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Perhaps no subject taught in colleges of pharmacy has changed as much in the past decade as has the subject of chemistry, especially organic chemistry. This explains the amount of time, attention and thought that has been given to this subject in the meeting of our teachers' conferences. The importance of it cannot be overemphasized. The papers by Dr. Jenkins and Professor Harrod are worthy of careful study by all teachers of organic pharmaceutical chemistry.—C. B. JORDAN, *Editor*.

TEACHING ORGANIC PHARMACEUTICAL CHEMISTRY.

BY GLENN L. JENKINS.*

NEED FOR MORE EMPHASIS.

The changing trend in Materia Medica has resulted, in many instances, in the partial or complete replacement of many natural drugs by pure chemicals. This tendency toward the more extensive use of pure chemicals, whether they are isolated from natural sources or made synthetically, has placed an ever-increasing responsibility and amount of subject matter upon those who teach chemistry in colleges of pharmacy. The burden falls especially to the lot of those who teach organic chemistry. Sufficient cognizance of the change that has occurred and is occurring has not been made in formulating new curricula. A casual perusal of the latest edition of The Pharmaceutical Syllabus and of The Prescription Ingredient Survey by Gathercoal furnishes evidence of this fact. In the Pharmaceutical Syllabus under the outline of the required course in pharmacognosy is written, "The course should include every crude vegetable or animal drug that the pharmacist is likely to be called upon to sell or dispense. The order of emphasis should be determined by the order of importance and the order of importance should be determined by usefulness and extent of use by pharmacists, physicians and laity." A primary list of drugs to be studied in detail as well as a secondary list of drugs to be studied less thoroughly is appended. The primary list includes such drugs as *Apocynum, Chirata, Matricaria, Pepo* and *Xanthoxylum*. The secondary list includes such drugs as *Absinthium, Adonis, Aletris, Aralia, Berberis, Geranium, Juglans, Mezereum, Rumex, Sassafras Pith, Trifolium, Triticum* and a host of others. The Prescription Ingredient Survey shows that these drugs and their preparations are seldom if ever used in prescriptions.

The only required course of instruction treating of organic chemicals in The Syllabus is the basic course in Organic Chemistry; a course that should be restricted in scope to the teaching of the fundamentals of organic chemistry, theory and practice. It should be obvious that this elementary course is not given sufficient time in the average curriculum to cover both the fundamentals of organic chemistry and the chemistry of the many complex and diverse types of organic chemicals used as medicaments. The irrationality of the situation is augmented when the importance and extent of use of such chemicals as the alkaloids, volatile

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oil derivatives, hypnotics, anesthetics, antiseptics, etc., are considered. The condition that pertains in many schools can be corrected in large measure by the introduction of a required course in organic pharmaceutical chemistry.

SCOPE OF THE COURSE.

The scope of a course in pharmaceutical organic chemistry should include natural as well as synthetic products. Those chemicals described in the United States Pharmacopœia, National Formulary and New and Nonofficial Remedies should be made the chief subject content of the course. It should not be restricted to them since many new remedies not included in these volumes, due to patent rights or other cause, are of equal and sometimes of greater importance. The emphasis given to any phase of instruction must necessarily be determined by the individual teacher. The formulation of any definite course content should be based on and correlated with that of the pre-requisite and other courses. Frequent revision of the subject matter should be made by adding new remedies as they are introduced into therapeutic practice. To do this, the teacher must continually survey the journal literature.

DIDACTIC INSTRUCTION.

The classroom teaching of organic pharmaceutical chemistry need not differ from or require a different method of presentation than that employed in teaching elementary organic chemistry. The difference should be chiefly one of emphasis. Thus, where fundamental theory and the reactions of functional groups in simple compounds are studied in the pre-requisite course, the applied course is limited primarily to a study of the reactions involved in the production, purification and identification of medicinal compounds. The compounds may be classified into characteristic groups according to therapeutic usage or according to chemical structure for the purpose of systematic study. The classification according to therapeutic use, *i. e.*, as anesthetics, hypnotics, antipyretics, antiseptics, etc., is of value if one primarily wishes to bring out chemo-therapeutic relationships. It may be of special value if a thorough course in pharmacology and therapeutics is not included in the curriculum. This method of approach to the subject has the disadvantage that widely varying structures are grouped together. Thus different classes of chemical compounds, such as alcohols, aldehydes, ketones, disulphones, esters, amides and urea derivatives would be considered in a single group under sedatives and hypnotics. Generalizations pertaining to methods of synthesis and isolation, reactions and properties are often impossible when this method is utilized. When a systematic chemical classification is followed in presenting the subject matter, compounds of related structure and, in many cases, of widely variant therapeutic use are grouped together. This system serves to emphasize the many instances of absence of relationship between structure and physiological activity which are much more common and striking than the cases of chemotherapeutic relationships. The chemical classification has the further advantage that compounds of related structure, isolated or synthesized by a general method, and having properties in common are considered at the same time.

It has been my experience that the presentation of the subject matter from the chemical viewpoint is best. Synthetic products can then be discussed along

with natural products to which they are related and derivatives of natural products are placed beside the parent substances. Since students are partially familiar with the chemical system of classification, they are enabled to draw upon and utilize knowledge gained in the elementary course. It makes unnecessary a detailed study of each compound, *e. g.*, the methods of synthesis and the properties of most of the barbiturates can be obtained from a detailed study of barbital.

Since no suitable text is available, the subject must be taken up in lectures or discussional groups or both. An abundance of reference works in English on such subjects as alkaloids, fats and waxes, volatile oils, enzymes, natural and synthetic medicaments, etc., are available, however. These and review articles in the journals can be used for collateral reading. Regular weekly assignments including specific questions that are to be studied and answered by the students have proved of value. Topic assignments which demand collateral reading also can be made advantageously.

LABORATORY INSTRUCTION.

Laboratory instruction is difficult to carry out when dealing with complex compounds. Experiments that require chain synthesis are better suited to the graduate than to the undergraduate laboratory. Simple experiments which are adaptable to performance often do not illustrate new reactions or require different technique from that used in the basic course. A valuable laboratory course of instruction can be built up without elaborate or expensive facilities, however. Thus experiments having for their object the isolation of enzymes, alkaloids, volatile oils, glycosides, etc., and a study of the purity and identity of the products obtained are practicable. The laboratory work on complex synthetic remedies can be limited to qualitative tests for identity and purity. If small amounts of the chemicals and reagents are used, a twofold objective may be attained, namely: economy of materials and perfection of technique. From this type of work the student gains a feeling of intimacy with the materials handled and experiences in some measure the spirit of the thought expressed in an editorial in the *Journal of Chemical Education*. "By all means let us encourage a student to experience his own romance of science—an acquaintance with Dante and Beatrice will do him good but it will be neither so illuminating nor so satisfying as an affair of his own."

CONCLUSION.

Rapid strides forward have been made in pharmaceutical education through the extension of the course of instruction to a minimum of four years. The next forward stride should consist of a further realignment of the content of the courses of instruction. In that realignment, more complete recognition of the changing trend in therapeutics should be made. The increasing importance of natural and synthetic organic chemicals should be acknowledged through the inclusion of required courses in organic pharmaceutical chemistry in the curricula. If the necessary time for the inclusion of this instruction cannot be found, it may be necessary to delete much teaching concerning therapeutically dead substances, the epitaphs of many of which are written in our official standards and dispensatories to make way for the new generation of used products.