place in the body. But he thought the most effective prescription would be for Devonshire to take a dose of calomel once a fortnight, to have a regular stool, to relax in his garden, and, most important—a recommendation made only with great deference to British custom—to reduce by half the large quantities of wine and liquor he consumed.

The grandfather of Charles Darwin is remembered in our day as elaborating a theory of species transformation in his major medical work, *Zoonomia* (1894–96). His theory bears less resemblance to his grandson's than Desmond King-Hele, the enthusiastic editor of his letters, suggests. Darwin's theory was, nonetheless, an impressive guess in the right direction. Samuel Butler, whose passion for science far exceeded his grasp of it, even thought the elder Darwin's biological speculations superior to those of the younger. But in his own day Erasmus Darwin's reputation rested more on those abilities for which the Duke of Devonshire consulted him.

Darwin often communicated his medical and biological ideas in ways that should have more restrained the editor from trying to unearth a mind of contemporary scientific temper. In the early 1790's, for example, Darwin completed *The Botanic Garden*, 2192 rhyming couplets singing of the sex lives of plants and other intimacies of the vegetable kingdom. To us certainly odd, but the young Coleridge judged Darwin "the first literary character in Europe, and the most original-minded man." In later years, though, he likened Darwin's poetry to "mists that occasionally arise at the foot of Parnassus."

This volume gathers all of Darwin's known letters (save one to be published by its owner), 272 in all. The editor provides admirable notes, detailing the events discussed, giving short biographies, and referring the reader to other literature. Darwin's letters reveal a man of capacious interests, shrewd ideas, and well-placed friends. He wrote to James Watt, who improved the steam engine, about a new design for a carriage; but only to Matthew Boulton, the great Birmingham manufacturer, of his secret plans for a "fiery chariot," a steam-driven wagon; to Benjamin Franklin on electrical experiments; to the financier John Barker about building iron mills on the new Trent and Mersey canal, then in the planning stages. He corresponded with his long-time friend the pottery magnate Josiah Wedgwood over many things: ideas—fuzzy at best—of heat storage and flow; new models for oil lamps; and always finances. (Wedgwood's daughter Susannah married Darwin's son Robert, and they became the parents of Charles.) Darwin reported to all of his friends the latest cures for a variety of maladies. He was especially sanguine about the use of "airs," such as oxygen, in therapy for lung disorders; together he and Watt devised machines to produce and administer these gases. Unfortunately few patients seemed to benefit from the new inhalation technology.

Dr. Darwin died fat. He preached the medicinal virtues of natural foods taken when needed, which was, for him, often. He left his heirs, including two illegitimate daughters, a goodly sum, the result of sound investments, a lucrative practice, and his keen desire to turn a shilling—he boasted to Watt that "I write for pay, not for fame." This volume will contribute modestly to his fame. It will contribute immodestly to the accounts of Cambridge University Press.

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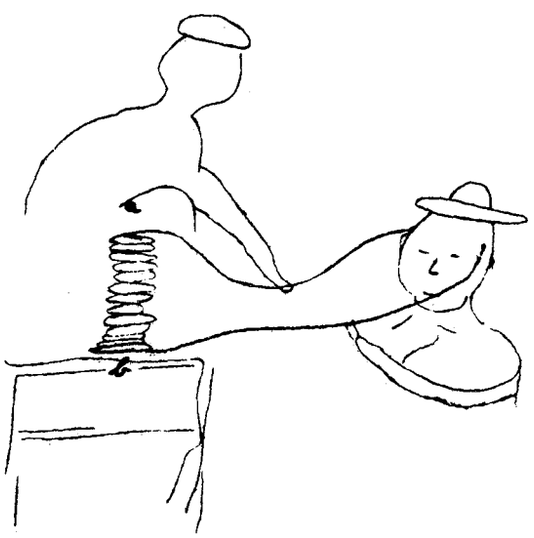

Galvanic pillar as drawn by Erasmus Darwin in a letter to Georgiana, Duchess of Devonshire, November 1800. "The Galvanic pillar may consist of about 30 or 40 half-crown pieces, as many pieces of Zinc of similar dimensions, and as many circular pieces of cloth, which must be wetted in salt and water. Two thick brass wires . . . communicate from each extremity of the pillar to each temple. The temples must be moistened with brine. . . . The shock is so great as to make a flash in the eyes, and to be felt th[r]ough both the temples, every time one of the wires is lift'd from the pillar, and replaced. So that 100 shocks may be given in a minute. I have one patient here . . . who has used it daily for giddyness with good success. I should be extreemly happy to show your Grace the application of Galvanism, the effects of which would surprize you, I am sure." [Touched-up version, from *The Letters of Erasmus Darwin*]

Electrophysiology

The Biophysical Approach to Excitable Systems. A Volume in Honor of Kenneth S. Cole on His 80th Birthday. Papers from a symposium, Woods Hole, Mass., 1980. WILLIAM J. ADELMAN, JR., and DAVID E. GOLDMAN, Eds. Plenum, New York, 1981. xii, 258 pp., illus. $29.50.

Among membrane biologists few techniques are more valued than the voltage clamp; the many membrane processes inherently dependent on voltage are best studied when the voltage is controlled by the investigator and not the membrane. Among American physiologists few investigators have had more significant careers than K. S. Cole, the inventor of the voltage clamp. It is wonderful that the inventor has lived to see his invention applied to so many tissues and cells with such important results.

Cole's invention of the voltage clamp is only one part, a small part if measured in quantity, of his life's work. And this collection of papers published in honor of his 80th birthday reflects Cole's wide range of interests. Sections deal with membrane channels, membrane transport, and stimuli and drugs. The opening section of five papers is devoted to the electrical characteristics of membranes, mostly nonlinear properties in the frequency domain as measured by sinusoidal or wide-band signals with many of the properties of noise.

Frequency domain measurements have much greater resolution than the usual measurements of transients; this resolution has proved helpful in the measurement and analysis of linear electrical properties arising from the complex structure of tissues. But so far, as is illustrated by several papers in the book, the extra resolution of frequency domain measurements has not been very productive in analyzing the inherently nonlinear properties of membranes. The significant properties of nonlinear membrane channels have been hidden by the detail of data at many frequencies and voltages

(and pharmacological conditions). No doubt, however, the extra resolution will eventually prove helpful in building (and falsifying) appropriate molecular models of the nonlinear channels.

Several papers in the book use wide-band signals to study membranes, and Fishman, Moore, and Poussart describe a new easy way to generate these signals. Measurements in the frequency domain are significantly improved if wide-band signals are applied to the membrane, since such signals contain significant energy over a wide band of frequencies. They allow simultaneous measurement of the membrane response at many frequencies. Any increase in speed of measurement is of great practical importance in physiological measurements, since all preparations have properties that vary with time, slowly drifting to death after their isolation from the animal. Wide-band signals have not been used as much as they might be, perhaps in part because of their misleading name; they are often called pseudo-random binary signals whereas they must be strictly periodic if they are to be of much use. In fact, the signals actually applied are usually strictly periodic, nearly Gaussian signals, almost a complete inversion of their usual name.

As pleasant as is the occasion commemorated in this volume, and as promising as are some of the contributions, I regret that the book does not present a balanced perspective of the state of the field, or of the work of Cole's collaborators and friends. The ubiquitous contributions of A. L. Hodgkin, Cole's collaborator in the 1930's and the foremost user of the voltage clamp method, are not represented. The exciting contributions of Armstrong and Bezanilla are given little space: the discovery and description of gating currents produced (presumably) by conformational changes in the channel proteins are hardly described. Similarly, the work of J. W. Moore on the voltage clamp of axons and of W. K. Chandler on the voltage clamp of axons and "gating" current in muscle fibers is not represented.

Without the contributions of so many important workers, the mainstream of electrophysiology is not well represented and the book is not the contribution the occasion deserved. We are given, nonetheless, a compilation of interesting work to accompany the lovely portrait of Cole that is the frontispiece of the book.

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Peptide Messenger Molecules

Cellular Basis of Chemical Messengers in the Digestive System. Papers from a symposium, Santa Monica, Calif., Jan. 1980. MORTON I. GROSSMAN, MARY A. B. BRAZIER, and JUAN LECHAGO, Eds. Academic Press, New York, 1981. xviii, 360 pp., illus. $28. UCLA Forum in Medical Sciences, no. 23.

This book of symposium proceedings deals primarily with peptide molecules that may transmit information in the process of neural and endocrine control of gastrointestinal function. The book is dedicated to one of its editors, Morton I. Grossman, who died on 26 May 1981.

The existence of a diverse array of putative peptide messenger molecules common to neurons and endocrine cells of both the central nervous system and the gastrointestinal tract now receives a great deal of attention. The popularity of the peptides is directly related to advances in immunochemistry and derives to a great extent from the rapidity with which they can be immunochemically identified in a variety of tissues. Information on immunocytochemical identification and characterization of these peptides has swelled into a flood. Neuroendocrinological and gastrointestinal biology are in the peptide era, and the 28 papers in the book offer a good update on these fields.

After four papers on introductory topics, including one on phylogenetic relationships, the papers are grouped into sections on methods; structural and functional classification of endocrine-paracrine cells; structural and functional classification of nerves; pathological aspects; and experimental aspects. Most of the papers are short, well-edited, and lucid summaries of the authors' work. Many are condensations of the authors' previously published papers.

With the exception of M. D. Gershon's nicely prepared paper on serotonergic neurons in the enteric nervous system and some discussion of purinergic neurons, all of the material in the book involves one or another aspect of peptidergic cells.

Papers on identification and biological actions of the gut peptides by authors such as J. M. Polak and A. M. J. Buchan, J. B. Furness *et al.*, and R. Håkanson *et al.* overlap somewhat. This is difficult to avoid, for many of the authors have worked with the same peptide.

After reading a paper entitled "Human gastroenteropancreatic endocrine-paracrine cells: Santa Monica 1980 classification," which presents the consensus of a panel chaired by E. Solcia, one suspects that another scheme bloated with abbreviations and morphological hairsplitting is evolving. Furness, in a two-page paper on terminology for gastrointestinal nerves, wisely concludes that present knowledge is insufficient for a useful classification scheme of enteric neurons.

Several presentations of techniques for immunocytochemical identification of peptides and uses of cultured tissues and cells for studies of release of peptides are included in the book. Especially timely is a discussion by L.-I. Larsson of the gold-labeled antigen detection (GLAD) technique. Two different bioactive peptides are known to exist in the same cell; it is not known, however, if two different messenger molecules occupy the same storage vesicle. The GLAD technique could answer the important question of whether two neurotransmitters exist within the same synaptic vesicle.

The principal topic of the book is immunocytochemical identification of peptides in nervous and endocrine structures. Many of the authors are histologists with a tendency toward overenthusiasm about the functional significance of the presence of a multitude of peptides and a bewildering number of molecular variations in forms of the same peptide in nervous and endocrine structures. These authors speculate freely on functional significance. Nonetheless, the recurring conclusion is that functional significance cannot be deduced from morphological identification in a particular cell type and that the functional significance of the presence of most of the interesting immunoreactive peptides in neural, endocrine, and other structures is unknown. The overall impression this book gives is that histochemical investigation of peptides has surged far ahead of physiological investigation. A few efforts to establish functional importance are reported in the book. The observations of Håkanson and co-workers of changes in topographic distribution of gastrin cells in response to experimental alteration of *p*H gradients in the gastric antrum are especially interesting.

Two papers are devoted to the significance of malfunction of peptide messenger mechanisms in gastrointestinal disease. One of these deals with the presence of a number of well-known immunoreactive peptides in ovarian carcinoids, and the other summarizes alterations of peptide content of gut nerves in Chagas's, Hirschsprung's, and Crohn's diseases and in ulcerative colitis.

Several revered concepts receive particular attention in the book. A. G. E. Pearse skillfully presents justification for