latter respond only when the neural membrane is stretched in a particular direction, a fact suggesting that an oriented, discriminatory molecular organizaation is involved. Neuromuscular junctions and stretch receptors are reviewed by M. P. Osborne and neurosecretion is reviewed by S. H. P. Maddrell. J. E. Treherne sums up the symposium and contributes on the central nervous system.

The book is illustrated with many good electron micrographs and some not so good. The conveners are to be congratulated for their selection of participants, but the presentations follow no particular order in the volume.

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Carbohydrates

Polysaccharides. GERALD O. ASPINALL. Pergamon, New York, 1970. xviii, 228 pp., illus. $8.75. Commonwealth and International Library: A Course in Organic Chemistry.

In the preface, the author of this concise and well-written treatise states that "polysaccharides seem at the moment to be less spectacular substances than proteins and nucleic acids [but] significant developments throwing light on structure-function relations will surely emerge in the near future."

The role of carbohydrates in nature is certainly an important one: cellulose, in number and in distribution, is by far the most prominent organic molecule in nature, and recent work on the biological processes occurring at the surface of animal cells has strongly implicated carbohydrate structures. Nevertheless, after reading this book one has a lingering doubt that any part of the material described in it will ultimately shed light on the relationship of structure to function. Aspinall's interest in the structure elucidation of complex polysaccharides isolated from plants, such as gum exudates and pectins, has strongly influenced his selection of material. The first 42 pages of the treatise concern methods of isolation and structure determination and offer an excellent summary to any chemist entering this very specialized field; of the remaining 180 pages, about 11 give a brief description of the biosynthesis of polysaccharides, sufficient for the chemist who is interested in the principles of biosynthesis mechanisms, but they do not do justice to the fascinating correlations recently established between changes in chemical structure of the connective tissue polysaccharides and the aging process or between the antigenic properties of bacterial polysaccharides and virus infection. The largest part of the remaining text concerns polysaccharides of plants and microorganisms, less than 15 percent being reserved for polysaccharides of animal origin.

The variety of the chemical structures devised by nature to protect plants from physical injury caused by such external forces as wind, weight of snow, frost, and heat or from microorganism attack is certainly astonishing. No correlation, however, has been established as yet between the structure of polysaccharides and their possible biological role, and consequently the reading of these numerous complex structures is rather tedious. This is unfortunate, because the selection of the references is judicious and the material well presented.

In the few pages devoted to the subject, Aspinall attempts a brief survey of the complex field of carbohydrates in animals. The progress of immunochemistry gives us hope that in this field the structure-to-function relationship will be understood earlier than in plant polysaccharides. The chemistry of the polysaccharides of connective tissues is extensively discussed, but a correlation of the structures with clinical problems would certainly have aroused the interest of the medical scientist. The treatment of the remaining carbohydrate structures of animal origin is much less effective, probably because of the preoccupation of the plant chemist with "purifying" polysaccharides until they are devoid of all "extraneous" material. Aspinall is not stressing the fact that all carbohydrate structures found in animal tissue (including the polysaccharides of connective tissue but with the possible exceptions of glycogen and hyaluronic acid) are glycoproteins having various carbohydrate chain lengths. To discuss blood group substances, which are glycoproteins having relatively short oligosaccharide side-chains, in the chapter on aminopolysaccharides, separately from other glycoproteins, is misleading; their structure is not different from that of other glycoproteins except at times for the terminal carbohydrate residue. Some of the structures discussed at length have not gained general acceptance, and other glycoproteins extensively studied by various groups are not mentioned.

The author has attempted a classification of his material based on chemical structure instead of the more usual classification based on origin. This more logical, new distribution presents as many problems as the old one: for example, chondroitin 4-sulfate, which contains an acid component (D-glucuronic acid), a sulfate group, and an amino sugar (D-galactosamine), and is, in the native state, a component of a glycoprotein (proteoglycan), is classified neither with the glycuronans nor with the complex acidic polysaccharides, sulfated polysaccharides, or glycoproteins, but with the aminopolysaccharides.

Because of its clear presentation and excellent, but restricted, selection of references (with the exception of the glycoprotein part), this small treatise would be most helpful for the reading of a course on the chemistry of plant and microorganism polysaccharides. But who, except perhaps the members of a few departments of agricultural chemistry and microbiology, still has the interest to teach such a course?

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Strengtheners

Whisker Technology. ALBERT P. LEVITT, Ed. Wiley-Interscience, New York, 1970. xiv, 478 pp., illus. $24.50.

Whiskers are metallic and nonmetallic filamentary single crystals that have ultrahigh strength, and many also have very high elastic moduli, low densities, and high melting points. Whiskers are potentially the most effective reinforcing agents for advanced structural composites, but their utilization is just beginning. The editor states that the purpose of this book is to present a "timely" summary of the progress since 1952, when Herring and Galt found that the strength of tin whiskers was an order of magnitude greater than that of ordinary tin.

After a brief historical introduction by the editor, the book proceeds from the growth, testing, and properties of whiskers to the mechanics of whisker strengthening in composites, and then to the fabrication of whisker composites and their properties. The 11 chapters, each by different authors, cover the

subjects in a logical fashion that is relatively free of overlap, because the authors represent diverse viewpoints. This diversity of viewpoint, rather than detracting from the book, is its greatest strength. Readers from other areas and interested students will find the volume excellent for learning about this intriguing field. Specialists will be familiar with much of the material, but there should be one or more chapters that present either new information or a different viewpoint.

The traditional concepts of vapor-phase growth are reviewed by W. B. Campbell. In each case Campbell discusses the extension of theory to practice. The third chapter, by R. S. Wagner on the vapor-liquid-solid (VLS) mechanism of growth, is written in a most interesting manner. Wagner reviews the many observations which led him with his colleague Ellis to hypothesize the VLS mechanism. He then describes numerous experiments which confirmed the VLS concept and revealed the reasons behind branching and kinking and other unusual growth features. Finally, he summarizes the 11 or 12 materials grown by the VLS technique, and notes that he is convinced that the principles can be applied to almost any material. Wagner, has so clearly outlined the basic principles in scientific terms that the successful application to almost any material will lie primarily in the originality of individual investigators.

The completeness of the chapter by Wagner is matched in Sutton's chapter on the principles and methods for fabricating whisker-reinforced composites. Each chapter is more than 60 pages long, and Sutton's shares the logic of Wagner's in emphasizing basic scientific principles underlying the methods. The manufacturer of whisker composites consists of several steps, which include whisker processing (coating and benefication), whisker alignment, incorporation in the matrix, and finally consolidation of the combination. If the process is to be useful there must be subsequent steps involving shaping the composite to the final form and then joining it to other structural components. The problems are unending, and yet the subject is presented in a clear and concise manner with scientific insight into potential solutions to each of the problems. Again, the author has made the fabrication of whisker composites more a science than an art.

All things considered, this volume contains much information about whiskers and the initial attempts to use them. The book should be valuable in stimulating the development of these materials and in opening up new areas of application.

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Infinite Power Series

The Padé Approximant in Theoretical Physics. GEORGE A. BAKER, JR., and JOHN L. GAMMEL, Eds. Academic Press, New York, 1970. xiv, 382 pp., illus. $17.50. Mathematics in Science and Engineering, vol. 71.

In a variety of physical and chemical problems, one obtains solutions in the form of infinite power series,

$$\sum_{n=0}^{\infty} a_n z^n.$$

Sometimes, the series will diverge for all z or for some z of interest or will converge slowly for some z of interest. In such cases, one is tempted to try a more devious method of "evaluating" the sum than straightforward summing. The Padé approximant is such a method—one tries to approximate the series with rational functions rather than polynomials. Explicitly, $f^{[N,M]}$ is the unique ratio of a polynomial of degree M to one of degree N with the property

$$f^{[N,M]}(z) - \sum_{n=0}^{N+M} a_n z^n = 0(z^{N+M+1}).$$

The folklore is that the approximants as N and M both go to infinity (usually with $N-M$ fixed) converge very well. This is based on a host of numerical examples and a small number of theorems which are either variants of a remarkable theorem of Stieltjes (1894!) or very weak.

Because of the power of the Padé techniques and their wide applicability, there is a real need for a book that can serve as an introduction to the method. Unfortunately this collection of articles edited by Baker and Gammel, two of the most distinguished Padéists, does not meet the need. To the novice, the heart of the book is the lead article by Baker. Like his famous 1966 review (which is better for the novice than this book), it has readable discursive sections but muddy statements and proofs of theorems (I am still unable to unravel the statement of theorem 5 on page 8). One is also likely to be confused by the fact that four of the articles are little related to the Padé method (chapters 3 and 7 are really on the moment problem; chapters 4 and 11 are on non-Padé summability methods). Finally one is disturbed by the lack of scope of the book: almost half the articles are on quantum scattering. Particularly missed is a discussion of the application to cooperative phenomena (one can picture a dandy article by Fisher or by the London group who have squeezed so much from perturbation series); the only mention of cooperative phenomena is by Baker, who limits his discussion to his own work.

If one does not evaluate the book as a pedagogic text, one must view it as a collection of research papers. On this score, it fares as do most such collections. It is spotty—there are some very good articles (the article by Langhoff and Karplus comes to mind) and several trivial ones (chapters 3 and 6 come to mind).

In summary, I am not much pleased with this book. But, alas, it is all we have. If a student wanted to delve further into the Padé method after reading Baker's review article, I would reluctantly send him to this volume.

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Books Received

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Advances in Steroid Biochemistry and Pharmacology. Vol. 2. M. H. Briggs, Ed. Academic Press, New York, 1970. x, 480 pp., illus. $19.50.

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Analysis of Feedback Systems. Jan C. Willems. M.I.T. Press, Cambridge, Mass., 1971. xviii, 188 pp., illus. $15.

Analytical Calorimetry. Vol. 2. Proceedings of a symposium, Chicago, September 1970. Roger S. Porter and Julian F. Johnson, Eds. Plenum, New York, 1970. xvi, 460 pp., illus. $19.50.

The Analytical Chemistry of Nitrogen and Its Compounds. C. A. Streuli and P. R. Averell, Eds. Wiley-Interscience, New York, 1971. Part 1, viii, 430 pp., illus; part 2, viii + pp. 431–764, illus.

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