The Association of American Medical Colleges.

REPORT OF THE COMMITTEE ON SYLLABUS.

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Report of Committee on Syllabus.

CHICAGO, Feb. 15, 1896.

A committee was appointed by the secretary of the Association, Dr. Perry Millard, on each of the branches of a medical curriculum in 1894. These several committees made reports which were presented at the meeting of the Association at Baltimore, May 7, 1895. The several reports were referred to a committee consisting of Drs. Perry Millard, Howard A. Kelly and Bayard Holmes, and ordered printed.[1] On account of the various standards used by the several committees, it was found impossible to coördinate this work so that a well-balanced course of study could be recommended. Therefore during the past year a plan was formed by the present secretary for the study of medical education in conferences. The work was laid out so that each conference would have a special part of the curriculum to consider.

In order to call together representative men and educators ten institutions were requested to send delegates to the first meeting. The call was addressed as follows:

My Dear Doctor.—The Association of American Medical Colleges has now arrived at practically the following condition of things: Nearly half of the medical schools in the United States are members of this Association, and more than half of the schools in which regular medicine is taught.

All members of this Association will hereafter require four years of attendance for graduation.

The minimum year of schools in this Association will consist of six months, the average year of eight months and the maximum probably of nine months of actual study.

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[1] Report of the Committee on Syllabus, JOURNAL AMERICAN MEDICAL ASSOCIATION, June 29 and July 6, 1895.

The entrance requirement is now fixed at the minimum, equal to about the second year of the ordinary high school course, and that requirement will probably soon be equal to the average requirements for admission to the literary department of colleges and universities.

The amount of study which any student of a medical school can be reasonably expected to do is fixed by pedagogic experience, and is four recitation hours a day, requiring each about an hour and a half of study for preparation.

It is very desirable in this formative period of education that the discussion cover the most desirable course of study, the most desirable methods of presenting each branch and the most desirable methods of testing the attainments of the students and giving them credit for their work.

Therefore the secretary of the Association of American Medical Colleges, with the consent of the President and Judicial Council, hereby calls upon the colleges to furnish representatives to a number of committees, to meet at suitable points and on suitable occasions to discuss these subjects and present a combined report at Atlanta next May. On account of the number of subjects he proposes to divide the curriculum into three groups.

Group 1 will be composed of all those branches that treat most exclusively of the normal human body.

Group 2 will consist of all those branches which consider most exclusively the diseased human body.

Group 3 will consist of all those branches which deal with the treatment of the diseased human body and the prevention of disease.

Three committees will be appointed, each consisting of as nearly ten persons as possible, one committee for each of these groups. Each committee will discuss the following topics: 1, the amount of time and the amount of work for each branch in this group; 2, the place in the four year course in which each branch in this group should appear; 3, the particular work *required* in each branch and the amount of work allowed to be *elective;* the particular work suggested by the committee as most desirable out of which to fill up the elective portion; 4, the methods by means of which each of these branches should be presented to the students; 5, the methods and means by which each student should be tested and given credit on each branch.

In order to begin this work the committee of ten upon Group No. 1, in which will be found anatomy, physiology, histology and embryology, is hereby called to meet at the Palmer House upon Saturday, the 15th of February, 1896, at 9 A.M. The University of Minnesota, the University of Michigan, the University of Iowa, the University of Wooster, the Lake Forest

University, the Northwestern University, Cincinnati College of Medicine and Surgery, Columbus Medical College, Detroit College of Medicine, Fort Wayne College of Medicine, are requested to send each a representative, to remain in the city three days at least, and hold a continuous meeting until the work is finished.

If your institution will coöperate in this work be kind enough to inform me by return mail and suggest the person whom you wish to represent your university upon the committee.

Trusting that I may hear from you by return mail, I am.

Very truly yours, BAYARD HOLMES.

The conference convened at the Palmer House at the hour mentioned with the following representatives present:

W. S. Hall, Northwestern University; W. E. Lewis, Cincinnati College of Medicine and Surgery; A. P. Ohlmacher, Wooster University; C. B. Stemen, Fort Wayne Medical College; Bayard Holmes, College of Physicians and Surgeons, Chicago; J. E. Brown, Ohio Medical University; W. D. Middleton, Iowa State University; H. O. Walker, Detroit College of Medicine; W. O. Gross, Fort Wayne Medical College; Thomas G. Lee, University of Minnesota.

The conference was called to order by the Secretary of the Association and the plan of conducting the business decided upon.

As a preliminary step to the arrangement of a curriculum the committee considered it expedient to recommend the use of certain terms in a more or less technical sense, thus avoiding misconceptions and facilitating the expression of ideas on the subject.

The Recitation Period.—A recitation period is the time occupied by the student in the preparation and recitation of one lesson. The time spent in a recitation is nominally one hour, and usually a topic assigned for a recitation requires about one and one-half hours of outside preparation. Let the expression "recitation period" be understood to mean two and a half hours' work. From this it is clear that a laboratory exercise requiring two hours of laboratory work and one-half hour of outside reading and preparation of notes is equivalent to a recitation period. Further, each didactic lecture involves, or at least should involve, a parallel course of supplementary reading assigned by the lecturer. In order to introduce uniformity into all the courses let it be understood that the assigned outside study accompanying a lecture course be equal to one and one-half hours for each one-hour lecture. In the same way a two-hour clinic should be made to consume in the aggregate an extra half-hour of work, either in reading up parallel cases, in taking and recording of histories or in the examination of pathologic material, for every two hours of actual work in the clinic.

By thus putting all work on the basis of the recitation period of two and one-half hours, the work of arranging a typical curriculum is much facilitated.

As to the number of recitation periods which should constitute a week's work, the discussion brought out many arguments. In the first place the medical colleges of to-day are for the most part the evolved product of those of yesterday when a year's work was crowded into five or six months, and a whole medical course into two or three of these short years. Under the earlier conditions as much as seventy-five hours of mental work, 30 recitation periods, was accomplished by the diligent student in one week. But the extension of the course of study to more than three times its original length has not been accompanied by a sufficient relief of the tension of work to admit the student of average strength to carry the course without manifesting signs of overwork. Most literary and scientific colleges require from 14 to 16 recitation periods per week of each student. Most medical colleges require from 20 to 30 recitation periods per week. The committee agreed that because of the greater maturity of students in medical schools, and the fact that a larger proportion of the work is "low-pressure" work, in laboratories and clinics, medical schools are justified in requiring 20 recitation periods per week. This represents fifty hours of work per week for the student. It is recommended that as far as may be these 20 periods be assigned to five days with 4 periods each. Somewhat more work than this may be permitted in special cases.

What shall constitute a year of work? Most of the institutions belonging to the Association of American Medical Colleges have seven or eight months for a year's work, a few have only six, while others have as many as nine months The committee agreed, that their work would be most useful if they based their recommendations upon a year of thirty weeks, of 20 recitation periods each, or an aggregate of 600 recitation periods. A college having only six months (twenty-five weeks) could attain about the same aggregate by requiring 24 recitation periods per week, while a college having nine months might well reduce the required number of recitation periods per week to 18. Such a reduction of quantity would naturally be accompanied by an improvement in the quality of the students' work.

Another very convenient expression is the term *year hour*, which is defined as *one recitation period per week throughout the year*, or *30 recitation periods*. But the number of recitation periods would depend upon the length of the year in any particular institution and might be 25 or 36 according to the length of the year. In any case the number of year hours multiplied by the number of recitation periods per week should equal 600 recitation periods.

It was further concluded by the committee expedient to divide the year into a Winter semester and a Spring semester of 300 recitation periods each.

The committee then considered the division of the four years of study now required by all members of this Association among the branches of study which it considered should be contained in the medical curriculum. This necessitated the consideration of the preliminary education of the student and the required and elective work.

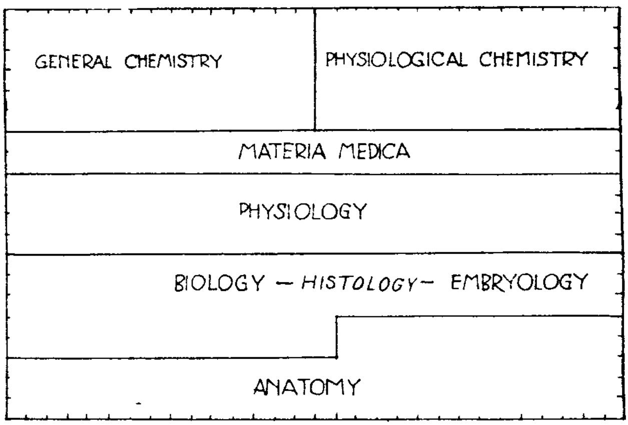
It was assumed that the students of our institutions are fully up to the requirements of the Association and possess a good knowledge of English, a thorough training in arithmetic and elementary algebra, a thorough training in elementary physics by the laboratory method, at least two years' work in Latin: but that they have had in a majority of cases no preliminary training in chemistry or biology.

In preparing students for medical study teachers should aim at a serviceable knowledge of English and English literature and a definite command of the English language in composition. Thesis work on topics with which the student is engaged should be strongly insisted upon, and every attention should be paid to forms necessary for the guidance of the printer. The work in arithmetic should be so thoroughly completed that it would become an unconscious tool in the mind of the student, and it should be combined with a thorough knowledge of the metric linear, square. cubic and liquid measure and with the metric weights. The algebra should be sufficient to cover simple and quadratic eqations. The course in physics should be much more extensive and thorough than that proposed by the committee of ten on secondary school studies, and published by the Bureau of Education (pp. 25, 26 and 117-127). It should be a careful course in experimental physics in which the student should prepare his own apparatus, conduct his own experiments after such a plan as that outlined in John Trowbridge's "The New Physics," or in similar works in the same pedagogic line.

The Latin should be studied from the philologic rather than the literary side, as so little is expected.

In regard to electives, the committee urged that all colleges allow a small margin of electives to begin in the second year and that each college make this work cover such branches as it is able to offer in the best quality. The value of even a small proportion, say five one-hundredths, of elective work in increasing the quality and spirit of all other work, can not be over-estimated when the resources of the school are such as to permit. Properly conducted the electives allow a choice of work adapted to the needs or inclinations of the students, while at the same time a larger number of medical teachers are given opportunity to devise and offer work some of which may be found of the greatest educational or professional value. Teachers may thus be discovered and methods of teaching thus be made known and the quality of teaching in the whole school greatly improved.

The following diagrams express the ideas of the committee on the proportion and disposition of the curriculum for the four years of the medical course.

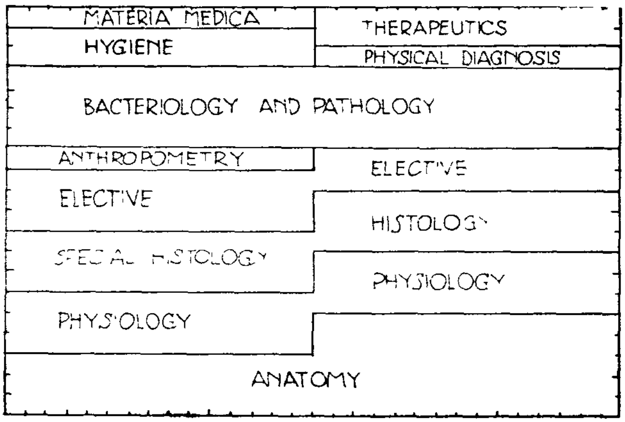


1.—Diagram showing the distribution of the 600 "recitation periods" of the first year. The lateral divisions represent thirty weeks, the vertical divisions the twenty "recitation periods" each week. The first half of the materia medica should be pharmacognosy and the other half pharmacology.

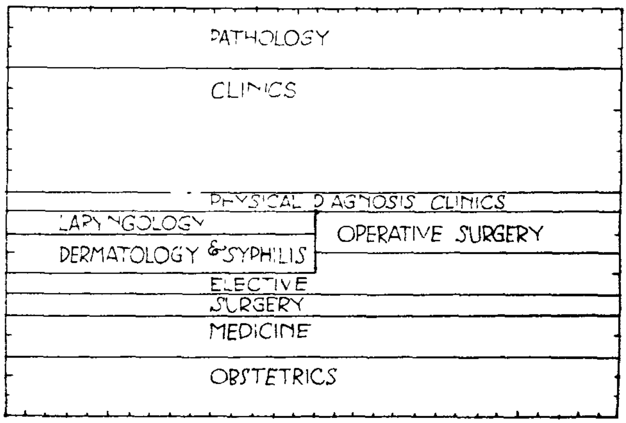
It will be noticed that chemistry and medical chemistry are crowded into the first year. This expresses the sense of the committee after very careful discussion. The committee holds that chemistry should very soon be required by the members of this Association for admission. The same may be said of biology or comparative anatomy. The high schools, academies and colleges now teach chemistry and biology by the laboratory method, and it will not long be necessary for medical colleges of the first class to teach either chemistry or biology.

ANATOMY.

The ground now covered in the course in anatomy is in accordance with the ideas of the committee. The separation of regional and surgical anatomy does not seem necessary or desirable.

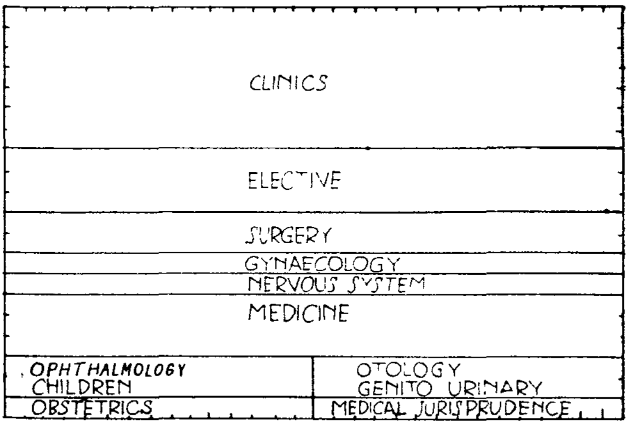


2.—Diagram showing the distribution of the 600 "recitation periods" of the second year.



3.—Diagram showing the distribution of the 600 "recitation periods" of the third year.

This branch was relatively well taught in the older medical colleges, but improvements have not been made as fast as the importance of the subject demands. The study of vertebrate morphology is a prerequisite to the proper study of human anatomy. The time which anatomy receives in the diagram above is three recitation periods a week during the first semester of the first year and five recitations a week during the second semester. Each of these recitation periods would consume two and a half hours of the students' time. The first semester may be devoted to the study of osteology. Every student should have the bones for his own use. The simpler parts of the skeleton should be studied first. The study of any bone should consist in a thorough study of every aspect of the organ with every pedagogical appliance. Drawings should be required in the various positions necessary to



4.—Diagram showing the distribution of the 600 "recitation periods" of the fourth year.

bring out all the parts. These drawings should at first be made from the object and later from memory. Only such features of the bone should be studied as the bones themselves present. Muscular attachments and the relation of other structures can not ethically or pedagogically be considered until the student sees the parts in position in the anatomic laboratory. In every possible way the teacher should maintain in the minds of the students the proper anatomic perspective and lead them to a vivid and indelible idea of the essential points. There ought to be an opportunity in every class exercise for students to propose questions. The recitation between the teacher and the students should be familiar and unrestrained.

The second semester of the first year should be spent in the dissecting room. This should be so fitted up as to be light, clean and commodious. The character of the dissections and laboratory study will depend not only on the motive and method of the teacher, but upon, and essentially upon, the proper preservation of the cadaver, the proper furniture of the laboratory and the proper equipment of the student with thoroughly good dissecting instruments, drawing books, note books and laboratory garments. A good workman must have good tools. In the dissecting room the muscles, nerves and vessels and their relation to the bones should be most carefully studied during the first year and all the dissections should be made so that these organs may be studied together. The bones should be at hand and the relations of parts studied and recorded by drawings. The muscles, for example, should be studied on the body, their separate offices demonstrated and their attachment recorded on the bones previously used. The blood and nerve supply should also be discovered and recorded on the drawings and sketches which each student should be required to make. Incidentally and in a general way the viscera should be carefully studied during the first year.

During the first half of the second year the careful study of the viscera should be begun. In this work it will be necessary if not desirable to use the organs of vertebrates for each member of the class in his laboratory examinations while the instructor will demonstrate from the human cadaver. All the important viscera should first be demonstrated in situ, then the organs of animals should be studied as detached specimens, and last of all each student should carefully dissect during the second semester the whole human body, making drawings and notes just as in the dissections of the first year.

During all this anatomic study the perspective of the subject should be carefully maintained by the teacher through demonstrations, recitations, quizzes and written exercises. The actual contact of the parts is of the greatest educational value and the use of dissecting gloves by students should never be countenanced. The necessity for a name should be felt by the student before he is required to learn a name. Anatomy should be a synonym for familiarity with the human body. Much attention should be devoted to the comparative study of the organs in the living human body. For this purpose students should be encouraged to use one another as subjects in the class. In this course, little place is left for didactic lectures and much attention is devoted to doing with hand and eye. Manual dexterity is acquired by the student on the dead body.

It must not be forgotten that any method of teaching which secures in the student a rational curiosity and provides a way for *him* to satisfy *it* is a success, while a much better method so used as to paralyze the student's curiosity while it secures ever so good a command of the anatomic nomenclature is a failure.

Any text-book is good enough if it follows or accompanies the careful dissection of a well preserved cadaver in a well furnished laboratory.

A library of anatomic works should be in the dissecting room. A list of very desirable literature will be found in the August, 1895, number of the *Bulletin* of the American Academy of Medicine, pp. 273–276.

BIOLOGY, EMBRYOLOGY, AND HISTOLOGY.

Inasmuch as biology is an essential introduction to the subjects comprehended in the usual medical curriculum, and since but a small proportion of students present themselves with the knowledge of this subject upon entering the medical school, this committee believes that it becomes the duty of the medical school to supply instruction in elementary biology until the entrance requirements are raised sufficiently high to include this branch. The object of this biologic work should be to serve as a natural introduction to the study of the normal and diseased human body, and not to make zoologists or botanists of medical students. Most of this work can be presented by the object method in the laboratory, and as an outline of the work the following plan is submitted.

Course A. Elementary General Biology.—This course will serve to introduce the student to the use of the microscope, to elementary microscopic and laboratory methods, and to acquaint him with a broadened idea of the phenomena of life in animls and plants. As types for study in this we recommend ameba, paramecium, vorticella, hydra, and earthworm on the zoologic side; and protococcus, yeast, bacteria, spirogyra, and molds on the botanic side. It is hardly to be expected that the teacher will be able to present all of these types in a given period and substitutes will doubtless be found necessary in certain cases.

In the laboratory exercises each student should be supplied with a microscope, and with simple equipment sufficient to enable him to independently prosecute all the technical work demanded. The laboratory exercises should be guided by simple directions such as are found in the "Practical exercises" of Huxley and Martin's Practical Elementary Biology. Free hand drawing from the object should be systematically demanded of every student in the class. Simultaneously with the laboratory work a reading or recitation course should be provided in which Parker's Elementary Biology will serve as an excellent text.

Course B. Elementary Vertebrate Anatomy.—Following Course A, in natural order, and serving as an invaluable introduction to descriptive and practical human anatomy, comes a laboratory study of several typical vertebrates. An elaborate study of comparative anatomy is impossible in the limits of a medical college course and it is expected that this course will prove mainly useful to the student in perfecting him in methods of anatomic laboratory study, while it incidentally familarizes him with the anatomy of the animals chosen as types.

This study should be pursued almost entirely in the laboratory by the aid of a suitable laboratory manual; and a comparatively thorough study of one or two types should be encouraged instead of the cursory examination of a number. By means of suitable equipment the student should make such preparations as wet and dry skeletons, vascular injections, and preserved specimens. Numerous free-hand drawings made directly from the objects are to be required. As types for the work we recommend the frog, as studied after the directions in Huxley and Martin's Practical Elementary Biology, and one mammal, the rat, the rabbit, the cat or the dog.

On account of the convenience with which each student can handle his material, and on account of the greater delicacy of the dissections we consider the smaller mammals preferable, and for this purpose the dissection of the rat as prescribed by Martin and Moale in Vol. III of their Handbook of Vertebrate Dissection is especially recommended.

Course C. Embryology.—During the spring months when eggs can be easily obtained, and upon completion of courses A and B, the study of embryology should be begun. The foundation for a study of this subject is furnished by practical laboratory exercises.

The most convenient type for introductory study is the embryo chick which should be studied after the plan outlined in the "Practical Suggestions for studying the Development of the Chick" given in the Appendix of Foster and Balfour's Elements of Embryology. A series of whole embryos of characteristic stages of development are to be studied by the student, in the egg, both as fresh transparent objects, and as opaque objects. A series of typical sections are now to be prepared *by the student* from the material *which he has obtained* and preserved, and at this time the technique of killing, hardening, imbedding and sectioning for microscopic study can be acquired. Mammalian embryology can be introduced by several laboratory exercises upon the embryo pig or sheep.

These embryos can usually be obtained in abundance from slaughter houses.

In connection with the laboratory work in this course we would prescribe reading or recitation exercises from some text-book, for example, Marshall's Vertebrate Embryology, Minot's Human Embryology, or Hertwig's Text-book of Embryology. Marshall's work will be found especially adapted to the laboratory course just presented, while the works of Minot or of Hertwig more properly serve as reference books for advanced students.

Course D. Histology.—In connection with Course A the student acquires a familiarity with the use of the microscope, and an elementary knowledge of the animal and vegetable cell both in unicellular and multicellular organisms. At this time also an acquaintance with simple microscopic technique is obtained.

Following that portion of Course B in which the frog is dissected the special study of elementary histology may be introduced. With the aid of such methods as teasing, maceration, dissociation, and possibly with some free-hand sectioning, the student should study the simple histologic tissues. A few of the more easily applied reagents should be employed by the student in his work upon the material which he obtains from his frog. Great weight should be laid upon the thorough mastery of the technique involved in this work, which is a step higher than that employed in Course A. A great deal can be done in the study of the blood, epithelium, connective tissue, muscle and nerve, and even of some of the organs with a very simple laboratory equipment and easily acquired methods, and we believe it the duty of the laboratory teacher to impress this upon the student. The directions for histologic study in connection with the laboratory work upon the frog in Huxley and Martin's Practical Elementary Biology may with certain modifications, be taken as a guide for this portion of histology.

The study of histology proper may be suspended in favor of Course C in which the more elaborate technical methods of microscopic anatomy are introduced, along with the subject of histogenesis.

Upon the completion of this elementary course in the first year's work, the study of special histology as applied particularly to the tissues and organs of the human body should be pursued. This is the work in histology which we would prescribe for the second year's course, and with students already trained in ordinary laboratory methods, it will be possible to include more of the special and advanced methods of histologic research.

Here also each student should be provided with a full working outfit and it is expected that *all of the preparations demanded in the course are to be made by the student from the raw material which he obtains himself* or which is furnished to him by the teacher. These laboratory exercises can best be guided by type-written or mimeograph syllabi prepared by the teacher to cover each given lesson, and in these syllabi brief technical instructions should be supplied together with a few hints as to the observations to be made by the student, and the prosecution of technical details and the detailed study of the object should be left to the student. Drawings directly from the preparations should be demanded throughout the course and full descriptive notes should be prepared by the students.

As a supplement to the laboratory exercises in histology the students may be referred to one or more of the standard text-books upon histology, and in some special subjects it may be found advisable to introduce a few lectures.

This department ought also to possess a working histologic library. Text-books ought not to be used at all. The student should be referred to the library for the further study of the problems presented to him in his laboratory work.

THE COURSE IN PHYSIOLOGY.

The course in physiology should be continued through two years and should be in a general way coördinated with the course in comparative anatomy and general biology and histology. By coördination in this connection is meant the arrangement of the courses in such a way that the student shall learn first the more fundamental and general and then the more special. To teach the student the physiology of the liver one year and the gross and minute anatomy of that organ the next year must be recognized by all as an inversion the logical order. To teach the anatomy of an organ one year and its physiology the next year puts the teachers of both these branches at considerable disadvantage. and the chances are great that the student will have a less clear comprehension of the subject presented in this way than he would if the interval elapsing between the study of the more general branch and the more special branch be a short one. Examples of coördination will be found in the arrangement of the following course in physiology:

Every course in physiology should be accompanied by laboratory exercises in which the student may familiarize himself with the technique of the subject and may demonstrate for himself the more fundamental facts of this science. The laboratory exercises should be coördinated with the recitations and demonstrations as far as it is possible to do so.

The first half of the first semester (eight weeks) should be spent in a study of the physiology of the cell as illustrated in unicellular plants and animals. While the student is studying the morphology of the protococcus, the yeast cell, the ameba and the paramecium in the biologic course he may profitably study the physiology of these organisms from such a text as, "The Cell" (Hertwig), and should repeat in the laboratory the experiments mentioned in Hertwig's book. "Allgemeine Physiologie" (Max Verworn, Jena, 1895) is a valuable help to the instructor who is conducting such a course.

The second half of the first semester should be spent on muscle-nerve physiology. Having already studied the reaction of ameba and paramecium to electricity. and having studied, in general histology, the structure of muscle fibers and cells, and nerve fibers and cells; further having made careful dissections of frogs and other vertebrate animals the student is in a position to comprehend and appreciate the reaction of muscle-tissue in response to various direct stimuli and to indirect stimuli applied to the nerve. The frog-heart and the "muscle-nerve preparation" are most used for such experiments. A convenient text to follow in the laboratory exercises is "Sterling's Practical Physiology."

Beginning with the second semester or second half of the first year the general subject of nutrition should be begun. Whether one introduces this field of physiology with the study of the circulatory system or of the digestive system is a matter of little consequence. The problems of the circulation being, for the most part, physical problems, would seem to justify the consideration of that subject first, followed by the respiratory system, which presents simple problems in mechanics, physics and chemistry. The student, having in the meantime made some progress in physiologic chemistry, is able to comprehend the general features of the chemic problems involved in digestion, and should now enter upon a systematic consideration of the nutrition: 1, food and foodstuffs; 2, preparation of foods; 3, mastication; 4, deglutition; 5, salivary digestion; 6, gastric digestion; 7, intestinal digestion; 8, absorption; 9, distribution; 10, assimilation or anabolism; 11, katabolism and animal heat, and 12, excretion. This course will propably consume the second semester of the first year and a part or all of the first semester of the second year. The remaining time allotted to physiology should be devoted to the physiology of the nervous system, the physiology of the special senses, and the physiology of reproduction. All of these courses should be accompanied by laboratory work. The laboratory manual already mentioned has exercises in all of the above subdivisions of the subject (except in reproduction).

After the student has completed the above required courses he should be given an opportunity to elect special courses in physiology during the second semester of the second year and during the third year. Profitable elective courses would be, for example: 1. physiology of intrauterine life, following Preyer's "Physiologie des Embryos;" 2. special problems in the physiology of digestion, following Brunton in "Handbook for the Physiologic Laboratory;" 3. physical examination of the blood, using hematokrit, hemometer, corpuscle counter, micrometer, and staining methods; 4. experimental physiology of the central nervous system, following Cyon; 5. physiologic psychology, following Wundt or Ladd. The instructor may get much help from such works as: Cyon's "Methodik der Physiol. Experimente;" Gscheidlen's "Physiologische Methodik;" Foster and Langley's "Practical Physiology; Schenck's "Physiologisches Practicum;" Brunton and Burdon-Sanderson's "Handbook of the Physiological Laboratory;" McGregor-Robertson's "Physiological Physics;" and Langendorf's "Physiologische Graphik."

THE ORGANIZATION AND EQUIPMENT OF THE DEPARTMENT OF PHYSIOLOGY.

Inasmuch as many of the colleges of the Association have not yet established physiologic laboratories, it is thought well to give a few general hints on the subject. The imposing equipments which one sees in the physiologic institutes of Europe, equipments which, in the aggregate, have cost many thousands of dollars, overawe one and make one hesitate to advise the undertaking of so great a task, so we are letting the years slip by without establishing physiologic laboratories. We must not forget that the equipment of European laboratories is a growth which has covered many decades; and further, that it is really advisable to allow a department to grow, collecting, in the course of a few years, an equipment which is perfectly adapted to the wants of the institution and to the special methods of the head of the department. The committee strongly advises the early establishment of physiologic laboratories, even if an institution can not appropriate for the purpose more than $1,000 to start with. If an institution can devote to this department a well-lighted general laboratory room 36 ft. to 40 ft. square, with two or three small rooms for instrument room, workshop and library, and can appropriate $1,000 to $1,500 for the first equipment, then a laboratory fee of $5 annually from each student who works in the department will, in the course of a decade, produce a sufficiently full equipment for all practical purposes.

At this point it may be well to give a hint as to the organization of the department, as this determines largely the character of the equipment and the number of duplications of each instrument.

The amount of personal supervision required by the student in practical physiology is so great that it is inexpedient to attempt to conduct large classes. A demonstrator and one assistant demonstrator can not properly supervise the work of more than thirty students at one time, even though each student be provided with a laboratory manual. In the organization and equipment here planned let it be understood that the laboratory class work in *sections* of thirty students each, and that each section be subdivided into ten *divisions* of three students each. Now, experience in many laboratories has shown that a student will accomplish practically as much in one laboratory period of three hours as in two laboratory periods of two hours each. The three-hour laboratory period promotes economy both for the student and for the department. Following this arrangement, two instructors would be able to supervise the work of 180 students, meeting one section of thirty students each day. With this allotment of time each student would have three hours of laboratory work each week during the year, which would enable him to demonstrate for himself all of the fundamental principles of physiology. In the question of the choice between, 1, the condensation of 180 hours of laboratory work in physiology into a period of sixty days with three hours per day, and 2. the distribution of the same number of hours over sixty weeks (two years) with three hours per week, and its coördination with the theoretic work in physiology and with the courses in gross anatomy and histology we would, without a moment's hesitation, decide in favor of the latter plan.

If this general plan of organization be adopted, and if the department wishes to provide for sections of thirty students, working in ten divisions of three students each, then the apparatus should be duplicated in tens. The following list of apparatus is suggested as a practical one with which to make a beginning:

EQUIPMENT FOR GENERAL LABORATORY WORK.

10 strong tables, 8 feet by 2½ feet, at $7.50	$75 00
10 kymographions, at $30	300.00
20 Daniell's cells half gallon size, at $3	60.00
4 pounds of copper wire, No. 16, double cotton cover, at 60 cts.	2.40
½ pound copper wire, No. 26, double silk cover, at $2.50	1.25
10 bichromate cells, medium size, at $3	30.00
10 simple compasses (for detectors) at 30 cts	3.00
10 mercurial keys, at 50 cts	5 00
10 contact keys, at 60 cts	6.00
10 DuBois keys, at $1 50.	15.00
10 Oxford rheochords, at $2.50	25 00
10 Du Bois-Reymond, induction machines, at $15.	150 00
10 Pohl's commutators with crossbars, at $2.	20.00
10 pairs of muscle forceps, at 75 cts	7 50
10 pairs of tambours, at $4	40.00
20 heavy-base stands, with fixtures, at $2	40 00
10 Bunsen burners, at 25 cts	2 50
10 bell jars, at 80 cts,	8 00
10 double-valve rubber bulbs, large size, at 75 cts.	7 50
5 hemometers (Fleischel's), at $15	75 00
5 sphygmographs (Dudgeon's) at $20.	100.00
5 blood corpuscle counters (Zeiss) at $15.	75.00
General surgical appliances, forceps, shears, etc	50 00
Assorted sizes of glass tubing	5.00
Assorted sizes of soft rubber tubing	5.00
Rubber stoppers, assorted sizes, perforated.	2.00
Corks and cork borers, sheet cork	2.00
Files, "knife-blade" for cutting glass tubing	2.00
Glassware, gas generators (2), graduated cylinders, pipettes, flasks, bottles, beakers, etc	50 00
Granite iron troughs and basins, assorted sizes	10.00
	$1,174.15

NOTE.—About one-third of this outlay can be saved by having five divisions of the section work on one problem while the other five divisions work on a related problem which involves other instruments. That would reduce the absolutely necessary equipment to $800.

INSTRUMENTS FOR SPECIAL USE AND DEMONSTRATIONS.

1 galvanometer	$50 00
1 metronome	4 00
1 hematokrit	5 00
1 plethysmograph	2.50
1 pair quantitative balances	30.00
1 pair dog scales	15 00
2 pairs medium scales for students' use.	10 00
2 mercurial manometers for blood pressure	10 00
2 Ludwig rheometers.	10 00
1 moist chamber.	20 00
1 capillary electromometer (Kuhne's)	5 00
1 Du Bois-Reymond rheochord	25 00
1 contact clock.	40 00
2 chronographs	20 00
	$266 00

This list might easily be extended to amount to several thousand dollars, but it is intended here to include only those instruments which seem necessary to start with.

THE WORK SHOP.

Demonstrators and students can easily construct, in a shop, many pieces of simple apparatus, which if purchased of some instrument house, would amount to many times the cost of the material and would deprive students of some very valuable experience. Frog, rat, rabbit and dog holders may be made, the tambour frames may be furnished with membranes and mounted as receiving or transmitting tambours, cardiographs, or stethographs. All writing levers, electrodes, etc., should be made by the students. A room with bench and vice and $25 for carpenter's and machinist's tools would be an ample start.

A FEW NECESSARY CHEMICALS.

20 pounds $CuSO_4$	$1 30
10 pounds H_2SO_4	.70
5 pounds mercury.	3 30
5 pounds bichromate of potassium.	75
5 pounds kaolin (for electrodes, etc)	.25
2 drams of curare	2 50
5 pounds gum damar	1 25
20 pounds benzol.	4.00
[2 per cent sol of damar in benzol makes the best fluid for fixing tracings made on smoked paper]	
10 pounds chloroform (imported duty free)	5 00
30 pounds sulphuric ether (imported duty free)	9.00
20 pounds surgical cotton at 25 cts	5 00
2 pounds sealing wax in sticks	1.00
1 pound mercuric chlorid	.80
2 pounds carbolic acid	.70

5 gals abs alcohol. . . . .
2 pounds sodium hydrate . . . . . .
2 pounds magnesium sulphate . . . .
2 pounds sodium chlorid (pure). . . . .
10 pounds glycerin . .
1 pound hydrochloric acid
1 pound nitric acid . .
1 pound ammonium hydrate

About $50.00

A WORKING LIBRARY OF PHYSIOLOGY.

Beside the laboratory manuals enumerated under the "Course in Physiology," we mention a few journals and general works that should be in every laboratory of physiology: Hermann's "Handbuch der Physiologie"; *Journal of Physiology*, ed., Michael Foster, Cambridge, England; Pfluger's *Archiv f. d. gesammte Physiologie*, Bonn, Germany; *Archiv fur Anatomie und Physiologie*, [physiol. part] ed., Du Bois Reymond, Berlin, pub., Veit & Co., Leipsig; *Centralblatt fur Physiologie*, pub., Franz Deuticke, Leipsig; *Journal of Experimental Medicine* [physiological part edited by Bowditch, Chittenden and Howell], D. Appleton & Co.; "Animal Physiology," Mills, D. Appleton & Co., 1889; "Text-book of Physiology," Michael Foster, Macmillan, 1888–93; "Human Physiology," Landois and Sterling, Blackiston, Philadelphia, last edition; "Refraction and Accommodation of the Eye," Landolt, Lippincott, Philadelphia, 1886; "The Frog," Marshall, London, 1894; "Anatomy of the Frog," Ecker, Oxford, 1889; "The Cat," Mivart, Scribner, 1881; "Dissection of the Dog," Howell, Holt & Co., 1888; "Anatomie des Hundes," Ellenberger & Baum, Berlin, 1891; "Dictionary of Medicine (4to), Gould, Blackiston, Philadelphia, 1895.

Beside these there should be recent representative manuals of histology, general biology, embryology, chemistry and physics.

PHYSIOLOGIC CHEMISTRY.

It has been taken for granted that the chemic problems of physiology will be assigned to the department of chemistry. The equipment of that department makes such a division of the subject highly advantageous. For years urine analysis has been taught, usually in the second year of the course in the department of chemistry. Many of the stronger institutions have long since expanded the second year course in chemistry into a very creditable course of physiologic chemistry, beginning with an investigation of foodstuffs, following this with qualitative and quantitative work on the chemistry of digestion, and devoting the last semester of the second year to the analysis of urine. The best laboratory manuals on this subject are: Sterling's "Practical Physiology" (first part): Long's "Laboratory Manual of Chemical Physiology," Colegrove & Co., Chicago, 1895; Halliburton's "Essentials of Chemical Physiology," Longmanns, Green & Co., 1893. The physiologic library should contain also: "Text-book of Chemical Physiology and Pathology," Halliburton, Longmanns, Green & Co. 1891; "Physiologische Chemie," Bunge, Vogel, Leipzig, 1894; "Lehrbuch d. physiologisch. Chemie," Neumeister, Gustav Fischer, Jena, 1893; "Physiological Chemistry," Hammarsten, Wiley & Sons, New York, 1893; "Physiological Chemistry of the Animal Body, Gamger, Macmillan, 1893; "Chemical Physiology and Pathology," Hoppe-Seyler.

GENERAL PATHOLOGY.

This course occupies the second semester of the second year. The student comes prepared for this course through his study of biology, histology, physiology and bacteriology. He is familiar with general laboratory technique. He is already somewhat of an independent observer. As the minimum amount of time to be set apart for this course the committee would recommend two hours weekly of class-room work and six hours weekly of laboratory work.

An ideal guide for elementary laboratory work in general pathology does not exist. As general reference works we have Ziegler's General Pathology, Thomas' General Pathological Anatomy, Birch-Hirschfeld's Allgemeine Pathologie, Senn's Tumors, Warren's Surgical Pathology, etc. For class-room work the majority of teachers will probably select (at the present time) Ziegler's General Pathology.

It is believed that the successful teaching of General Pathology depends essentially upon creating in the student a correct and vivid understanding of some of the more important, fundamental pathological processes than upon imparting a mass of miscellaneous and disconnected information without any visible footing upon clinical manifestations on the one hand or upon naked-eye changes on the other. As an illustration in point: There can be no doubt but that a student who observes a patient with general passive congestion and œdema, then studies the naked-eye appearances of the organs in the post-mortem room, and finally examines the histological changes under the microscope will obtain a clearer, more lasting conception of this form of disturbance of the circulation than one who hears a brief oral explanation of the subject in general and sees under the microscope a prepared and labeled slide of a congested organ without any history and without any tangible connection with anything living; and so on through the list. At the present time the majority of our colleges are not in position to teach pathology in this, the rational manner. Stock specimens must be used. The connection of the tissue with the patient must be supplied by second-hand information. But much can be done, even in the most desolate institutions in this regard to improve upon the old, cut-and-dried plan. Animal experiments can be made by the student and the resulting changes studied in specimens secured and prepared by himself. Suitable, fresh, post-mortem material can also be secured from the occasional post-mortem and from the surgical and other clinics. An enumeration of the various groups of processes into which general pathology (general pathological anatomy) is customarily divided will call to mind the opportunities presented for improvements indicated in the teaching of this important subject:

1. The Disturbances of Circulation (anæmia,

hyperæmia. hæmorrhage. thrombosis. embolism, œdema, etc). In every hospital and clinic opportunities to observe at least some of these conditions during life are presented at frequent intervals. Post-mortems nearly constantly furnish material for the study of the gross changes due to some disturbance of circulation. Suitable animal experiments are easily made. Guided by judicious syllabi, by the suggestions of the wise teacher. and by the study of books the student in the systematic course will soon be led to think and reason correctly concerning the mechanical and other problems of changes in the circulation.

2. The Retrogressive Changes of the Tissues (the degenerations. infiltrations. necroses and atrophies). The same combination of methods as hinted at above are applicable here also as well as in the study of

3. The Progressive Changes (hypertrophy and regeneration). All surgical clinics furnish abundant material for the study of regeneration and the healing afterward. which the student should fix and prepare for microscopic study.

4. Inflammation. In this instance the frog's mesentery secures for every student the chance to study the vascular changes. The various forms of inflammation are to be studied in organs. preferably from patients observed ante-mortem by the student. who describes the gross appearances of the pneumonic lung, the basilar meningitis. etc., and then fixes and makes his own preparations.

5. Tumors. The surgical clinics supply an inexhaustable fund of the common and important neoplasms from the careful study of a few of which the student will soon work out for himself the principles of classification.

6. The Processes caused by Pathogenic Microorganisms. Here is a wide field for the student to make what to him would be original observations; his conception of the importance of pathogenic bacteria will be widened and his technical skill increased by staining commoner bacteria in the tissues. The

extent of his laboratory studies in this direction must at this time be judiciously circumscribed.

7. Animal Parasites.

8. Teratology.

9. The Exogenous and Endogenous Intoxications (common poisonings, uræmia, thyroid cachexia, etc.) These subjects present difficulties that may be overcome, in part, by the use of museum specimens (7 and 8), in part by experiments.

A laboratory course planned according to the same methods of note-taking and drawing, and real laboratory work on part of the student, as the previous laboratory courses—modified as demanded by local conditions— and supplemented by appropriate reading and class-room exercises, would, in the opinion of the committee, make the study of general pathology of immeasurably greater benefit to the student than the methods now generally in vogue. The student would now be in some measure prepared to really master the practical branches to be presented in the third and fourth years, and also to profit still further by the opportunities given him, in the third year, to study.

SPECIAL PATHOLOGICAL ANATOMY.

Special pathological anatomy occupies three recitation periods a week during the whole year.

In this course the student makes post-mortem examinations, under the direction of the teacher, of patients the clinical symptoms of which he has studied. He protocals the post-mortem findings; makes cultures from the various organs and isolates the bacteria present; he should prepare and study microscopic sections from the organs, describe their appearance and present complete reports upon as many cases as consistent with the time and opportunities at his disposal. Post-mortem specimens may be collected and demonstrations in gross morbid anatomy given for the purpose of teaching diagnosis of pathological anatomy, the student describing and determining the lesions present as far as possible.

The laboratory work should consist, as stated, in the bacteriological and histological study of the material derived from post-mortem examinations, made (or witnessed) by the student, upon patients that he has studied clinically. In connection with this work he should study the literature bearing on the cases and, in some cases, at any rate, he might write more complete papers suitable for publication. Systematic lectures could be given upon selected topics.

The committee as a whole is responsible for the report, but the greatest thanks are due Dr. W. E. Lewis for his service in preparing the report on anatomy, to Dr. W. S. Hall for the report on physiology and general supervision, to Dr. Ludvig Hektoen for the report on pathology, to Dr. A. P. Ohlmacher for the report on histology, and to Dr. David H. Galloway for the report on laboratory equipment.

BACTERIOLOGY.

On account of its intimate bearing upon the problems of disease, bacteriology, as presented in the medical school, should be studied closely in connection with pathology. The laboratory method should be employed in introducing the student to this subject, and progress is much facilitated when the student possesses an elementary knowledge of practical biology and some training in the methods of laboratory work. It therefore seems desirable to assign bacteriology a place in the first half (semester) of the second year's course, immediately preceding practical pathology which is begun in the second semester of this year. At least three laboratory exercises of two (calendar) hours each a week for fifteen weeks should be spent in the work. Two lectures, or conferences, weekly, may also be employed during the semester. Instead of the usual lecture it would seem advisable to devote the two weekly lecture hours to conferences in which the teacher discusses with his classes the various phases of the problems which naturally have suggested themselves in the course of the laboratory work. Later in the course, when a good store of observations have been made by the class, a few systematic lectures may be employed to discuss problems which are of a purely theoretical nature, or which are too difficult to be worked out in the class-room.

No single text-book fulfills the requirements of a course of this kind. and while the student may be encouraged to purchase one or more of the standard text-books. a laboratory library with various text-books. and including especially a file of the leading bacteriologic journals. should be provided for the use of the students.

The most important thing to teach the student in the bacteriologic laboratory is *how to work.* He should be instructed in bacteriologic technique so that he masters the various methods and can put them into independent practice. Instead of flooding the student with a great variety of imperfectly studied specimens in a frantic effort to illustrate all the disease-producing bacteria described in the text-book. teach him the technique of the bacteriologic laboratory and the use of the library so that he has the means for working out the problems which will present themselves when he sets out to work for himself.

Each student should be supplied with a full equipment of apparatus and material of a *simple kind* so that individual practice may be obtained in all of the methods demanded in the course. Everything in the student's equipment should be as simple and inexpensive as possible. Cheap tin stew pans and spoons, and tin funnels are more economical than corresponding pieces in glass. Instead of one or two large and complicated steam sterilizers for general class use, a small-sized Arnold sterilizer or a cheap tin apparatus on the principle of the steamer used in cooking should be given to each student. Salmonsen's cracker-box is a better dry sterilizing oven for the beginner in bacteriology than the elaborate ovens of Rohrbeck or Muencke. A simple, double-walled drying oven claims the advantage over an elaborate and expensive thermostat for the purpose in hand.

Every detail in the manufacture of the various kinds of culture media should be carried out by the student. He cultivates his own bacteria; makes all the temporary and permanent preparations; inoculates animals and recovers the bacteria; all by his own handiwork. Instead of depending on the stock of pure cultures with which most bacteriologic laboratories are provided, the teacher should require the student to obtain his own pure cultures of both non-pathogenic and pathogenic bacteria from the *raw material.* The hay bacillus should be obtained from the hay, the potato bacillus from the potato, the *staphylococcus aureus* from a boil or pimple, the colon bacillus from feces, and so on as far as possible.

The pathogenic microbes are naturally of the greatest importance to the student of medicine, and in a short course like the present one it will be found necessary to confine the work pretty closely upon those bacteria which are associated with human pathology. On the other hand, the time spent upon the non-pathogenic bacteria must be short. For the preliminary technical training, however, the non-pathogenic bacteria must be chosen instead of the pathogenic species, which would be unsafe to place in untrained hands. By exposing a slice of sterilized potato to the air the student can usually obtain several varieties of harmless bacteria, together with yeast and mold. Several of these accidental species may be studied in detail upon various culture media, by the hanging-drop, and in stained preparations the separation of bacteria can be learned by practice on samples of tap-water, while the methods of bacteriologic analysis of water, ice, milk and soil are at the same time illustrated. In this introductory work the general principle of morphology and physiology of bacteria will be acquired by the student and the way opened for the study of classification. With the data obtained in this work the student should now attempt to classify one or more of his unknown species, making use of the keys in some such work as Eisenberg's Bacteriological Diagnosis or Sternberg's Manual of Bacteriology.

When this introductory work is completed the study of some of the disease-producing bacteria may be commenced. A few of the more readily obtained types, like the pyogenic cocci from acne pustules and the *bacillus coli* from the feces of man or the domestic animals, should first be chosen by the student, and the species should be isolated, studied in detail and identified by each member of the class. No rule can be made for the order of this portion of the work, for much will depend upon the supply of material. Aside from those ever-present harbors of pathogenic bacteria, like the skin and mucous membranes, which may be called upon to furnish the student with specimens, material from a variety of pathologic conditions like the pus of appendicitis, the membrane of diphtheria, the spleen of typhoid, the lung of pneumonia, which constanly find their way into the bacteriologic laboratory may be utilized for further class-room study. Here the technique of the smear preparation, alike of secretions, exudates and of tissue can be learned. Suppose, for example, that the surgeon sends to the laboratory a sterilized test tube full of appendicitis pus. Each student in the class makes plate cultures from the pus, and then studies it microscopically as a fresh preparation and finally makes smears which he fixes and stains in various ways. When the cultures develop they are studied in detail and compared with the bacteria found in the fresh and stained pus. Thus the student obtains a good picture of the relation of the bacteria to the morbid process, and incidentally he learns how to work independently. Only a few examples like this need be given to a student to furnish him with the proper foundation for future independent work.

Somewhere in connection with the foregoing work the technique of blood, pus, sputum examination, and the culture test for diphtheria can be introduced and duly emphasized.

The final step in the identification of a pathogenic bacterial species, that is, the experimental inoculation of a susceptible animal and the recovery of the bacterium in the blood and tissues by smears, sections and cultures, may be acquired by the study of a mouse or a guinea pig which the student inoculates with anthrax. Here, also, the technique of a bacteriologic autopsy in all its details can be learned. Once having learned this method the student may test the pathogenic activity of some of the species which he has isolated, as for example, the bacillus of diphtheria

Only when the student has learned to work and has learned from his own experience the relation of bacteria in their various habitats, should he be furnished with cultures out of the laboratory stock. There is then no objection to furnishing him with examples of the more important pathogenic bacteria which he would not be likely to encounter in his class room work, such as the spirillum of cholera and the bacillus of tetanus, for instance.

The laboratory study of the bacterial products, of immunity, of bacteriologic therapy, and many other advanced lines of work must be left for elective courses.

The application of the knowledge gained in the above mentioned course should be made in the third and fourth years' courses. In the third year's course, when special pathology is studied, a bacteriologic examination of the morbid material brought into the class room should go hand in hand with the study of the gross and microscopic lesions in all diseases of infectious origin. In the fourth year's course, also, the student should be given the facilities for making bacteriologic examinations of the material obtained in the medical and surgical clinics and at the bedside. In this way the practical bearings of his knowledge of bacteriology will be indelibly impressed upon the student, and constant practice will keep the technique fresh so that, upon leaving the medical school, he can at once apply his knowledge in private practice or in his hospital course.

It must be evident that no laboratory text-book will meet the requirements of a course of this kind. The teacher must supply his students with syllabi prepared to cover the particular work in hand, especially in the early part of the work. In these syllabi careful technic directions should be given, along with suggestions as to the observations which the student is to make and to record, along with appropriate drawings. The slip system of taking notes and drawings has much to recommend it, and it should find its way into all lines of laboratory work. A convenient size of slip for laboratory work is $5\frac{1}{2} \times 8\frac{1}{2}$ inches with portfolio to correspond.[1]

LABORATORY EQUIPMENT.

The efficiency of the laboratory depends in a large measure upon the care devoted to the enormous amount of detail required to obtain the proper kind and amount of apparatus and material, to care for it when obtained, and to properly distribute it for the use of students and teachers. This can not possibly be left to the teachers in the various departments, but must be concentrated in the hands of one man who will attend to it impartially for all the laboratories in the institution. This should be the duty of the curator. The person selected to fill this important office must be possessed of peculiar abilities and command the entire confidence of the management of the institution. He should be given general instructions regarding the policy of the management toward the laboratories and complete information as to the resources at his command. Beyond this he should be allowed to work out the details without interference.

The curator must be provided with ample store rooms and a laboratory in which to prepare reagents and fit up apparatus. This room should have a table with lead-covered top gently sloping to a drain at one end, water and gas pipes tapped at short intervals with

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[1] Teachers unfamiliar with the slip system of taking notes will find a detailed description in Wilder and Gage's Anatomical Technology, 1882, pp. 45–52.

attachment for rubber hose. The curator should be competent to prepare all reagents used in the microscopical laboratories and the ordinary solutions used in chemistry, which means that he should have a good general knowledge of chemistry.

He must first procure for himself all apparatus and material for a manufacturing laboratory, beakers, evaporating dishes and flasks, from the small sizes issued to students up to those of several liters' capacity. Graduates, measuring flasks, pipettes, a druggist's balance, a counterpoise balance for weighing liquids, and by all odds let all weights and measures be in the metric system. Bunsen and dental burners, retort stands, tripods, an assortment of corks, xx, from number 1 to 24, rubber tubing, bottles in abundance, from one-eighth ounce morphin up to five gallon seltzer; a list so long that a day or two will be required to make it out. Then in a book he must set down everything that is to be manufactured, adding to this list as new requirements arise, checking off each item as it is finished, making a record of the amount made, when made, indicating the formula used and referring to the place where the formula may be found. Only a small part of his duties can be outlined here, but where special instructions are necessary they will be given under their appropriate heads. Everything issued to students in the shape of material and reagents must be labeled. For this purpose order from the druggist's label printer gummed strip labels the size of a druggist's shake label. A large number of these will be required, but they are inexpensive, about thirty cents per thousand. The following list will do for a basis and may be modified to suit:

LIST OF LABELS.

——% acetic acid.
——% chromic acid.
——% hydrochloric acid.
——% nitric acid.
Sulphuric acid.
Agar agar.
$AgNO_3$.
Fehling's solution, quantitative.
Flemming's solution.
FeS.
Grape sugar.
Guaiac.
Glycerin.

Albumin fixative.	Gelatin.
Absolute alcohol.	Gentian violet.
——% alcohol.	——Hematoxylon.
Alum carmine.	$K_2Cr_2O_7$.
Ammonia.	$KClO_3$.
Analin.	Labels.
Analin water.	——Methyl blue.
Baryta mixture.	Miller's fluid.
Benzine.	Methyl violet.
Bismarck brown.	Molybdic acid sol.
Borax carmine.	$NaNo_3$.
Bromin Water.	Oil bergamot.
Canada balsam.	Oil cloves.
Carnoy's solution.	Oil cedar.
Carbol-fuchsin.	Peptone.
—— Carmine.	Paraffin, hard.
Chloroform.	Paraffin, soft.
Chlorin water.	Phenylhydrazin chlorid.
Celloidin.	Rubrin.
Congo red	Salt.
CS_2.	——Safranin.
Cupric acetate solution.	Sulphur.
Distilled water.	Sodic carbonate sol.
Dahlia.	Turpentine.
Eosin, aqueous.	Uranic acetate.
Eosin, alcoholic.	Ultramarine blue.
Eosin in glycerin.	Weigert's deodorizing sol.
Fehling's solution, qualitative.	Xylol.

A week or ten days will be required to get these out.

IMPORTATION OF APPARATUS AND MATERIAL FREE OF DUTY.

The import duty on apparatus and material used in the laboratories averages about 40 per cent. Provision is made in the law whereby institutions of learning may have these duties remitted.

Each laboratory teacher should be required to make out a list of things he wishes to use and an estimate of the probable quantity. From these the curator makes his list which will include but once the name of every article used in all the laboratories of the entire institution, he can then make his own estimate of the quantity needed. The curator should familiarize himself with the work being done in all the laboratories so that he may judiciously trim the order to fit the appropriation, so that if economy is necessary it may be applied where it can best be borne. An order was once given including five orders for nitrate of silver, a pound package, a half pound, a quarter pound and two ounce packages. The price varied from $8 for the pound to a rate of $16 per pound for the ounces. In a $2000 order where one teacher's quota was about $200 he called for 100 grams of an organic preparation the price on which varied from $1250 to $1600. This list with price was "O.K.'d" by the purchasing committee and would have been ordered had it not been cut out by the curator. Of the curator's list half a dozen or more copies should be made and sent to as many importing houses with a request for quotations. Ordinarily the price should include delivery at the laboratory.

All material so obtained must be used in the institution and heavy penalties may be exacted should any of it be given away or sold. Two to five months are absolutely necessary to get goods from Europe. Experience, however, teaches that six months is not too much time to allow, and if this time is allowed there will be fewer disappointments.

The number of different kinds of apparatus should be kept as low as possible. For instance, have but one style of beaker, one style of flask and one style of evaporating dish.

Five sizes of each will be ample. Each size must have a separate place in the store room and it will be easier to provide places for five sizes of one style of beaker than for five sizes of each of five different styles. A little judicious consulting with demonstrators will make this feasible. It is difficult to detail the annoyance and expense caused by a disregard of this rule. Ten different teachers will call for ten different kinds or makes of the same thing and it will require the services of half a dozen men to take care of the supplies which one might otherwise easily do. When the goods arrive some representative of the institution must go before the collector of customs and make oath that they are intended for use in the institution and that they will not be sold or otherwise disposed of. The goods must be examined by the customs authorities either in the customhouse or at the college when they are unpacked. The latter is preferable and should be requested.

TAX-FREE ALCOHOL.

Alcohol intended for scientific purposes may be withdrawn from bond without payment of internal revenue taxes. Instead of its costing $2.75 per gallon it may be obtained for about 50 cents, a saving of $80 or $90 on a barrel. To accomplish this the curator must make out a bond which is to be signed by two persons who are not officers of the institution. and who are citizens of the United States. This bond must be for an amount at least twice as great as the tax on the quantity of alcohol to be withdrawn at any one time. Thus a two hundred dollar bond will only allow one barrel to be withdrawn at one time, therefore the bond should be for at least $500 in which case a second barrel may be withdrawn before the first is entirely used up and the bond released. He must now go to a bonded warehouse and get the "description" of a barrel of alcohol and have the barrel set aside, he must take this description together with the bond to the collector of internal revenue for the district in which the institution is located. These papers are sent to Washington and in a week or ten days a permit to withdraw for scientific purposes, the described alcohol will be received by the curator from the office of the Secretary of the Treasury. Some time and annoyance to all parties to the transaction will be saved if the application be made early in the month so that the alcohol may be delivered before the last day of the calendar month, otherwise it must be rebonded. The curator will now be required to sign a receipt which says he has *already received* the alcohol; this is to be sent to the collector who will then issue an order on the manufacturer or storekeeper to deliver it to the college. A page in the curator's record should be devoted to alcohol. Here is entered the description of every barrel of alcohol, just as in the application, with space for the date of receipt and date of release.

In the bond a time is mentioned when proof that it has been used according to law must be submitted to the collector. This time is usually six months or a year. At the expiration of this time or when application is made for more, the curator must present to the collector this proof, which is simply his affidavit to that effect.

LABORATORY TABLES.

A convenient laboratory table for microscopic work may be of the following dimensions:

Top, 7 ft. 3 in. x 2 ft. 2 in.; from the floor to top of table 2 ft. 6 in. It will have four cupboards 18 inches wide, 12 inches high and about 2 feet deep.

The upper part of the cupboard is occupied by a drawer 3 inches deep. The box containing the student's kit of apparatus just fits in under the drawer. The stools for the students to sit upon while at work should be 22 inches high. This table will accommodate two students at a time and afford accommodation for two classes. Two desks are to be placed with their backs together one inch apart and the space between bridged over by a board 3 inches wide. A gas pipe comes up in this place and runs the length of the table 3 inches above it. A four-way T opposite each place is fitted with a gas tap for each student.

The gas pillars instead of brass should be cast iron with the slit cut larger; these being much more convenient for slipping the rubber tube on and off. These double tables are placed with their ends to the windows if daylight is to be used. If gas is to be used for illumination, burners having chimneys are necessary, as an open gas flame is too unsteady for microscopical work. Some of the patented incandescent gas lamps furnish a white light which is very serviceable. Incandescent electric lights are said to be unsatisfactory owing to the yellow color. Perhaps kerosene lamps are best though somewhat troublesome to keep in order.

This gives each student $3\frac{1}{2}$ x 2 feet of table space which is ample for most of the work but not too much. The door on this cupboard should be fitted on the *outside* where the hinges are placed so that it will swing round through three-fourths of a circle and thus be where it will not be broken.

If it is hinged to the left instead of to the right it will swing under the student's own table and thus not interfere with his neighbor.

LOCKS AND KEYS.

This is rather a large item of expense but it will not do to get a poor lock. Ability to settle with students satisfactorily depends in a large measure on the integrity of the lock. A Yale lock with corrugated key is not too good. Stipulate with the manufacturer that he mark each key *(but not the lock)* with a consecutive number and this number must be continuous for all the locks, having a similar key in the institution. Each laboratory must be designated by a number or letter, and all the doors having a lock in each laboratory must be numbered consecutively.

Each lock and its two keys will come wrapped in a separate paper or box; take these at random, or better still, mix them up with some care; now take a book ruled as follows with horizontal lines and three vertical columns.

	KEY.	LAB.	DOOR.	
	1	A	24	
	2	B	36	
	3	C	48	
	4	D	91	

In the first column the numbers are consecutive and there are as many lines as you have locks. The first column is headed KEY, the second is headed LABORA-

TORY and the third is the DESK OR DOOR in that particular laboratory. After the desks are all in place and numbers on, take the locks and key list. go into the laboratory, begin at one end, select a lock at random. place it in the cupboard or drawer it is to be put on. mark the laboratory and door in their appropriate columns and on the line corresponding to the number on the key. Follow this up till every door has its lock and every line and column on your key list is full. The curator must do this himself and never trust it to workmen. A carpenter follows, puts on the locks and leaves the key in each one. When this is done the curator takes a portable key board and gathers up the keys. The keys are to be kept in a drawer where they are protected from moisture, dust and the fumes of chemicals. Such a drawer may be fitted up in the following manner:

The drawer selected should be three inches deep. Set in a loose false bottom three-fourths inch from the top. Rule this off in squares one inch each way and where the lines intersect bore holes just large enough to allow the keys to drop down to the shoulder. Number the holes with the gummed paper numbers made by Dennison and varnish the whole drawer. A drawer eleven by twenty-one inches will contain 200 holes. Each hole will contain the two keys of the lock whose number corresponds to the number on the hole.

When desks are to be assigned, one key for each lock in that laboratory is taken on a portable key board and issued as places are assigned. The duplicate key is never allowed to go out of the hands of the curator and taken out of the drawer only to unlock the desks for the purpose of examining their contents, or when first key is lost. If a student loses a key he is charged the full price of the lock. The lock is removed and replaced by another. If a key is broken it is replaced for 25 cents. This prevents students from carrying the keys away and then "going through" that desk the next term when it is occupied by some one else. A key picked up anywhere can be at once located by reference to the chart, while without the chart it is useless to anyone finding it.

MICROSCOPES.

The microscopes should be kept in a special room or cabinet where they are protected from injurious influences. This place should be fitted with shelves and these shelves spaced off with cleats and each space numbered to correspond with the number on a microscope. If the microscopes are of different quality, or not enough so that each student in the class can have one, they may be satisfactorily issued in the following manner: A large sheet of paper (one for each class) is prepared with as many horizontal lines as there are students in the class and with a vertical column for each laboratory day during the term. The names are arranged on this chart alphabetically. Then if there are seven students and only five microscopes they will be issued from day to day according to the accompanying chart.

PATHOLOGY 1892-1893.

	Sept. 21.	Sept. 23	Sept. 25	Oct 1	
Bennett, G. L... .	1	3	5		2
Hamilton, A. C. . .	2	4		1	3
Mellon, J. S.	3	5		2	4
Smith, C. J	4		1	3	5
Thomas, A L . .	5		2	4	
Wilson, M. S.		1	3	5	
Williams, H. L .		2	4		1

The numbers being filled in before class time, then no matter who comes first he will get the microscope allotted to him for that day. There will thus be no incentive to crowding. As they are returned at the close of the lesson each is returned to its appropriate place and the curator can see at once when all are in. In case a microscope is injured or any of its parts missing the responsibility can be instantly located by reference to the chart. Lamps, dissecting microscopes, micrometers, oil immersion, objectives, drawing apparatus, etc., can be kept and issued in the same way and at the same time. Microscopes should not be allowed to go into the chemical laboratory except with the most careful precautions to protect them from injury. The evolution of injurious gases in the rooms where they are kept or are in use must not be tolerated for a moment. If a large class is to begin the study of the microscope (and every class should study the microscope before studying microscopy), a number of students with some experience should be invited to assist the teacher at the first lesson, at least, so that there will be, if practicable, an instructor to each microscope. This will be of real advantage to both the beginner and the student who assists.

STUDENTS' KITS OF APPARATUS AND MATERIAL.

Order from a box factory as many boxes as there are students expected. A good quality of packing box will do, made of dressed lumber, seven-eighth inch ends and one-quarter inch sides and bottom, without covers, of such dimensions that they will fit into the cupboards in the laboratory tables. Boxes 18 inches wide, 24 inches long and 8 inches deep will about fit the tables described, and will cost not to exceed $12 to $15 per hundred. Printed lists of the apparatus and material to be furnished each student are provided, where laboratory courses in two or more subjects are conducted in the same room and with the same students the outfit for them all may conveniently be combined into one kit. These kits are best fitted up by arranging the boxes in a row on a table, then taking a tray containing a sufficient number of the first item on the list, walking down the row and putting in each box the number called for. Then follow with a tray of the next article, and so on till all are filled, and lastly put in one of the printed lists. The boxes are then piled up out of the way and are ready for distribution to the students on the day in which places in the laboratory are assigned. When the box is delivered to the student he is required to take it to his place in the laboratory, check up the kit with the printed list, sign his name and desk number to the latter and return it to the curator as a receipt. These lists are now put separately into envelopes bearing across the end the name of the student to whom it belongs. The envelopes are arranged alphabetically and placed on end in a drawer prepared for the purpose. Each student is furnished with a small tablet of order blanks, plain pieces of paper 2½x5 inches, and henceforth every order on the curator for anything must be written on one of these slips and bear the name and desk number of the student. No orders on other paper will be honored. As these orders are filled, they are checked with a blue pencil and put into a convenient box. As the close of the term approaches these slips are assorted by an assistant and put in the envelopes with the printed slips. When the kits are returned to the store-room at the close of the term the curator and his assistant checks them up with the contents of the respective envelopes, puts a price on each item missing, dirty or damaged, marks the amount on the outside of the envelope and returns to each envelope its contents. Each envelope now contains the complete itemized account of a student and is preserved until a final settlement is made and the student receipts for settlement, when it is to be burned.

The amounts on the outside of the envelopes are entered in the curator's record book in the proper column and the total charged against each student is found by adding together the various charges on his line.

Everything possible should be issued to the student individually and charged up to him, then if he wishes to be wasteful and extravagant it will be at his own expense. Nothing should be "on tap" except gas and water. Each laboratory should have a gas meter and the gas charged to the class, and the cost divided equally among the members of that class. Slides, cover-glasses and other material are often prepared by the demonstrators for distribution to this class; but this is a faulty, pedagogic method and should not be permitted. Students must obtain everything from the store-room on their personal order and there should be no bottles "on the side" from which they can help themselves. Every one should be required to leave his desk clean and in perfect order on quitting the room. Habits of cleanliness and order should be insisted upon, and any indication of rowdyism repressed. Smoking should not be allowed in any of the laboratories. Young men who believe that it is the student's prerogative to smoke while at work, chew tobacco and spit upon the floors of laboratories or lecture rooms, mark up walls, whittle and break up furniture and otherwise bring into the school the habits of the rowdy should be promptly advised to become sewer builders, street pavers or enter some other occupation where their habits will not be an offense to all decent people. The medical profession is surely not in need of such material.

The following lists represent kits which have been found suitable for the work in the laboratories named. The following shows the form of the printed slips. The other laboratory lists are set solid to save space.

NAME . . . . DESK NO. .

LABORATORY OF BACTERIOLOGY.

See that your apparatus and material is all here and in perfect order, then sign your name at the top and return this slip to the curator.

Check here.		$	cts.
	Agar agar		
	Apple corer		
	Blotting paper		
	Bunsen burner and tube		
	Cotton		
	Cheese cloth		
	Droppers, 3		
	Forceps, cover glass		
	Filter papers, 1 doz., 25 cm		
	Flasks, 1,000 c.c., 3		
	Funnels, 2		
	Gelatin, 40 grams		
	Grape sugar, 5 grams		

Note book, peptone 15 gm., 6 petrie dishes, Pillsbury box, platinum needle, potato knife, granite-ware pan, tripod, salt, slide, concave center, sponges for cleaning desk, test paper, 100 test tubes, test tube brush, towel, wash bottle, 2 wire baskets.

STAINS AND REAGENTS IN BOTTLES.

Aniline water, balsam, nitric acid, sodic carbonate solution, glycerin, carbol-fuchsin, gentian violet, methyl blue aqueous.

LABORATORY OF EMBRYOLOGY, HISTOLOGY AND PHARMACOLOGY.

Alcohol, 3 camel's hair pencils, cheese cloth, oblong cover glasses 2 sizes, cover glasses, circles, drawing paper, 3 droppers, eraser and brush, filter paper in strips 1 package, cover glass forceps, fine pointed forceps, 2 glass rods, 1 box labels, tripod magnifier, 12 morphin bottles and corks, 2 teasing needles, 1 box hard paraffin, 1 box soft paraffin, 2 pencils hard and soft, 6 French drawing pens, 2 Pillsbury boxes, 2 porcelain dishes, 1/2 gross plain glass slides, concave center glass slide, section lifter, 2 pairs scissors fine and coarse, sponge for cleaning desk, towel, tin pan, 5 test tubes, 6 watch glasses, 1 solid watch glass.

STAINS AND REAGENTS IN BOTTLES.

Alum carmine, balsam, borax carmine, eosin aqueous, Carnoy's solution, celloidin and clove oil, chloroform, chromic acid solution, gentian violet, hematoxylon Delafield, hydrochloric acid, Mueller's fluid, oil of cloves, oil of cedar, safranin, 1 per cent. solution silver nitrate, xylol and carbolic acid.

LABORATORY OF BIOLOGY, HISTOLOGY AND PHARMACOGNOSY.

Alcohol, beaker, benzine, blotting paper, glass blowpipe, 1 oz. q. s. bottle, 3 camel's hair pencils, cheese cloth, celloidin, 5/8 inch No. 2 box cover glasses, cork sheet, drawing paper, 6 drawing pens, 2 drawing pencils, india ink, eraser and brush, dissecting pans, 3 droppers, 12 filters, 2 forceps, funnel, 2 glass rods, 6 4 oz. screw cap jars, one 16 oz. screw cap jar, 1 box labels, tripod magnifier, notebook, 2 needles, paraffin hard and soft, Pillsbury box, box black pins, 2 porcelain dishes, 1 retort stand, 3 retort rings, scissors, scalpel, 1/2 gross glass slides, sponge, 5 test tubes, test tube brush, towel, wash bottle, 6 watch glasses, 1 solid watch glass.

STAINS AND REAGENTS IN BOTTLES.

Alum carmine, albumin fixative, balsam, borax carmine, chromic acid sol., eosin aqueous, gentian violet, hydrochloric acid, hematoxylon, Delafield Müller's fluid, oil of cloves, oil of cedar, safranin, silver nitrate sol., ultramarine blue.

LABORATORY OF EMBRYOLOGY, PATHOLOGY AND SURGICAL PATHOLOGY.

Alcohol, absolute alcohol, quart tin basin, blotting paper, 3 camel's hair pencils, cheese cloth, cover glass circles, cover glass oblong (18 large, 18 small), drawing paper, drawing pencils, 6 droppers, eraser and brush, fine pointed forceps, coarse straight forceps, weight forceps, box labels, tripod magnifier, 12 morphin bottles and corks, 2 needles, paraffin hard and soft, scissors, ½ gross glass slides, concave center slide, sponge, 3 test tubes, test tube brush, towel, solid watch glass, 6 watch glasses.

STAINS AND REAGENTS IN BOTTLES.

Acetic acid, alum carmine, ammonia, albumin fixative, balsam, Bismarck brown, Carnoy's sol., celloidin, chloroform, cupric acetate sol., eosin in glycerin, eosin in alcohol, hydrochloric acid, hematoxylon Weigert, hematoxylon Delafield, methyl blue, oil bergamot, oil of cloves, Weigert's decolorizing sol., rubin, xylol and carbolic acid.

LABORATORY OF CHEMISTRY.—A

Burette, 5 beakers, Bunsen burner and hose, file. 2 packages filter paper, filter stand, 2 flasks, 2 funnels, funnel tube, 2 feet glass tubing, 2 glass rods, hydrogen sulphid tube, mortar and pestle, pincers, platinum needle, 2 porcelain dishes, retort stand, 3 retort rings, sand bath, 10 test tubes, test tube rack, test tube brush, pipe stem triangle, urinometer, wash bottle, water bath, 3 watch glasses, wire gauze.

REAGENTS.

Anilin blue, baryta mixture, congo red, eosin, Fehling's solution quantitative, Fehling's solution qualitative, gentian violet, tr. guaiac, phenylhydrazin chlorid, sulphanilic acid, potassium dichromate, sodium nitrite, sodium chlorid, sulphur, ether, alcohol, iodic acid, bromin water, chloroform, hydrogen peroxid.

LABORATORY OF CHEMISTRY.—B.

Aluminum wire, 5 beakers, blow pipe, Bunsen burner and hose, file, filter paper, 4 and 6 oz. flasks, 2 funnels, funnel tube, 2 feet glass tubing, 2 glass rods, hydrogen sulphid tube, pincers, platinum foil, platinum needle, porcelain dish, retort stand, 3 retort rings, sand bath, sponge, test paper, 10 test tubes, test tube rack, test tube brush, towel, pipe stem triangle, wash bottle, 3 watch glasses, wire gauze.

REAGENTS.

Red lead, ferrous sulphid, potassic chlorate, carbon disulphid.

CURATOR'S RECORD BOOK.

In order to reduce book-keeping to practical limits a special book is required. It may be of any convenient size, but where there are a number of laboratories and many students the following is a good size. The page is seventeen and one-half inches high and the double page twenty-three inches wide. It is check-ruled so that there are one hundred horizontal and about one hundred and forty vertical lines on a page. Every other horizontal line is heavier than the rest. The account of each student is placed on one of the heavy horizontal lines, making fifty on a page. Five vertical columns are allowed for the account in each laboratory. The heavy lines are numbered both at the left and right of the double page. The names of the students are written on the left, their accounts in the respective laboratories filled in the proper column and when settlement is made the student signs his name at the extreme right of the same line. Thus each student's account occupies but one double line and is a matter of permanent record. This book must also contain a complete inventory of all the microscopes and other permanent apparatus, with description, manufacturer's and private marks to be used for purposes of identification. Also, alphabetically arranged a list of *everything* in the original purchase, with columns for the amounts purchased each year, and the price paid. This is necessary as a basis for the price to be charged students and for future orders.

WM. OSLER, Pres't, Baltimore.

BAYARD HOLMES, Sec'y, Chicago.