closely related to cortical funneling in ways that are not at all understood.

Von Békésy does not adopt a single viewpoint or comprehensive theoretical position toward funneling and inhibition processes. Rather, he shows the advantages of a many-sided investigation of these phenomena. The experiments presented succeed in demonstrating funneling and inhibition as processes common to different sensory organs and to different levels of the nervous system. The research reported thus discloses the commonality among diverse phenomena. The pulling together of different phenomena in a way that reveals similarities will provide stimulating insights not only to sensory physiologists and psychologists but also to those interested in more complex perceptual and decision processes. Von Békésy's research clearly fulfills the quotation from Goethe inscribed at the beginning of the book—*Willst du ins Unendliche schreiten geh nur im Endlichen nach allen Seiten.*

JACOB BECK

Department of Psychology,
University of Oregon, Eugene

Newton as an Elder Statesman

The Correspondence of Isaac Newton. Vol. 4, 1694–1709. J. F. SCOTT, Ed. Published for the Royal Society by Cambridge University Press, New York, 1967. 611 pp., illus. $38.50.

With the publication of this fourth volume the monumental Royal Society edition of the correspondence of Newton has now turned the corner toward completion of its seven volumes. It is very fortunate that J. F. Scott was available and willing to shoulder the heavy burden of continuing the work which had been carried so far by the late H. W. Turnbull.

The present effort covers the years 1694–1709, and since Newton's earliest letters were from 1661 the four volumes represent about three-quarters of his writing years (he died in 1709), leaving the next three volumes to contain the last quarter of years, the undated material, and the collected indexes and scholarly machinery. This fourth volume, though only slightly larger in pages than its predecessors, carries almost twice as many individual items. As a sign of the times, in the lapse of five years or so during the change of editors, the price of the volumes has jumped to half as much again; but then no standard library or specialist researcher on Newton and his period can afford to be without constant access to this fundamental work of the highest caliber.

The Newton that is found in the pages of this volume is already the elder statesman of science, reaping the just rewards of the *Principia* and beginning, seven years after its publication, to toy with the idea of extending it in a second edition. To continue his work with the fundamental lunar theory he had need of the observations of Flamsteed; and so developed one of the most famous and unpleasant altercations between scientists of great worth but incorrigibly prickly character. Further in the matter of rewards, Newton was appointed to his office at the Royal Mint, an office which was intended as a sinecure, but taken so conscientiously and seriously that one must credit quite a lot of the later economic strength and security of England to the efficient reforms and administration of Newton; perhaps one might suggest that the next Nobel prizewinner should be drafted to a similar "sinecure" in the office of Postmaster General. From the same period comes Newton's absolutely uneventful term as a Whig University Member of Parliament, and his being knighted, though exactly why he got these two honors still remains a rather dark mystery.

As usual with the Newton material—and we can expect nothing different from the remaining volumes—there is hardly a trace of the human being existing within this scientist shell. Even the tirade at Flamsteed, though violently angry, nevertheless maintains a certain impersonality. Just a touch of the triumphant mathematician may be seen in number 561, where he copies at length the challenge to solve the problems of the brachistochrone as just proposed by Bernouilli, then adds, "Thus far Bernouilli. The solutions of the problems are as follows. . . ." Perhaps most important is the interesting matter of number 695 and number 697, where Newton writes to Sloane to arrange for Francis Hauksbee, well-known inventor of electrical machines and of a fine new air pump, to bring his pump and demonstrate the phenomena of vacuum. What is interesting is that Newton suggests that Hauksbee come to his house where he can "get some philosophical persons to see his Expts who will otherwise be difficultly got together." It must be supposed from this that there is some possibility that a group of the Royal Society amateurs may have actually met at Newton's house; it gives an image far from that of the completely antisocial recluse.

Of more direct scientific interest in this volume, apart from the already mentioned and very extensive contributions to lunar theory, there is a fine dissertation on the quantifying of degrees of heat in the temperature scale, with astute experimental observations on melting points and other fixed marks in the range. To speak, however, of the matter of scientific content rather than the historical information of the letters must bring up another publication that has just started to come forth from the Cambridge University Press in their same superlatively competent style. The new series is that of *The Mathematical Papers of Isaac Newton*, of which the first of a projected set of eight volumes has just come out, edited by D. T. Whiteside [reviewed in *Science*, 13 Oct. 1967]. Now that we have both sets of Cambridge University Press volumes begun and a full variorum edition of the *Principia* long promised and on its way, we may take this passing of the halfway point of the *Correspondence* as a signal that Newton studies have now become very much an excitingly successful and full-time occupation for very competent people.

DEREK J. DE SOLLA PRICE

Department of History of Science and Medicine, Yale University,
New Haven, Connecticut

Whither Queues?

Queuing Theory: Recent Developments and Applications. Proceedings of a NATO Science Committee conference, Lisbon, Sept.–Oct. 1965. R. CRUON, Ed. Elsevier, New York, 1967. 240 pp., illus. $13.50.

"Queuing theory" is a term of recent vintage (the 1940's) for mathematical studies of situations producing congestion and hence delays or waiting lines (queues). The typical mathematical model is that of a service system in which a stream of demands for service appears before a service center with one, or many, servers, and either the time epochs at which demands are made or the service time required, or both, have a probabilistic (stochastic) character. With the appearance of a flood of recent books, the study of this model in all its many guises, elaborations, and variations may be regarded

as in a sense completed. What now happens to queuing theory, and to operations research (in which it has played an important role)? One of the most interesting aspects of the book under review is the light it casts on this question.

In his introductory lecture, Philip Morse (U.S.) suggests a promising line of growth by effectively invoking the Jacobi injunction: always invert. In present uses of the theory, the input and structure of the system are usually taken as given, in some convenient probability form, whether or not measurements or observations are available to establish their relevance. In the inverse uses, the characters of the input and structure would be inferred from the output. Of course, an extensive mathematical development, probably more difficult to carry out than the existing theory, is necessary.

In the third session of the conference, J. F. C. Kingman (U.K.) in an invited paper examines the heavy-traffic condition (that is, a condition close to the limit of stability of the system) with a view to finding an approximation of the performance of the system (the distribution of delays) which holds under more relaxed assumptions than the usual independence ones. For a single server and order-of-arrival service, he finds a remarkably simple approximation. For many servers and for other orders of service, there is an open field for hardy investigators. Finally, in the closing session, T. L. Saaty (U.S.) offers many nonmathematical remarks under the title "Ordering disorderly queues." The matters he mentions range from improving the condition of waiting rooms (more comfort) to improving the behavior of waiting people (more courtesy). In supermarkets, the multiple checkout lines seem to him less efficient and less equitable than a single line with first-come, first-served service to the idle checkers. Curiously, he does not consider the question of whether there may not be a critical queue size beyond which order is impossible, that is, beyond which the waiting line becomes a mob. It has been known for some time that telephone operators handling long-distance calls by ticket inevitably pass from order-of-arrival service to random service as the number waiting increases, and such transition in any service control may be expected to alter waiting behavior.

Aside from these glimpses into the future, the technical reader will be pleased to find a résumé, though a somewhat disjointed one, by R. Syski (U.S.) of the work of a pioneer in the theory, Felix Pollaczek, who at last receives the appreciation he deserves. The individual papers, which cannot be given detailed notice here, illustrate the variety of interesting uses of the theory.

JOHN RIORDAN
Bell Telephone Laboratories, Murray Hill, New Jersey

Antimicrobial Agents

Biosynthesis of Antibiotics. Vol. 1. J. F. SNELL, Ed. Academic Press, New York, 1966. 246 pp., illus. $10.

It is historically fitting in a volume devoted to the review of our knowledge of the biosynthesis of antibiotics that the first group of antibiotics to be discussed in depth is the penicillins and cephalosporins. In an excellent contribution, A. L. Demain reminds us that penicillin "still remains the most active and one of the least toxic" antibiotics. Advances in the biochemistry of fermentation and production methods are especially impressive when one reads that in the early stages of the development of penicillin it took over a year to accumulate enough for clinical trials. Today's cultures produce 5 milligrams per milliliter. Evidence for the biosynthetic origins of the β-lactam-thiazolidine ring nucleus common to all penicillins is reviewed. It is particularly useful to have the associated pathways of sulfur and carbon synthesis in cysteine and other pathways related to penicillin biosynthesis presented in parallel. A review of the "new penicillins," penicillinases, and the biosynthesis of cephalosporin C and its derivatives and mention of the use of particulate fractions bypassing permeability difficulties all make this chapter well worthwhile.

A concise and lucid chapter on the status of the biosynthesis of the tetracycline antibiotics is presented by R. H. Turley and J. F. Snell. The use of mutants in working out the probable steps of formation of 7-chlortetracycline from 6-methylpretetramide is of interest; it is evident that other mutant-selection techniques will be needed before the steps from acetate or malonate to naphthacenic intermediates can be worked out.

It is surprising that although the chemistry and the major sources of carbon atoms in the streptomycin molecule have been known for years, there is still no knowledge of the manner in which the individual units are linked together by *Streptomyces*. However, a clearer idea of the immediate precursors of the streptidine moiety and streptose has emerged from recent studies. J. D. Bu'lock reviews the biochemistry of the polyacetylenes, an interesting group of fungal compounds which have not reached the chemotherapeutic eminence of other antibiotics. The macrolides represent the final group of fascinating antibiotics covered in this book, and although they are relative "newcomers," considerable progress in the understanding of their chemistry and biogenesis is evident from the data given in the chapter by J. W. Corcoran and M. Chick.

The chapter on the "Preparation of radioactive antibiotics" is a useful source of material, although it would have been better placed at the end of the volume so that the reader would have first been informed about the biosynthetic pathways. The volume is well supplied with references and will provide many with a very useful condensation of current knowledge in this field.

MILTON R. J. SALTON
Department of Microbiology, New York University School of Medicine, New York 10016

Organic Compounds

Carbohydrate Chemistry. EUGENE A. DAVIDSON. Holt, Rinehart, and Winston, New York, 1967. 447 pp., illus. $11.95.

The author indicates that a major stimulus for this work has been the need for a book on carbohydrate chemistry in which the principles of modern physical organic chemistry are applied to the properties and chemical reactions of the carbohydrates.

The principles of optical activity and of the spectroscopic methods of nuclear magnetic resonance, infrared, and optical rotatory dispersion, with some applications to carbohydrates, are well presented. The discussions of NMR and infrared are not illustrated with reproductions of spectra and their interpretation; the *tau* values and the infrared absorption bands for some important substituents are listed in tables, however. Aspects of the biochemistry of carbohydrates, including pho-