and efficiency of amebacides. An endless series of interesting experiments suggest themselves. It is certainly reasonable to suppose that a skilled and experienced investigator can derive vastly more information from a series of tests and observations made upon a comparatively complex organism of which the multitudinous and highly complex reaction behaviors are constantly before the eye, than from a series of tests which reveals nothing more than an indication of either death or no death, as in the older methods for the determination of the phenol coefficient. Undoubtedly the proposed method will in time give us more accurate information regarding the manner in which the different germicides and disinfectants cause death. A few observations made upon Paramecium in the presence of toxic agents under the ultramicroscope would indicate that this method will disclose many interesting facts regarding the behavior of toxic and germicidal substances *via* the realms of colloidal chemistry, in which the beginnings have already been made. It is for example known that bacteria suspended in liquids behave as negatively charged colloids and are, therefore, driven to the anode end of the electric current. Bacteria are precipitated by the ions of the heavy metals and they take up certain of the disinfectants according to the law of adsorption. Disinfectants may kill by virtue of forming chemical compounds within the bacterial cell, or they may kill because of the precipitating effects upon the plasmic proteins, or through the adsorption and subsequent absorption, osmosis and chemical decomposition of the chemically or physically (colloidally) active ions.

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ABSTRACT OF DISCUSSIONS.

The foregoing paper was discussed by Drs. Bernard Fantus, Horatio C. Wood, Jr., and H. C. Hamilton. It was the consensus of opinion that the weak point in the present methods is that they have no practical application. The effectiveness of a given disinfectant varies to a very great degree with the organism upon which it is allowed to act. A disinfectant might be very effective in killing streptococci but almost useless against *Bacillus typhosus* and *vice versa*. One of the objections to the method of testing disinfectants as proposed by the Hygienic Laboratory of the U. S. Public Health Service is the high cost of conducting the test. The need for a more satisfactory and practical test was generally conceded.

SOME OBSERVATIONS RELATIVE TO TRAINING IN DRUG ANALYSIS.*

BY C. O. EWING.

When your chairman suggested the preparation of a paper dealing with the teaching of drug assaying and analysis, it seemed to me that the request would more properly have been addressed to one who had had more collegiate teaching experience. Upon further consideration, however, it occurred to me that it might not be amiss to point out certain phases of the subject that some years of Federal and commercial experience have accentuated.

With regard to preliminary training, drug analysis, even in a semi-routine control laboratory, is an occupation requiring a broad general training. It is

* Read before Section on Education and Legislation, A. Ph. A., City of Washington meeting, 1920.

not at all comparable to certain types of analytical control work in the steel and rubber industries, where a comparatively uneducated person can quickly be taught to run through a standardized procedure day in and day out. In the large pharmaceutical houses the type of work required is much more diverse. The laboratories with which I am at present connected, for instance, assay regularly a thousand or more different crude drugs and chemicals, in addition to a larger number of finished products. With such diversified work it is obvious that a wide knowledge of analytical methods is required, as well as a broader outlook than is generally possessed by one who has not had a complete high school and collegiate training. The same is true of Federal, State, municipal and consulting laboratories where much drug work is done. In the analysis of proprietary preparations, for instance, not only must the analyst be well grounded in general, organic and inorganic chemistry, but he should have as well a knowledge of such widely separated subjects as microscopy, materia medica, physics and bacteriology. The Bureau of Chemistry recognizes the importance of these supplementary subjects and requires of its employees a B.Sc. degree from a recognized college or university or its equivalent, and this in turn generally implies a preliminary general high school training. We have observed too that it is easier to develop a good drug analyst from a well-grounded chemist than from a graduate of a short pharmacy course of two or even of three years. At present, we but rarely consider any applicant who has not a Bachelor degree from a first-class college or university or its equivalent.

In view of the supplementary knowledge required of a drug analyst, it follows that no student is ripe for drug assaying until the third or, preferably, the fourth collegiate year. After all, drug assaying is but the practical application and amplification of the fundamental principles of the other studies mentioned and especially of qualitative and quantitative inorganic and organic chemistry. Therefore, adequate laboratory courses in these subjects are absolutely essential before a course in drug assaying can be attacked with the proper degree of understanding.

In the teaching of drug assaying we cannot follow the general procedure generally pursued in teaching the prerequisite studies previously alluded to. In the latter it would be folly to attempt to force large volumes of facts upon students to the exclusion of adequate considerations of general principles. While a course of drug assaying should be so designed that the students are forced to do correlative studying in standard reference texts, it should provide a maximum of time for actual laboratory practice. The general principles of any particular exercise can be briefly reviewed, leaving the major portion of the session, which should extend over three or four hours, for practical laboratory manipulations. The personal contact of a good laboratory instructor with the individual as the special problems arise is of more lasting benefit than general lectures and subtracts less time from actual laboratory manipulations. The theoretical aspects of the exercises can be cared for by the correlative reading and the quizzing of the laboratory instructor.

With regard to the shortcomings of graduates of courses as constituted at present, the most frequent and most serious criticism is the lack of appreciation of the value of accurate and comprehensive notes. Notes will be taken on a scrap

of paper, the back of an envelope, anywhere but in a note book—I have even seen a young lady take notes on a paper cuff improvised to protect the sleeves of her dress. These notes are apt to be lost or incorrectly transcribed. Moreover, in a case at law transcribed notes would have no legal standing whatever. Original notes only are accepted in court. In writing up a report after the completion of an investigation, it is well enough to transcribe notes and very desirable to have a systematic, orderly presentation of the data obtained, but during the actual investigation too much stress cannot be laid upon the taking down of all original data in a permanent notebook. The student should be taught that it is no disgrace to have his original notebook show a "lost" determination. Too often the knowledge to be gained from a negative result is overlooked. This is especially apt to happen if the original notes were not taken in a permanent notebook, for more often than not the data will never be permanently recorded.

The next most striking observation regarding inexperienced analysts is their almost unanimous neglect of the qualitative possibilities of their nose and mouth. Many a young worker will go accurately and painstakingly through a long chemical analysis, when a smell or taste will show such an analysis to be superfluous. Of course, one should use discretion in the indiscriminate tasting of drugs and pharmaceuticals, but the potentialities of the senses should be further accentuated in a course in drug assaying. These are the tests, together with sight and touch, to which a pharmaceutical, especially, will be subjected by the ultimate consumer; if it fails in respect to these tests, it may comply with the requirements of all the pharmacopoeias extant to no avail.

Another phase of the subject that should be stressed is the value of comparative tests on standard samples. The official descriptions are not always sufficiently explicit or delimiting; it sometimes happens, therefore, that a sample will answer to the stated requirements and still not be a normal product. For this reason, it is very desirable and advantageous to have as complete a museum of U. S. P. and N. F. articles as possible and compel the students to use them. Standard samples are especially useful also for practicing the organoleptic tests mentioned in the preceding paragraph.

With regard to physical tests, such simple operations as melting and boiling point determinations, specific gravity and refractive index are generally well taught and understood by the graduate, but the same is not always true of the use of the polariscope and microscope. Too many workers fail to appreciate and have frequent recourse to these invaluable accessories for drug analysis, a fault which could be partially overcome by more adequate presentation in the drug assay course.

The chemical assays are apparently well presented, the only type requiring special mention being the alkaloidal assays. These, of course, are largely empirical and require careful and painstaking manipulation. In this work more than in any other is long continued practice necessary; it should, therefore, receive more attention than any other part of the course, especially since it involves manipulations not usually dwelt upon in the prerequisite courses.

In my opinion, biological assays should not be included in the laboratory work of a regular drug assaying course. They are so distinct from all other assay processes and require such a knowledge of physiology and anatomy, as well as.

considerable expensive and complicated apparatus and experimental animals, that they could not conceivably be adequately presented as part of a regular course; the subject would, in fact, constitute a very respectable course in itself and, if presented at all, were better done by a medical school. This practice is followed at present in some universities which have colleges both of medicine and pharmacy.

In the foregoing no mention has been made of the number of exercises that should be assigned a class. Suffice it to emphasize again the value of repeated practice of laboratory manipulations. This end can only be attained by assigning a considerable number of exercises. An excellent incidental feature of such a procedure is the opportunity which it presents to teach the art of laboratory management, a valuable attribute infrequently possessed by students.

In conclusion, it is not desired to leave the impression that the theoretical aspect of the work should be slighted; on the contrary, the student should be encouraged in every way to resort to the standard textbooks and journals. It is desired, however, to emphasize that a course of drug assaying should be primarily an intensive laboratory application of fundamental principles acquired during prerequisite courses and that such a course should be designed to provide a maximum of actual laboratory practice in the time available.

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HOW TO OVERCOME INDIFFERENCE CONCERNING STERILIZATION IN DISPENSING.*

BY A. W. LINTON.

It may seem like carrying coals to Newcastle to offer a paper dealing with sterilization in dispensing to the American Pharmaceutical Association. We may safely assume that the members of this body are well informed on the subject. With them it requires no argument to prove that all solutions intended for hypodermic and intravenous injection, solutions for application to the eyes and to inflamed and irritated membranes, as well as many dusting powders and ointments, should be dispensed in a sterile condition.

That the importance of sterilization in pharmacy has been well understood for years is evidenced by the splendid discussion of that subject in the fourth edition of the National Formulary, as well as by the briefer treatment in the Ninth Revision of the Pharmacopoeia. Recent editions of many textbooks on pharmacy and dispensing include chapters on sterilization as applied to pharmacy. During recent years numerous valuable articles on sterilization have appeared in the journals. There have appeared texts on bacteriology intended especially for the use of the pharmacy student, and these give excellent treatment of sterilization. It must be agreed then, that ample opportunity has been offered to those who would inform themselves as to the best methods to be followed in sterilizing medicinal preparations. It is true that even after a careful study of the authori-

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