succinate also shows a negative Cotton effect. Esterification of the secondary hydroxyl group is associated with a change in optical rotation resulting in a negative ORD curve for the o^1-ester compound whose ORD curve prior to esterification was positive. Also characteristic of esterification of the o^1-hydroxyl group is a paramagnetic shift of the C(1)—H. Both of these phenomena were observed in the rearrangement of chloramphenicol-3-monosuccinate.

Complete migration of the succinyl function was ruled out on the basis of NMR and chemical data. Complete migration would have given a terminal hydroxyl. No peak corresponding to that for the C(3)—OH proton of chloramphenicol was observed. Chemical evidence indicated that the 0 → 0 migration product was incapable of existence in equilibrium with chloramphenicol-3-monosuccinate under experimental conditions.

Attempts to acetylate or methylate the isomeric compound resulted in complex reaction mixtures, presumably due to the breakdown of the cyclic structure by the reacting anion. All spectral and chemical evidence support the proposed structure.

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Covalent Addition of *N*-Chlorosaccharin to Cyclohexene

Keyphrases □ *N*-Chlorosaccharin—cyclohexene addition □ Cyclohexene—*N*-chlorosaccharin addition □ *N*-(2-Chlorocyclohexyl)-saccharin—synthesis, structure, formation rate □ IR—identification, structure □ NMR—identification, structure □ UV—rate of formation

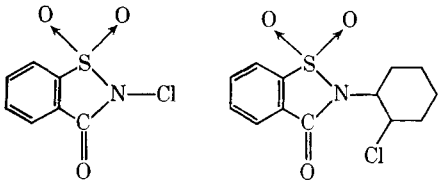
Sir:

It has recently been reported (1) that *N*-chloro-*N*-methylethanesulfonamide will add covalently across the >C=C< double bond of 1-hexene under photoirradiation. In similar, but apparently more facile, reactions, *N,N*-dichlorobenzenesulfonamide (2) and *N*-aryl-*N*-halosulfonamides (3) will add covalently to cyclohexene. Because *N*-chloro compounds are used as chlorinating and oxidizing agents for a wide variety of compounds, additional reactions of the above type must be expected to occur if the molecules to be chlorinated contain unsaturated groups.

Table I—Rate Constants for the Covalent Addition of *N*-Chlorosaccharin to Cyclohexene in Carbon Tetrachloride at 25°

[Cyclohexene]$_{added}$ × 10 *M*	[*N*-Chlorosaccharin]$_{added}$ × 10^4 *M*	$10^2 k_{obs.}$ sec^{-1}	$10^2 k_1$ M^{-1} $sec.^{-1}$
4.96	6.30	1.69	3.41
3.22	10.00	1.16	3.60

We have recently discussed (4) the possible usefulness of *N*-chlorosaccharin (I) as an organochlorinating agent on the basis of its low chlorine potential in water and its solubility and stability in a variety of organic solvents. However, we now present evidence that I will also covalently add to cyclohexene in a facile reaction at room temperature to yield *N*-(2-chlorocyclohexyl)-saccharin (II).



I II

When I (400 mg.) was added to cyclohexene (15 ml.) at 25°, it gradually dissolved and simultaneously a white powder crystallized out of solution. After recrystallization from acetone–water, this powder had m.p. 171–172.5° and the same elemental analysis as II. (Found: C, 52.07; H, 4.86; Cl, 11.94; N, 4.78; S, 10.97. II, $C_{13}H_{14}NClSO_3$, requires C, 52.0; H, 4.67; Cl, 11.85; N, 4.67; S, 10.70.) Its structure was confirmed by NMR and IR spectroscopy. Its NMR spectrum showed the presence of 4 benzene protons and 10 cyclohexene protons, but no cyclohexene-ethylene protons were evident. The IR spectrum of the compound was consistent with that of Structure II and contained a strong band at the carbonyl-stretching frequency region. This latter piece of evidence ruled out the possibility that an O—C bond existed between saccharin and cyclohexene. The product did not release iodine from aqueous solutions of potassium iodide, thereby indicating that it was not in equilibrium with *N*-chlorosaccharin and that its chlorine was fixed and no longer "active."

The rate of formation of the adduct was determined by measuring changes in UV absorbance at 270 mμ after carbon tetrachloride solutions of I and cyclohexene (which had been equilibrated at 25.0 ± 0.2°) were mixed in a 1-cm. spectrophotometer cell. The rate of change of absorbance was first order when [cyclohexene]$_{added}$ was much greater than [I]$_{added}$ and pseudo first-order rate constant, $k_{obs.}$, values were calculated. At two different cyclohexene concentrations the value of $k_{obs.}/[\text{cyclohexene}]_{added} = k_1$ was constant and thus

the reaction appeared to be first order in cyclohexene and I. Results of two experiments are presented in Table I.

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Books

REVIEWS

The Molecular Orbital Theory of Organic Chemistry. By MICHAEL J. S. DEWAR. McGraw-Hill Book Company, New York, NY 10036, 1969. vii + 484 pp. 15.5 × 23.5 cm. Price $16.50.

This book is representative of a general class of books written over the past decade in which quantum chemistry is applied to organic chemistry, with major emphasis on molecular orbital theory. The book is divided into ten chapters, the first four of which develop the concepts of molecular orbital theory useful to the organic chemist. In subsequent chapters, molecules of increasing complexity are treated with considerable emphasis on the conceptualization of the theory. The continual relationship to more classical concepts such as reaction types based upon valence bond mechanisms and the Hammett relationships makes the entrance into molecular orbital theory particularly useful.

There is much emphasis on self-consistent field theory, with very little attention paid to the less exact but simpler Hückel schemes in common use. This is particularly true of Hückel all-valence electron methods which are completely ignored. In places, the level of sophistication of treatment exceeds the needs of the medicinal chemist. There is much written about hydrocarbons but perhaps too little about heteroatom-containing molecules, which, of course, are the tools of the medicinal chemist's trade.

In summary, this book is a useful reference for the organic or medicinal chemist who already has some background in molecular orbital theory.

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Principles of Physical, Organic, and Biological Chemistry. By JOHN R. HOLUM. John Wiley and Sons, Inc., New York, NY 10016, 1969. x +728 pp. 17.2 × 23.5 cm. Price $10.95.

This book consists essentially of two parts. The first deals with basic physical and chemical principles, including the concepts of energy, atomic structure, thermodynamics, chemical bonds, spontaneity, equilibria, and organic chemistry. The second comprises the application of these principles in developing an understanding of and an appreciation for the molecular basis of life.

The material, which contains appropriate illustrations and examples, is well organized and easily understood. Particularly noteworthy is the author's lucid treatment of the rather difficult subject of thermodynamics. His qualitative discussions of such concepts as internal energy, entropy, enthalpy, and spontaneity are commendable. Indeed, the student of physical chemistry would do well to read his account first and then proceed to the advanced texts.

The latter chapters deal with such topics as, "Biochemical Regulation and Defense," "Important Fluids of the Body," "Energy for Living," "Metabolism of Lipids, Carbohydrates and Proteins," and the "Chemistry of Heredity." These chapters apply the fundamental principles presented in earlier chapters to explain the compositions and functions of living matter. The author's approach in explaining life on a molecular basis should prove to be not only informative to the student but stimulating and fascinating as well.

As stated in the Preface, this book "...is intended for use in a two- or three-term terminal college course in chemistry for students in the humanities, the social sciences, and the paramedical sciences, including nursing, home economics, physical therapy, many areas of biology, and many programs in the agricultural sciences." It is well suited for that purpose.

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