The Bioengineer's Bookshelf

Reviewed by Y. C. Fung, UCSD, La Jolla, California

Exempla Haemorheologica, "Das stroemende Organ Blut," by Holger Schmid-Schoenbein, Guenther Grunau, and Hans Braeuer, with an introduction by Hans Schaefer. Published and copyrighted 1980 by Albert-Roussel Pharma GMbH, Wiesbaden, Germany, 1980. In German.

The book opens with a quotation from Baker, 1743:

> "An observation of Mr. Leeuwenhoek is very well worth regarding: he took notice, that when he was greatly disordered, the Globules of his Blood appeared hard and rigid, but grew softer and more pliable as his Health returned."

Then from J. E. Thornton:

> "The more we treat the theories of our predecessors as myths the more inclined we shall be to treat our own theories as dogmas."

These are indeed fitting inscriptions for this most beautiful, extraordinarily well-illustrated and well-printed book on flowing blood. The title may be translated as "Examples of Hemorheology: The Flowing Blood as an Organ." Most American readers are familiar with Frank H. Netter's Ciba Collection of Medical Illustrations, a Compilation of Paintings on the normal and Pathologic Anatomy and Physiology, Embryology, and Diseases of various organs. The present book is like Frank Netter's Ciba book, equally well illustrated, much shorter, but presented with even greater exuberance and enthusiasm. Some of the paintings are covered with transparent pages on which are printed arrows, numbers, borders, to lead the reader to the explanations to the text. The paintings are thus preserved as works of art. The text is printed in two colors, black for the the main flow of ideas, green for explanation of the figures. The size of the book is large: 12 × 14 in. Using very thick sheets of paper, the 78-page book makes up a pretty thick volume. It is a luxury publication.

The book begins with a general description of the history of blood physiology, blood phylogenesis and ontogenesis, the blood vessel system, and blood function. Then there follows part B, the flow properties of blood, and part C, the microcirculation, both normal and disturbed. The theme of the book is that the fluidity of the blood is of major importance, that the flexibility of the red blood cells can vary and be controlled. This theme is illustated by the paintings collected here. The book ends with a chapter on the methods of hemorheology, with photographs of instruments used in the measurement of the flow properties of blood.

Unfortunately, this book is not generally available in the bookstores at the present time. I happened to see it on a friend's bookshelf. At a party given by Professor Arnost Fronek, he showed me this remarkable publication. I then wrote to the senior author, Professor Schmid-Schoenbein, who said that they are contemplating publishing an English version. Let us hope that this will be done, and that when it is done, the price will be reasonable so that students can afford it.

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Mechanical Properties of Bone. Proceedings of a Joint ASME-ASCE Applied Mechanics, Fluids Engineering, and Bioengineering Conference, Boulder, Colorado, June 22–24, 1981. Edited by Stephen Cowin. The American Society of Mechanical Engineers, New York. ASME Publication No. AMD-45, 238 pages, 1981.

This is a collection of several excellent papers on the mechanical properties of bone. It is one of the best ASME publications. The aforementioned conference was sponsored by the Joint Biomechanics Committee of the Applied Mechanics Division and the Bioengineering Division, ASME. The contents are as follows:

Professor Roesler's paper on the history of the Wolff's law is particularly interesting. It now appears that at the very beginning things were a bit fuzzy. Some claims were not proven, and some statements were not substantiated. Roesler relates that in 1867 G. H. Meyer published a paper called "Die Architektur der Spongiosa," in which he presented a line drawing of the cancellous bone structure he had observed in the proximal part of the human femur. When Meyer gave a lecture on his findings at a meeting of the "Züricher Naturforschende Gesellschaft" in 1866, the mathematician C. Culmann was present. Culmann had published a book on graphic statics in the same year. When he saw Meyer's drawings he pointed out that the lines resembled closely the principal stress trajectories in graphic statics. Meyer (1867) reported that, stimulated by the pleasant drawings of bone structure in the proximal end of the human femur, Culmann asked a student of his to construct the principal stress trajectories in a cranelike curved bar loaded in a fashion similar to the human femur. This construction was to become known as the Culmann crane, referred to in the many publications of the following decades.

Roesler shows that the trajectories of Culmann's crane are merely those of a straight cantilever beam loaded by shear at the free end, bent to look like a crane but without readjustment for the changed stress field. J. Wolff, convinced that Culmann's crane represented exactly the cancellous structure

of the human femur, made it the basis of his trajectory hypothesis and his "law of bone transformation."

Key developments following this beginning are discussed by Roesler.

Other papers in this volume are also excellent. Currey is a fascinating speaker with a broad perspective. Hayes' article is a superior stereological study of the trabecular bone. Woo's paper on long bone remodeling contains many new data. And there are many others on which I will not comment. This volume is highly recommended to bioengineers.

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Perspectives in Biomechanics, Vol. 1, Parts A and B. Edited by H. Reul, D. N. Ghista, and G. Rau. The first of a series of mongraphs edited by D. N. Ghista. Part A, 528 pages, Part B, 363 pages. $214.50 (2 Vols). Harwood Academic Publishers, New York, Chur, London, 1980.

Biomechanics is mechanics applied to biology. It indeed covers a very broad territory. The area covered by this volume is described by the following chapter headings:

1 Towards an effective theory-to-medical practice approach in biomechanics, by D. N. Ghista, R. Reul, G. Rau, M. Waschmann
2 Solid mechanics in biomedicine, by H. G. Kingsbury, J. L. Nowinski, T. W. Chou
3 Fluid mechanics in cardiovascular flow, by T. J. Pedley, T. K. Hung, and R. Skalak
4 Human micro and macro heat transfer, in vivo and clinical applications, by W. J. Yang.
5 System theory in biomedicine, by R. Rosen
6 Mechanics of walking and running, by R. M. Alexander
7 Ergonomics in medicine, by R. Barnotat and G. Rau
8 Mechanics in agriculture, by A. T. Johnson
9 Homeokinetic physics of societies, by Iberall, H. Soodak, and C. Arensberg
10 Dynamic response and protection of the human body and skull in impact situations, by R. H. Huston and N. Perrone
11 Mechanisms, evaluation, prognosis, and management of head and neck injury, by King Liu
12 Spinal mechanics: kinematics, kinetics, and mathematical models, by M. M. Panjabi and A. A. White, III
13 The impact of biomechanics on the neuromuscular rehabilitation, by L. Vodovnik, T. Bajd, and A. Kralj
14 Compartment analysis in biomedicine, by M. Kwahara.
15 Biomechanics of neuro-sensory systems, by E. Biondi, F. Grandori, A. Pedotti, and R. Schmid
16 The mechanics of the interaction between ventilation and perfusion, by S. Cameron
17 Kinematic theory of function and evaluation of articular joints, by Y. Youm
18 Selection criteria for polymeric implant application with representative modifications for increased acceptability, by J. W. Boretos

These articles survey the fields covered, and present selected lists of references up to about 1978. But a perspective is a personal thing, and different persons see different things in the same field. For example, the motion or locomotion of man and animals is treated several times in this book; by Kingsbury et al. in Chapter 2, by Huston and Perrone in Chapter 10, by Liu in Chapter 11, and by Youm in Chapter 17. They are all good. But the substances are very different, and the lists of references differ to a surprising degree. Some references considered basic and central in importance by one author are not mentioned at all by another.

There are lots of very good passages in this volume. Overall this is a very useful reference book. Its wide coverage will broaden people's views on biomechanics.

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Osteoarthromechanics, edited by Dhanjoo N. Ghista, Ph.D., 485 + x pages, $49.50. McGraw-Hill, New York, 1981. Copyright by Hemisphere Publishing Co.

This book opens with a chapter by Subrata Saha on the dynamic strength of bone, which contains a very useful survey and lists of data. The second chapter is by J. L. Nowinski on the effects of holes and perforations on the strength and stress distribution in bone elements. This contains detailed analyses of holes with mathematical details given in several appendixes. Chapter 3 by R. Collins and H. B. Kingsbury presents a comprehensive review of the theories on the lubrication of human articular joints, and experimental results. Chapter 4 by James Pugh is entitled "Biomechanical Aspects of Osteoarthritic Joints: Mechanisms and noninvasive detection." The pathological changes in the tissues are discussed thoroughly, and the method of impact testing as a noninvasive diagnostic technique is presented with some detail. I find this an excellent chapter. Chapter 5, "Finite-element applications in joint-replacement design and analysis," by Thomas P. Andriacchi and Steven J. Hampton, presents the finite element method succinctly. Design applications are emphasized in the discussions. The next chapter, 6, by Peter S. Walker, is on Artificial Joints. It presents the history of the subject, the kinematics, kinetics and materials of artificial joints, and their design and performance. It is an excellent survey.

The rest of the book, about half of the volume, is concerned with the spine. It begins with Chapter 7 by the Dutch authors A. W. M. Schijvens, C. J. Snijders, J. M. Seroo, and J. G. N. Snijder, on the mechanics of the spine: analysis of its flexibility and rigidity, postural control, and correction of the pathological spine. This is a good, simple, introductory chapter. The analysis of standing and sitting is very good. The next chapter, 8, by Lars Sonnerup, is entitled "Stress and strain in the intervertebral disk in relation to spinal disorders." Chapter 9, by Gordon C. Robin and Zvi Yosipovitch, is entitled "The biomechanics of thoracic and lumbar spine fractures: their fixation and stabilization." Chapter 10, by J. E. Lonstein and R. B. Winter, is entitled "Mechanics of the deformity and treatment in scoliosis, kyphosis, and spine fractures." The final chapter, 11, by Rae R. Jacobs and D. N. Ghista, is entitled "A biomechanical basis for treatment of injuries of the dorsolumbar spine."

Thus it is seen that the spinal mechanics is given a major share of attention. The style of most of the chapters remains physical and physiological as opposed to mathematical and computational.

The whole book is lucid and concise, well illustrated and well printed. I recommend it highly.

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Cardiovascular Fluid Dynamics, by Uric Dinnar, Ph.D. 252 pages, U.S. $69.95, Foreign $79.95, CRC Press, Inc., Boca Raton, Flordia.

After a brief introduction of the cardiovascular bed as a system, and some elements of physiology of the circulatory system, the book begins with a chapter on the properties of flowing blood, then goes on to the structure and physiology of blood vessels, propagation of waves in arteries, pulsatile flow in rigid and elastic tubes, analog models of the circulation, the heart as a pump, blood flow in the microcirculation, and finally, fluid mechanics of thrombus formation. Thus in a relatively small space it surveys the arterial blood flow, some aspects of microcirculation, heart, and blood. No specific reference is made to the specialized circulatory systems of various organs. Features of flow in vein caused by its collapsibility are not discussed.

The text is mathematical. It leads the reader quickly to the mathematical formulation of the problem and the solutions and interpretations. In many places the mathematical level required of the reader seems to be quite low. So is the required