynamics are two major subbranches of mechanics. Statics is the study of systems that are in a state of constant motion, that is, either at rest (with no motion) or moving with a constant velocity. Dynamics is the study of systems in which acceleration is present.