current literature on the subject in its varied forms, journals, preprints, and private letters, including obscure papers by derelict authors, is absolute and amazing, and he has been very careful in tracking down the original sources of interesting ideas. The bibliography alone (about 30 pages of fine print) is a welcome contribution.

TULLIO REGGE
Institute for Advanced Study, Princeton, New Jersey

Hematology

Blood Clotting Enzymology. WALTER H. SEEGERS, Ed. Academic Press, New York, 1967. 640 pp., illus. $27.50.

When thrombin acts on fibrinogen, it splits off the amino-terminal portions of two of the three peptide chains. The amino acid sequence of these peptides liberated from a great number of different fibrinogens is now known. As one of the contributors to this book points out, the structure of these peptides reveals a phylogenetic relationship similar to the morphological taxonomy. These peptides represent only about 3 percent of the fibrinogen molecules, and many people are reluctant to use such a small portion of the amino acid sequence of a protein to establish phylogenetic relationships. To me the correspondence is so striking that I can hardly consider it to be accidental. I think that these peptides have an important physiological role and that this is the reason why evolution has left its mark on them.

As the title indicates, this book recognizes the importance of enzymology in the study of blood clotting. At least two of the dozen or so clotting factors are enzymes, thrombin (the clot-forming enzyme) and the clot-stabilizing enzyme, and there are indications that other clotting factors may also be enzymes. This book deals not only with the two known enzymes but with all the known clotting factors. The chapters cover such topics as the molecular characteristics of substances active in blood coagulation, the activation of prothrombin, the transformation of fibrinogen into fibrin, the immunochemistry of the clotting factors, antithrombin, platelets in hemostasis, irregular blood coagulation, and the ultrastructure of the fibrin clot. A discussion of the role of fibrin in the spread of tumors would have been welcome.

Of course, not all the topics could be treated with the same degree of sophistication. It is quite obvious to the reader that fibrinogen and its clotting are better understood than are other aspects of blood clotting, and in fact are in the forefront of protein and enzyme chemistry.

A large portion of the book deals with prothrombin and its conversion to thrombin. Prothrombin now appears to be a complex entity giving rise under various conditions to prethrombin, autoprothrombin C, autoprothrombin I_p and I_c, autoprothrombin II, and autoprothrombin III. As purer and purer prothrombin preparations become available, this complicated picture will probably be modified. As far as I can see at this stage, there is room for different interpretations to develop. The sequence of events depicted by the "cascade" or "waterfall" propositions (which are mentioned in chapter 1 only to be immediately discarded) is attractive, easy to grasp, easy to teach. One is inclined to believe with Keats that "Beauty is truth, truth beauty."

In spite of the determined efforts of the authors to present only well-established facts, occasionally some outmoded concepts come up. I was surprised to read that thrombin is also a "polymerase." The experiments refuting this are clear-cut (provided highly purified components are used). Experts in the various fields may find similar minor points to criticize.

The contributors have attempted to present their topics in such a manner as to profit the uninitiated as well as the expert. A lack of continuity among the chapters reflects more the state of the field than any lack of effort on the part of the authors and the editor, who are to be commended for having undertaken this work.

KOLOMON LAKI
National Institute of Arthritis and Metabolic Diseases, Bethesda, Maryland

Botanical Phenomena

Plant-Water Relationships. R. O. SLATYER. Academic Press, New York, 1967. 378 pp., illus. $16.50. Experimental Botany monographs.

This is the first book to be devoted largely to a biophysical description of plant-water relations. In contrast with other works on the subject, which deal with specific experiments describing ecological and physiological phenomena, this book begins from the other direction, with tools from supporting sciences, and illustrates their applicabiity with experimental evidence. Thus, it is written from the conceptual point of view and represents a unique and valuable contribution to the field.

Starting with a physicochemical chapter on the properties of water, the author continues with one on the ecological significance of water in the plant environment and then two chapters that are excellent summaries of the physics of soil water. The rest of the work deals specifically with interactions between water and plants, beginning with a chapter on terminology and measurement techniques. Here the author changes from the older terminology based on diffusion pressure to that based on chemical potentials. Although osmotic pressure is defined in terms of potentials in this chapter, it is the one questionable term which is retained in the rest of the book. I would have preferred the use of potential terminology throughout, for uniformity and because of the differences in definition of osmotic pressure in botany and in physical chemistry.

Chapter 6 describes cell water-uptake and permeability phenomena in terms of nonequilibrium thermodynamics. The presentation is quite clear, although the reader will probably need to consult the early work of Kedem and Katchalsky in order to appreciate the reasoning fully. Two chapters follow with a description of water flow through the soil-plant-atmosphere and include valuable insights into the effects of energy exchanges between the leaf and the environment. The author concludes with a concise chapter on the physiological significance of internal water deficits.

On the weaker side, more extensive coverage of the material in the last chapter would have been desirable. For example, there is only passing reference to the extensive literature on hormonal control of water uptake associated with growth and on the effects of water stress on protein metabolism. Missing from the book as a whole are descriptions of solute accumulation and translocation, which, though large subjects in themselves, might well deserve treatment here. The equations used in this account are accurate, and the symbology is clear. There are some typographical errors in the text, however, although these are troublesome only in a few instances, where physical units are quoted incorrectly.

The subject of plant-water relationships lends itself to a combined ecological-physiological approach. It is rare to find a book which integrates these two subjects so well. The author is particularly well qualified to write about them, having contributed extensively to the literature of both fields.

The book is a major addition to earlier works which, though less biophysically based, are still important summaries of plant-water relations. There can be little doubt, however, that in the future we will see more of Slatyer's approach and, one hopes, will have an increasingly healthy combination of the two points of view.

JOHN S. BOYER

Department of Botany, University of Illinois, Urbana

Motile Systems

Structure and Functions of Contractile Proteins. BORIS F. POGLAZOV. Translated from the Russian edition (Moscow, 1965) by Scripta Technica. Academic Press, New York, 1966. 339 pp., illus. $17.

The ability to produce controlled movements is one of the fundamental properties of living organisms. Even though a large number of apparently different motile systems have been described, ranging from the slow streaming of protoplasm to the high-frequency oscillations of insect flight muscle, it is reasonable to suppose that one is dealing with a class of phenomena exhibiting common features and evolutionary relationships. This book is probably the first attempt to provide a unified treatment of the broad area of motile systems. It deals primarily with the question, Is there a group of proteins with common properties which could be referred to as "contractile proteins"?

A translation of a 1965 Russian edition, the book covers the literature in detail up to the end of 1963. The translation is adequate but often awkward, and one gains the impression that the author's exact meaning has not always been conveyed.

The first third of the book is devoted to a review of the structure and chemistry of muscle. In view of the pioneering work of Engelhardt and Lyubimova on the adenosine triphosphatase activity of myosin, the volume of Russian work is surprisingly small. Except for the discussion of Poglazov's own studies on the role of sulfhydryl groups in polymerization of actin and in adenosine triphosphatase activity of myosin, the same ground has been covered by a number of reviews in English. A short chapter devoted to tropomyosin leaves the (mistaken) impression that invertebrate paramyosin and vertebrate tropomyosin are essentially the same protein. An important difference in emphasis occurs in the treatment of the mechanism of contraction. Although most British and American workers seem to regard the Huxley-Hanson sliding-filament model as at least the starting point for a discussion of contraction, here it is accorded the status of one hypothesis among a number of possibilities. Poglazov emphasizes the importance of the "α-spiral" in cross-β configuration as the basis of contraction in muscle and as the unifying principle which relates muscle contraction to other motile systems. The finding of the cross-β configuration in bacterial flagella by Astbury is taken as support for the general importance of this type of mechanism.

This point is amplified in a long chapter devoted to the "Motor apparatus of bacteriophage." The T2 caudal sheath has been extensively studied by Poglazov and collaborators. In brief, the sheath protein is believed to bear some resemblance to actin; and since adenosine triphosphatase activity is also present, a contractile protein system presumably functions in DNA injection. The mechanism involves a change in pitch of the helix formed by sheath protein. Similar suggestions have been made by Kozloff and co-workers, but Poglazov goes further in suggesting that the change involves an α to cross-β transformation and that the adenosine triphosphate is hydrolyzed by the sheath protein by a mechanism similar to the hydrolysis of bound nucleotide in the G to F transformation of actin. The phage system is described as a "monomolecular muscle." The hypothesis is certainly interesting and must await further characterization of the proteins, but the role of the cross-β configuration in muscle contraction would probably be disputed by most American and British workers.

A chapter is devoted to flagella and the mitotic apparatus. The author tends to regard bacterial and animal flagella as chemically similar systems, both related to actin and myosin. Unfortunately, much of our knowledge of the properties of animal cilia proteins was obtained after the preparation of this book. There may be some resemblance between actin and microtubule protein, but the thesis that a cilium is an actomyosin-like system is difficult to defend. Studies on the mitotic apparatus by Mazia and collaborators are adequately reviewed, but no important new evidence is added from Russian sources.

A discussion of the role of actomyosin-like proteins in protoplasmic streaming is presented, based on the work on slime mold (myxomyosin) and on a protein preparation obtained from *Nitella flexilis* by Vorob'eva and Poglazov (algomyosin). Here we are on firmer ground, since a pure protein has been obtained from slime mold by Oosawa and by my own laboratory which is essentially identical to actin. However, it should be emphasized that this is the only case so far in which a pure actin or myosin preparation has been obtained from a motile system other than muscle. Poglazov also describes crude preparations from a variety of organelles, cells, and tissues which are said to be actomyosin-like, in the sense that they exhibit adenosine triphosphatase activity and a decrease in viscosity with the addition of adenosine triphosphate. If these criteria are acceptable, then actomyosin-like proteins are found in most cells, including erythrocytes, and in mitochondria and chloroplasts. Furthermore, it is suggested by Poglazov that contractile systems could operate in permeability and active transport. One should also add that a contractile system, in reverse, could therefore function as the energy acceptor in oxidative phosphorylation in mitochondria and photophosphorylation in chloroplasts, and thus lead to the synthesis of adenosine triphosphate.

At present, the problem of energy conversion in any motile system has not been solved, and Poglazov's book provides us with a general survey of this interesting field. Perhaps the tendency to describe all systems as "actomyosin-like" is premature. It indicates our lack of satisfactory criteria for distinguishing "contractile proteins" except by analogy with the properties of actomyosin. The ciliary adenosine triphosphatase (synein) is not myosin-like, yet the cilium is an efficient motile system. On the other hand, the failure to confirm earlier reports of the pres-