

dergoing the most rapid rate of increase in knowledge and the one in which the most exciting papers appeared. To single out any small number of papers must be somewhat invidious, but four of the most fascinating to a reader of the book are "The Structure of Adenosine Triphosphate" by the Cambridge team of O. Kennard, W. W. Isaacs, W. D. S. Motherwell and D. G. Watson, "The Stereochemistry of Actinomycin Binding to DNA" by Henry M. Sobell, "Solid-State Stacking Patterns of Purine Bases" by C. E. Bugg and "Conformations in Polynucleotides" by S. Arnott.

All the papers were submitted to a critical but appreciative audience and it is one of the merits of the book that the discussion is included. Particularly relevant criticisms to many of the papers came from M. Sundralingam and W. Pfeleiderer and two recurrent themes discussed on several occasions were the forces controlling base stacking and the positions of protonation in several related purines. The two editors, E. D. Bergmann and B. Pullman, were themselves authors of papers which linked theoretical propositions with practical and they are to be congratulated for their editorial work.

The book is well produced with clear formulae, tables, diagrams and photographs, but the index is somewhat short for a book of this size. A final chapter entitled "Concluding Remarks", by E. D. Bergmann, is useful for a rapid check of the main theme of each paper and the summary which several authors give could with advantage have been made mandatory for all.

Regulation of Purine Biosynthesis is a stimulating and exciting book which should be read by all those interested in purine chemistry and in the study of structural problems in heterocyclic chemistry in general. *The Chemical Monographs* published by the American Chemical Society since 1921 are intended to make available to chemists a thorough treatment of a selected area in a form usable by persons working in more or less unrelated fields to the end that may correlate their own work with a larger area of physical science and to stimulate further research in the specific field treated. Professor Henderson has undoubtedly been thorough in his review of the biochemical literature for the production of the monograph *Regulation of Purine Biosynthesis*. In a final chapter, however, he is inevitably brought to the conclusion that practically nothing is known of how regulatory mechanisms operate in intact cells and how the different regulatory mechanisms for the discrete steps are integrated. It is furthermore obvious from reading the book that very little is known of the mechanism at the molecular level of each of the eleven steps in the bio-

synthetic pathway from inosine-5'-phosphate to inosinic acid.

Possibly because the author attempted to refer to so many original papers the book seems at times to be a catalogue of summarized findings from other workers. One would have welcomed a more critical approach and a call for help from theoretical chemistry, X-ray crystallography, ¹³C n.m.r. spectroscopy and other potentially useful areas. There are several printing errors, particularly in the formulae, and pyrimidinones, pteridinones, purinones and mercaptopurines are all incorrectly represented in their unlikely tautomeric structures.

Regulation of Purine Biosynthesis shows how too narrow an approach by very many workers has not answered important biochemical questions. The Jerusalem symposium demonstrates the types of tool which are effecting major advances in other biochemical areas and which must surely be valuable in the solution of all heterocyclic biochemical problems.

D. G. WIBBERLEY

Neutral Mutations

Theoretical Aspects of Population Genetics. By M. Kimura and T. Ohta. Pp. ix+219. (Princeton University: Princeton, New Jersey, 1971.) \$12.50.

THIS is an excellent book, which should be read by everyone interested in population genetics. The authors are two of the world's outstanding theoretical geneticists, and this book is essentially an account of their contributions to the field over the past five years or so. It is admirably clear and concise; the non-mathematically minded are catered for by the relegation of most of the mathematical proofs to an appendix. In chapter 1, the problem of the fixation of mutant genes is treated; this is used in chapter 2 in discussing the interpretation of observations on the rate of evolution as measured from protein sequence data. Later chapters deal with the concept of effective population size, the theory of genetic load, two-locus problems, the maintenance of variability in populations, and the adaptive significance of sex.

Kimura and Ohta believe that most nucleotide substitutions in evolution are due to the random fixation of selectively neutral alleles, and that protein polymorphisms revealed by electrophoresis merely represent a transient phase of this molecular evolution. Most of the mathematical results described in this book have been developed in order to show that this theory can account for the known facts of protein variation and evolution. Kimura and Ohta do a very good job of presenting this view, and only the most dyed-in-the-wool pan-

selectionist can fail to be impressed. Nevertheless, there are some facts which are hard to fit into a neutral scheme of things, notably Prakash and Lewontin's discovery of non-random associations between inversions and protein variants in *Drosophila pseudoobscura*. It is a pity that these observations are not discussed in this book.

Many criticisms have, of course, been levelled against the authors' arguments for neutral mutations. In this book, most of them are dealt with quite convincingly. There does, however, seem to be an inconsistency which is hard to overcome. Kimura and Ohta show that, on the neutral mutation theory, the rate of amino acid substitution in evolution is equal to the rate of origin by mutation of new alleles affecting protein structure. If the data from proteins which have been sequenced are taken as representative, the average rate of mutation to neutral alleles per locus per generation can be computed. Kimura and Ohta find that this rate is less than one-tenth the order of magnitude of the mutation rates per locus measured experimentally in higher organisms. These mutation rates are based almost exclusively on rates of mutation to deleterious alleles. They therefore conclude that "this suggests that the neutral mutations constitute a rather small fraction of the total mutations".

Now the rate of neutral mutation for the whole genome can be estimated by multiplying the rate per nucleotide site by the total number of sites in the genome, calculated from the DNA content of sperm. For man, Kimura and Ohta estimate that between sixty and seventy-five neutral mutations occur per genome per generation. They argue that this means that "nucleotide substitution has an appreciable effect on fitness in only a small fraction of DNA sites", otherwise "the mutational load must be unbearably high for human populations".

This is a puzzling contradiction, which is difficult to resolve without serious damage to some other parts of the case for neutral mutations. For example, if one assumes that much of the DNA is functionless, the argument that most amino acid substitutions cannot be adaptive (because there would otherwise be too high a substitutional load) loses its force. Perhaps Kimura and Ohta would argue that observed mutation rates are biased in favour of loci which are known to have mutated and which therefore must have higher than average mutation rates. This can be tested by measuring mutation rates for electrophoretically detectable loci. Some data of this sort have been published by Mukai and by Kojima, and these agree quite well with usual mutation rates.

I would emphasize again that this is

an important and well-written book. The question of the possible selective neutrality of most protein variation is one of the most interesting in contemporary biology. Kimura and Ohta have greatly refined the mathematical tools needed for tackling this problem, and have made us all much more critical in our attitude towards evidence in favour of selection. This book is a valuable account of their work.

BRIAN CHARLESWORTH

First Know Your Rocks

Petrology of the Igneous Rocks. By F. H. Hatch, A. K. Wells and M. K. Wells. Rewritten thirteenth edition. Pp. 551. (Thomas Murby: London, April 1973.) £7.40.

Most students of petrology will be familiar with "Hatch and Wells", which has enjoyed a long and honourable career as a student textbook since its first appearance in 1891. Even those nurtured on the rival "Harker" were (and indeed still are) advised, when sufficiently mature, to consult this work for its excellent account of igneous activity in the British Isles, although they may have been firmly directed to read no further. In this book the emphasis has always been placed firmly on a clear interpretative exposition of petrography based on evidence that can be gleaned from the rocks. Despite the esoteric temptations offered by some modern treatments or by the *art nouveau* of plate tectonics, the Wells family has adhered firmly to its belief that any appreciation of the global setting of petrology can only be achieved properly if the student first knows his rocks.

During the twelve years that have intervened between the twelfth and thirteenth editions, our knowledge of the evolution of the Earth's crust has been completely transformed: no less dramatic have been the advances in the fields of experimental petrology and geochemistry which have enabled a degree of certainty, hitherto lacking, to be given to petrogenetic theory. It is clear that these changes have been appreciated by the authors, although they have not exactly been swept off their feet. Although much of the otiose crystallographic material has been removed, surely it is petrographic mineralogy that is needed; all the structural mineralogy should have gone as well. A chapter on the geological setting of igneous activity has been added and those dealing with basalts, andesites, trachytes and rhyolites have been completely revised and extended. A new approach has been made to the vexed problem of rock classification and nomenclature. Although a satisfactory classification of silic rocks is presented,

no clear scheme is apparent for the intermediate and mafic varieties; a comprehensive classification table should have been included. New material has been added to other chapters where needed and references have been updated. All this has been achieved without substantially increasing the size: alas, the same cannot be said of the price.

In view of the extensive rewriting, it is a pity that the opportunity was not taken to increase the page size, for the book does not lie open well. References could have been found more easily and the appearance would have been improved if the numerous footnotes had been replaced by a full bibliography. It is pleasant to note that the fine micro drawings have been retained; these portray so much more clearly than do photomicrographs the textural features of the rocks. The treatment of chemical data is less satisfactory, for although many tables of rock analyses are included and the principles of both the CIPW Norm and Niggli values are explained, they are little used. Variation diagrams are treated very briefly, and although simple phase diagrams are introduced early in the book they are rarely used to explain the petrology.

In spite of these criticisms the authors deserve to be congratulated on presenting a well balanced, interesting and thoughtful modern account of igneous petrology written for the level of a second year student.

I. D. MUIR

Interstellar Scatter

Light Scattering Functions for Small Particles with Applications in Astronomy. By N. C. Wickramasinghe. Pp. 506. (Adam Hilger: London, 1973.) £12.

AFTER a short summary of observational evidence for interstellar dust and the extinction of electromagnetic radiation by that dust, followed by a similarly short account of the computational procedures used to calculate the efficiency factors for scattering, absorption and back-scattering and the forward directivity of scattering of spherical cylindrical and composite dust grains, the book goes on to detail these factors over a wide range of refractive and absorptive indices and radius of particle in wavelength units. Graphs of the results are given for selected cases. Specific computations are given for ice, iron and graphite and for composites with graphite and iron cores.

From this brief description it will be obvious that this is a book for the aficionado, even if these should include students of meteorology and colloid science, as claimed. It is a pity that computations were not given for the

currently favoured silicate material. Nevertheless, the book covers a very wide range of conditions and will be useful both for itself and as a spur for others contemplating similar computations.

The book is well and attractively produced, the tables being of tidily laid out computer output. Its main fault is the price, surprisingly high for a book of over 90% of photolitho content. The user will probably borrow his copy from his library, which ought to have one.

H. SEDDON

Hyperfine Structure

Theory of Hyperfine Structure of Free Atoms. By Lloyd Armstrong, Jr. Pp. ix+209. (Wiley: New York and London, March 1972.) £7.

TECHNICAL progress in atomic spectroscopy in the last twenty years, the development of highly monochromatic sources of radiation such as atomic beam frequency standards, masers and lasers, and sophisticated spectrometers capable of detecting transitions between individual atomic states, has allowed a great increase in the precision with which hyperfine interactions in free atoms can be measured. It is not surprising that there has been a corresponding development in the rigour and complexity of the theory to such an extent that it is now difficult for an active research worker to follow developments without reference to the original literature associated with several diverse fields. This volume represents what is probably the first comprehensive review of the theory of fine and hyperfine interactions. The interactions between the nucleus and the electrons are analysed using a consistent set of techniques and clearly defined approximations in such a way that the relationship between the theory of hyperfine interactions and the theory of atomic fine structure is stressed. The basic theories of angular momentum, second quantization, relativistic electrons and Lie groups are presented in the first place and then used to develop the theory of atomic structure and the hyperfine interaction. There is one chapter on the effects of external electric and magnetic fields and another concerned with higher order effects such as the hyperfine anomalies associated with nuclear structure and electric dipole moments. The final chapters deal with the hyperfine interactions in one electron and many electron atoms. The presentation is too sophisticated for the average experimentalist who will probably find some of the techniques used unfamiliar and difficult, but the volume will be of great help to the research worker and the graduate student who needs to study the subject in depth.

K. E. SMITH