which is the best currently available on ticks in general. Parasitologists, health officers, and medical entomologists, as well as people in related academic fields will find the book particularly helpful as a summary of the knowledge of ticks and to a lesser degree, as a source of information on diseases that ticks transmit to man and his domestic animals.

G. W. WHARTON
Department of Zoology and Entomology, Ohio State University

Regulation of Growth

Regeneration. Dorothea Rudnick, Ed. Ronald, New York, 1962. v + 272 pp. Illus. $9.

These papers, which were prepared for the 1961 symposium on growth, reflect the importance of control mechanisms in the regulation of growth. Each paper emphasizes how the components of regeneration, including morphogenesis, differentiation, dedifferentiation, proliferation (and even reproduction) are complex processes that cannot be left to chance. It is natural, therefore, that hypothetical growth-regulating factors should be postulated. It is abundantly obvious that such factors are easier to speculate about than to identify.

However, one group of such agents has been chemically characterized—the plant hormones. Stonier, for example, describes how the application of auxins in appropriate doses to decapitated tobacco plants will elicit shoot outgrowths from wound tissues that are otherwise incapable of regeneration. Yet not all plant systems are so obliging, for Steeves stresses the importance of elucidating the nature of hypothetical "morphogenetic substances" presumably responsible for determining whether an isolated fern leaf primordium will become a shoot apex or a leaf.

Zoological systems confront the investigator with equally perplexing phenomena. Rasmont analyzes asexual reproduction by gemmule formation in sponges, and concludes that gemmulation rate is a function of the increasing population density of archeocytes in relation to the number of differentiated cells. But how one translates concepts of size and population densities into chemical and physiological terms remains to be demonstrated. In another chapter, Burnett treats the reader to a lucid account of how the hypostome of the hydra stimulates growth in the subjacent region, which in turn provides cells to the rest of the organism. This contantly regenerating creature must possess a variety of control mechanisms if it is to remain a recognizable hydra. Thus, cells induced to proliferate under the influence of growth stimulators are themselves the source of a growth-inhibiting substance that suppresses proliferation elsewhere in the body. A similar interplay of inducing and inhibiting influences is proposed by Wolff to explain the sequence of interdependent events that occur in planarian regeneration. It is encouraging that at least one of these hypothetical influences has gained some substance as a result of the demonstration that brain extracts can induce regeneration of eyes in planaria.

There may be comparable mechanisms operating in vertebrate regenerating systems. This is most clearly illustrated by Reyer's account of the proposed stimulatory effect that the neural retina exerts on lens regeneration from the iris of the newt eye, an influence also responsible for the remarkable polarized orientation of the regenerated lens. (More problematical is the status of an inhibitory effect of the original lens on the lens-regenerating cells of the dorsal iris). The regenerating amphibian limb still challenges the experimentalist to explain in theoretical terms the controlling mechanisms of its morphogenesis, as Rose's contribution emphasizes. Hay's impressive investigations with the electron microscope have gone far to dispel much of the confusion that once surrounded the phenomenon of cellular dedifferentiation. Clearly, dedifferentiation of chondrocytes and muscle fibers occurs as a prelude to blastema formation; what the implications are in relation to the potentialities of subsequent blastema cell differentiation is an important problem yet to be solved.

If we can extrapolate from these examples of current interests and achievements in the field of regeneration, we may confidently expect the experimental demonstration of many more growth-regulating factors in the future. But unless greater emphasis is placed on modern biochemical approaches, so conspicuous by their absence in this volume, the eventual chemical characterization of such factors will be inexcusably delayed.

RICHARD J. GOSS
Department of Biology, Brown University

Reinitzer's Crystals

Molecular Structure and Properties of Liquid Crystals. G. W. Gray. Academic Press, New York, 1962. vii + 314 pp. Illus. 63s.

Liquid crystals, discovered in 1888 by Reinitzer, comprise several states of matter intermediate between ordinary liquids and true crystals, for they are capable of flowing, much like liquids, but they are optically anisotropic. Most scientists probably learned of these crystals as a result of Lehmann's book *Flüssige Kristalle,* or of the 1933 symposium sponsored by the Faraday Society on liquid crystals and anisotropic melts. This is the first book in English on this subject.

There are ten chapters: "Introduction" (16 pages); "Smectic, nematic and cholesteric mesophases" (38 pages); "The identification of mesophases and the determination of mesomorphic transition temperatures" (11 pages); "Molecular arrangement and order in the nematic mesophase—the swarm theory and the distortion hypothesis" (14 pages); "X-ray, ultra violet and infra red spectroscopic and proton magnetic resonance studies on the mesomorphic states" (17 pages); "Other physical characteristics of the mesomorphic states" (28 pages); "Liquid crystalline behavior of mixtures" (14 pages); "The mesomorphic behavior of compounds and their chemical constitution" (58 pages); "The regular trends of mesomorphic transition temperatures for homologous series" (42 pages); "The effects of substituents and of steric factors on mesomorphic thermal stabilities" (61 pages).

The first chapter is a general introduction to liquid crystals, for which a better name is Friedel's term *mesophase.* The *mesomorphic state* is known only among organic compounds that have more or less elongated molecules. Such a compound may, in general, exist in more than one mesomorphic state, in addition to the crystalline and liquid states. A typical compound might pass through these states successively when heated, with the mesomorphic states occurring between the crystalline and the liquid states. There are three distinct categories of mesomorphic states, smectic, nematic, and cholesteric. In chapter 2 some characteristic properties of these phases are described. In

the smectic state, the long molecules lie parallel to one another, with matched ends, and form sheets; in the nematic state, they lie parallel without matched ends; apparently the cholesteric state is not well enough defined for the author to describe it succinctly.

Properties of the three kinds of mesophases are described in chapter 3. The smectic state is characterized by the so-called focal-conic texture, which is not very clearly described. The nematic state can assume several textures; the cholesteric state is related to the nematic state, but the reader is not given a clear impression of its exact characteristics. Identification of the various kinds of mesophases is discussed in chapter 3. In this work a polarizing microscope equipped with a heating stage is the chief experimental tool.

Chapter 4 is devoted to proposed views of the molecular arrangement in the nematic state, specifically to Bose's "swarm theory" and Zocher's "distortion hypothesis." The study of the mesomorphic states by various physical experiments is described in chapter 5. X-ray diffraction studies have been made by several well-known crystallographers, including Friedel, Hermann, Bernal, and Crowfoot. The last two demonstrated that crystals which, when heated, transform to a smectic mesophase have layer structures in which the molecules are transverse to the layers. Thus, transformation from the crystal to the smectic state consists essentially of rotational disorder of the molecules in the layers as well as of shear disorder between the layers. Physical properties such as viscosity, dielectric constant, transition properties, refractive index, light scattering, and surface tension are discussed in chapter 6.

Chapters 7 and 8 are chiefly concerned with the molecular structures of materials capable of forming mesomorphic phases. The chapters are intended partly to rationalize the occurrence of mesophases in terms of molecular structure.

This book, which is written from the point of view of the organic chemist, is heavily documented and has an extensive coverage of chemical examples.

M. J. BUERGER
Department of Geology and Geophysics, Massachusetts Institute of Technology

Research Adventures

Design and Function at the Threshold of Life: The Viruses. Heinz Fraenkel-Conrat. Academic Press, New York, 1962. vii + 117 pp. Illus. Plates. Paper, $1.95.

This little book is a labor of love. It deals with the intimate laboratory adventures that have led to one of the great and dramatic achievements of modern biology: The elucidation of the nature and function of viruses in the genetic processes of living things. But it is more than that. Its central theme is concerned not so much with the significance of this particular area of investigation as it is with insight into the process of doing research. And the protagonist is the research scientist, his motivating curiosity, his long, arduous, and often disappointing labors, his embarrassment about errors of judgment, his skepticism in the face of established views, his puzzlement over unexpected results, and sometimes his exalted joy when the challenge has been successfully overcome.

There have been many attempts to explain scientific research to the intelligent layman. The necessarily witless pedantry of much of the significant scientific literature of our time has placed it beyond the layman's reach and understanding. In its stead, an incredible proliferation of popularized research reports (not to mention advertisements) have abused the term *scientific research* to the point of meaninglessness. Fraenkel-Conrat has written one of the very few authoritative books that can bridge the gulf between the scientist and the humanist with depth and substance. This gulf, however, will not be easily traversed by a casual reader. Though the style is lucid and the explanations frequent, even a practising scientist may find it necessary to read the book with unusual care and attention.

Perhaps this is because the author took too much for granted and left a considerable number of key technical terms undefined. Thus, it is questionable whether this book "will be readily understood by laymen," as its jacket suggests. But there can be little doubt that many students will find this work a source of information and inspiration.

ELIE A. SHNEOUR
Department of Genetics, Stanford University

Botany in India

Summer School of Botany, 1960 (Darjeeling). *Proceedings*. P. Maheshwari, B. M. Johri, and I. K. Vasil, Eds. Ministry of Scientific Research and Cultural Affairs, New Delhi, 1962. viii + 522 pp. Illus. Rs. 25.

A review of these proceedings necessarily brings into consideration the merits of the school itself. Unlike the summer institutes organized in recent years by the Botanical Society of America, the Darjeeling program brought together a group of persons who participated both as lecturers and as discussants. Another difference, this one in favor of the American format, was the lack of laboratory sessions to augment and clarify the lectures.

Almost all papers have been published *in extenso*. The variations in subject matter, treatment, and qualification of authors is so great that evaluation of the book as a whole is difficult. I assume that my bewilderment was not shared by the participants, who undoubtedly were stimulated and carried along by personal contact. That the various contributions exhibit varying degrees of competency is to be expected. Papers by such authorities as T. V. Desikachary (electron microscope studies on algae), P. Maheshwari (contacts between embryology, physiology, and genetics), V. Puri (morphology of the flower), and A. K. Sharma (chromosome structure) are understandably noteworthy. It is puzzling, however, to discover that some papers are not reviews of current concepts and methods, such as would be appropriate for a summer school, but are reports of original research. While the inclusion of these papers probably was not a drawback to the sessions themselves, the resulting heterogeneity narrows the usefulness of the proceedings. The value of this collection of papers would seem to be chiefly historical: it furnishes an excellent transect of Indian botanical research in 1960.

The report of a discussion on the "Promotion of teaching and research in botany" is especially interesting in that it gives insight into the problems and limitations faced by Indian botanists. There is no doubt that the Darjeeling summer school substantially aided the Indians in achieving their worthy goals.

PAUL C. SILVA
Department of Botany, University of California, Berkeley