because of their complex differentiation of the soma, must start their differentiation in the zygote from a genotype which varies only within rather narrow limits ; this includes the nucleus and cytoplasm. For the environment of the zygote is constant and often rigorously controlled and unless the genotype is nearly constant and unaffected by the changes of differentiation in the preceding generation then the organism begins life and differentiation not at the beginning but at the end. Such an isolated genotype which is essential to the well-being of higher organisms might well be a disadvantage to bacterial cells which, right from the beginning of their lives, are in danger of a big change in their environment.

The other point is that despite the advance made in bacterial cytology it is not known whether there are any special cells which are the result of a sexual process and which are isolated cytoplasmically. Clearly they are a possibility but bacteria could well get on without them.

One great drawback at the beginning of bacterial genetics was the lack of knowledge of the genetic system. Now, since the elegant experiments of Lederberg which have demonstrated linkage and crossing-over, a more exact genetical analysis is possible. In surveying bacterial genetics it is clear that genetics has contributed greatly to bacteriology. And it is perhaps reasonable that our knowledge of the gene in the last decade has not come from bacteria but from *Drosophila*, higher plants and fungi. It is to be expected that in the next ten years, now that the bacterial genetical tools have been made that bacteria will reciprocate by contributing to genetics.

D. LEWIS.

BLOOD GROUPS IN MAN. By R. R. Race and Ruth Sanger. Oxford : Blackwell Scientific Publications. 1950. Pp. 290. 30s.

In their preface to this book the authors tell us that another volume in the series (by Dr A. E. Mourant) will deal with the human blood-groups and ethnology, and a third (by Dr P. L. Mollison) with the clinical aspects. This is a wise sub-division. Apart from the special application to ethnology, the present volume provides just what is wanted by the student of genetics, for it describes most lucidly and with all necessary detail the inheritance of the various blood-groups, giving at the same time sufficient, but not too much, information on the serological background.

The history of the growth of this particular subject must be one of the most remarkable in genetics. The original ABO system was discovered in 1900 and until 1927 remained the only one known. In that year the existence of two more was established. That was the state of knowledge in 1934 when Professor Fisher, perceiving with characteristic foresight that this was one of the best, if not the best, subjects for research in human genetics, founded a unit at the Galton Laboratory under the late Dr G. L. Taylor, who was soon joined by Dr Race. So it was that a British school was ready to play a very large part in the developments that came so rapidly from 1940 onwards. During the last twelve years no fewer than six additional blood-group systems have been discovered, the latest of them after this book was written. So there are already markers for nine of the twenty-three autosomes, or ten if the ability to taste phenyl-thio-carbamide (which has been described as a sort of honorary blood-group) is added to the list. As with other forms, so it will probably happen in

man, that once linkages commence to be picked up, they will be detected at an ever-growing pace.

The first impression likely to be made on students of genetics is the utter simplicity, speaking genetically and not serologically, of the human blood-groups. Those who established the present structure of formal genetics have been accused of using only the good genes, those that mendelise neatly, and ignoring the bad ones, whose effect is obscured by genetic and environmental interactions. In this field there are no bad genes. There are no environmental interactions. Each gene corresponds to an antigen on the surface of the erythrocytes. Furthermore, dominance is usually, perhaps always, absent. Each of the allelomorphic genes in each system determines an antigen for which, sooner or later, an antiserum is forthcoming by which its presence can be detected. Thus the Duffy group, of 1950, was discovered by means of an antiserum which reacted with the Duffy positive cells possessed by those who have one or two doses of the corresponding gene. But an anti-serum that would react with heterozygous and Duffy negative blood was confidently anticipated, and it has duly appeared. So it has been with the Kell system and the S,s component of the MN system ; and so it may be in due course with all the others. For these reasons the working out of the genetics of each system has followed almost immediately on the heels of the serology, the actual amount of family investigation needed being almost absurdly small in comparison with what is required in many other fields.

The blood-groups have much to contribute to genetics in addition to their practical use in connexion with blood-transfusion, or in the study of hæmolytic disease, or in ethnology, or as chromosome markers. The complexities, if that is not too strong a word, are likely to make an increasing contribution to genetic theory. When Fisher propounded his theory of three closely linked loci to account for the intricacies of the Rhesus system, the most immediate reaction was probably the gasp of relief from those who teach students. Then came almost immediate verification of the predictions made by the theory and there is other supporting evidence as well. Fisher pointed out that given the frequencies of the three common Rhesus combinations in Western Europe, the frequencies of the rarer combinations could be accounted for by crossing-over ; and it now appears that this may be true of other populations with different common combinations. He was led by this argument to suggest that the order of the loci on the chromosome was DCE, a supposition that was brilliantly confirmed by the discovery of a deletion involving the C and E loci, the story of which forms a worthy postscript to Race and Sanger's book. Now it would appear that the M, N and S,s components of the MNSs system also depend on a pair of closely linked loci, and perhaps other groups may behave in the same way. Clearly the conception of closely linked genes with allied effects is one to be taken very seriously and this is an excellent field in which to study it. There are a number of other points also at which blood-group genetics may well contribute to the whole subject, for example, the possible step allelomorphs of some of the rarer Rhesus genes and the indications of competition for a common substrate.

Race and Sanger have written an excellent chapter on problems of parentage and identity. They show that an expert laboratory equipped with the necessary antisera could exclude about 62 per cent. of wrongful

accusations of paternity. It is most unfortunate that so little use is being made of this knowledge. The creaking legal machinery needs complete reconstruction and it is to be hoped that one of the results of the publication of this book and of all the work that lies behind it may be the revival of Lord Methyr's bill, which lapsed owing to the outbreak of war in 1939.

Workers in many fields have reason to be grateful to Race and Sanger for writing this book, and of these not least the geneticists. It is so much a model of what such a book should be that one feels ill-disposed to offer any criticisms (except perhaps to say that the bibliographies would be more convenient if they were arranged alphabetically). Such criticisms could only be trivial. This is a first edition and a new one is sure to be demanded very soon ; the authors can be trusted to make better improvements in matters of detail than any that could be suggested by well-meaning critics.

J. A. FRASER ROBERTS.

THE NEW YOU AND HEREDITY. By Amram Scheinfeld. London : Chatto and Windus. 1952. Pp. 618+xv. 25s.

You and Heredity requires little introduction. First published in 1939, it achieved a very large circulation in the U.S.A., and besides a separate publication in Great Britain it was translated into several other languages. The new edition has been almost entirely rewritten and has expanded in the process until it is half as large again as its predecessor. For this the author gives two reasons, the growth of human genetics in the past decade and his own increasing knowledge and understanding of the subject. Certainly the coverage is comprehensive enough : there are very few features of man which are not discussed.

The author, very properly, does not set out to give a textbook of genetics. Rather he aims at providing a sufficiency of the basic principles to make possible a discussion of man, in all his aspects, as a product of the joint action of heredity and environment. He covers physical and functional features, disease, deformity, twins, mental capacity, sexual upsets, blood groups, longevity, social behaviour, personality and crime, winding up with chapters on evolution, race, eugenics, population problems, and the future. The treatment is full, with frequent reference to the work and views of specialists, chiefly American, in the various fields. Many of the topics, mental capacity and crime for example, are of course sources of dispute rather than agreement. The author does not shirk these issues ; on the contrary he does his best to present the case from all points of view. This must obviously lead to a certain diffuseness in the discussion ; but the sooner the lay-reader, for whom the book is intended, realises that in much of human genetics final answers are the exception rather than the rule, the sooner he will appreciate how urgent it is to push on with research. If by his presentation of the problems Mr Scheinfeld helps to dispel some long cherished illusions and arouses a wide interest in achieving true solutions, he will more than repay genetics for the material it has provided him.

On the technical side some criticisms must be made. The book contains certain false statements such as that " . . . genes are highly complex protein molecules, composed chiefly of nucleic acid, which is the basic material of all protoplasm . . . " (p. 57). Some old and popular loosenesses of usage are perpetuated, as when it is said that " . . . Darwin held . . .