Chromosome Organization

There is a difference in the general thinking of the early 1950's and that of the middle 1960's with respect to chromosome organization. Ten to fifteen years ago, when the terms *chromosome phenotype, chromosome gradient,* and *chromosome organization* were introduced, the general attitude was dominated by what Ernst Mayr calls "beanbag genetics." At that time those terms seemed to many geneticists premature or unjustified. We had to wait until the link between genetics and biochemistry was established for the new approach to be accepted. The study of DNA replication in chromosomes and the gene behavior in microorganisms has suddenly exposed a large number of investigators to pressing problems on interactions between chromosomal segments with the result that, in the last years, the new concepts of chromosome organization and gene interaction have become part of the general thinking. **The Role of Chromosomes in Development** (Academic Press, New York, 1964. 302 pp., $11) edited by Michael Locke, illustrates this trend. Among its contributors are some who, a few years ago, would have avoided using the terms *chromosome phenotype* and *chromosome gradient* but who now take these concepts for granted. Of the many symposia on chromosomes that are published, this is a publication that deserves special attention. The subjects chosen by the editor have resulted in a coherent attempt to elucidate chromosome structure and function, a task usually difficult to achieve in a symposium. Few other publications on the subject cover the field so well.

The Role of Chromosomes in Development opens with an introductory chapter by M. Markert which is a summary of the other articles presented in the volume. At present, the role of DNA in the chromosome is relatively clear, but the role of the protein and other molecules is not equally well understood. DNA builds complexes with these molecules, and the interactions thus established are of paramount importance for the understanding of gene expression and its relation to development. This is the main theme treated in the various chapters that constitute this book.

In the first chapter M. J. Moses and J. R. Coleman discuss chromosome organization in relation to DNA and protein replication as well as the arrangement of chromosomes in the sperm of insects. The authors also point out that there is not yet a plausible link betwen the pachytene chromosome structure seen with the electron microscope, the mechanism of crossing over, and the time of DNA replication at meiosis. Of the three main components of the chromosome—DNA, RNA, and protein—the least well known are chromosomal proteins, which are divided into three groups: (i) histones, (ii) acidic nuclear proteins or structural proteins, and (iii) aggregate enzyme systems. During the course of the organism's development, the DNA does not seem to be altered, but the histones and the acidic nuclear proteins are supposed to influence cell function. It can be shown that histones have a stimulatory or an inhibitory effect on RNA labeling (Busch, Starbuck, Singh, and Ro). The binding of actinomycin to DNA contributes to clarifying the problem of interaction of DNA with protein in relation to cell differentiation. Actinomycin at low concentrations inhibits DNA-dependent RNA synthesis, but does not impair DNA replication. It forms reversible complexes with DNA, but not with other cellular components. Of the four bases in DNA, only guanine is indispensable for binding actinomycin. These three properties of actinomycin fit well into a mechanism that would involve regulation of gene action by a protein (Reich). The problem of gene regulation leads to the discussion of the pattern of DNA replication in mitotic chromosomes of higher animals, and the relation of heterochromatin to DNA replication (Hsu, Schmid, and Stubblefield). The localized synthesis of DNA observed in polytene chromosomes also has implications connected with this phenomenon (Plaut and Nash). Edström discusses the function of chromosomal RNA and other nuclear RNA fractions. It seems well established that at least part of the nucleolar RNA is transported to the cytoplasm as ribosomal RNA and that this RNA is coded by a small fraction of the genome.

That the late-replicating X chromosome of mammals is instrumental in gene inactivation is disclosed by interactions of its heterochromatin with neighboring genes. This phenomenon is studied in translocations involving the X chromosome and autosomes of the mouse. The inactivation of autosomal genes proceeds from one point of the X, and the degree of inactivation is dependent on the position of the rearrangement points (Russell). Brink has also made extensive studies of the interactions between genes in maize. These involve genetic repression of certain loci in which gene expression varies with the genetic "history" of the allele. The occurrence of clusters of closely linked genes with similar effects which control the course of development of certain body segments of *Drosophila* is also given as an example of systems of gene interaction that may help us to understand the coordination of development (Lewis). Finally, Nanney describes the macronuclear differentiation and subnuclear assortment in Ciliates which lead to the disintegration of macronuclei and micronuclei, and to the establishment of nuclear interactions that decide the fate of the different nuclei within the body of the Ciliates.

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Aerodynamics and Physics

The Dynamics of Real Gases. J. F. Clarke and M. McChesney. Butterworth, Washington, D.C., 1964. x + 419 pp. Illus. $17.50.

A review of V. Rojansky's *Introductory Quantum Mechanics*, which I wrote for *The Purdue Engineer* in March 1940 concludes as follows: "Of what value is quantum mechanics to the engineer? It required more than half a century before the mathematical principles of electromagnetism reached fruition in the useful arts of electrical and radio engineering. Insofar as quantum mechanics has made possible the solution of long-standing problems in physics and chemistry, it cannot fail to have a profound effect on the technical arts, although this may require some time." The book here under review, *The Dynamics of Real Gases*, written by a British aerodynamicist and a mechanical engineer and intended for advanced engineering students and research workers in the field of aerothermodynamics, opens with a chapter on the quantum mechanics of the atom and freely uses quantum-mechanical results throughout, especially in the last chapter. Because the artificial satellite has partially eclipsed the atom from the public consciousness during the past few years, it is interesting to see that basic aerodynamic problems related to space physics reduce ultimately to problems in atomic and molecular physics. This is the main theme of the book under review.

The authors have set themselves an ambitious task—that of providing the background in theoretical physics needed to understand recent developments in the theory of hot gases in nonequilibrium states. The first five chapters, which take up nearly half the book, are devoted to surveys of quantum mechanics and atomic structure (33 pp.), chemical thermodynamics (20 pp.), statistical mechanics (43 pp.), chemical kinetics (18 pp.), and advanced kinetic theory of gases (45 pp.). In each case that minimum of theory is developed which is needed to derive, or make plausible, formulas and concepts that are directly relevant to future applications.

Chapter 1 presents the Schrödinger equation and its applications to the harmonic oscillator, rigid rotator, and hydrogen atom, and then discusses the quantum numbers and allowed states of atoms and of diatomic molecules. Chapter 2 reviews the thermodynamic basis of the law of mass action. An introduction to statistical mechanics is given in chapter 3, which follows closely the development in Rushbrooke's well-known book. The Maxwell-Boltzmann statistics are applied to quantized systems; the translational, rotational, vibrational, and electronic partition functions are derived; and the equilibrium constant of a dissociating diatomic gas is calculated. Chapter 4 reviews chemical reaction-rate formulas and includes a discussion of the simple collision theory and of the Eyring transition-state activated-complex theory. Chapter 5 opens with the Boltzmann transport equation, develops the equations of change expressing the microscopic conservation laws, and then provides a resume of the Enskog-Chapman approximation method of solving the Boltzman equation to obtain the Navier-Stokes equations for gas mixtures. The chapter concludes with the elementary free-path theory of the transport coefficients.

The first five chapters are well written and will serve as admirable refresher courses for those already familiar with the material. Readers who are not acquainted with quantum theory, statistical mechanics, and Boltzmann transport theory (that is, most engineering students in this country) will frequently need to consult other books for fuller explanations and for details of proofs.

The last two chapters contain the main substance of the book. Chapter 6 deals with numerous problems in the aerothermodynamics of hot gases, and chapter 7, which discusses some of the basic physics related to these problems, begins with a résumé of quantum-mechanical scattering theory for both elastic and inelastic collisions. The inelastic collisions of main interest are those in which translational energy is converted into rotational energy and into vibrational energy. The inelastic collision frequencies and cross sections determine the rate of approach to equilibrium of a gas initially in a nonequilibrium state. Relaxation times, measuring the time of approach to equilibrium, are associated with the conversion of translational energy into rotational energy and also into vibrational energy. Chapter 7 develops the general kinetic equations describing relaxation processes and then discusses the Landau-Teller theory of vibrational relaxation and recent improvements in the analysis, especially those due to Herzfeld and his co-workers. The predicted temperature dependence of the vibrational relaxation time is compared with experimental results obtained mainly from shock-tube studies in which the hot gas behind the shock front relaxes from its initial nonequilibrium state with the conversion of translational into vibrational energy. More general theories of vibrational relaxation, due to Shuler, Montroll, and others, are discussed, and the rotational relaxation problem is then taken up briefly: here the collisions are nonadiabatic, the conversion of translational into rotational energy is efficient, and the relaxation times are short.

The next general topic discussed is that of thermal dissociation of the molecules of a hot gas, and all of the principal theories of dissociation and of recombination are reviewed. Recent nonequilibrium theories of chemical reactions are mentioned, and the chapter concludes with a discussion of radiation from hot gases. A brief introduction to quantum-mechanical radiation theory is given, and transition probabilities and selection rules are discussed for atoms and diatomic molecules. Limitations of space preclude further comments on this long and interesting chapter (140 pp.). Its clear and up-to-date treatment of the subjects mentioned, with many references to recent papers, will make it valuable to workers in this field.

Chapter 6 deals with problems in aerodynamics that cannot be treated within the framework of macroscopic, continuum theory but which explicitly require molecular physics for their explanation. Consideration is given to general nonequilibrium states in which the hot polyatomic gas is partly dissociated and in which the translational and the internal (for example, vibrational) degrees of freedom are not in equilibrium. The analysis is based partly on kinetic theory and partly on a quasi thermodynamic theory (credited to Kirkwood) in which different temperatures are assigned to different degrees of freedom. The authors discuss the propagation, absorption, and dispersion of sound waves in a dissociating gas and then go on to a consideration of nonequilibrium flows and the structure of shock waves. In addition to viscosity and heat conduction, the relaxation times associated with the internal modes and the characteristic chemical times of the dissociation reactions are shown to determine the form of a shock wave and the nature of the relaxation zones behind the shock front. The chapter concludes with a discussion of energy transfer through a flowing, dissociating, polyatomic gas and considers related heat transfer problems, including accommodation effects at the walls. I am unfamiliar with much of the material discussed in this chapter. A considerable background in aerodynamics is required for some sections; other sections seem to have been transferred directly from research reports and papers with little effort given to pedagogical rearrangement. There are not enough simple examples to provide orientation and the complex problems discussed involve so many superimposed effects that it is hard to disentangle them. Perhaps the authors are here too close to their subject; several sections refer to the work of the first author who has made important contributions. The "real gas" of the title is one undergoing many complex processes, and the authors pull no punches in discussing it.

In view of the vast amount of theoretical physics, chemistry, and engineering which the authors have been required to master in the preparation of this book, it is not surprising to find some errors and misstatements. Examples of these are: an incorrect definition of the associated Legendre function (p. 13), incorrect statements about the term symbol (p. 29) and the parity (p. 35) of a many-electron atom, an incorrect definition of quantum statistics (p. 59), confusion between inverse and reverse encounters (p. 137), and confusion between the distance of closest approach and the impact parameter of a collision (p. 280). I noted very few misprints in the many equations, and the typography and printing are excellent. This book will have a significant influence on the curriculum of graduate engineering departments, and it will be widely read by physicists, chemists, and engineers in industrial and government laboratories.

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The Pawnee Culture

The Lost Universe. Gene Weltfish. Basic Books, New York, 1965. xxii + 506 pp. $12.50.

In 1875 the last Pawnee Indians left their aboriginal homeland in Nebraska and joined their previously migrated relatives in Oklahoma. The 1910 census listed 633 persons left of a tribe that had numbered close to 12,000 during the 1830's (p. 4). A viable, integrated culture had ceased to exist—a universe was lost.

Gene Weltfish has sought to rediscover this universe. Beginning in 1928, she has studied the language and used it to gather myths, tales, and the life experiences of informants who had known the old culture and the people who had maintained it. This material has been cross-checked by field observations and expanded with information from archeology, history, and ethnography into this quite detailed portrayal of Pawnee life during the course of a hypothetical year, 1867. Details of hunting, planting, ceremony, and ritual, as well as of tools, techniques, ideas, and behavior, form the warp on which she weaves the ordinary events of life to produce the fabric of Pawnee culture.

Weltfish intends this to be more than another good ethnography. She has studied Pawnee culture carefully and finds within it lessons for today. The Pawnee maintained an ordered society without any individual exercising power over another. No one gave orders. Theirs was a democracy without coercion, of consensus rather than majority rule. The Pawnee case, then, can be a possible source of solutions to modern problems.

> The Pawnee way is one of thousands of ways of life that mankind has developed. . . . A study of its ways and social interactions help us to throw into sharp relief our most widely accepted hypotheses on the nature of "the basic human character" and to test whether some of these assumptions are in reality universal human nature or rather limited modes of learned behavior that we have developed for needs that are now becoming obsolete (p. 12).

This thesis is examined in the introductory remarks and in a final chapter. The author briefly and thoughtfully explores the implications of her Pawnee study as these relate to family, home, and work in the face of the population explosion and increasing automation. The need, as she sees it, is for a reassessment of our evaluation of work, for a shift from a mercantilist to a humanist society, and for a modification of settlement patterns that will allow for better human relations. She offers a thought-provoking plan for "family oriented housing" that would provide urban apartment dwellers a physical milieu within which meaningful social interaction could develop. Whether or not these ideas provide the answers, the Pawnee culture, as presented in this volume, bears examination as we attempt to order our own way of life.

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European Biochemical Societies

Structure and Activity of Enzymes. A symposium (London), March 1964. T. W. Goodwin, J. I. Harris, and B. S. Hartley, Eds. Academic Press, New York, 1964. viii + 190 pp. Illus. $6.

In March 1964 the first meeting of the Federation of European Biochemical Societies was held in London. The 23 papers presented on what must have been a busy day in the middle of this meeting are collected in this small volume. The editors and publishers have done a good job of preparing a well-organized and carefully printed book in a reasonable period of time after the meeting, compared to many symposium reports; but one still wonders why, with the help of modern technology, such a volume cannot be published within two or three months after a meeting.

The organizers wisely limited the topics to a detailed consideration of three proteins—ribonuclease, chymotrypsin, and hemoglobin—and a discussion of active sites. The inclusion of hemoglobin in a symposium on enzymes was based on the useful principle that if not much is known about a subject, such as enzymes, it is desirable to consider something else about which more is known. This was a particularly good decision in this case, because the structure, dissociation into subunits, cooperative effects in the oxygen dissociation curve, and changes in structure and acid dissociation constants upon reaction with "substrate" (oxygen) of hemoglobin are all topics of great current interest in enzymology.

The most interesting and useful papers are those that summarize and interpret the important available data on a particular enzyme or protein. The first paper, a summary (by Richards) of present knowledge about ribonuclease, is an excellent example. Mathias, Deavin, and Rabin present kinetic data on this enzyme, which was obtained in their laboratory and is largely already published. Brief reports of amino acid sequence work on chymotrypsinogen and chymotrypsin are presented by Keil and Šorm, and by Hartley. Oosterbaan and Cohen give a short but useful summary of the considerable amount of information that is now available on the amino acid sequences near the active sites of the "serine" and "sulfhydryl"