# Preface

Collagen type I is the most abundant protein in mammals. It has outstanding mechanical properties and is present in virtually every extracellular tissue with mechanical function. In tendons and ligaments, collagen transmits the force from muscles to bones and stores elastic energy. Smooth walking would not be possible without these properties. Collagen also represents most of the organic matrix of bones and tooth dentin and confers them their fracture resistance. It is a major constituent of skin and blood vessels and is even present in muscles, which could not function without a collagen-rich matrix around the contractile cells. A slightly different type of collagen (type II) is a critical component of a tissue as soft as articular cartilage. The function of collagen is not only mechanical. In the cornea of the eye, for example, the ordering of collagen fibrils confers transparency in addition to mechanical stability.

The versatility of collagen as a building material is mainly due to its complex hierarchical structure. Adaptation is possible at every level, leading to a great variety of properties, to serve a given function. The basic building block of collagen-rich tissues is the collagen fibril, a fiber with 50 to a few hundred nanometer thickness. These fibrils are assembled into composite materials with a variety of more complex structures, which may have anisotropic or nearly isotropic mechanical properties, depending on fiber arrangement. In bone and dentin, collagen is combined with mineral to yield very stiff tissues. In tendon or cornea, collagen is combined with other organic molecules, such as proteoglycans.

Given the size of the collagen fibrils, the important structures are often in the nanometer scale, and recent progress in characterization methods has revealed many details of these structures and of how they relate to the mechanical behavior. Moreover, a large number of molecules have recently been identified as members of the collagen family. This is described in the first part of this book (Chapters 2–4), which is devoted to the structure and biochemistry of collagens. The second part of this book (Chapters 5–8) discusses mechanical properties and the mechanisms at the origin of deformation, fatigue and fracture of collagen-based materials, both from an empirical and from a theoretical viewpoint. The major part of the book (Chapters 9–17) addresses a particular collagen-based tissue per chapter, including tendons and ligaments, artery walls, cornea, bone and dentin, among others. The last two chapters focus on the more special issues of genetic collagen diseases and collagen-based tissue engineering. Chapter 1, finally, is meant as an introduction to the subject in general and to the other chapters in the book. It also gives elementary definitions of mechanical quantities needed throughout.

In this way, this text approaches collagen-based tissues from very different perspectives, highlighting structure and biochemistry, general principles of mechanical behavior, as well as structure, composition and mechanical behavior of a number of important tissues in our body. We hope that by this interdisciplinary approach, the book will be useful as an introduction and as a reference for advanced students, researchers and engineers in very diverse fields, such as materials science and engineering, collagen biochemistry and biophysics, as well as tissue engineering and regenerative medicine. This diversity is also reflected in the different backgrounds of the authors, who are all well-recognized specialists in the fields which they are covering. In addition to providing the best introduction and up-to-date reference, we really hope to transfer to the reader some of our excitement about the beauty of structure and mechanics of collagen-based tissues.

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