EXPERIMENTAL PHARMACODYNAMICS FOR STUDENTS OF PHARMACY.*

BY A. RICHARD BLISS, JR.

Following the reading of the writer's paper entitled "Pharmacodynamics in Schools and Colleges of Pharmacy"[1] before the Section on Education and Legislation of the American Pharmaceutical Association at the New York meeting last August, there were addressed to him between fifteen and twenty letters of inquiry by various schools and colleges of pharmacy concerning the following:

1. The number of hours deemed necessary for a *General Course* in Pharmacodynamics, including didactic and laboratory work, in the School of Pharmacy.
2. An outline for a course in Experimental Pharmacodynamics for the pharmacy student to show the scope of the laboratory work.
3. The materials required for giving a laboratory course in this subject and the approximate cost of the same.

It is the endeavor of the writer to cover the foregoing topics in this paper, and it is his hope that the material submitted may prove of some use to the schools of pharmacy and that it may lead to some discussions, suggestions and criticisms that will foster the rapid development of proper instruction in this important branch of pharmaceutical education.

The fact that 51 percent of the pharmacy schools are already claiming to be giving instruction in pharmacodynamics, that 52 percent of the schools that are not at present giving such instruction have signified that they consider it a desirable addition to their courses,[2] and the fact that the United States Pharmacopoeia recognizes several pharmacodynamic methods of standardization all serve to indicate the growing importance of this comparatively new subject of the medical and pharmaceutical curricula. Although 51 percent of the schools have indicated in their replies to the questionnaire[2] sent them last summer that instruction in this subject is being given, analyses of the replies and a study of the catalogue material of these schools have shown that a rather high percentage (about 62 percent) of these schools are not giving instruction that could be properly termed instruction in pharmacodynamics along with a laboratory course. One is hardly justified in calling instruction in Materia Medica that includes under each drug a statement or two concerning the uses a course in pharmacodynamics. Neither is one justified in calling the macroscopic and microscopic examination of drugs Experimental Pharmacodynamics. These things are, of course, important and have their proper place in the courses of study, but they cannot be substituted for the subject under discussion. It is undoubtedly true that there are some schools of pharmacy that are giving excellent courses in pharmacodynamics including the proper kind of laboratory work, but, unfortunately, no data concerning such instruction are available at this time. It is further true that there are three or four schools that require the pharmacy student to take the same courses in pharmacology that the medical student in these institutions must take,

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[1] JOUR. A. PH. A., 9, 378, 1920.

[2] *Ibid.*, 9, 382, 383, 1920.

and that the instruction is given to the medical and pharmacy student in one section. The writer seriously doubts the wisdom of this method. It seems hardly necessary to point out that the previous training of the pharmacy student in anatomy, physiology, etc., does not fully qualify him for such extensive courses given in the medical school; and, what is possibly more important, that such extensive courses are unnecessary and possibly undesirable for the pharmacy student even though he were fully qualified to pursue and profit by the instruction.

A large proportion of the schools reporting actual instruction in pharmacodynamics including laboratory work are limiting the laboratory work to the pharmacodynamic assays of the United States Pharmacopoeia.[1] This instruction should, of course, form an important part of the work and occupy a fairly high percentage of the total laboratory hours given to the subject; but if the laboratory course is limited to such work it is quite incomplete, not satisfactory, the work itself is likely to be carried out in a rather mechanical fashion, and does not serve the full purposes of Experimental Pharmacodynamics in the pharmaceutical courses. On the other hand $61\frac{1}{2}$ percent of the schools giving courses in pharmacodynamics are offering no laboratory work whatsoever.

The majority of the schools have apparently decided that the subject is essential enough and important enough to warrant its addition to the pharmaceutical curricula (this has been done by 51 percent of the schools),[1] that didactic instruction alone will not suffice, and that an elemental course in Experimental Pharmacodynamics, suitable for and useful to the pharmacist, should be given. Dr. Francis E. Stewart, in his excellent paper entitled "Shall We Reorganize the American Pharmaceutical Association?"[2] says: "Pharmacy is inherently and historically a branch of medical science and practice and, therefore, can never become a profession independently of the medical profession. * * * —it does require a pharmaceutical education of a high order to qualify a pharmacist for the vocation of selecting, preparing, compounding, and dispensing of medicine to meet the demand of *rational drug therapeutics* as practiced by educated and competent physicians. * * * That pharmacy and *drug therapy* (medicine) shall be conducted as closely related and mutually dependent branches of medical science and practice; that the practitioners of these important vocations shall work in coöperation with a common object, namely, to prevent disease and heal the sick, each profession working in its special field of practice." It is the opinion of the writer that the pharmacist will be unable to coöperate to the fullest extent in this important work of preventing disease and healing the sick, will be unable to perform his part of such scientific endeavor in an entirely satisfactory and efficient manner unless he has, as Sollman expresses it,"[3] an intelligent understanding of the broad principles that guide treatment, of the objects which are to be accomplished, and of the means that are utilized." It should be the object of any course in General Pharmacodynamics in a school of pharmacy to give the "pharmacy student that information that will prove useful to the pharmacist without burdening him with unnecessary and possibly dangerous material."[3]

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[1] JOUR. A. PH. A., 9, 381, 382, 1920.

[2] *Ibid.*, 9, 263, 1920.

[3] Sollman, "The Action of Drugs," p. 18.

The writer ventures to state that there is no other subject in the medical and the pharmaceutical curricula that will tend more to bring the physician and the pharmacist closer together, that will foster that relationship and coöperation between the medical and pharmaceutical professions that all of us are looking forward to as ideal, that will assist in securing that recognition of pharmacy as a profession by the medical brotherhood, than proper instruction in pharmacodynamics in the schools of pharmacy; for it is the real basis of relationship between the two professions. The topic of most discussions between physician and pharmacist is—useful drugs. The physician is interested, more or less, in all the phases of pharmacology as usually taken up in the pharmacy school, but he is most interested in the pharmacodynamics, and it is at this point that the discussions usually abruptly stop because of the fact that the large percentage of pharmacists know little if anything about this branch of pharmacology. Thus a gap, a chasm of separation springs up between the two and abruptly cuts short a discussion that has probably proved useful and valuable to both parties up to this point, but it remains incomplete, broken at this most interesting and important phase of the conversation. Let the pharmacy school foster and develop proper instruction in this branch of pharmacology and considerable additional headway toward that ideal relationship between medicine and pharmacy referred to above will be surely made in a very short period of time.

The three topics, discussed in the communications mentioned in the first paragraph of this article, will be taken up in the order there given.

1. THE NUMBER OF HOURS NECESSARY FOR A GENERAL COURSE IN PHARMACODYNAMICS.

The average number of hours being given to the subject of pharmacodynamics by the schools and colleges of pharmacy, as shown by the replies to the questionnaire last summer,[1] is 60, including both didactic and laboratory instruction. This number, in the writer's opinion, is sufficient. There seems to be but little uniformity, however, in the proportion of didactic to laboratory work. It is highly desirable to devote from one-half to two-thirds (30 to 40 hours) of these hours to laboratory work; that is, Experimental Pharmacodynamics. If the instruction in Materia Medica follows the method of taking up the drugs in groups classified according to similarity of action, much of the didactic instruction in pharmacodynamics can be taken up in that course, thereby leaving more time for the experimental work. It is the writer's conclusion, based upon twelve years of experience in teaching pharmacology in the medical, the dental, and the pharmaceutical school, that the most efficient and satisfactory method of instruction in Materia Medica and pharmacodynamics is the plan of taking up the drugs in pharmocodynamical groups, considering first the usual topics included in the study of Materia Medica under each individual member of the groups, following this briefly with the pharmacodynamics of the most important member of each group, going from this phase of the study into the toxicology, and completing the material with the most important uses and methods of administration. The medical school devotes from about 200 to 300 hours to instruction in pharmacology, from 90 to about 150

[1] JOUR. A. PH. A., 9, 381, 1920.

hours of which are devoted to laboratory work. Such an extensive course is unnecessary and undesirable for the student of pharmacy. If a total of 200 hours, including about 90 hours of laboratory work, is sufficient for the medical student, surely a total of 60 hours, including from 30 to 40 hours of laboratory work, is sufficient for the student of pharmacy. In the outline of laboratory work that appears below it will be seen that the course suggested fits into the above number of hours very nicely.

2. AN OUTLINE FOR A COURSE IN EXPERIMENTAL PHARMACODYNAMICS FOR STUDENTS OF PHARMACY.

The elementary laboratory course outlined on the next page is necessarily somewhat unevenly balanced. The writer has tried to keep in mind the limitations likely to be found in the average school of pharmacy, particularly in the cases of those schools that are not connected with a university having a medical school and in the cases of schools in which the subject is of very recent introduction. The course is better adapted for the development of some pharmacodynamic facts than of others, and, as a result, it is possible that the student will be led to place undue stress upon the former. However, this possible drawback can be readily overcome by a didactic course properly balanced for the pharmacy student. In order to keep the experiments within the scope of the experimental knowledge of the average student of pharmacy, they have been made as elementary as possible. Time is, of course, an important consideration in an abbreviated course of this kind; therefore, demonstrations may be resorted to advantageously if they are arranged in such a manner that as many students as possible actually assist in the experiment and that every student may see the work. A considerable portion of the work outlined below can be carried out, if necessary, in this fashion. Additional time may be saved by having sections of the class perform analogous experiments but using different drugs, and having the results of each section reported and demonstrated to the entire class. The experiments compiled below have been chosen because they demonstrate certain fundamental pharmacodynamic facts and methods in the simplest manner. The purposes of the instruction in pharmacodynamics in the school of pharmacy should be impressed upon the student. He should be indelibly impressed with the fact that he is not being prepared to treat disease; that his training and knowledge do not qualify him for such work, that he is receiving an elementary course in the subject which is considered sufficiently complete and thorough for the pharmacy student but not for the medical student; that the information that he can derive from the laboratory work forms the proper basis of the didactic instruction, will materially assist him in understanding those facts that are deduced from the experiments, will illustrate their value, and will impress them upon his memory; that the primary object of the course is to enable him to better coöperate with the physician because of the fact that through this laboratory work and didactic work in pharmacodynamics he will have an intelligent understanding of "the broad principles that guide treatment, the objects which are to be accomplished, and the means that are utilized *by the physician.*"

The student's notebook is a most essential and important part of the laboratory course. He should have a definite conception of the purpose of each experi-

ment before he carries it out; he should carefully make detailed notes during the progress of the experiment; and finally draw brief and concise conclusions. There is nothing that develops the powers of observation like the careful taking of detailed notes during the progress of experiments. In addition the critical faculty of the student is stimulated by condensing the detailed account of the results of experiments into concise conclusions.

A feature of the laboratory work that may well be stressed, in addition to the pharmacodynamic assays, is that part concerned with toxicology, for it is doubtless true that a larger number of cases of poisoning are given first aid by the pharmacist than by the physician. Instruction in experimental pharmacodynamics will certainly enable the pharmacist to more intelligently and efficiently institute preliminary treatment in such emergency cases. In the laboratory work dealing with toxic drugs, when the animal is to be sacrificed, the action of the drug should be pushed to the toxic stage in order to give the student the opportunity to see, to study, and to learn to recognize the toxic action of the more important poisonous drugs. Advantage should also be taken of opportunities to illustrate the treatment of poisoning.

The course outlined consists of sufficient work for thirty laboratory periods of one hour each or fifteen periods of two hours each. It is believed that the material will be found suitable, interesting and valuable to the pharmacy student. Although the work includes experiments on animals, the technique is simple, the intact animal being employed in the majority of instances. A fair proportion of the experiments are carried out on the student himself, for the worker will find the experiments most instructive, in certain types of laboratory work, if he performs as many as possible on himself. In arranging the course the writer has drawn freely on the works of Sollman, Greene, Edmunds and Cushny, Jackson, McGugin, Bush, Pittenger, Pembrey and Phillips and others, all of which were prepared for the medical student or advanced workers in the field of Pharmacodynamic Assays.

Period 1. Absorption and Excretion of Drugs.—A short series of simple experiments on rabbits, dogs and guinea pigs to illustrate: (*a*) Systemic Action; (*b*) Methods of Administration; (*c*) Sites of Absorption; (*d*) Rapidity of Absorption; (*e*) Effects of Colloids on Absorption; using the drugs Strychnine, Nicotine, Ether and Chloroform; (*f*) the Decomposition of Drugs in the Organism, using Potassium Iodide and Calomel to illustrate that chemical reactions may take place between two or more drugs within the body, and using Potassium Iodide and saliva to show that chemical reactions may take place between the drugs administered and normal body constituents; (*g*) Sites of Excretion; (*h*) Rapidity of Excretion; (*i*) the Excretion of Volatile Drugs by the Lungs; (*j*) the Form in Which the Drug Is Excreted (changed or unchanged); using Acetphenetidin, Phenyl Salicylate, Rhubarb, Quinine, Copaiba, Methylene Blue, Iodides, Antipyrine, Methyl Salicylate, Sodium Acetate, Sodium Citrate and Hydrogen Sulphide.

Period 2. Protectives: Demulcents and Emollients.—A few simple experiments to illustrate that these substances (1) lessen the effects of irritant drugs, using decapitated frogs and diluted solutions of Hydrochloric Acid in water, in a demulcent, and in an emollient to show the effect on the "Reaction Time;" (2) that they lessen the intensity of characteristic tastes, using solutions of Citric Acid in water and in Starch Paste; and (3) that they may interfere with the absorption of drugs (see Period 1).

Period 3. Counterirritants.—Experiments to illustrate the phenomenon of "*Inflammation,*" the four successive stages—rubefaction, vesication, pustulation and corrosion—and the treatment of irritation. The action on the *Skin* may be readily shown by having the student apply to his forearm (*a*) Chloroform by rubbing, (*b*) Cerate of Cantharides, (*c*) 10% Ointment of Anti-

mony and Potassium Tartrate; on the *Mucous Membrane* by having him (*d*) snuff a little powdered Soap Bark or well diluted Veratrine, (*e*) taste 10 times diluted Tincture of Aconite, Alum, Tincture of Ferric Chloride, (*f*) place a drop of Tincture of Iodine on the inner surface of the lip; and lastly the *Treatment of Irritation* may be illustrated by having him immerse the fingers of one hand in 5% solutions of Phenol in Water, Alcohol, Glycerin, Turpentine and Cottonseed Oil.

Period 4. Caustics (Astringents, and Styptics).—A—The Action on Proteids and Blood: Test-tube experiments using Egg Albumin and defibrinated Blood, to separate portions of which are added solutions of Hydrochloric, Sulphuric and Nitric Acids, Potassium and Sodium Hydroxide, Mercuric Chloride, Copper Sulphate, Lead Acetate, Ferric Chloride, Silver Nitrate, Alcohol, Phenol and Tannic Acid. Results are noted and conclusions drawn as to which might be used as Astringents and Styptics. *B—The Action on Skin, Mucous Membranes and Muscle:* Test-tube experiments in which pieces of fresh dog's skin, intestine and muscle are treated with the same reagents. *C—Stains on Human Skin:* Drops of concentrated Nitric Acid, Hydrochloric Acid, Sulphuric Acid, Picric Acid, Tincture of Iodine, Silver Nitrate Solution, Phenol and Methylene Blue are applied to the student's forearm and the characteristic color, intensity of action, etc., etc., noted. Advantage is taken of the opportunity to study methods for the removal of such stains and immergency local treatment in cases of poisoning.

Period 5. Digestive Ferments.—Test-tube experiments with Milk and Rennin in the presence of Water, Diastase, Pancreatin, Formaldehyde and Sodium Citrate. Also methods for standardizing Pepsin, Pancreatin and Diastase.

Period 6. Emetics.—Experiments on dogs to illustrate the classes of Emetics, using Apomorphine, Zinc Sulphate, Copper Sulphate, Ipecac, Antimony and Potassium Tartrate and Mustard, the rapidity of action, etc., and also employing Morphine to show the primary emetic action and the secondary paralysis of the vomiting center.

Period 7. Anthelmintics.—The parasites may be obtained from the intestines of dogs sacrificed during some of the other experiments or common rain worms may be used. The relative activity of infusions of Aspidium, Quassia and Spigelia, 1/10% Mercuric Chloride solution, 1% Emulsion of Oil of Turpentine, saturated solution of Santonin, and 1-5,000 solution of Oil of Chenopodium may be studied.

Period 8. Cathartics.—This work may be carried out on the student himself as well as on dogs, to illustrate "laxatives," "purgatives," "drastics," rapidity of action, duration of action, intensity of action, after constipation, griping, etc., etc. Rhubarb, Senna, Cascara Sagrada, Aloin, Resin of Podophyllum, Jalap, Compound Jalap Powder, Magnesium Sulphate, Sodium Sulphate, Seidlitz Powder, Solution of Magnesium Citrate, Potassium and Sodium Tartrate, Potassium Bitartrate, Castor Oil, Sulphur, Calomel, Compound Cathartic Pills, Agar Agar, Phenolphthalein, and Liquid Petrolatum may all be included in this series.

Period 9. Racial Idiosyncrasy.—A short series of experiments on dogs, rabbits, frogs, toads and cats to illustrate the term "Idiosyncrasy" and to distinguish between it and "susceptibility" and "tolerance." Atropine, Digitalis, Strychnine, Apomorphine and Morphine may be used.

Period 10. Treatment of Poisoning.—A—Chemical Antidotes: Test-tube experiments to illustrate the objects for using and the manner of action of such chemical antidotes as Tea and Coffee, Iodine, and Potassium Permanganate for Alkaloids; Tannin and Albumin for Metallic Salts; Alkalies for Acids; Acids for Alkalies; Copper Sulphate for Phosphorus; soluble sulphates for Barium; Calcium salts for Oxalates; etc., etc. *B—Treatment of Poisoning:* Experiments on rabbits to illustrate (1) Removal of the poison; (2) Chemical Antidotes; (3) Mechanical Measures; (4) Physiological Antidotes. Strychnine may be used for one series, and such measures as the lavage tube, artificial respiration, catheterization, chemical antidotes, and Chloral Hydrate employed with individual animals. Caffeine may be used for acute alcoholic poisoning, and other demonstrations carried out.

Period 11. The Action of Drugs on the Circulatory System.—A—General Circulatory Stimulants: Experiments on frogs to study the actions of such drugs as Digitalis, Strophanthus, Epinephrine and Caffeine by (1) inspection of the exposed heart, and (2) by kymograph tracings. *B—Cardiac Depressants:* In the same fashion studying the effects of such drugs as Aconite and Veratrum. *C—The Effects on the Pulse and Respiration:* A short series of experiments on the student using small doses of such drugs as Digitalis, Atropine, Aconite and Amyl Nitrite. *D—*

The Effects on Blood Pressure: Using the student and such drugs as Ammonia, Sodium Nitrite, Epinephrine, Strychnine, Amyl Nitrite, Atropine, Nitroglycerin, Caffeine and Tobacco.

Period 12. Drugs Acting Chiefly on the Central Nervous System.—A—Stimulants: Experiments on the frog using such drugs as Caffeine and Strychnine. *B—Depressants:* Similar experiments using Ether, Chloroform, Morphine, Alcohol, Chloral Hydrate, etc.

Period 13. The Action of Drugs on the Pupil.—Experiments on cats or dogs with such drugs as Atropine, Physostigmine, Pilocarpine, Cocaine, and Dionin.

Period 14. Anesthetics.—A—Local: A series of experiments on rabbits, frogs and the student using such drugs as Cocaine, Novocaine, Stovaine, Quinine-Urea Hydrochloride, Aconite and Ethyl Chloride. *B—General:* Using dogs and Ether and Chloroform.

Period 15. The Action of Drugs on Muscle.—A—Frogs: Kymograph work with such drugs as Caffeine, Quinine and Veratrine. *B—Man:* Experiments on the student using the ergograph to show the effect of Caffeine and Alcohol on fatigue.

Period 16. The Action of Drugs on the Salivary Glands.—A—Man: Using the student for the administration of a little Diluted Acetic Acid by mouth, and a little Ether or Chloroform by inhalation. *B—Animals:* Using rabbits or dogs for the injection of Pilocarpine and Atropine.

Period 17. Diuretics.—A series of experiments on the students who will take such drugs as Caffeine, Alcohol, Theobromine Sodio-salicylate, Oil of Turpentine, Oil of Santalwood, and water.

Period 18. Antipyretics.—Experiments on rabbits using Chloral Hydrate, Morphine, Cocaine, and Antipyrine, Acetphenetidin and Antipyrine after Albumose and without the previous administration of Albumose.

Period 19. Antiseptics.—A—Urinary: A series of experiments on the student using Hexamethylenamin, Sodium Salicylate, Sodium Benzoate, Creosote, Methylene Blue, Boric Acid and Santal Oil. *B—Intestinal:* Using fresh pancreas and duodenum with Bismuth Subcarbonate, Calcium Carbonate, Calomel, Carbon, Creosote, Guaiacol Carbonate, Phenyl Salicylate, Sodium Phenolsulphonate, Sodium Salicylate, Tannin and Thymol. *C—Antiseptic Dusting Powders:* Using fresh defibrinated blood and Acetanilid, Betanaphthol, Bismuth Subnitrate, Boric Acid, Calcium Carbonate, Carbon, Iodoform, Tannin, Thymol Diiodide and Zinc Oxide.

Periods 20 through 30. The Pharmacodynamic Drugs Assays of the United States Pharmacopoeia.

3. THE MATERIAL REQUIRED FOR A COURSE IN EXPERIMENTAL PHARMACODYNAMICS AND THE COST OF THE SAME.

Each section or group of students, preferably not more than two although three or four may work in one group if absolutely necessary, should be provided with the following apparatus:

4 Small Cannulas, @ $0.14	$0.56	1 Simple Electric Key, @ $1.65	$1.65
1 Tracheal Cannula, @ $0.65	0.65	6 Aluminium Writing Levers	0.10
4 Artery Clamps, @ $0.55	2.20	1 Plethysmograph Tube, @ $0.30	0.30
1 Ergograph, @ $1.70	1.70	1 Iron Stand, @ $1.50	1.50
1 Inductorium, @ $10.00	10.00	1 Iron Stand with Adjusting Screw, @ $4.00	4.00
1 Kymograph, @ $32.00	32.00	1 All-glass Hypodermic Syringe	2.50
2 Heart Levers, @ $1.00	2.00	1 Sphygmomanometer	15.00
2 Muscle Levers, @ $1.35	2.70	2 Stopcocks, @ $0.85	1.70
1 Mercury Manometer, @ $3.00	3.00	1 Fishtail Burner, @ $0.25	0.25
1 Pneumograph, @ $3.10	3.10	1 Bell Jar, @ $1.00	1.00
1 Seeker, @ $0.75	0.75	1 Clinical Thermometer	1.00
1 Signal Magnet, @ $1.35	1.35	2 Rubber Catheters, @ $0.25	0.50
1 Marey Tambour, @ $1.50	1.50	1 Scalpel, @ $1.25	1.25
1 Sphygmograph Tambour	1.00	1 Surgical Scissors, @ $1.00	1.00
1 Tuning Fork, @ $1.00	1.00	1 Forceps, @ $0.40	.40
4 Double Clamps, @ $0.30	1.20	1 Enamel Pan, @ $1.50	1.50
1 Platinum Electrodes	1.95		

2 Burettes, @ $2.35	4.70	10 Double Hooks	0.15
1 Double Burette Clamp, @ $0.75	0.75	1 Moist Chamber	4.00
1 Large Iron Clamp, @ $0.35	0.35	1 Small Scale Pan	0.20
1 Animal Holder, @ $9.00	9.00	2 Dry Cells, @ $0.45	0.90
1 Piece Colophony Cement	0.05	10 Weights	0.12
1 Curved Jaw Clamp, @ $1.55	1.55	2 Hypodermic Needles	0.50
1 Flat Jaw Clamp @ $1.55	1.55	6 Wire T. T. Baskets, @ $0.45	2.70
1 Frog Board, @ $0.70	0.70	2 Woulff Bottles, @ $0.50	1.00
8 Frog Board Clips, @ $0.02	0.16		
		Total Cost	$128.69

In addition the following ordinary apparatus should also be provided:

4 Pieces Rubber Tubing, 12 in. long.
4 Small Glass Funnels.
1 Iron Ring Stand with rings.
5 Small Beakers.
2 Bank (Pithing) Pins.
8 Pieces Insulated Wire.
1 Minim Glass Graduate.
1 Four-Ounce Glass Graduate.
1 Stoddart's Clamp.
2 Evaporating Dishes.
1 Bunsen Burner and Tubing.
1 Small Glass Mortar and Pestle.
3 Florence Flasks (100, 250, 500).
2 Medicine Droppers.
24 Test-Tubes.
1 Test-Tube Rack.
1 Test-Tube Brush.
1 Spool Thread (coarse).
2 Needles.
1 One-Ounce Glass Graduate.
1 100-Mil Glass Cylinder.
2 Mohr's Clamps.
2 Glass Stirring Rods.
2 Watch Glasses.
1 Piece Wire Gauze.
1 Water Bath.

Prices for these are not given since the above apparatus is all found in the pharmaceutical school laboratories.

Other apparatus necessary for demonstrations and special work follows:

1 Anesthetic Bottle and Air Warmer	$25.00	1 Electric Clock, Harvard	31.00
1 Brodie's Respiratory Pump	57.00	2 Bone Cutting Forceps, @ $2.00	4.00
1 Animal Balance ($18.00) and Weights ($5.00)	23.00	1 Bone Saw, @ $3.00 (*in addition to other ordinary dissecting instruments*)	3.00
		Total	$143.00

A large galvanized iron tank should also be provided to be used as a constant temperature bath for frog methods of assaying. If funds are available a Brodie's Animal Table might be added; cost, about $85.00. Kymograph paper can be purchased for about seventy-five cents per hundred sheets. A long paper Kymograph would also be desirable as a part of the general laboratory equipment.

Dogs can be purchased for from $0.25 to $0.50 each. About forty dogs are required for the experiments outlined above. Guinea pigs can be bought for from $0.75 to $1.00. Two or three pigs are needed for each section in the laboratory work above. Frogs can be purchased for $10.00 a gross. Each section requires about two and a half dozen, not including those needed for the pharmacodynamic assays of the Pharmacopoeia. Rabbits cost from $0.75 to $1.00. About forty are required in the foregoing work. One toad for each section is also required. Considerable sums can be saved by raising the guinea pigs and the rabbits.

Although prices are fluctuating almost daily, the above figures will give the approximate cost of the materials required for this laboratory work. All of it can be used for giving laboratory instruction in the Department of Physiology as well. According to the above figures, then, we can total the cost as follows:

1. Cost of special physiological apparatus for each section or group of students..... $130.00
   (It should be noted that this does not include the ordinary apparatus also required, such as beakers, funnels, etc.)
2. Cost of additional apparatus for the general laboratory, to be used for demonstrations, etc..... 350.00
3. Cost of animals. (The figure that follows will doubtless be sufficient for providing enough animals for a class of fifty)..... 150.00

Many may look upon the cost of the materials that should be provided for each group of two students as rather high. It is true that this amount will be increased to about $150.00, when the cost of the ordinary apparatus, like beakers, funnels, etc., is added. However, when one takes into consideration the importance and value of the work, the fact that the apparatus can also be used by the Department of Physiology for laboratory instruction, and the fact that the apparatus with ordinary care will last indefinitely, the amount is not extremely high. The annual cost of up-keep is comparatively small. The cost of animals can be materially decreased by breeding them. Some medical schools require the students to furnish their own animals, or charge an additional fee for providing them with the necessary animals.

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PHARMACY AND THE NEW EDUCATION.*

BY CHARLES O. LEE.

In the educational rôle of this country, pharmacy has not played a very conspicuous part. However, it has been only a little more than a generation ago since it began to be introduced into our colleges and universities as an integral part of such institutions. Its growth among the schools has been slow but certain. The requirements for entrance to and graduation from schools of pharmacy have gradually increased so that pharmaceutical education promises to be an educational factor of much greater moment in the future than it has been in the past. The teaching of pharmacy has not been thought of much as a problem in education probably because of its professional or technical character. The purpose of such training whether by schooling or by apprenticeship or by both is to fit a man to do certain peculiarly technical things. As in other courses of like nature the study of the subject had to follow certain prescribed courses and no one has ever changed the procedure very much.

Conditions have changed, however, and the signs of the times are that pharmacy must not be forgotten in the readjustment of the great educational upheaval which is upon us. Students of education and sociology tell us that we have suddenly come into a new democracy, and education must readjust itself to the demands of a contemporary civilization. If education means anything it must

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