TEACHING ORGANIC CHEMISTRY TO PHARMACY STUDENTS.

BY J. R. HARROD.*

INTRODUCTION.

Since the dawn of history, man has been interested in his own physical welfare—health, comfort and appearance. He has consequently discovered and invented remedies, sedatives and cosmetics, first empirically and then scientifically. Pharmacy and chemistry were one; finally, chemistry, because of many other applications, developed into a distinct and separate branch of science, but the close relationship still exists. Serving to reveal physiological functionings, both regular and irregular, and to develop means by which useful medicinal compounds may be prepared from natural sources or synthesized from the elements—organic chemistry is a fundamental factor in the pharmacist's professional education.

THE AIM IN TEACHING THE COURSE.

The primary purpose in offering any course of study to a student is to assist him in gaining a working knowledge of its facts and fundamental principles. It is desirable to organize the material of the course so that the student's time may be reasonably conserved and that he may be enabled to acquire the knowledge without confusion and bewilderment. Organic Chemistry being a highly specialized branch of science, is usually taught, not as a part of general information or cultural education—although this may be done—but as an important component of the technical preparation for life's vocation.

In the university, where students of many different motives are working, the question often arises as to whether they should be segregated according to their respective interests and each group offered a course in organic chemistry peculiarly adapted to its particular viewpoint, or whether all should be offered the same course. It is the opinion of the writer that there are many advantages to be realized from requiring all students, regardless of their ultimate interests to carry on the same basic course, and that these advantages outweigh the disadvantages that may arise from such procedure. In the first place it is thought that any student of science should see it in perspective as a great relationship of various types of compounds; should see it in relation to other branches of science as inorganic chemistry, physics and biology; should see it in its relation to the solution of human problems such as those found in the practice of pharmacy, the practice of medicine and the operations of industry and agriculture. It is believed, moreover, that the student being made acquainted with the application of organic chemistry in these various fields will have created in his mind a keen desire to make use of it in the solutions of the specific problem found in such technical courses as pharmacology, pharmacognosy, urinalysis and physiological chemistry. By this means the student will be directed to observe and offer his own solution to a given problem rather than have these items pointed out and suggested by his instructor.

Furthermore it is believed that the student should be led to see that in whatever vocation or profession he finally orients himself, his part of the world's work will always be definitely related to all other parts, and that unless he takes this fact

*Ohio Northern University, Ada, O.

into consideration he cannot expect maximum success. He cannot afford to assume a snobbish attitude toward any other profession or to become clannish in his habits. It is not presumed here that the course in organic chemistry shall be transformed into a course in sociology or social relations, but the atmosphere of the general course may be made to impart these ideas without in any way impairing its efficiency to teach chemistry.

THE CONTENT OF THE COURSE.

The choice of material for any course of study is an important problem. At least two considerations must be made, (1) material that will give the desired factual information must be chosen, (2) material that will illustrate the right method of attack will be required.

It is conventional to classify organic compounds as hydrocarbons, halogen derivatives, alcohols, aldehydes, ketones, acids, etc., and this classification is usually followed in the teaching process. Because of the great wealth of information presented in the average textbook, a definite study program including a systematic arrangement of facts pertaining to the respective groups, together with methods of synthesis by which compounds of one group may be prepared from appropriate compounds of other groups, is indispensable to the student. This study program will logically include:

1. *Occurrence.* The compounds of the given group may be only laboratory products or may be found in nature, or both.
2. *Preparation.* A study is made of the reactions whereby the compounds may be prepared from the natural sources or by synthetic means.
3. *Properties.* Both physical and chemical properties are classified and then, later, expressed for the most part by means of equations.
4. *Structure.* The relationships of the various types of compounds are established by studying the structures of the molecules and the groupings found therein, and by studying the reaction whereby these structures may be proved.
5. *Isomerism.* The student on his first acquaintance with organic chemistry is puzzled to know how such an enormous number of compounds can arise from so few elements. He soon learns that a given empirical formula may represent a dozen, twenty, a hundred or almost any number of compounds, and that this is true because the atoms may be arranged in great variety within the molecule.
6. *Nomenclature.* When one first reads the literature of organic chemistry, he is surprised by the endless confusion of names. The variety of systems and the lack of system is sometimes bewildering even to the experienced chemist, while for the beginning student it may become a matter of utter discouragement. A careful consideration of this topic is imperative.
7. *Representative Compounds.* It is shown that because of homologous relationship a detailed study of one or two compounds of a group will be sufficient to establish the general properties of that group.
8. *Medicinal Compounds.* In the respective groups at appropriate points a few medicinal compounds are studied, and whenever possible one of these may be used as a type compound, thus lending interest and utility to the course.
9. *Commercial Compounds.* In the same manner commercial compounds that have general application are introduced.

This definite program is applied to each major subdivision of the science in skeleton form until the student has the perspective and then in considerable detail. For the latter he is required to read his textbook. Thus it is found possible to interest and accommodate the various types of students—pharmacy, pre-medical,

engineering, arts majors—and at the same time be so specific that each student will find sufficient reference to his particular field that he may readily make application in his respective technical courses.

METHOD OF PRESENTATION.

College students are generally interested in personal achievement. The facts and principles of chemistry become particularly attractive when associated with the individuals who are responsible for their discovery and development. Dalton, Lavoisier, Berzelius, Dumas, Liebig, Wöhler, Kekule and Faraday were real human men, possessing the emotions, passions, virtues and vices that are found in mankind generally. To know of them, as well as many others, and their work lends incentive to the study of chemistry.

This science took on a new perspective when Liebig and Wöhler discovered that cyanates and fulminates might contain the same elements in the same proportion. When Wöhler found that he could prepare a compound, that he had always supposed was made only by life processes, from a common inorganic compound that in turn could easily be prepared from the elements, a revolution was achieved.

The reasonings and controversies of these great pioneers of chemistry lend interest to isomerism; and the sympathy, humanity, kindness and industry of Pasteur give attraction to optical rotation. Kekule's dream of wriggling molecules fixes indelibly the structure of benzene; and the perseverance of Erlich lends enchantment to organic synthesis, while Fischer's superb work adds dignity and fascination to research.

Too often organic syntheses are just so many chemical reactions that must be committed to memory so as to be able to pass the examination. Malonic ester may mean starting with chloroacetic acid and winding up with the sour, foul-smelling constituent of rancid butter; or, it may mean the preparation of the beneficent compounds of barbital, luminal and amytal. If so, there is no trouble to remember it. The synthesis of acids is not in itself a particularly attractive topic, but when Kolbe's synthesis is applied to salicylic acid, attention is obtained immediately. Sulpho ethers sound like far-fetched and foreign compounds, but when a substituted one in the form of mustard gas is discovered they take on new significance; and the topic of sulphones becomes a surprise of interest when one comes across sulphonal. The diazo reaction also becomes interesting when it is found to be used in the preparation of such common compounds as methyl orange and methyl red. The significance of phthaleins becomes apparent when phenolphthalein, fluoroescein, eosin and mercurochrome are mentioned.

CONCLUSION.

This, in briefest outline, is the plan of the course in organic chemistry offered to a mixed group of students at Ohio Northern University. It is the writer's experience that interest is aroused and maintained, and that the student, who satisfactorily completes the course succeeds well in his chosen field, be it pharmacy, medicine, teaching, industrial work or graduate study. At the same time those who have followed the course for general information are enabled to see how the science contributes to the development of human welfare.