THE TEACHING OF PHARMACOGNOSY.

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Pharmacognosy is perhaps the least standardized course in the present American Pharmaceutical curriculum. The subject matter presented is fairly uniform in that the important U. S. P. and N. F. drugs are studied as to their identity and properties. Teaching methods, however, vary widely. Let us hope it always remains so. Teaching methods are a mark of individuality and individuality is a far greater factor in education than standardization. Kremers,[1] in discussing how the teacher of pharmacognosy should teach his subject points out—"it largely depends upon the scientific preparation and inclination of the teacher. The pharmacognosist whose preparation has been largely botanical will naturally make the most of his botany. If his preparation has been largely chemical he will make the most of his chemistry." It is not, however, the purpose of this paper to discuss factors affecting teaching methods.

Several recent numbers of the JOURNAL have carried articles relative to the teaching of pharmacognosy. These together with the Round Table on teaching methods of the annual Plant Science Seminars prove the subject to be of interest. At this Round Table many experiences are exchanged and the meetings become of vital value to those attending in the acquisition of new ideas and especially in seeing "how the other fellow does it." Such a motive prompted the writing of this paper.

With the advent of the three-year curriculum at the University of Illinois came the acquisition of a new building and the remodelling of old ones. This was accompanied by a subsequent remodelling of courses and Organic Materia Medica and Pharmacognosy were placed in the second year. First-year courses in this department are designed to be more or less preparative for, and are considered as prerequisites of the second- and third-year courses. These prerequisites are as follows:

A 4- (credit) hour course in General Botany dealing chiefly with the flowering plants and consisting of 3-lecture or recitation (clock) hours and one laboratory period of 3 (clock) hours, covering one semester.

A 3- (credit) hour course in plant histology covering microscopical and microchemical technique, a study of the plant cell, tissues and the structure of organs. This course comprises two 3- (clock) hour laboratory periods and one recitation hour per week and continues over one semester.

A one semester, 3- (credit) hour course in Physiology and Hygiene consisting of three-lecture or recitation hours weekly.

MATERIA MEDICA.

The second-year course in Materia Medica continues over both semesters and comprises two lectures and one recitation weekly. Dean Day, in his lecture work covers all of the U. S. P. and N. F. (and several unofficial) drugs of vegetable and animal origin as well as their official derivatives, considering them in regular

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[1] JOUR. A. PH. A., 16 (1927), 72.

taxonomical order. These lectures are illustrated with specimens, charts, maps and lantern slides and the drugs are discussed as to titles, synonyms, botanical source, cultivation, collection, preparation and commerce, standardization, therapeutic properties and uses, dose and preparations. The Dean also includes many informal reminiscences concerning the history and use of the various drugs. Entirely separate from this course yet running hand in hand with it, is the course in pharmacognosy.

PHARMACOGNOSY.

Pharmacognosy is a division of Materia Medica. At Illinois we consider it to be the laboratory work accompanying the lecture work in Materia Medica, and as such confine ourselves to the following definition: "Pharmacognosy is the study of the identification, the quality and the purity of crude vegetable (and animal) drugs." This definition gives us a concrete basis to work upon. We are to study the drugs with a two-fold purpose, *first*, how they may be identified, and *second*, after being identified how one may determine if they are pure and of good quality. With these as principles upon which to base our studies we outline our course. The first laboratory periods are devoted largely to orientation, an explanation of how to study drugs, and a brief review of the bearing of the prerequisites upon the work. While this is all included in the author's manual it is nevertheless gone over carefully and illustrated with specimens. This preliminary outline creates a "point of view" for the student.

In discussing the first part of the definition, *viz.*, identification, the fundamental methods for drug recognition are taken up. The subject is first divided into two parts, macroscopical and microscopical. The recognition of whole or entire drugs can only be of value if associated with their description, and the closer the descriptive features of the drug are studied the more definite mental picture will remain. For convenience these descriptive features are divided into four groups, (1) size and shape, (2) color and external markings, (3) fracture and internal color and (4) odor and taste, and the preliminary work occupies itself in discussing the various shapes in which drugs occur as well as the various markings such as fissures, scars, lenticels, lichens, etc., found upon them. For example, underground parts such as rhizomes, roots, bulbs, corms, tubers, etc., may occur (1) entire, (2), in longitudinal slices, (3) in oblique or transverse slices or (4) in small cubical pieces. In shape they may be cylindrical, cylandraceous, conical, fusiform, ovoid, pyriform, terete, disk-shaped, etc. They may be branched and are frequently curved and twisted. Among the external markings commonly found are furrows, wrinkles, annulations, fissures, nodules, abrasions, leaf scars, leaf bases, stem bases or the scars of stem bases, roots, root scars, buds, bud scars, bud scale scars and so on. Every effort is made that the student may see these points and learn to use the proper terms in describing them. Types of fractures and fractured surfaces are discussed as also are color, odor and taste, in relation to both their organoleptic conception and their value in crude drug identification. Microscopical identification of a whole drug involves the study of cross and longitudinal sections and here the importance of the histological prerequisite is dwelt upon. It is essential that the student be able to recognize regions, tissues and cell contents, not only in the study of sections but also in the study of powdered drugs. Along with identification several types

of identity tests are considered, such as those depending upon anthraquinone derivatives, tannin, etc.

In connection with the second part of the definition, quality and purity, the factors influencing them are gone over. The quality of a drug is dependent upon its active constituents and as these have been studied previously in the course in Histology under cell contents, this connection is pointed out. Methods for the determination of active constituents, that is, the quality of the drug, are considered. The purity of a drug is dependent upon the presence or absence of foreign organic and inorganic matter and these items are considered together with methods for their determination and detection. Finally the U. S. P. and N. F. are discussed

Fig. 1.—Pharmacognosy laboratory, University of Illinois School of Pharmacy. The laboratory accommodates 72 students working at one time; each student having approximately six square feet of working space. Desks are equipped with gas, water, electricity and sink, locked drawers being provided for the keeping of apparatus. The case to the right of the door contains the microscopes and the collection to the right of that includes drugs official in foreign pharmacopœias. The collection on the left wall is described under Fig. 2.

as standards for the three divisions of the definition; identification, quality and purity. After this preliminary discussion the student has a fair idea how to go about the work in general.

THE LABORATORY.

The pharmacognosy laboratory (Figs. 1 and 2), is about 34 x 42 feet, and is equipped with three work tables each consisting of six sections. One section accommodates four students and is equipped with water, gas, electricity, reagent shelf and reagent block, sink, tripod, test-tube rack, microburner, etc. At each disk are five kit drawers. Thus the laboratory accommodates 360 students, seventy-

two at one time. Each student has about six square feet of working space. Seventy-two compound microscopes, equipped with ocular and objectives to give 100 × and 600 × magnification are part of the general equipment. These are augmented by six micropolariscopes and six binoculars. A stereoptician is also part of the equipment. The lights for microscope illumination are so placed beneath the reagent shelf as not to cast their rays upon the screen, thus microphotographs thrown upon the screen may be shown at the same time that sections are studied microscopically. One side of the laboratory is lighted by windows; one end contains blackboards and maps and the other two sides collections of crude drugs. These collections are particularly interesting. The one situated on the longer wall contains a specimen of every drug of vegetable and animal origin ever

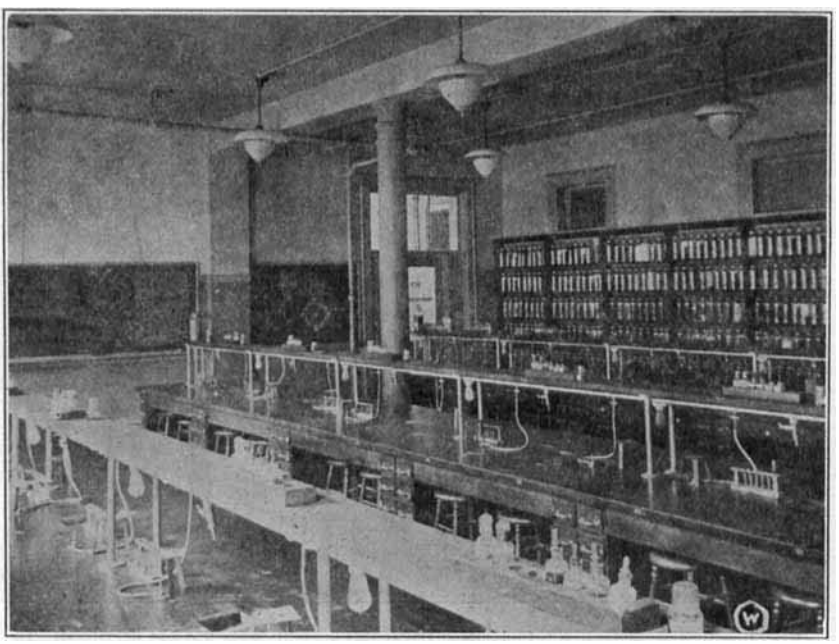


Fig. 2.—Another view of the Pharmacognosy Laboratory. University of Illinois School of Pharmacy, showing the blackboards and lantern screen. The collection on the right wall, (also partially seen in Fig. 1) includes samples of every drug of vegetable and animal origin ever official in the ten editions of the United States Pharmacopœia or in the five of the National Formulary.

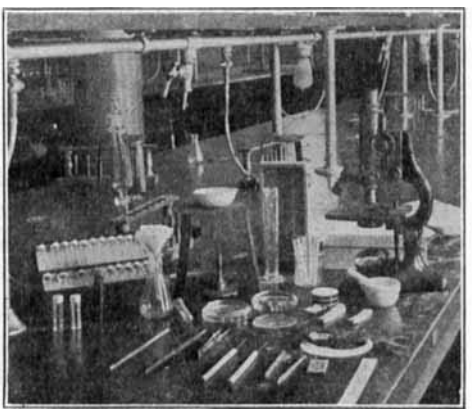
official in the United States Pharmacopœia or the National Formulary. The other collection includes drugs official in prominent foreign pharmacopœias but never official in the U. S. P. or N. F.

Coming into the laboratory at the beginning of the course the student is assigned to his place, the microscope he is to use, and his kit. This latter (Fig. 3), consists of the usual microscopical kit consisting of slide boxes, slides, cover glasses, forceps, needles, labels, hand lens, ink, crowquill pen, etc., together with beakers, flasks, evaporating dish, funnel, mortar and pestle, separatory funnel, test-tubes, graduated cylinder, watch glasses, filters, litmus paper, etc., to be used in running the various tests. He also receives at this time a box containing four telescoping

trays each in turn holding twelve screw-cap homo-vials (Figs. 3 and 4) to be used for his collection of pure powders. He further supplies himself with a padlock for his kit drawer, the laboratory manual and a loose leaf note-book containing ruled and unruled sheets about 8 x 10 inches in size.

METHODS OF STUDY.

At approximately the same time as a drug is considered in Materia Medica it is also taken up in pharmacognosy. Each student receives an ample supply of drug both for study and for his own collection. In connection with the latter he receives a 5 x 7 manila envelope with clasp fastener which he uses as a container for the portion of drug he keeps for his own collection, placing whatever information he may desire upon the outside of the envelope. (Fig. 4.) If the powder is studied he also receives a sample of it which he keeps in one of the vials of his powder box for future use as checks in powdered drug examinations. The instructor in charge opens the laboratory period with a brief discussion (usually illustrated with lantern slides) of the drugs to be studied during that period and the student then commences work. He writes a description of the drug, makes drawings of the entire drug, its cross-section and its powder, describes them in his notes, and performs the official identity and purity tests as well as others outlined in the manual. In order that his notes be not too long and that a fair degree of uniformity is maintained he uses the following outline for the notes:



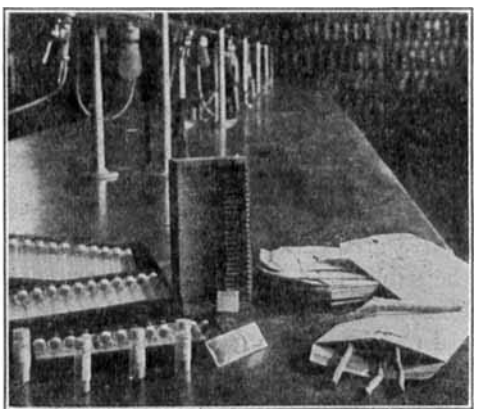


Fig. 3.—Apparatus used in Pharmacognosy. Each student receives a kit containing in addition to the usual microscopic apparatus (shown in the foreground), sufficient apparatus to run the official identity and purity tests as well as other tests on constituents.

Fig. 4.—The items pictured above form the students personal collection, which, when completed at the end of the course, he takes with him. The telescopic box with four trays, at the left is used for powdered drugs. The slide box contains 30 mounted and stained specimens of cross- and longitudinal sections. The manila envelopes shown at right are 5 x 7 inches in size and are used as containers for whole drugs, of which the student has about 140 in his collection.

OFFICIAL LATIN TITLE.

1. English title. Synonyms.
2. Definition. 3. Shape. Size.
4. External markings. Color.
5. Fracture. Internal color.
6. Odor. Taste. 7. Structure.
8. Constituents. Quality standards.
9. Tests for identity and purity. Common adulterants. 10. Dose. (Metric.)

Points 1 and 2 he copies from the Pharmacopœia or National Formulary. No's. 3, 4, 5, 6 and 7 are records of his own observations. In connection with structure (Point 7) he cuts his own sections or if this is impractical previously cut sections are distributed. His structure description includes descriptions of (1) the regions present with reference to their comparative size, (2) the tissues with regard to their arrangement in the regions, (3) the cells which compose the tissues and (4) the cell contents. Diagrams are usually made of the cross-section as also are tissue drawings from certain parts. If the powder is studied careful drawings of its elements are made and sizes recorded. The student is not required to memorize a structure description but he should be able to write such a description from a section before him. There is some item characteristic about every structure and that item is stressed. Furthermore, a knowledge of the structure as seen in sections is essential to an understanding of the elements seen in the powdered drug.

Constituents have been discussed by the instructor in his preliminary talk. Where identity tests depending upon constituents are available the student performs them. Among the common pharmacopœial tests of this nature are, the sclererythrin test for ergot, the Borntrager test and its modifications for anthraquinone drugs, the H_2SO_4 test for cubeb, the lead acetate test for acacia, the NaOH under althea, the $Ca(OH)_2$ and the $FeCl_3$ test under granatum, the Scoville organoleptic test for capsicum, etc. Various tests may be run upon alkaloids extracted from the drug by immiscible solvents. Drugs having sublimable constituents, as uva ursi, rhubarb, etc., may be microsublimed and subsequent tests run upon the sublimates. Where assays are given involving chemical reactions such as in black mustard the student writes the equations for these in his note-book. Standard requirements are of course, recorded.

Common adulterants of drugs are studied both microscopically and chemically. Among those studied microscopically are Bermuda grass in connection with triticum, starches with lycopodium and other drugs, calendula and carthamus with crocus, curcuma with mustards, curcuma and capsicum with ginger, pepper shells with pepper, close stems and fruits with clove, other cinnamons with the official cinnamon, mullein with digitalis, Japanese chillies with capsicum, phytolacca with belladonna root, etc. Among those involving tests the following serve as examples, gelatin in agar, ghatti gum and Mesquite gum in acacia, rosin in guaiac, gum Karaya in tragacanth, bdellium in myrrh, etc.

Some time ago the author called attention to the importance of the study of the constituents of drugs as a part of the laboratory curriculum in pharmacognosy,[1] and here again wishes to stress this most important phase of the work. The host of identity and purity tests, while simple to perform, leave a decided impression with the student, stimulating his interest not only in the constituents themselves and their reactions, but also in the activity of the drug. Furthermore, constituents will play by far the most important rôle in the pharmacognosy of the next generation.

The dose is included in the notes not because of any relation to our definition of pharmacognosy but rather because the memorizing of doses being a common stumbling block in Materia Medica, their repetition in pharmacognosy often serves to further stimulate an association between the drug and its posology.

[1] Jour. A. Ph. A., 12 (1923), 196.

After performing and recording his tests and completing his notes and drawings the student places them in a folder which is turned in to the instructor. Drawings are first made lightly with pencil and then finished in India ink, students with an artistic bent often coloring them with crayon or water color, this latter, however, not being required. Each drawing bears a descriptive legend and the scale to which it is drawn. Drawings and notes must be completed during, and turned in at the close of the laboratory period. During such a 3-hour period one or two important drugs and one or two of lesser importance, involving only notes but no drawings, are studied.

Ratings in the course are based upon four counts: (1) Written recitations are given weekly and cover the drugs taken up during the previous week. These consist usually of ten questions bearing upon the identification, quality and purity of the drugs. (2) Drawings and notes, while turned in at each period, are rated collectively at about three-week intervals after which they are returned to the student who places them in proper order in his note-book. The complete note book is again checked at the end of the course. (3) Powdered drug unknowns are given about five times during each semester and include the powders previously studied of which the student has samples in his collection. These unknowns may consist of pure powders, adulterated powders or of mixtures, the student identifying the adulterants as well as the drugs. (4) Crude drug identification examinations are given about four times during each semester and include all whole drugs previously studied. About thirty drugs are given at one time, the student receiving a sheet ruled in three columns and numbered in the left margin. The drugs are placed in deep numbered boxes located about ten feet apart. Thirty students enter the room each taking his place at a box. A gong is sounded at 30-second intervals at each tap of which the student moves to the next box. During the 30-second interval he must identify the drug and write its official title, botanical source and dose. Such examinations are alternated with the type in which the student receives several drugs in one container which he separates and identifies.

The last two weeks of the second semester are spent in review and in practical examinations. During this time the student prepares three classifications of the drugs he has studied: (1) a taxonomical one, (2) a morphological one and (3) one based upon the chemical classification of active constituents. Tests are also given in writing descriptions of whole drugs, sections and powders from samples. An interesting exercise we have carried out during the past four years consists of giving the student five unknown powders, at least three of which he has not previously studied. He traces these down by a process of elimination in one of the various keys: Schneider's "Microanalysis of Powdered Drugs" or the author's Key for the "Identification of Powdered Drugs."[1] After tracing his powder he may obtain samples of pure powders for checking, no more than two such being allowed for any one unknown. Some 300 powders are used in this exercise and the mean class average for it over four years has been 94.3 per cent. Sometime during the course, usually at the beginning of the second semester the student prepares a set of 30 single- and double-stained cross-sections. While this has no value other than the technique involved it creates considerable interest and many students employ particular care in preparing a perfect set of mounts.

[1] This key is published in the last edition of "Kraemer's Pharmacognosy" (1928).

The number of drugs and their selection is often a problem in outlining a course in pharmacognosy. To include all of the drugs in the U. S. P. and N. F. would, of course, be impossible except if one had unlimited time or sped over them rapidly. It seems far better to limit the number and study them well. In selecting the drugs for the above course we first selected those classified as "*a*" and "*b*" drugs in Charters' "Basic Material for a Pharmaceutical Curriculum." This list, probably familiar to the reader, includes the drugs most frequently found in retail pharmacies. We then eliminated from this list such drugs as were too bulky or for some other reason were unsuitable to give to the student for his permanent collection, thus limiting ourselves to about 140 drugs. The total laboratory time of 200 hours is none too long for the study of these, only half of them being studied in sufficient detail to involve drawings. It is interesting, however, to note that practically all of the U. S. P. drugs are included in the list. Samples of powdered drugs given to the student for his permanent collection are limited to 48, these being selected according to their importance, a decided effort also being made to give samples representative of each group in the classification key.

The reader may ask, "Does the student ever see official drugs not taken up in the pharmacognosy course?" Ample opportunity for this is given. Museum specimens are always available and as a special inducement prominent window displays of all of the U. S. P. and N. F. and of several unofficial drugs together with their constituents are situated in the corridors. These displays are changed weekly accompanying the progress of the course in Materia Medica.

CONCLUSION.

What then does the student get out of pharmacognosy? First, he has learned to recognize the important vegetable and animal drugs both in their entire and powdered state. This he has learned to do by a logical and scientific study of their characteristics. Second, he is able to tell if the drug at hand is pure and of good quality, and third, and perhaps this is his greatest asset, he can read his pharmacopœia intelligently. He has studied the pharmacognosy of the drugs simultaneously with their materia medica and associates with the drugs all of that knowledge which Charters considers to be essential. Among the material things the student takes with him out of the course are, (1) a collection of some 140 crude drugs, and 48 pure powders, (2) a collection of 30 stained permanent mounts and (3) a note-book, in which many students highly pride themselves.

While the general revision of the course in pharmacognosy including the introduction of tests, the designing of laboratory furniture and equipment has been the work of the author, due credit must be given to his chief, Prof. E. N. Gathercoal, whose many helpful suggestions and constant kindly advice, encouragement and support have made many of the details a reality.

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