below and above the zero line with a plus sign is nonplussing; only reference to the next figure (p. 75) can show which is which, and there the zero error in the pulmonary arterial blood flow appears to be in excess of 20 percent of the mean flow in that vessel. The reader who would like to look these figures up is foiled by the fact that their reference "From Assali *et al.*, 1965" is not numbered.

As a further example, the effects of drugs on the pulmonary circulation are discussed on pages 94–104. The effect of acetylcholine on pulmonary flow and pressures is illustrated by a figure on page 98 which shows a proportionally greater change in pulmonary arterial blood pressure than in flow. Yet its legend states there is no change in resistance.

There is no doubt, however, that Assali has recruited some expert contributors. The chapters "Growth and composition of the fetus and newborn" and "Maternal and fetal blood constituents" are perhaps excessively occupied with facts, but they are sound, and the chapters on the fetal kidney and lung are new and exciting.

One is perhaps inclined to demand more from *Biology of Gestation* than from *Foetal and Neonatal Physiology* because of its greater pretensions in title, number of pages, and price, and then one finds oneself disappointed. Part of the large bulk of *Biology of Gestation* is occupied by material that is so elementary or treated so superfically as to be useless—for examples, the review of Starling's hypothesis of the capillary (p. 164) and the discussion of neurophysiological methods (p. 262). It contains a chapter on modeling of the fetal and neonatal circulation that, like so many similar projects, proves little more than that it can be done. Nevertheless, the book can be useful as a source book, it being the most completely referenced work on the subject since Davies' *Survey of Research in Gestation and the Developmental Sciences* published in 1960. It is unfortunate that the references are given in order of citation in the bibliographies of some chapters and alphabetically in others, all without titles. Perhaps this was done to insure that the user must read the text to make use of the references.

We should have known better, perhaps, but when confronted with these summaries of the last 20 years' worth of work on prenatal physiology we expected to see a glimpse of "the spectacular progress of science." The disappointment is no fault of their authors. Prenatal research is expensive. It is therefore often done on a casual basis by workers whose primary obligations lie elsewhere, and the results are less than brilliant.

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Plant Constituent

Constitution and Biosynthesis of Lignin. K. FREUDENBERG and A. C. NEISH. Springer-Verlag, New York, 1968. x + 132 pp., illus. $7. Molecular Biology, Biochemistry and Biophysics, vol. 2.

The elucidation of the chemistry of lignin has been an intractable problem. Lignin is universally present in the older cell walls of higher plants, and its presence in association with cellulose and the hemicelluloses is indicative of maturity of the tissue, in that the cells are no longer capable of a change in dimension. Although lignin is not unreactive, its removal from plant tissues can be accomplished only by relatively drastic treatments that result in structural change and the formation of derivatives. It has long been recognized as aromatic, in part at least, and its association with polysaccharides suggested some mechanism of synthesis from intermediates of a carbohydrate nature.

This volume is peculiarly interesting inasmuch as it brings together the results of two distinguished investigators who have chosen entirely different approaches to the study of lignin. Karl Freudenberg, in the classic tradition of organic chemistry, has prepared derivatives, degraded these to identifiable products, identified functional groups, and attempted to construct structural formulas consistent with the information thus laboriously assembled. Freudenberg's lignin investigations have extended over a period of more than 40 years.

Arthur Neisch's approach has been to seek biosynthetic pathways by which precursors might be converted to, or incorporated into, lignin. In this he has been aided immeasurably by the use of C^{14}-labeled materials. He was led quite early into the study of the formation of the aromatic amino acids through the shikimic acid pathway and demonstrated that a variety of C_6–C_3 phenylpropanoids could be incorporated into lignin. Much of this work has been done in the past 15 years.

Side by side, then, the reader has presented to him aspects of lignin chemistry from two entirely different vantage points. Yet another approach, referred to only in passing by Freudenberg and Neish, is that followed by F. F. Nord in investigations of the biological decomposition of lignin-containing material by wood-rotting fungi and in the identification of products. The addition to this book of a chapter by Nord would have logically triangulated the topic.

Both Freudenberg and Neish agree that there is a family of lignins derived from phenylpropanoid compounds, such as coniferyl alcohol and homologs. Both agree that some form of polymerization is involved, but Freudenberg goes much further than Neish in attempting to develop empirical and structural formulas, as have other lignin chemists through the years, such as Hibbert, Erdtman, and Brauns, each on the basis of extensive degradative studies. Neish, on the other hand, speculates on the evolution of lignification in vascular plants from a condition in which lignin-like materials are essentially secondary or by-products to one in which the lignins confer certain physical and mechanical properties to the tissue that are advantageous to the structure of the plant.

Each author's contribution is an excellent review of his own beliefs on the nature of the lignin. There is no interplay between them. Nevertheless, the book would be a valuable addition to the not overly long bookshelf on plant cell wall constituents.

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Physical Acoustics

The Acoustical Foundations of Music. JOHN BACKUS. Norton, New York, 1969. xiv + 314 pp., illus. $7.95.

The word "acoustics" is derived from a Greek antecedent meaning "hearing." Thus, to the purist, "the acoustics of music" must imply the hearing of music. The field known as the acoustics of music is, however, a complex, extensive discipline ranging in subject matter from the microscopic, physical

acoustics of sound production and wave propagation, through the physiology of the ear, to the psychology of the perception of musical form. At the perception end of its purview, the world of musical acoustics must diffuse into its image-world of musical esthetics, the two together forming the musical experience.

The part of musical acoustics concerned with perception has a poor experimental basis at this time. The acoustical literature refers only occasionally, for example, to the Jamesian theory of the perception of the psychological present or its alternatives, or to the ability of a listener to discriminate between major and minor triads, both of which subdivide the fifth into a major and minor third.

On somewhat surer grounds are the subareas of physical acoustics, namely the study of vibration and sound, of overtones and scales, of auditoriums and instruments. It is to these fields that Backus restricts his attention. In his view, the acoustical foundations of music are the phenomena that occur before the music strikes the ear. In most of the subareas, the focus is on the Western musical experience: the scales are Western scales and the instruments are, in the main, the instruments of the Western symphony orchestra. The tunings of Javanese patets and the complexities of Indian ragas, the construction and tone of the anklong and hichiriki are outside the scope of this book.

The book covers essentially the same topics as have been covered in earlier books on "acoustics of music," similarly restricted. It is directed to nonspecialists and should serve the nontechnical reader well, whether he be composer, performer, or listener. The prose style is easygoing and the presentation is eminently transparent.

After a presentation of the theory of wave motion, the book discusses all too briefly the structure of the ear. The discussion of intensity and loudness is excellent. The section on tone quality, scales, tuning, and other such topics is classical but most readable, and will be of interest to the nonspecialist.

The second half of the book is concerned with the nature of Western musical instruments, the area of the author's own research. It is a clear and absorbing presentation of a large amount of often little-known information concerning the properties of these instruments in the mode in which they produce sustained sound. The problems of attack and decay of instrumental sounds are not discussed significantly, although instrumental quality depends heavily on these properties. However, the discussion of the properties of sustained tones of Western instruments is fascinating and readable and will be of value to both the musical amateur and the professional.

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Nuclear Reactions

The Theory of Neutron Resonance Reactions. J. E. LYNN. Clarendon (Oxford University Press), New York, 1968. xiv + 504 pp., illus. $16. International Series of Monographs on Physics.

Resonance phenomena are observed in all branches of physics. Study of them has proven especially fruitful in nuclear physics, and the theory of low energy neutron resonances as presented by Lynn is a reasonably complete and self-consistent subject. This book meets well its goal of unifying the treatment for experimentalists working in the field.

The time-honored and tested *R*-matrix formalism developed by Wigner and his students is emphasized from the outset. A highly condensed outline of the essential features of this framework is presented first, and then follows an even briefer summary of the Humblet and Rosenfeld *S*-matrix theory. We are indebted to Lynn for a very clear discussion of the relationship between these two quite different formalistic approaches to reaction theory. However, one must still labor through the earlier excellent review article on *R*-matrix theory by Lane and Thomas before one obtains sufficient skill for application to real problems. The original papers must be consulted on *S*-matrix theory.

A detailed treatment of the spacing and distribution of neutron resonances is contained in this book. This is the heart of the subject, and Lynn rightly devotes his considerable knowledge and talents to providing what is the most complete exposition available in a single volume. Large quantities of experimental data are correlated in a fashion that reinforces the physical concepts.

Low energy neutron reactions proceed primarily through the elastic scattering, radiative capture, and fission channels. Each of these is covered rather completely in a highly sophisticated and up-to-date manner. Again, the material is not suitable as a textbook but functions best as a handbook for research. The sections on elastic scattering and capture are particularly good illustrations of the high density of information that can be assembled by a true expert.

Although neutron fission is a very specialized topic, it certainly is relevant to neutron resonance phenomena. The discussion in this book, limited by space restrictions, is unusually good. Many of the threads of present-day nuclear theory are woven together in a manner which gives a better understanding of this complex problem.

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Water and Aqueous Solutions

Hydrogen-Bonded Solvent Systems. Proceedings of a symposium, Newcastle upon Tyne, England, Jan. 1968. A. K. COVINGTON and P. JONES, Eds. Taylor and Francis, London, 1968. xvi + 356 pp., illus. $14.50.

This volume comprises the papers presented at a symposium held to mark the retirement of Lord Wynne-Jones of Abergele as professor of physical chemistry at the University of Newcastle upon Tyne ("a sort of funeral ceremony," Wynne-Jones lightly remarks). The papers are grouped loosely around themes representing the research interests pursued by Wynne-Jones throughout his career, and by and large they fall within the scope of the title chosen for the collection as a whole.

The first 100 pages are taken up by five review papers, and these are followed by 18 shorter papers dealing with current work of their authors. Appropriately, the first and outstanding review is Walrafen's description of his investigations of the structure of water by Raman spectroscopy. Vibrational spectroscopy has long been considered crucial in deciding the fundamental and deceptively simple question of whether water is a homogeneous medium or a mixture of hydrogen-bonded molecular clusters in various states of aggregation. Walrafen's demonstration