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THE OBJECTS, PLANS, AND NEEDS OF
THE LABORATORY OF HYGIENE.

*An Address delivered at the Opening of the Laboratory of Hygiene of
the University of Pennsylvania, February 22, 1892.*

BY

JOHN S. BILLINGS, M.D.,

DIRECTOR OF THE INSTITUTE; SURGRON, U. S. ARMY.



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FROM those who have preceded me you have heard of the origin of this Laboratory, and something of the wishes, hopes, and expectations of the public with regard to it, as indicated by the donor, and by representatives of the University and the State.

You see clearly that this magnificent gift imposes a heavy responsibility upon those who are charged with the duty of managing it, and of seeing that it is so used as to meet the many and various demands which may rightfully be made upon it; and, in attempting to explain to you briefly what the Laboratory now is, and why it is as it is, I come before you oppressed with a keen sense of this responsibility, which is not lessened, but rather increased, by the fact that I feel that I am speaking to friendly critics.

For this new building, with its equipment and resources, is but an implement—a piece of mechanism—which may be used to shape products of vast importance, not only to the world as it is, but to generations not yet conceived; or which, on the other hand, may be so used as to be of little more importance to humanity than the toy tool-chest or the doll's-house of a child.

What this use shall be depends upon the force and skill applied to it; upon the materials submitted to it; upon the ability of those who guide it to foresee the direction in which at each moment of time it is best to move it; upon the knowledge and patience of those who are working in it; and, when all these are at their best, the results must still depend upon the decrees of Divine Providence, upon circumstances which no man can fully foresee, and which, therefore, no man can, with certainty, control to the end desired.

The position of laboratories in their relations to education, to science, to technology, and to the executive departments of governments and the welfare of the public, has become a very notable one within the last fifty years. A laboratory—or, as it was called in old times, an “elaboratory”—is, as its name indicates, a place for labor, for work—and especially for skilled labor, in the making of delicate and difficult observations and experiments; for analysis, to determine composition and causes; for synthesis, to determine the results of new combinations; for solving old problems, and for stating new ones. It is not a museum, or a store-room, or a show place; nor does this kind of a laboratory offer much for sale, except opportunity.

Only an opportunity—just a few possibilities, offered to the man who desires knowledge, who wants to see, and touch, and try for himself. Yet this offer of such an opportunity is what distinguishes it from those institutions established for the benefit of individuals.

The ideal laboratory of the alchemist or philosopher of bygone days was a mysterious, dusky place, the operations in which were kept a profound secret, and which thus gained in repute what they could not have obtained by publicity and free criticism.

Laboratories planned and fitted for public use, offering to anyone who is able and willing to pay a moderate fee and to submit to a few simple regulations, not only

opportunities for learning the details of the processes carried on therein, but also facilities and means for making special research that he could only obtain otherwise at great expense and loss of time; such laboratories, I say, are all of comparatively recent date.

It is not yet twenty years since the first separate institution of this kind was established for hygiene—and even now there are not more than a dozen such laboratories, specially built and fitted for their purpose, in existence throughout the world. Of these, the best known is probably that of the University of Munich, under the direction of Professor Pettenkofer, while the largest is that of Berlin.

This laboratory is the first structure of its kind erected in the United States, and it therefore opens a comparatively new field of work in this country. What is the nature of this field, and what are its boundaries?

The object of hygiene is to preserve and to improve health, and there are few matters affecting the physical, intellectual, emotional, and moral condition of man as an individual, or of men in communities that may not come within the scope of its investigations. The destruction or avoidance of causes of disease is but a part of its objects—it is at least equally concerned with the means of making a man better fitted to resist these causes. "That kind of health," says Montesquieu, "which can be preserved only by a careful and constant regulation of diet is but a tedious disease." Disease, like health, is a vague term, including widely different and often very complex conditions, processes, and results, which must be observed, classified, and described in such a way that different men, widely separated in space and time, may know that they are seeing the same things, and thus may have the benefit of each other's experience.

In its scientific aspects, then—those which relate to definite and precise knowledge—hygiene rests largely on physiology and pathology, the third leg of the tripod

being formed by vital statistics; while, in its practical aspects, it must rest on chemistry, physics, and the data of sociology and politics.

At any given time, therefore, its scope and practical value must depend largely upon the breadth and solidity of the foundations which these various branches of science can provide for it. The opinions of the medical faculty of Paris as to the causes of the "black death," and the advice which they gave as to the means for lessening the "great mortality," absurd and preposterous as they now appear to us, were yet fully in accord with the knowledge and opinions of the time.

At the beginning of this century physicians did not distinguish with any certainty between typhoid, typhus, and malarial fevers; or between consumption and various other chronic diseases of the lungs, and, until this was done, investigations into the causes of these affections were necessarily almost fruitless.

When, however, a clue is once given to the student of causes, he may be able, by detecting differences in these causes, to call the attention of the pathologist to differences in the results, and thus the bacteriologist, by proving specific differences in microorganisms, all of which produce fever, suppuration, etc., induces closer study of details of cases by physicians, and the recognition of new and more clearly defined groups of symptoms and results, or, in other words, of new diseases.

We live in an age of specialization. Progress in science as a whole depends upon special progress in each of its branches. Our present knowledge of physiology depends largely upon the perfection of electric methods. Pathology and pathologic bacteriology are now waiting for increase of knowledge in organic chemistry. The law of evolution applies to this as it does to modern industrial progress.

The physician deals with sick men, and his first question is, What is the matter with this person? That is,

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What group of symptoms does he present, and to what derangement of his mechanism are these due? The hygienist deals with two sets of problems—the first relating to men who are not sick, and how their health and vital resistance-power are to be not only preserved but improved and strengthened; the second relating to sick houses, feverish blocks or wards, infected localities—where the first questions to be solved are, What are the causes of this condition of things? how have they found entrance? are they still acting?

In the investigation of causes he must consider not only the immediate or exciting, but also the remote or predisposing; not only those which are preventable, but those which, with our present knowledge, are unpreventable; and thus it is that heredity, race, local meteorology, occupation, and many other circumstances must be studied by him, as well as the effects of food, clothing, habitation, poisons, and viruses.

Much of all this was known to a few wise men long ago, as is shown by the scheme of inquiry stated by Lord Bacon in his *Articles of Inquisition touching Life and Death*:

“3. Inquire touching the length and shortness of life in living creatures, with the due circumstances which make most for their long or short lives.

“4. But because the duration of bodies is two-fold; one, in identity, or the self-same substance; the other, by a renovation or reparation; whereof the former hath place only in bodies inanimate; the latter, in vegetables and living creatures; and is perfected by alimentation or nourishment; therefore, it will be fit to inquire of alimentation, and of the ways and progresses thereof; yet this, not exactly because it pertains properly to the titles of assimilation and alimentation, but, as the rest, in progress only.

“Inquire touching the length and shortness of life in men, according to the ages of the world, the several re-

gions, climates, and places of their nativity and habitation; . . . according to their races and families, as if it were a thing hereditary; also, according to their complexions, constitutions, and habits of body; their statures; the manner and time of their growth; . . . according to their fare, diet, government of their life, exercises, and the like. . . . But because it will be hard to know the ways of death, unless you search out and discover the seat, or house, or rather den of death, it will be convenient to make inquisition of this thing; yet not of every kind of death, but of those deaths which are caused by want and indigence of nourishment, not by violence; for they are those deaths only which pertain to a decay of nature, and mere old age. . . . Inquire touching the point of death, and the porches of death leading thereunto from all parts; so as that death be caused by a decay of nature, and not by violence."

Most of this is wise and far-seeing, yet little came of it for two hundred years. By way of contrast, let us take a few of the rules which Lord Bacon fixed for his own use, in order to prolong life:

"1. Once in the week to take the water of Mithridate distilled, and some grains of niter and saffron, in the morning between sleeps.

"6. To take every morning the fume of lign-aloes, rosemary, and bays dried, which I use; but once in a week to add a little tobacco, without otherwise taking it in a pipe.

"10. In the third hour after the sun is risen, to take in air from some high and open place, with a ventilation of musk roses and fresh violets; and to stir the earth, with infusion of wine and mint.

"17. To use once during supper-time wine in which gold is quenched.

"28. To provide always an apt breakfast."

A curious mixture of good-sense and rubbish, these rules, which are well worth reading.

The scheme of inquiry as to causes of disease and preservation of health to-day includes most of Bacon's questions, and also many others of which 'he did not dream. Let us consider, briefly, some of those which belong to our laboratory work.

The recent advances in our knowledge as to the action of certain microorganisms in the production of disease in animals and man have been largely made by laboratory methods, and indicate clearly that the study of bacteria and microzoa, and of their development, products, and effects, must be an essential part of the work of a hygienic laboratory, which should provide the peculiar arrangements and apparatus which are required for this sort of work. In fact, several so-called hygienic laboratories are simply bacteriologic laboratories, the interest in this particular branch of investigation having, for the time being, overshadowed all others.

Our laboratory, however, must provide also the means for chemical investigations of air, water, food, sewage, secretions and excretions, and the products of bacterial growth; for testing the effects of gases, alkaloids, and albumoses of various kinds upon the animal organism; for investigations in the domain of physics, pertaining to heating, ventilation, house-drainage, clothing, soils, drainage, etc.

Perhaps a summary of what the German hygienic laboratories have been occupied with for the last five or six years, as indicated by the published reports and papers of those who have been working in them, will afford some indications as to the field which they have occupied.

First in number and extent, as just stated, come the bacteriologic investigations relating to anthrax, tubercle, typhoid fever, erysipelas, suppuration, diphtheria, pneumonia, cholera, and other diseases of men and animals.

Closely connected with these are the experiments on

disinfection, and the testing of various forms of apparatus for disinfecting by steam or by dry heat.

Next come examinations of drinking-waters, of the effects of various impurities in waters, effects of lead pipe on waters, self-purification of running waters, changes in stored waters, etc. The effects of working in compressed air; the air of school-rooms, of assembly halls, of hospitals; the dusts and germs of the air, its changes by respiration and by ventilation, form another group of subjects.

Foods and drinks have occupied much attention—the quantity and quality of different articles that are most desirable—their adulterations, preparation, and preservation, including studies of meats, bread, milk, beer, wines, meat-extracts, etc.

Soils of streets, gardens, cemeteries, etc., with reference to their moisture, gases, and bacteria, seem to have received much investigation.

Clothing, various kinds of lighting, of heating, of plastering, and of floors and floor fillings, have kept some of the students busy. "Poisonous colors in clothing," "Bacteria in rags, canned foods, damp walls, shoes, ice," "Modes of disinfecting walls and floors," "How can a polluted well be purified?" are titles taken at random.

Just at present, research is being specially directed to certain minute animal organisms—the microzoa—such as are found in the blood in malaria and in the skin in certain diseases, and to immunity, especially to that immunity which may be artificially produced.

Experimental investigation is a slow process, and very uncertain in its results.

An experiment may be conceived which seems as if it would give important results. The experiment itself would require only a few moments or a few hours if all the apparatus were ready to produce the required conditions, and to record in terms of weight and measure

the results obtained. But to make this apparatus in the best form, and to provide the means of recording, may take a year or more, and in making this preparation a dozen problems will come up to be solved by other experiments. You are pretty sure to discover something new, but by no means sure that it will be what you began to seek. Every discovery opens new questions and indicates new experiments, and the precise shape in which the work presents itself varies with place and season.

We cannot foresee precisely the demands which will be made upon us, or which we shall make upon ourselves, but we do know that we shall want some large rooms in which a dozen or twenty men can be at one time taught how to investigate, working under the eye of an instructor; and also a number of small rooms, each fitted for the work of one or two men who have attained a certain degree of skill, and are engaged in original research. In all of these rooms we shall at times need to use microscopes, gas-heating, and steam; there will be vapors and fumes produced; there will be delicate instruments scattered about, and the rooms must, therefore, be light, have abundance of gas, steam, and water, hoods and flues for conveying away fumes, and they must have plenty of fresh air without dust.

Many of the things that will be seen through the microscopes will be rapidly changing form, and we shall need pictures as well as descriptions of their different shapes.

The most useful drawings for our purposes are those made by sunlight, and, therefore, we want photo-micrographic rooms.

We shall wish to test the merits of various articles of house-equipment, such as different patterns of steam radiators, of traps, of sinks and closets, etc., and for this purpose we must have places where they can be fitted and put into use.

We must know what other investigators in other laboratories, and many places besides laboratories, have done and discovered, that time and effort may not be wasted. We must, therefore, have the books and journals in which these are recorded, which are already many, and coming rapidly. A small library and reading-room is therefore essential.

Much of the apparatus to be used must be either made or specially fitted and adjusted on the spot to meet special indications which it is impossible to foresee, and, therefore, we need a large workshop, with tools and appliances for working in wood, glass, and metal, and with power.

Let us now look for a moment at the plan of the building, and see how all these things, and some other needs, have been provided for. Entering the building from Thirty-fourth Street, on the west front, we find, on the main floor on our right, that part of the building which is more especially intended for the use of those not working in the research rooms, but coming in from the Arts or Engineering and Architectural Departments of the University for special lectures and demonstrations. This contains a lecture-room and class-room, a room for preparing apparatus, etc., for demonstrations, a small museum-room, and the janitor's office. The lecture-room is fitted with various devices for experiments and demonstrations upon different methods of heating and ventilating assembly halls, such as school-rooms, churches, theaters, including means for propulsion or aspiration of air, for introducing and removing it at various levels, etc.

On the left of the vestibule are doors which separate the laboratory and research part of the building from the semi-public portion just described.

Passing through these, we have in front of us the large chemical laboratory in which the students are to be made practically familiar with methods of examining

air, water, foods, soils, etc. Next to it is the balance-room. Then come, on the north front, four special research-rooms, and on the south one research-room and a large drafting-room for the preparation of drawings and plans relating to heating and ventilation, house-drainage, sewerage, and water-supplies.

The radiators in the large chemical laboratory on the north front are each of a different pattern, and so arranged as to permit of the testing of the relative efficiency of each, or to permit of the substitution of other forms for such testing.

Ascending to the second floor, the outlines of which are the same as those of the first, we find, over the chemical laboratory, a large bacteriologic laboratory well lighted from the north, with working places for twenty students.

On this floor are five research-rooms, the photograph and photo-micrographic rooms with dark-rooms, the director's room and private laboratory, a library and a supplies-room.

The basement contains a large, well-lighted workshop, a combustion-room, a cremating furnace, a boiler-room, and an engine-room, and rooms for the janitor.

I will not go into details as to the purposes and uses of the various flues, hoods, pipes, and valves which you will see in every room. It is sufficient to say that they are designed not only for the convenience and use of the workers, but for experiments and demonstrations of many kinds.

The drainage of the building is on a double system, and is so arranged as to permit of the trial of new forms of traps, sinks, closets, etc. All pipes are freely exposed to view, and the different systems for cold water, steam, drainage, etc., are each painted a different color.

When you visit the Laboratory—as I hope you will do not only immediately after these exercises, but many times in the near future—you will see more clearly its

arrangement than you can from a mere inspection of the plans.

As regards the external appearance of the building, opinions will, of course, differ. I will only say that it has been planned from within outward, which is the reason why it looks like a laboratory and not like a castle or a cathedral; and there is very little useless exterior decoration. Sky-lines and projections or recesses to obtain shadows have not received much consideration; space, light, and adaptation to the work to be done have been the points insisted on.

In many respects it affords a striking contrast to the library building in which we are assembled, and it is fit and proper that it should do so. The library represents the garnered experience and wisdom of the past; the laboratory is the workshop of the future. One is fruit, the other is seed.

In this connection I wish to express my high appreciation of the important work of the architects, Messrs. Collins & Autenrieth, of this city, in preparing the plans and specifications for this building and in supervising its construction, and especially to thank Mr. Collins for the many valuable, practical suggestions which he has made as the result of his careful study of our purposes and needs.

So much for the building and its contents as it is, and why it is as it is. The chief object of its existence is to fit a certain number of men from all parts of the country to investigate and solve the problems connected with the securing of the best health and vigor among our people.

We hope, also, that some increase of knowledge will be made here by the workers in the Laboratory itself; but the main point to be kept in view is to provide well-trained, scientific, and practical men for other fields of labor. Dr. Mitchell has said that the true rate of advance in medicine is not to be tested by the work of

single men, but by what the country doctor is. So, also—and even more so—advance in practical sanitation is not to be measured by laboratory records, but by what health officers and sanitary engineers are able to accomplish.

Even now we *know* much more than we *do*, and the skilled sanitarian too often finds himself in the position of the unhappy daughter of Priam and Hecuba, who could foretell, but to no purpose.

This Laboratory is fortunate in being closely connected with, and in the immediate vicinity of, a great medical school, and of great hospitals. As was said before, one of the essential foundations of scientific knowledge of the causes of disease is minute and accurate diagnosis and pathology, and we are, therefore, in constant need of the best knowledge of leaders in these branches of medical science. The hospital is filled with specimens of the results of such causes, acting on the human body—from one point of view, Nature's experiments with poisons cunningly elaborated in the tissues of the body, or with viruses coming from without, upon blood and bone, muscle and brain. Much of the work of this new department will be connected with the results of these experiments.

The Laboratory is also fortunate in being located in a great manufacturing city, where the effects of different occupations, of trades dangerous or offensive by reason of dusts, or of vapors, or of waste-products, can be readily observed and the materials for study obtained. There is an immense field for a sanitary clinic here, and in the habitations, the streets, the water-supply, and the sewers of Philadelphia.

These clinics, however, cannot, as a rule, be reported for the press, either lay or medical, since to do so would, to a great extent, defeat their object; the great majority of sick houses and manufactories must be considered as strictly private patients, and their affairs held as confi-

dential. In the case of public institutions, or of public nuisances, a somewhat different rule may apply.

Practical hygiene is to play an important part in municipal government, to secure the best form of which is now one of the most urgent questions of the day. Many of the questions to be decided by city officials as to water-supplies, sewage disposal, etc., require expert knowledge to answer.

Of course, the subject of hygiene and the work of a University department devoted to the increase and diffusion of knowledge in sanitary science extend far beyond the experiments and demonstrations for which this Laboratory is specifically fitted.

Bacteriology, chemistry, pathology, physics, and medical and vital statistics give us the foundations, but sociology and jurisprudence must also be studied in their relations to sanitation to obtain the best results.

It is in and to the home and the workshop that these results are to be applied, and he who aspires to be his brother's keeper must know how his brother lives.

Labor questions, education questions, maritime and inter-State commerce questions, and methods of municipal finance and government are all intimately connected with matters of personal and public hygiene; and economic consequences, as well as health, must be considered in the advice and regulations of the sanitarian.

I count it as fortunate, therefore, that there is a law school and a school of finance and political economy in this University to which the Department of Hygiene can look for advice and friendly criticism when these are needed, as they surely will be.

And now a very few words as to the needs of the Laboratory. First of all it needs men—men thirsting for knowledge, and fitted by previous training and education to come here and acquire that knowledge, not merely the knowledge that exists in books or that the

teachers in this Laboratory may possess, but that which is yet unknown, the weight of that which no one has yet put in the balance—the shape, and size, and powers for good or evil of things the existence of which has not yet been demonstrated—men who will patiently and earnestly seek the answers to the questions, “what?” “when?” and “how?” in the hope that thus they may by-and-by obtain some light upon the more difficult problems of “whence?” and “whither?” even if they may never be able to answer “why?”

There are not many such young men whose tastes will be in the direction of these lines of research, and of these there will be very few who will have the means to support themselves while engaged in the work. We need, therefore, the means to help them in the shape of half a dozen fellowships, paying about five hundred dollars a year each, and granted only to those who give satisfactory evidence of capacity and zeal.

The second thing we want is a demand on the part of the public for really skilled, well-trained sanitary investigators and officials, such as we hope to send out from here; we want a market for our product; we want the legislators of this and other States, and of our rapidly growing municipalities, to be educated to appreciate the importance and practical value of such health officials, and to give the best of them employment.

Thirdly, the Laboratory wants the coöperation and assistance of sanitary authorities and inspectors, and especially of those of this city and State.

It needs to know from time to time what they are interested in and are working at, to have the opportunity of showing to its students cases of special interest—sick houses, localized epidemics, special forms of nuisance.

And, on the same principle and for the same reasons, it desires to have its attention called to special methods of heating, ventilating, and draining buildings, and especially public buildings, such as schools, hospitals,

prisons, churches, and theaters, and to matters connected with the hygiene of manufacturing establishments and special occupations, methods of disposal of offensive or dangerous waste-products, of protecting workmen against dusts, gases, etc.

In short, we want to know how these things are managed by the men who have a practical interest in them; and if, in our turn, we can suggest improvements, we shall be glad to do so.

Fourth, the Laboratory wants a reference library as complete as it can be made, and always up to date. Many of the books and journals required must be purchased, and for this purpose a special fund is needed, but many of the works required can only be obtained by gift.

Thus, we want all the reports of boards of health—State and municipal—of municipal engineers, water-works and water commissioners, park commissioners, etc.

We want the catalogues and circulars of all manufacturers of heating and ventilating apparatus, of plumbers' supplies and house fixtures, of electric and gas fixtures, of machinery and apparatus connected with water-supply and sewage-disposal.

We want copies of plans and specifications of large buildings of all kinds.

And these things can only be obtained through the aid and good-will of manufacturers, engineers, architects, and sanitarians all over the country; and this aid I venture to ask, feeling sure it will be granted by those who know what is wanted.

I will mention but one more special want to-day, and that is of means for the proper publication of illustrated reports and accounts of the work done in the Laboratory.

In the meantime we must be patient, and not too eager to touch the fruit of the blossom that is not yet blown.

In the chambers of this Laboratory are to be explored and tested some of the strangest and subtlest of the manifestations of force which surround and are within us.

Here we are to deal with problems of life and death ; to seek to unravel some of the webs which bind and choke our children, and which make our strong men helpless, that we may for a time, at least, put these trammels aside, or sever them.

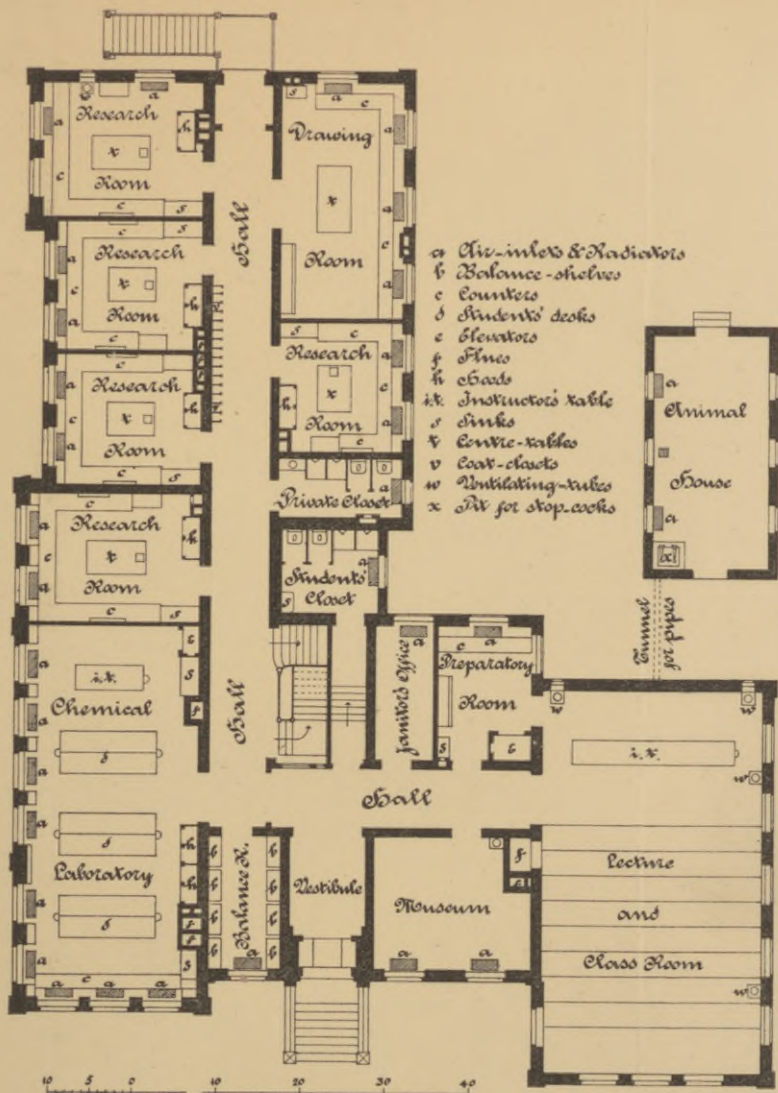
I dare not attempt to promise or to prophesy as to the work which will be done here, or as to the future of this new department of the University.

Those who are to be connected with it may not do the best that can be done, but at least they must do the best they can, and, if needful, give place to others who can do better.

Those to whom we owe this Laboratory and its equipment and endowment, have been generous and wise in their generosity, which has been in accord with the teaching of the son of Sirach, "Having grace in the sight of every man living, and detained not for the dead."

Death comes by many paths to one or other of the three porches of the microcosm through which he enters, and brings his poppy flowers to all doors soon or late ; but if we knew that which we might know, and did that which we might do, he would be preceded by fewer heralds of suffering, and would arrive only when we were ready to be "hushed in the infinite dusk."

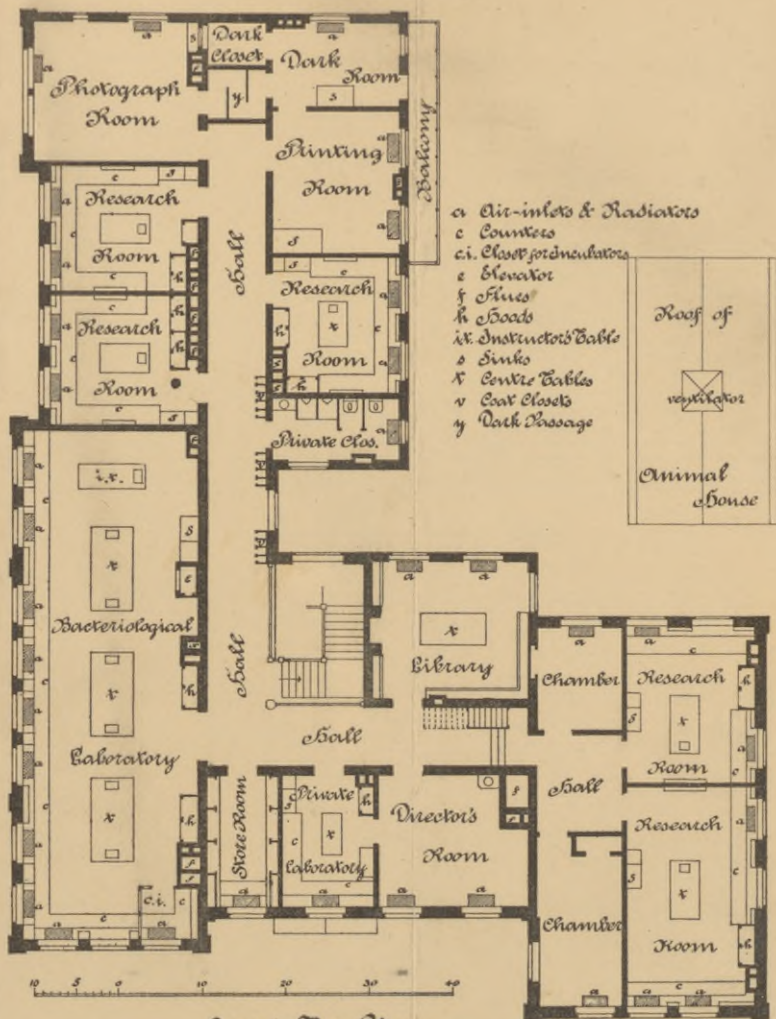
If "ye shall know the truth, the truth shall set you free"—not free from change, or from grief, or from the final passage beyond the veil, but free from causeless fears, from unnecessary pain, from useless labor ; and this is a part of that wisdom "which passeth and goeth through all things," and is "the brightness of the everlasting light, the unspotted mirror of the power of God."



First Floor Plan

Collins & Antonietti,
 Architects,
 410 Walnut St. Phila.

Laboratory of Hygiene,
 University of Pa., Phila.



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