activity enhances the uptake of small molecules. These are incorporated into a "marker," probably a protein, that is characteristic of that nerve cell and that, when released, causes the postsynaptic cell in some way to repress transmission from other terminals bearing different markers. What else effect will prove a key to understanding ouabain does, and whether the observed learning, remain to be seen.

Although this book is so compact that most of its arguments can be made only sketchily, it remains a valuable volume. It critically reviews the many diverse and often conflicting theories of learning. More important, it draws together many strands of evidence that the formation and regeneration of neural connections are highly specific and that, during maturation, these connections can be "enduringly modified" by experience. Mark's specific model may prove to be an overenthusiastic interpretation of findings that are still inadequately established or understood. Nevertheless, it is not a rash extrapolation to suggest that once the mechanisms involved in developmental plasticity are understood one can look for similar mechanisms of adult learning and memory.

ALAN D. GRINNELL
Department of Biology,
University of California,
Los Angeles

Outermost Components of Cells

Surface Carbohydrates of the Eukaryotic Cell. G. M. W. COOK and R. W. STODDART. Academic Press, New York, 1973. xiv, 346 pp., illus. $19.50.

It has been recognized for about a century that the plasma membrane acts as a permeability barrier. Historically, in the study of membranes, we have started with a presumed knowledge of the function and then proceeded in identifying the molecular structure. This sequence appears to have been reversed for the outer component of the membrane, the cell surface carbohydrates. At present one might call them structures in search of function. We have learned much about their localization and even their molecular composition without understanding why nearly all cells are covered with such material. Our knowledge about these carbohydrates developed, as if incidentally, from investigations apparently having little in common. Laboratories working on such diverse topics as plant lectins, blood group substances, cell-cell interaction, and cancer cells found that they all were studying interactions of cell surface carbohydrates. This book attempts to bring much of this diversified information to bear on that general topic. Its goals, as stated by the authors, are "to cover the basic tenets upon which the subject is founded . . . to draw attention to . . . points of growth for the future [and] to provide a comprehensive view of present knowledge of carbohydrates in cell surfaces."

The first chapter summarizes the structure of plasma membranes. The authors present a comprehensive and well-thought-out review of the steps that led to our present concepts of membrane structure. Naturally, as happens in any fast-moving field, there are some new concepts and ideas that are not included, but they can be easily found in more recent review articles such as that by S. J. Singer (*Annu. Rev. Biochem.* **43**, 805 [1974]).

The next chapter reviews the principal lines of evidence for the presence of carbohydrates on the surface of animal cells. Electrokinetic and microscopic studies are discussed in detail, as well as the evidence obtained by the use of lectins. The following two chapters, constituting a large portion of the text, are devoted to the structural characterization of glycolipids and glycoproteins of animal cell surfaces, fungal cell walls, and the carbohydrates of plant cells. Methods for the study of complex carbohydrates are discussed. Examples of glycopeptides from a variety of tissues are given. It might have been helpful, at least to a beginner in the field, to include some generalizations that can be drawn about the frequency and localization of carbohydrates within polysaccharide chains, the types of linkages between polysaccharide chains and peptides, and the behavior of the chains on hydrolysis. This kind of information was given by R. C. Hughes in a more recent review of the subject (*Prog. Biophys. Mol. Biol.* **26**, 191 [1973]). The problem of microheterogeneity also should have been discussed at this point. The large number of references, however, will allow the beginner to bring himself up to date on these subjects.

The mechanism by which the cell synthesizes a glycoprotein and incorporates it into membranes is a controversial subject. The authors present a well-rounded review of this topic with some critical evaluation, a difficult task because of the insufficiency of knowledge and experimentation in this area.

The final chapter of the book deals with the question, What is the biological role that these materials play in the cell membrane? While the authors restrict themselves to the evidence pertaining to the membrane alone, the question could be asked about the function of carbohydrates attached to proteins in general. One might then obtain additional clues from the work of investigators such as Ashwell and DeVries, which is not discussed in this book. The major topics included in this chapter are cell recognition, intercellular adhesion, the role of glycoproteins in cell growth regulation in animals, and the plasticity, permeability, and hydration of plant cell walls.

This book is welcome as a much-needed treatise on a current topic. It is well balanced and is enjoyable reading and deserves a warm recommendation.

ALEXANDER EICHHOLZ
Department of Physiology,
Rutgers Medical School,
New Brunswick, New Jersey

Surface Analysis

Characterization of Solid Surfaces. PHILIP F. KANE and GRAYDON B. LARRABEE, Eds. Plenum, New York, 1974. xviii, 670 pp., illus. $32.50.

The study of solid state surfaces is one of the most rapidly developing areas of physical science. In the past 10 years a multitude of techniques have become available that can be used to study the structure and composition and the physical chemistry of solid surfaces on a monolayer atomic scale. These techniques have found applications in research on catalysis, adhesion, and lubrication, as well as in the development of integrated circuitry and other solid state devices of high surface-to-volume ratio. As a result, our knowledge in solid state surface science is increasing explosively, and this area promises to be the birthplace of many new technologies.

This book is a timely contribution to the field. There are 23 chapters, each of which concentrates on either a new research technique or a whole field of surface analysis. The first seven chapters discuss techniques of physical structural characterization, including light and scanning electron microscopy and the x-ray diffraction methods that are useful in surface analysis. In later chapters,

chemical characterization techniques are discussed. These include electrochemical techniques, radioisotope techniques, and x-ray fluorescence and photoelectron spectroscopy.

All of the chapters are by experts actively working in the field. Their contributions reflect the present state of the art. Even readers who do not intend to use the techniques can find valuable information in this book.

It is useful to have the various techniques of surface science gathered in one volume, and the book should find easy acceptance among surface scientists. Although it may not be useful to students, the book is a welcome addition to the libraries of most workers in the field.

G. A. SOMORJAI
Department of Chemistry, University of California, Berkeley

Chemosystematics of Plants

Chemistry in Botanical Classification. Proceedings of a symposium, Lidingo, Sweden, Aug. 1973. GERD BENDZ, JOHAN SANTESSON, and VERA RUNNSTROM-REIO, Eds. Nobel Foundation, Stockholm, and Academic Press, New York, 1974. 320 pp., illus. $27.50. Nobel Symposium No. 25. Medicine and Natural Sciences.

During the last 18 years we have seen a number of important developments in systematics. There have been philosophical and conceptual challenges to the classical assumptions and concepts, and there have been changes in methodology as a result of new tools such as the computer and the scanning electron microscope. A very important advance has been the widespread and systematic use of chemical characteristics in classification. This development was particularly important in botany because of the rich spectrum of chemical substances possessed by plants. It also marked the entry into the field of botanical taxonomy of scientists trained outside biology, largely in organic chemistry or biochemistry.

The present volume records the proceedings of a symposium which, according to the introduction, started "an important and useful dialogue between chemists and systematists." Although the dialogue has been in progress since chemosystematics began and the subdiscipline of chemotaxonomy has been noted in its brief life by the publication of at least one "synthetic" volume a year, the papers in the volume demonstrate that chemists and botanists are still not quite comfortable working together.

All but three papers are by active practitioners of chemosystematics, many of them trained as chemists. Two of the papers by nonchemosystematicists are by A. Takhtajan and A. Cronquist, who present the response of the traditional taxonomist to chemosystematics. They regard chemical compounds as an additional set of characters, to be treated in the way morphological and anatomical characters always have been treated. Both writers appear to be impressed by the possibilities offered by nucleic acid sequencing of proteins such as cytochrome c, but they seem to be less impressed by the information offered by the distribution of the betalins, in part, one suspects, because the former do and the latter do not fit in with classical schemes of classification.

The third paper by a nonchemosystematist, V. H. Heywood's "Chemosystematics—an artificial discipline," presents a critical, well-documented assessment of the subdiscipline of chemosystematics. Heywood points out that the taxonomic component of chemosystematics lacks the rigor of the chemical methodology. He also points out, however, that there have been a number of recent attempts to clarify the principles and concepts of systematics and that it is incumbent on chemists working in this field to familiarize themselves with these developments. He further points out that because the process of selecting, processing, and arranging data to produce a classification is still imprecise and subjective, it nullifies the rigor and precision with which the data are obtained. He thinks that the main service of systematics to biology and chemistry is in providing an "effective information system based on the taxonomically circumscribed classes." This allows all kinds of data (not merely chemical ones) to be stored, so that all kinds of relationships can be extracted when needed.

All the other papers are to a greater or lesser degree specialized reports on the distribution of special classes of compounds in the plant kingdom and their use in creating phylogenies. Most of them—notably T. Swain's "Flavonoids as evolutionary markers in primitive tracheophytes," J. B. Harborne's "Flavonoids as systematic markers in the angiosperms," W. Herz's "Pseudoguaianolides in Compositae," and D. Boulter's "The use of amino acid sequence data in the classification of higher plants"—are welcome updatings. The edited transcripts of the discussion following each paper are for the most part uninteresting, but the final discussion session is illuminating and one of the best parts of the book.

Symposium volumes are usually uneven, and this one is no exception. However, in view of the claim this volume makes to represent a dialogue between systematists and chemists it is important to note what is missing. Absent are spokespersons for the body of doctrine that has been called "numerical taxonomy." Only Heywood mentions this crucial aspect of systematics. Absent are presentations of new philosophical trends, particularly the phylogenetic theories of the Hennig-Brundin school. Absent are also spokespersons for population biologists and chemists working with isozyme distribution in populations, applications of chemistry that have revolutionized population genetics. Absent (except for a brief paper by Kullenberg and Bergström on pollination in the orchid *Orphrys*) is the entire body of information on the possible role of secondary compounds in the evolution of plants.

In his essay, Heywood writes, "For reasons which I do not entirely comprehend, the work of many chemical or biochemical contributors to systematics seem to be aimed at assisting in the elucidation of phylogenetic relationships within the angiosperms." This volume is an example of this preoccupation. However, as Heywood notes, "angiosperm phylogeny is not a major concern" to most biologists in the world. This is the main drawback I find with this volume: although entitled *Chemistry in Botanical Classification*, it is preoccupied almost exclusively with phylogenetic relationships at the family or suprafamily level. Moreover, even in this narrow area, the symposium fails to come to grips with the logical and philosophical problems that are involved in this approach, and does so at a time when they are being explored and debated in the literature. On the other hand, for the biologist interested in knowing what the latest contributions of chemistry and biochemistry to plant phylogeny are, it is an excellent review.

OTTO T. SOLBRIG
Department of Biology, Harvard University, Cambridge, Massachusetts