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.

J. J. FABER
B. B. ROSS
Department of Physiology, University of Oregon Medical School, Portland

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.

A. G. NORMAN
University of Michigan, Ann Arbor

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