rems which give necessary and sufficient conditions for the existence of network flows that satisfy additional linear inequalities of various kinds. Adopting linear programming terminology, the authors call these feasibility theorems. These results, combined with the use of a theorem obtained in Chapter 1, the integrity theorem, are then used to consider various combinatorial problems for the remainder of the chapter. Examples of the latter are the König-Egerváry and Menger graph theorems.

The problem of constructing network flows that minimize cost is the substance of Chapter 3. An algorithm is given for obtaining solutions to the Hitchcock problem (the standard transportation problem) which is a generalization of a combinatorial procedure developed by Kuhn for the optimal assignment problem (a special case of the Hitchcock problem), and the equivalence of the Hitchcock and minimal cost flow problems is shown. This chapter also contains brief discussions of the warehousing and caterer problems.

In the short concluding chapter, "Multi-Terminal Maximal Flows," a return is made to the topic discussed in the first chapter. However, instead of focusing on the value of a maximal flow from one specified node to another, attention is shifted to certain questions that arise when all pairs of nodes are considered.

The book should be of value not only to those interested in linear programming but also to those who are concerned with graph theory.

Biophysical Science. By Eugene Ackerman. 626 pp. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1962. $13.35. *Reviewed by Joseph G. Hoffman, University of Buffalo.*

BIOPHYSICS is a vast and sprawling area which probably will never become defined. Ackerman's book does not define areas but rather shows the general approach to biology from the physical sciences side. The title is appropriate because in the 31 chapters he discusses 31 distinctly different facets of biology covering a wide range of diverse subjects. The range is enormous and presupposes a teacher who will be fluent in both physical and biological sciences. I refer to "teacher" because this is a classroom text. It is a guide to an interdisciplinary subject whose involuted topics require pedagogic elaboration.

Take for example the statement in Chapter 21, p. 389 that: "The second law of thermodynamics is concerned with the direction of time." In the context presented, the student might be led to believe that physical entropy could be used as a kind of measure of time. Physical theory does not permit this inference. It may yet turn out that our biological sense of time originates in some as yet unknown feeling of entropy. On the other hand, there are the pacemaker ideas according to which the brain may have in it cells that are electromechanical oscillators and serve as chronometers. Thus entropy, as a thermodynamic quantity, becomes a starting point for the examination of our biologic concept of time. One is reminded of Eddington's earlier discourse on time and its possible relation to entropy.

Entropy might be a starting point for another basic exploration: on p. 465, Chapter 25, Information Theory and Biology, a single sentence is devoted to the relation between negative entropy and average information. Here much discussion is called for, and a teacher will have to expound the possible relationship between these strange quantities in the life process. Ackerman has left the topic wide open, which is undoubtedly the best approach for pedagogic purposes. Physical entropy of a cell is a lively and unresolved problem. Its mention in this text gives an indication of the author's broad point of view toward problems of living systems.

The format is of the best. There is a generous supply of figures and tables, as well as four appendices. The table of contents and index serve the reader well. Each chapter has at its end a list of selected references. Each of the six major sections into which the book is partitioned ends with about twenty questions aimed to illuminate further the several chapters of each section. For pedagogic purposes this is a highly commendable text.

Physicomathematical Aspects of Biology. Proc. of Internat'l School of Physics "Enrico Fermi" (Varenna, Italy, July 1960). N. Rashevsky, ed. 524 pp. Academic Press Inc., New York, 1962. $16.00. *Reviewed by George H. Weiss, University of Maryland.*

RECENT years have seen increasing expression of the feeling that biological research suffers a lack of theoretical underpinnings. In just the same way as physics acquired direction with Newton's axioms so, it is argued, will biology benefit from a systematic application of those quantitative techniques which have been successful in theoretical physics. For the last twenty years or more, Professor N. Rashevsky of the University of Chicago has been the leader of a most vocal school of mathematical biology. The present volume contains a collection of papers which to a great degree have been influenced by the work of his school.

Perhaps the best—and in a sense the most disappointing—of the papers is one by M. E. Wise on human radiation hazards. It is an extensive discussion of the relation between radiation and leukemia incidence and gives a careful summary of all of the factors which are believed to be operative. Unfortunately, all of the conclusions of the paper seem to be beset by many approximations and assumptions. As a consequence, it would not be difficult to take exception to any of them. This is due not to the author, who has done an excellent job of marshaling data, but rather to the nature of biological phenomena which seem always to be compounded of many mechanisms that cannot easily be separated. Other interesting articles include a review by Bartholomay of reaction-rate theory and a review of enzyme reactions of biological interest by Boeri. There are twelve other papers discussing mathematical models of lung ventilation, neural nets, the ingestion

of drugs by the body, and the pumping action of the heart. Finally, Rashevsky has ended the book with an article on "mathematical principles in biology". This article purports to treat such diverse phenomena as the shape of plants and of quadrupeds, the internal structure of animals, the branching of arterial systems, and an axiomatic theory of the "mapping" of organisms onto one another.

So far it cannot be said that mathematical methods have been very popular in biology. Few biologists consider the work of Rashevsky's school to be of any importance. I do not think that this is purely a matter of professional prejudice. All of the significant discoveries in biology have been experimental; none of these has been predicted by a mathematical theory. Lacking a predictive element, a mathematical theory can be regarded as a sophisticated method of curve fitting, perhaps interesting, but not significant. I am sure that the biological sciences can profit by closer collaboration with more theoretical thinking, but most of the work reported on in these proceedings seems to be curve fitting and ad hoc theorizing. Success still seems to be just over the horizon.

Theory of Elementary Particles (2nd ed.). By Paul Roman. 580 pp. North-Holland Publishing Co., Amsterdam, 1961. Distr. in US by Interscience, New York. $12.75. *Reviewed by Denis Keefe, Lawrence Radiation Laboratory.*

THE first edition of Dr. Roman's book was rightly hailed as a fundamental and pedagogically beautiful addition to the reference literature on elementary particles. In this, the second edition, he has made the necessary corrections, expanded slightly the main body of the material, and brought up to date the final section reviewing the most recent progress in the field.

The field of elementary-particle physics is now so vast, and the philosophical approaches so varied, that an author can fill up several hundred pages with basic and essential material and still be accused of being incomplete. Because he concentrated mainly on the field-theoretic approach and particularly on considerations of symmetry and invariance properties, the author has been so accused. In opening a book with this title, I must confess to a certain feeling of disappointment that the dispersion-theoretic point of view was not covered, but on reading it as a one-volume work, I could not find any material which could be omitted to make room for such a description. To keep the same volume of information and shorten the derivations and explanations would be to rob the work of its most attractive and valuable feature. The presentation of group theory, field equations, and especially the explanation of parity, charge conjugation, time reversal, and isotopic spin, are valuable to all theoretical and most experimental physicists.

On historical grounds, the second edition can be criticized for being a little before its time. The recent work by Ne'eman, Gell-Mann, and many others on the