tions but also by creating an atmosphere conducive to interest in the field among the administration, staff, and students.

Bidwell obviously feels that good education in international relations is important, and he amply demonstrates that the present situation is deplorable. His proposed remedies deserve careful consideration by academic administrators, and indeed by everyone interested in a responsible American citizenry, an adequate American foreign policy, and a less dangerous world. Educated leaders are needed, as are educated followers, because "the quality and effectiveness of leadership in foreign policy will in large measure depend on the response of an educated public opinion" (p. 145).

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Negentropy and Living Systems

Life: Origin and Development. Gösta Ehrensvärd. University of Chicago Press, Chicago, 1962. ix + 164 pp. Illus. $4.50.

Life in the Universe. Francis Jackson and Patrick Moore. Norton, New York, 1962. ix + 140 pp. Illus. $3.95.

The origin and evolution of life and its distribution in the universe are inseparable problems, involving extrapolations far into time and space which are both fascinating and risky. If we start from different basic concepts, very different conclusions may be reached. From a strictly "deterministic" point of view, the emergence of life may appear as a necessary outcome of the accumulation of molecular species, following, in some way, a kind of "law" that also governs the accumulation of those species. From what might be called the "opportunistic" view, life seems to have emerged and evolved as the result of chance events taken advantage of by selective processes. Both approaches have weaknesses—the truth may lie somewhere between.

Both Ehrensvärd's *Life: Origin and Development* and Moore and Jackson's *Life in the Universe* follow closely the deterministic approach. It is important that the reader keep this in mind, the more so because both books are well and convincingly written. Within the limits of their approach both books are critical, particularly the first, which has been long in preparation.

Ehrensvärd's predominantly biochemical treatment emphasizes the seemingly continuous evolution of the kinds of molecular species that characterize life, from the clearly nonliving primordial environment on through the evolution of living organisms themselves. He stresses eloquently the apparent continuity of this record, where one sees no distinct boundary between the nonliving and the living. His admittedly deterministic argument finds its support in this apparent continuity which, viewed from a great distance in time, may suggest a continuously flowing process.

Moore and Jackson are at their best in the astronomical realm. Although they point out that the planets of our solar system, other than earth, seem to offer very unfavorable environments for the kind of life we know, they entertain the idea that life—even intelligent life—may occur in other parts of the universe. This is a logical outcome of the deterministic point of view, and one gains the impression that these authors tend to lean in that direction, although remaining properly uncommitted. They reject the idea that life has been seeded about the universe from some unknown source, which might also accomplish a wide distribution. Implications of the opportunistic approach, which would suggest that the array of living forms we know on earth might find little parallel in life evolving elsewhere, or even that life is unique to our planet, are barely touched upon.

Neither book indicates that the authors have considered their problems in terms of information theory, yet this would seem a cogent means of approach. It would seem that the origin and evolution of living systems, or even the evolution of the organic compounds that became ultimately incorporated into them, must have entailed the accumulation of a vast amount of negentropy. This does not, of course, represent a denial of the second law of thermodynamics, there having been a tremendous increase in entropy in the sun-earth system. But does not the strictly deterministic point of view reflected in these books tacitly assume that the accumulation of negentropy follows a directing principle, and thus inject a note of finalism? The question is far from trivial, and that it is not posed may evidence a limited perspective. But, faced with so troublesome an enigma, may we not be tolerant in this regard?

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A Reader for Chemists

The Nature of Biochemistry. Ernest Baldwin. Cambridge University Press, New York, 1962. xiii + 111 pp. Illus. Paper, $1.45; cloth, $2.75.

The authoritative soundness of Ernest Baldwin's work cannot be questioned, and with his previous books, particularly *Dynamic Aspects of Biochemistry*, he has performed a notable service to the profession.

In the present volume, 111 pages in length, Baldwin seeks to present a picture of what biochemistry is about, and the book is intended, as the author says, ". . . to be read, not studied." His use of language is excellent, and his ability as an expositor is commendable. Even before the reader gets very deep into the book, it becomes obvious that he must be able to read meaning into the complex formulas of organic chemistry in order to comprehend the book. Clearly this book is for those who have some considerable proficiency in organic chemistry and who want to supplement this with introductory knowledge about biochemistry. To such readers the work is recommended.

Some idea of the contents can be gained from the chapter headings: "The constancy of the internal environment," "Respiratory function of the blood," "Proteins," "Physico-chemical behaviour of proteins," "Enzymes," "Fate of amino acid nitrogen," "Carbohydrates," "Fuel for the machine: Carbohydrates," "Fuel for the machine: Fat," "The powerhouse of the cell," and "Nucleic acids and nucleoproteins."

It is not a criticism to say that Baldwin emphasizes the portions of biochemistry that particularly interest him. Every author has a right, indeed an obligation, to present his own point of view; otherwise his book will be dull and unimaginative and of little value. However, it may be said in this case, by way of criticism, that the writer has left out several chapters of biochemistry which to me and to many laymen are of unusual interest, from the standpoint of both science and practical application. Although there is some material on the functioning of amino acids in nutrition, the general subject of nutrition is not treated—that the word *vitamin* is not found in the index is evidence of this. While the vitamin field, as such, is not as active an area of investigation as it was a decade or two ago, there is evidence that these entities were crucially im-

portant on this planet hundreds of million of years ago, and they are not at all likely to go out of fashion. Another omission is a satisfactory treatment of the subject of hormones. That we are considerably in the dark about exactly how these substances act biochemically does not, in my opinion, justify so much neglect, even in a short book.

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On the Nature of Mathematics

Mathematics in Your World. K. W. Menninger. Translated from the German by P. S. Morrell and J. E. Blamey. Viking Press, New York, 1962. viii + 291 pp. Illus. $5.

Some have called our times the Aspirin Age, but to many it has long been clear that ours is the Age of Mathematics-Made-Easy. Whereas the 18th century had its Newtonianism for the Ladies, our more democratic age has its Mathematics for the Millions. *Mathematics in Your World* is a new title, but it is in the familiar genre. Like its forebears, it opens with pejorative comments on "aspects so often neglected in school" and with the expressed desire to keep the reader from thinking "he has fallen among pedants." The author then follows precedent by assuring us that "Only the pure essence of mathematics is presented." The miracle is accomplished, of course, by avoiding "traditional nomenclature, which means nothing to the uninitiated." The theme of this recent addition to the lighter mathematical literature is a familiar one, although names and locale may be novel. This time the man-on-the-street is called John Smith, and the curves used for illustrations are those of the Rhine River, the Nürburg race track, and the Müngsten railway bridge across the Wupper River. (The work was first published in 1954 for a German audience.)

A listing of the topics in the book would be gratuitous for all except the one in a million who somehow has missed the ubiquitous popularization of his generation. The Moebius band, the bees' honeycomb, the multiplication of rabbits, the Wheel of Aristotle, the cycloid, the cardioid, the barber paradox, continuous compounding of interest, the fourth dimension—these, and many more, predictably find a place in the book. That these old chestnuts are presented with sprightliness could have been foretold from the fact that this American version was preceded by two editions at Göttingen and one at London. The script and translation are attractive and accurate, despite the misprint (page 39) of 1822 for 1882 as the date of the proof of the impossibility of squaring the circle and the occasional failure (for example, on pages 43 and 55) to distinguish clearly between exact and approximate values.

Menninger's book resembles its many close relatives in the folksiness of its examples and exposition and in the sometimes hasty abandonment of a topic when the going gets rough. It differs from its cousins perhaps chiefly in respect to the ample space devoted to themes from probability and statistics: chapter 7 is entitled "The realm of lady luck"; chapter 8 is "A tip on the football pools"; much of chapter 6 is on "Normal and not normal"; chapter 9 opens with Monte Carlo methods; and chapter 11 deals largely with the mathematical analysis of life and death.

It is well to bear in mind that the book is intended to be read for enjoyment rather than to be analyzed. If one looks too closely, one may be disturbed by touches of flamboyant showmanship. In the epilogue we are told: "Man has a natural talent for detecting order in his world and this helps us to understand why mathematics is independent of both people and time. . . . It is the sublime spirit in man, from which mathematics arose, that makes it as impossible to deny a mathematical truth, as it is to deny a dictate of the conscience. It is completely unassailable, and from its very truth issues forth its beauty." Such Platonic views shield the reader from an uneasy contemplation of the internecine strife concerning the nature of mathematics and its antinomies. One is reminded in this connection of another contemporary book title, *Mathematics in Fun and in Earnest*. Menninger has indeed given us a very readable account of mathematics in fun; but our generation needs to be warned again and again that this is no substitute for mathematics in earnest. We are living in the Golden Age of Mathematics, but we have not yet found a Royal Road.

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Green Function

The Green Function Method in Statistical Mechanics. V. L. Bonch-Bruevich and S. V. Tyablikov. North-Holland, Amsterdam; Interscience (Wiley), New York, 1962. xii + 251 pp. Illus. $9.75.

Quantum Statistical Mechanics. L. P. Kadanoff and G. Baym. Benjamin, New York, 1962. 203 pp. Illus. Paper, $4.95; cloth, $6.95.

The outstanding postwar development in theoretical physics has been in the improved ability to handle quantum mechanical perturbation theory. With the aid of new techniques the triumphs of quantum electrodynamics in the late 1940's were followed by the successful explanation of superconductivity of metals and of superfluidity in liquid helium and by improved descriptions of the binding energy of nuclei, of electric interactions in plasma, and of ferromagnetism. Not only have specific problems been solved but the theory of both equilibrium and nonequilibrium statistical mechanics has become more complete. These developments are associated with the names of Bogolyubov, Feynman, Yang, Landau, Lee, Brueckner, Bardeen, and many others.

Very few books have been written on these new techniques, and each new contribution is most welcome. The present volumes are not comprehensive surveys of the entire field but rather detailed descriptions of one technique, the Green function as it is applied to quantum statistical mechanics. A Green function is defined as the ensemble average of the product of two operators evaluated at different points of space time. If one is to work with Green functions, the implication is that one has gone over from the differential to the integral equation form of mechanics. This transition emphasizes instead of the instantaneous coordinates of a particle or system, its correlation functions in space and time and its propagation. In the integral formulation it becomes much easier to sum certain parts of the perturbation series. For example, an atom in liquid helium is in more or less violent interaction with its neighbors, but a collective view such as that afforded by the Green functions shows that weak excitations are possible with the long relaxation times characteristic of almost free particles.

Bonch-Bruevich and Tyablikov go into the mathematical structure of the theory in considerable detail, but they