that is known about the kinetics of the pump as a function of the inside and outside substrate concentrations was determined by the use of the human red cell.

The Na pump is not one of the systems discussed in this volume, presumably because it would rate a book of its own. Of the 38 papers, most of which are reports of current research, about a third deal with the anion transport system, a third with Ca^{2+} transport and Ca^{2+}-stimulated K^+ transport, and a third with a variety of other topics, including the arrangement and interaction of membrane proteins and the behavior of lipids. Each paper is followed by an edited transcript of the discussion that followed it at the meeting. The discussions occupy about a third of the book and are well worth the space. They highlight matters of controversy among the participants, and they communicate a feeling for those aspects of the papers that were new and exciting to the audience.

Of the topics covered, the anion transport system is the one on which the most rapid progress is being made. Because a large fraction of blood CO_2 is carried in the plasma as bicarbonate, while the carbonic anhydrase is located in the red cell, efficient respiratory exchange of CO_2 requires that the red cell have a very high bicarbonate permeability. The function of the anion transport system is to facilitate a chloride-bicarbonate exchange. It is an obligatory exchange mechanism: chloride-chloride exchange is 10,000 times faster than the net chloride flux. Besides chloride and bicarbonate the system also transports many mono- and divalent anions, including sodium and lithium as the anionic complex with carbonate (discussed in a paper by Funder and Wieth). The kinetics of the system is discussed in four papers, by Kaplan, Pring, and Passow, Knauf and Lau, Gunn and Frölich, and Jennings. There is general agreement that the system has a "Ping-Pong" type of kinetics in which the protein undergoes a conformational change catalyzed by anion binding, exposing the anion binding site alternately to each of the two sides of the membrane.

The 100,000-dalton anion transport protein, the band 3 protein, is the major transmembrane protein component of the red cell. There are four papers on the structural features of the band 3 protein, by Cherry and Nigg; Guidotti- Rothstein, Ramjeesingh, and Grinstein; and Weinstein, Khodadad, and Steck. They contain information about the general arrangement of the chain, the sites of proteolytic cleavage, and the general location of active sites, but no fine structural detail. It is still not clear how many times the chain traverses the membranes.

Proof that at least a major fraction of the band 3 protein is responsible for anion transport is provided in a paper by Cabantchik and Loyter. Using purified band 3 protein, they reconstituted anion transport into either pure lipid vesicles or Friend erythroleukemia cells (by fusion of vesicles containing Sendai virus envelope glycoprotein). The promise of reconstitution has long been that it could enable one to study structure and function of various fragments of the protein. With the preliminary report in the paper by Rothstein, Ramjeesingh, and Grinstein that anion transport could be reconstituted by using just a 15,000- and a 9000-dalton fragment, this hope seems about to be fulfilled for this system.

In general, the papers in this book are authoritative and provide a good survey of the current status and future directions of research, especially on the subjects of anion and calcium transport processes.

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Developmental Phenomena

Senescence in Plants. KENNETH V. THIMANN. CRC Press, Boca Raton, Fla., 1980. xii, 276 pp., illus. $69.95. CRC Series in Aging.

Senescence in Plants is the first comprehensive book on this topic since *Die Lebensdauer der Pflanzen* by Molisch, which was first published in 1928. Research on plant senescence has become very active in the past decade, and there has been a need to take stock of what is known and to point out where additional research is required. Thimann and the 12 other contributors to this book have undertaken this task.

The emphasis of the book is on monocarpic plants, that is, plants that have only one reproductive phase, such as annuals. In monocarpic plants, senescence is a very accurately timed phase in development, as can be seen yearly in, for example, cereal fields, where all plants lose their chlorophyll simultaneously, turn golden-yellow, and die. Chapters by Thimann (leaf senescence), Frith and Dalling (role of peptide hydrolases), and Noodén (whole-plant senescence) and in part one by Leopold (senescence in plant development) deal with physiological and biochemical aspects of this phenomenon. These authors report on the known and suspected signals—some of them hormonal—that regulate senescence. The view clearly emerges that senescence is at least partly controlled by an interaction of factors of which some promote and others retard it. Also, the controls that one organ, for example the fruit, exerts over another, for example the leaf, are described in detail. The biochemical processes that underlie senescence in monocarpic plants are given broad coverage. According to the current view, senescence of monocarpic plants requires the synthesis of specific proteins but, overall, senescence is characterized by a shift in metabolism from anabolic to catabolic processes. The agricultural implications of protein breakdown in senescing leaves are outlined by Frith and Dalling. Proteolysis in leaves and transport of reduced nitrogen from the leaves into the developing fruits are one important factor determining crop yield.

Senescence of reproductive structures is described by Mayak and Halevy (flower senescence), Rhodes (fruit ripening), and Goldschmidt (pigment changes during fruit ripening). Both in flowers and in fruits, ethylene is an important regulator of senescence, and effective removal of endogenously produced ethylene and control of its biosynthesis emerge as major goals of research in postharvest physiology. Physiological and biochemical aspects of longevity and senescence of seeds are covered by Osborne and ultrastructural changes during seed dormancy and senescence by Villiers. Senescence of seeds, unlike that of monocarpic plants, is not developmentally programmed but probably is the result of cumulative lesions to cellular structures. The chapter on senescence in fungi by Esser and Tudzynski, though interesting in its own right, is somewhat out of context in a book devoted to higher plants. Last, credit must be given to Woolhouse, whose preface to the book introduces the topic of plant senescence and places it in a wider biological framework.

In summary, *Senescence of Plants* achieves what it sets out to accomplish. The reader gets an appreciation of current concepts, of open questions, and of problems important to agricultural applications. Workers in the field will also profit from the comprehensive reference lists at the end of each chapter, which include citations of the older literature as well as of publications up to 1979.

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