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.

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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.

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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

for the first time since 1945 a sharp reaction against militarism, is it inevitable that public support of universities should also be declining?

Hilbert possessed a robust common sense which allowed him to see the folly of wars of national aggrandizement and still remain a patriotic German. Politically, his finest hour came in October 1914. The German government then published a Declaration to the Cultural World in which the leaders of German science and art and literature were invited to proclaim their support for the German war machine. Among other dubious statements, the Declaration said: "It is not true that Germany violated the neutrality of Belgium." At a time of intense nationalistic hysteria, to refuse to sign the Declaration was in many people's eyes an act of treason. Almost all the Germans of international repute, including Röntgen and Planck, signed. Of the leading scientists, only Einstein and Hilbert refused.

The catastrophe of 1933 found Hilbert already retired and too old to comprehend fully what was happening. "The so-called Jews are so attached to Germany," he said at that time, "but the rest of us would like to leave." He did not leave, but stayed in Göttingen to the bitter end, a relic of past glory. Of his vast circle of brilliant pupils and friends, only Sommerfeld, a relic like himself, remained to stand at his grave.

The author says in the preface that the book was "to a large extent written from memory." By this she means that she has mined the memories of the many people still alive who have been colleagues of Hilbert's or wives and children of colleagues. Looking at her list of sources, it is hard to think of any important witness that she has not successfully contacted. In addition, she has researched all the surviving correspondence and public records that have any bearing on Hilbert's life. As a work of historical scholarship, this biography maintains a consistently high level of critical accuracy. Hilbert is shown as he was, warts and all.

But the book is much more than a piece of conventional historical research. Beyond this, it is a poem in praise of mathematics. It brings to life through the many-sided personality of Hilbert the struggles and glories of mathematical creation, giving birth to the purest and most durable works of art that the spirit of man has yet produced.

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Inorganic Preparations

The Synthesis and Characterization of Inorganic Compounds. WILLIAM L. JOLLY. Prentice-Hall, Englewood Cliffs, N.J., 1970. xiv, 594 pp., illus. $15.95. Prentice-Hall International Series in Chemistry.

To those who are familiar with the author's contributions to synthetic inorganic chemistry the excellence of this book will come as no surprise. There is no comparable book available in inorganic chemistry, and this one will rapidly assume the position of a standard text. The book is far more than a revision of the author's previous monograph on the subject, *Synthetic Inorganic Chemistry* (Prentice Hall, 1960), although the themes developed in that work have been utilized more effectively in this volume.

The book falls naturally into four sections. The first section, which assumes a knowledge of thermodynamics and kinetics, shows quite clearly the application of these subjects to synthetic chemistry. The second is concerned with the techniques available and utilized in preparative chemistry. This section quite naturally varies widely in amount and level of presentation. The author seems, wisely, to have chosen to survey some areas critically and to concentrate on those subjects concerning which information is not so readily available, rather than to compete with other well-known texts. The third section deals with structural characterization; here again the author undertakes a critical survey with numerous well-chosen examples rather than an exhaustive review of each technique. The last section is a truly representative set of inorganic preparations chosen to illustrate not only the techniques and principles outlined in the previous chapters but, more importantly, the diversity of preparative inorganic chemistry. In addition to accounts of the preparations described in *Synthetic Inorganic Chemistry*, all of which have been rewritten and improved, in some cases substantially, this section contains detailed descriptions for the preparation of some 50 compounds. Considerable emphasis is also placed on adequate characterization of the materials when obtained. I was particularly struck by the organization of this section into types of operations and classes of compounds rather than a random list of increasingly difficult experiments.

The text is exceptionally well referenced and well illustrated with drawings and diagrams and contains a large number of useful tables. A feature I found particularly attractive is the large number of problem sets contained in the various sections.

I think that the author has lived up to the objectives he stated in the preface and the book will be "a useful reference guide for all experimental chemists."

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Semiconductor Technique

Current Injection in Solids. MURRAY A. LAMPERT and PETER MARK. Academic Press, New York, 1970. xiv, 354 pp., illus. $18. Electrical Science series.

The literature on current injection in solids is very extensive, and it is therefore enormously beneficial to scientists or engineers engaged in research in semiconductor physics to have available to them a lucid and comprehensive book on the subject. The conduction of electricity in semiconductors or insulators is frequently nonohmic, and it is not always easy to separate out the various effects that produce such behavior. One set of such effects results from carrier injection, usually from the contacts, leading to a disturbance of the carrier concentration in thermal equilibrium. Majority and minority carriers, together or separately, may be injected and can then give rise to unusual current-voltage relations and field distributions within the solid. An understanding of the field is, however, desirable not merely for the purpose of unraveling nonohmic behavior phenomena. As the authors point out repeatedly, carrier injection can be used as a tool to study the solid itself. Examples abound in the book, but just two of them will suffice to illustrate the point. From experiments with single-carrier space-charge-limited currents it is possible to gain information about trap densities and energies. From single-carrier drift experiments it is possible to measure mobilities in solids (usually films) which do not lend themselves to steady-state, thermal-equilibrium determinations of mobility.

The book is admirably organized and lucidly written. The theoretical treatment is always carefully broken down into approximate and analytical sections. Uniform treatments are also fre-