Skeletal Tissue Mechanics

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R. Bruce Martin David B. Burr Neil A. Sharkey

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R. Bruce Martin
University of California Davis Medical Center
Orthopaedics Research Laboratories
Research Building I
4635 Second Avenue
Sacramento, CA 95817
USA

David B. Burr
Indiana University School of Medicine
Department of Anatomy, MS 259
635 Barnhill Drive
Indianapolis, IN 46202
USA

Neil A. Sharkey
The Pennsylvania State University
Center for Locomotion Studies
29 Recreation Building
University Park, PA 16802-5702
USA

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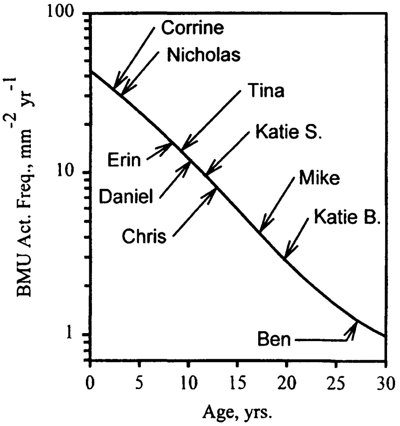
Dedication

Many books are dedicated to the authors' children, but in this case it seems all the more appropriate because of the cornucopia of biology and mechanics present in a child's developing skeletal tissues. Rather than just listing our children's names, we have chosen to present them in the context of this book by using the accompanying graph. As you will learn, teams of cells called Basic Multicellular Units continually repair and remodel the interiors of our bones. The graph plots the activity of these multicellular units as a function of age. Bone remodeling is most rapid in toddlers like Corrine, and decreases logarithmically on the way to adulthood. Allowing for individual variations, everyone slides down this curve in the process of growing up.

We want to express here our heart-felt gratitude to our particular tribe of decidedly unbasic "multicellular units." Activated varying numbers of years ago, they have repaired our fatigue damage, adapted us to stress, and generally remodeled our lives for the better ever since. In an age of information technology, new and wondrous instruments of learning appear almost daily, but not one compares with the ability of children to educate the adults around them. We have learned much from our children, and dedicate this book to them.



Preface

This book was written primarily as a textbook for graduate and advanced undergraduate students. It grew out of the lecture notes for a course called *Skeletal Tissue Mechanics,* which is part of the biomedical engineering curriculum at the University of California at Davis. Most of the many books available on skeletal biomechanics fall into one of two categories: textbooks dealing primarily with the biomechanics of locomotion and sport, or edited collections of reviews or tutorials on tissue mechanics. Although several of the latter are excellent resources for teaching at the graduate level, they generally lack a didactic presentation of the various topics and do not include exercises for the student. There are also textbooks aimed at teaching orthopaedic biomechanics to clinicians. However, very few of these attempt to analyze the biologic processes and mechanical behaviors of skeletal tissues in an integrated fashion. The integration of anatomy and physiology with structural and material behavior was one of this book's principal objectives.

Another objective was to develop an introduction to tissue mechanics that can be shared by students from several disciplines, including human and veterinary medicine, physical anthropology, mechanical engineering, and zoology, as well as bioengineering and biomechanics. In the interest of this diverse audience, time is taken to introduce basic mechanical and biologic concepts, and the approaches used for some of the engineering analyses are purposefully limited. We have tried to make the book an effective bridge between these classically dissociated disciplines. In the classroom we have observed spontaneous and enlightening discussions between students from dissimilar backgrounds. If the book sparks similar discussions in other classrooms, then we will have achieved at least a portion of our goal. In recent years, "interdisciplinary" has become a byword of productive research, and nowhere is this more evident than in the field of skeletal biomechanics. Traditional boundaries have dissolved, and today's graduate students, be they engineers or physiologists, clinicians or basic scientists, are required to synthesize knowledge across disciplines to become tomorrow's successful researchers. We hope that this text helps students to be more receptive to the possibilities for scientific enlightenment in disciplines beyond their chosen area of specialization.

The exercises at the end of each chapter endeavor to maintain this diversity of application. Also, it should be noted that few of the exercises are simply practice at solving problems demonstrated in the book. Instead, most of the exercises are designed to stimulate the student to synthesize concepts based on material discussed in the text and to develop analytical problem-solving skills that will serve them in the future. Thus, it is important for the student to work out a reasonable number of the exercises.

The third reason for writing this book was a selfish one: it has given us the benefit of stretching our brain cells again, in the way that only this kind of a writing project can. It is an exciting challenge to write a textbook in which the goal is to weave a fabric from the many disparate threads of a broad field, and to do so in a manner that is comprehensible to students as well as researchers. This statement does not imply that we suffer the illusion of having accomplished so much. We hope we have a proper sense of the limitations of this book, but at the same time we cannot help but believe that we have learned much in the writing of it. We look forward to learning still more as we invite comments from other instructors and students that may improve future editions.

We hope the book also serves as a useful resource for researchers. In a sense, it is a sequel to the monograph *The Structure, Function and Adaptation of Cortical Bone* (Martin and Burr, 1989). The present volume covers much of the same material, but has been updated and expanded to include trabecular bone, cartilage, synovial joints, and tendons and ligaments as well.

We thank the many colleagues who have contributed directly or indirectly to this effort; your insights and critiques were invaluable. James Paul Maganito was extremely helpful, and patient, in preparing the illustrations, as were the editors and production staff at Springer-Verlag in bringing the book to print. Finally, many thanks are owed to the students in the skeletal tissue mechanics course at UC Davis who helped refine earlier versions of this work.

R. Bruce Martin
Neil A. Sharkey
David B. Burr

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