that may be transmitted by the respiratory route to man. Such studies are necessary to understand (i) how microorganisms remain alive and are disseminated in the air, (ii) what environmental factors alter the ability of such organisms to produce disease, and (iii) how important the agents are in maintaining a healthful atmosphere.

The techniques of aerobiology are presented in six chapters which cover such topics as the production of aerosols and the bioassay of airborne pollution. Various types of aerosol chambers and their uses are described in detail in four chapters. Nine chapters are devoted to an analysis of concepts and results obtained in experimental aerobiology. These cover the various aspects of microbial survival, aerosol immunization, and the significance of aerobiology in hospitals, dental clinics, and veterinary medicine. A glossary and a good index are presented.

The book is easy to read, the figures and illustrations are clear and serve a purpose, and the chapters are well documented with recent references.

Even though aerobiology may be in an early stage of development, everyone concerned with clean air or air pollution can learn from the data presented in this volume.

J. R. PORTER
Department of Microbiology, University of Iowa, Iowa City

Protein Chemistry

Enzymes and Isoenzymes. Structure, Properties and Function. Vol. 18 of the Fifth Meeting of the Federation of European Biochemical Societies, Prague, July 1968. D. SHUGAR, Ed. Academic Press, New York, 1970. x, 362 pp., illus. $14.50.

This book has been excellently edited by D. Shugar. The first ten papers are contributions from participants in the symposium entitled Relation of Enzyme Structure and Activity (organized by J. I. Harris and B. Keil). Papers 11 through 35 comprise the symposium entitled Isoenzymes, Their Properties, Structure and Function, which was organized by G. Pfleiderer and B. Večerek. The subject matter is somewhat heterogeneous, but this defect is compensated for by the articles themselves, which provide clear and concise discussions of various enzymes.

The first group of papers give a rather comprehensive view of the current knowledge of the structure and function of pig and lobster muscle glyceraldehyde 3-phosphate dehydrogenases, yeast and liver alcohol dehydrogenases, and the cytoplasmic aspartate transaminase from pig heart. Other papers in this group present specific information on rabbit muscle aldolase, muscle-type lactic dehydrogenase, trypsin, and pepsin. The molecular evolution of some of these proteins is considered. Harris and co-workers observe that the amino acid sequence of glyceraldehyde 3-phosphate dehydrogenase is strongly conserved, which suggests that the three-dimensional structure and enzymic mechanism of action likewise are conserved during evolution. In contrast, Zwilling and Pfleiderer note many divergencies between bovine and invertebrate trypsins and suggest that proteases might be most variable owing to adaptation needs arising through their contact with the exterior environment in the digestive tract. Noteworthy too is the review by Braunstein, who presents extensive data and references on the molecular mechanism of action of aspartate transaminase, a pyridoxal phosphate-enzyme.

The second group of papers gives an excellent accounting of the currently available data on lactic dehydrogenase isoenzymes. Some other enzymes that exist in multiple molecular forms are discussed more briefly. These include malate dehydrogenase, a hormone-sensitive lipase, alkaline phosphatase, α-amylase, β-galactosidase, creatine kinase, and aldolase isoenzymes. A general paper by Tepper and Hommes treats "Changes in activity and isoenzyme patterns of glycolytic enzymes in the developing rat liver." Other papers discuss some factors that affect isoenzyme distribution within a single tissue and the tissue distribution of various enzyme forms. For example, Hellung-Larsen and Andersen present kinetic studies of changes in lactic dehydrogenase patterns of human lymphocytes induced by variations in pO_2. The heterogeneity of human alkaline phosphatase is described by Moss, who discusses thoroughly the differentiation of this enzyme in human tissues, the heterogeneity of the enzyme within a single tissue, and the possible origin of these variations. Schapira and co-workers discuss results obtained for aldolase, lactic dehydrogenase, and creatine kinase in diseased muscle. In these cases it was noted that the isoenzyme patterns appear to resemble that of embryonic muscle, which shows a predominance of the brain type; the authors point out that this may be an expression of dedifferentiation at the molecular level through repression of the synthesis of the most specific forms of the enzymes.

In conclusion, this book will be useful to investigators engaged in protein chemistry and in studies of the structure, properties, and physiological significance of isoenzymes.

ANN GINSBURG
Laboratory of Biochemistry, National Heart and Lung Institute, Bethesda, Maryland

Blood Hormone

Erythropoietin and the Regulation of Erythropoiesis. SANFORD B. KRANTZ and LEON O. JACOBSON. University of Chicago Press, Chicago, 1970. x, 330 pp. $9.75.

Considerable evidence has been amassed over the past 20 years to establish now with certainty the existence of a circulating principle, erythropoietin, that controls erythropoiesis in vertebrate organisms. Krantz and Jacobson review, in a comprehensive and often critical manner, physiological, biochemical, and clinical aspects of erythropoietin and the regulation of erythropoiesis. More than 1400 references are listed, and it is difficult to find a pertinent article in the erythropoietin field in the last 20 years that has not been cited. Consideration is given to the factors that influence production of erythropoietin, its metabolism, site (or sites) of formation, and chemical properties as well as its loci and mechanisms of action. Of particular interest are recent indications that: (i) erythropoietin is a glycoprotein with a molecular weight of 60,000 to 70,000 and although highly purified is not as yet entirely pure; (ii) the kidney in mammals serves as the primary site for the production of a precursor or activator of erythropoietin; (iii) the stimulating action of erythropoietin on erythroid cell differentiation is mediated most likely through transcriptional and translational effects concerned with the production of hemoglobin and other proteins in the hematopoietic precursor cell (erythropoietin committed cells) and probably in more distal components of the erythroid cell line as well; and (iv) hormones of the adenohypophyseal-target organ axis influence erythropoiesis by altering the production of erythropoietin, effects that may arise in part from the ability of anterior hypophyseal, gonadal, thyroidal, and adrenal cortical hormones

to alter the relations between oxygen supply and demand.

Attention is also given to cell cycle analysis and to the methodology involved in the establishment in vitro of systems of hematopoietic cells for determining the biochemical actions of erythropoietin at a molecular level, a subject with which Krantz has had considerable direct experience. There is a good discussion of embryonic and fetal erythropoiesis and the influence exerted by erythropoietin on these processes. It is of interest that mouse fetal liver cells are responsive to erythropoietin for a period associated with hepatic erythropoiesis, which suggests that an erythropoietin may play a physiologic role in red cell development in fetal liver. Finally, relations of these basic considerations to clinical problems are discussed, with the possibilty that derailments of erythropoiesis, such as those that occur in aplastic anemia and in primary polycythemia, may be attributable not only to basic defects in the hematopoietic elements themselves but also to alterations in the production, utilization, or metabolism of erythropoietin as well as to plasma erythropoiesis inhibitors. In this regard, the authors call attention to the need for a pure erythropoietin to initiate clinical trials for the treatment of anemias of renal origin and those in which the requirement for erythropoietin may be greater than normal.

This valuable reference book is recommended for both neophytes and experts in the study of erythropoiesis and its humoral control. It should also prove useful to general biologists interested in pursuing the mechanisms underlying the action of a specific triggering agent, in this case erythropoietin, on differentiation processes in a mammalian cell system.

ALBERT S. GORDON
Department of Biology, Graduate School of Arts and Science, New York University, New York City

Multiple Births

The Biology of Twinning in Man. M. G. BULMER. Clarendon, New York, 1970. x, 206 pp., illus. $6.40.

Written by a lecturer in biomathematics in the University of Oxford, this monograph considers a field in which he has researched. In the first chapter he reviews the evidence for two types of twins, monozygotic and dizygotic, and then the evidence for a third, or intermediate, type of twinning in which a double gametic contribution comes from the father. Such might take any one of three forms, called (i) primary oocytary if the primary oocyte divides equally, (ii) secondary oocytary if the second oocyte divides equally, and (iii) uniovular dispermatic if the ovum divides equally. The evidence would suggest that if such a third type occurs it is rare. One of the best indications of its existence is the rare occurrence of unlike-sexed twins both with mongolism.

A chapter on the embryology of twinning discusses the three types of monozygotic twins according to placentation, this depending in turn on the stage at which the separation occurs. (i) If the division of the zygote occurs before the morula stage, that is, before differentiation of the trophoblast from which the chorion and placenta develop, the twins develop separate choria and amnia and are indistinguishable in fetal membrane from dizygotic twins. About a third of monozygotic twins are of this type; division must have occurred before the fifth day after fertilization. (ii) If the inner cell mass divides into two after the differentiation of the trophoblast but before that of the amnion, the resulting twins will have a common chorion but separate amnia. A majority of monozygotic twins are of this type. (iii) About 1 percent of monozygotic twins have a single amnion (and single chorion). In these instances division occurs in the embryonic disc late, after differentiation of the amnion. The very rare conjoined ("Siamese") twins are a special example of the third type. Information on differences in the degree of dissimilarity of monozygotic twins according to the type of placentation is meager; such as there is the author reviews in the third chapter.

The frequency of twinning in relation to factors such as geography, race, and maternal age and parity, higher multiple births, and the inheritance of twinning are other topics discussed. The use of twins in genetic research is discussed from a methodologic point of view; results of application of the method are not presented except for a few examples, such as Kallmann and Reisner's data on tuberculosis. In an interesting chapter the evolutionary significance of litter size is discussed beginning with Wood Jones's theory, advanced in *Arboreal Man* (1916), that multiple births represented a selective disadvantage under conditions of life in the trees.

In appendices to three chapters, the author discusses some more specifically biometrical aspects: methods for estimating the likelihood of monozygosity, including the use of quantitative traits such as the dermatoglyphic ridge counts; the Poisson and Yule processes, expounded in relation to higher multiple births; quantitative genetics (partitioning the variance and correlation between relatives), discussed in relation to the inheritance of twinning. A rather long and seemingly well-selected bibliography, as well as author and subject indexes, is provided.

This is a welcome addition to the literature in human genetics. Nothing quite like it is available.

VICTOR A. MCKUSICK
Division of Medical Genetics, Johns Hopkins Hospital, Baltimore, Maryland

Life of a Mathematician

Hilbert. CONSTANCE REID. With an appreciation of Hilbert's mathematical work by Hermann Weyl. Springer-Verlag, New York, 1970. xii, 292 pp., illus. $8.80.

This biography is woven out of three distinct themes. It presents a sensitive portrait of a great human being. It describes accurately and intelligibly on a nontechnical level the world of mathematical ideas in which Hilbert created his masterpieces. And it illuminates the background of German social history against which the drama of Hilbert's life was played.

Hilbert's life (1862–1943) coincided with the golden age of German science and with the flowering of German militaristic nationalism. He lived long enough to see his country's intellectual and military preeminence shattered in a common ruin. Anyone who reads this book comes face-to-face with the central enigma of German destiny. How could it have happened that, as Hilbert's pupil Hermann Weyl said in 1945, "Two classes enjoyed a prestige far higher than corresponds to American standards: the military and the scholars. Germany was unquestionably militaristically minded; but that is only one side of the picture: the German nation gloried in her army *and* in her universities"? To an American in the year 1970 it seems especially urgent to understand the roots of the German tragedy. In our culture too there has been, in the years since Weyl spoke, a parallel rise in public respect for military and for academic institutions. Now that there is