INSTITUTE OF PHYSIOLOGY UNIVERSITY OF COPENHAGEN

BY

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PROFESSOR OF ZOOPHYSIOLOGY

The Institute of Physiology of the University of Copenhagen built during the years 1926–28 on a site very close to the "Rigshospital" and the medical institutes for general pathology, pharmacology, and morbid anatomy provides accommodation for the following five institutes and laboratories: the Institute of Medical Physiology and the Institute of Biochemistry in the School of Medicine; and the Laboratory of Biophysics, the Laboratory for the Theory of Gymnastics, and the Laboratory of Zoophysiology in the Science School.

While retaining complete independence these laboratories have a number of facilities and installations in common and have arranged for mutual support on several points. They have in common one large and one small lecture-theater, a library with bookbinding shop, a large photographic studio, and a lunch-room for the workers. The engineering installations in the sub-basement are also used in common and the workshops of the four laboratories are placed in pairs to economize machinery and to facilitate cooperation.

Figure 2 shows the site and the arrangement of the main and accessory buildings; Figures 3–5 are floor plans of the main building showing the distribution of rooms.

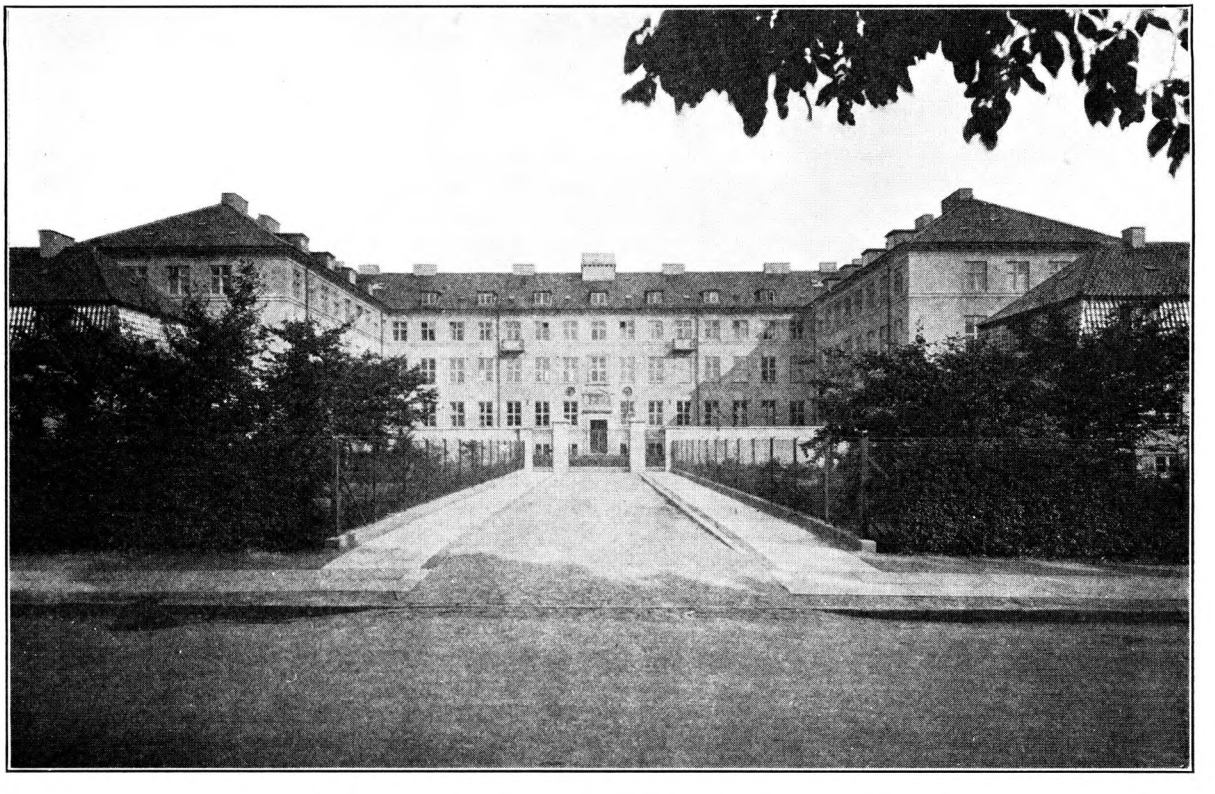

FIG. 1.—INSTITUTE OF PHYSIOLOGY, UNIVERSITY OF COPENHAGEN

These plans were worked out from the point of view of making the rooms and installations in common as easily accessible as possible. The large lecture-theater is in direct communication with the laboratories of medical physiology, biochemistry, and biophysics, who use it daily, while the laboratories of gymnastics and zoophysiology generally use the smaller lecture-room.

The building is arranged on the central corridor plan with unit rooms. The dimensions are as follows: height: sub-basement 2.00 m, basement 3.00 m, first floor 4.00 m, second floor 4.00 m, third floor 3.15 m; width of corridors 2.20 m; depth of rooms 4.81 m in basement, increasing to 4.93 m on the second floor. The unit room is 2.50 m wide with one double window of the Swedish type, 1.50 m broad and 2.50 m high. The window sill is at 1.08 m above the finished floor.

As seen from the plans the unit system is not at all strictly adhered to.

The floor areas of the laboratories are approximately as follows:

	Square meters
Institute of Medical Physiology	1,300
Institute of Biochemistry	900
Laboratory of Biophysics	700
Laboratory for Theory of Gymnastics	275
Laboratory of Zoophysiology	800
Lecture-rooms	185
Library, photographic studio, lunch-room, etc.	180
Corridors, etc.	550

The third floor of the main building is mainly occupied by apartments for two of the professors and a number of assistants in the laboratories.

It is a special feature of this Institute that most of the laboratories have guest rooms to accommodate scientists from abroad during their period of work in the Institute.

All supporting walls are of brick, but many of the partitions are of wood. The walls are plastered and painted. The horizontal partitions between the basement, first, and second floors are of reinforced concrete. To facilitate the use of the ceilings for the support of apparatus a number of suitably distributed flanged tubes with internal screw-threads were let into this concrete during construction.

In most of the laboratory rooms the floors are covered with ⅛ inch (3 mm) sheet rubber laid on a 3 cm layer of cork cement. This floor covering has so far proved quite satisfactory, being resistant to most chemicals and agreeable and almost noiseless to walk on. The construction as a whole has proved unsatisfactory, in so far as the noise from motors and machines is transmitted over long distances through the building.

EQUIPMENT

High pressure steam (10–12 atm.) is supplied from the power house of the "Rigshospital" through two pipes of 5 and 10 cm diameters respectively. Of these the smaller is used alone in the summer and in winter during the night. The general heating in winter is brought about by circulation of hot water through radiators placed in the niches below the windows and isolated from the walls by cork plates. In several rooms there are radiators supplied with automatic regulation securing a nearly uniform temperature. The general heating system is closed down in the summer, but low pressure steam is available to heat special rooms all the year round.

Natural ventilation is provided through shafts from each room combined into groups in the walls of the corridors and carried up to outlets on the roof. Forced ventilation can be resorted to when necessary. Blowers installed in the sub-basement can force air into the corridors whence it can be directed into any room or set of rooms desired through the transom windows above the doors. In winter this air is suitably heated. This system is in regular use and indeed is a necessity in the large lecture-theater (where the air is let in under each seat) and in the large laboratory for practical classes in biochemistry, but in the research rooms it is rarely used and could probably be dispensed with.

The fume cupboards provided in most of the rooms are of the ordinary type with a sliding front; one of the glazed sides can be opened as a door. They are connected with the ventilating shafts through two shuttered openings, in the lower of which a Bunsen burner can be placed for ventilation. In a small number of fume cupboards artificial suction is provided by a fan (0.4 h.p. motor) placed in the attic, but controlled from a switch at the fume cupboard itself. The fume cupboards are as a rule provided with gas, compressed air, and water; a few also receive low pressure steam.

Cold water is let in from two different mains of the city system in order to avoid as far as possible interruptions in the supply. The Copenhagen water coming from deep wells is of very uniform temperature throughout the year; it is practically free from organic impurities but is rather hard (35 parts of $CaCO_3$ in 100,000). This hardness has proved fatal for the working of the hot-water system, the temperature of which can be raised only to 55° C. without endangering the pipes by incrustation. The hot water which is supplied generally to one sink in each room is therefore of little use for laboratory purposes. It is intended to put in a permutit filter to soften the water so that its temperature can be raised. The hot water is supplemented by low pressure steam which is far more useful, but unfortunately this is available only in a few places throughout the building.

To supply the Institute with "distilled" water an

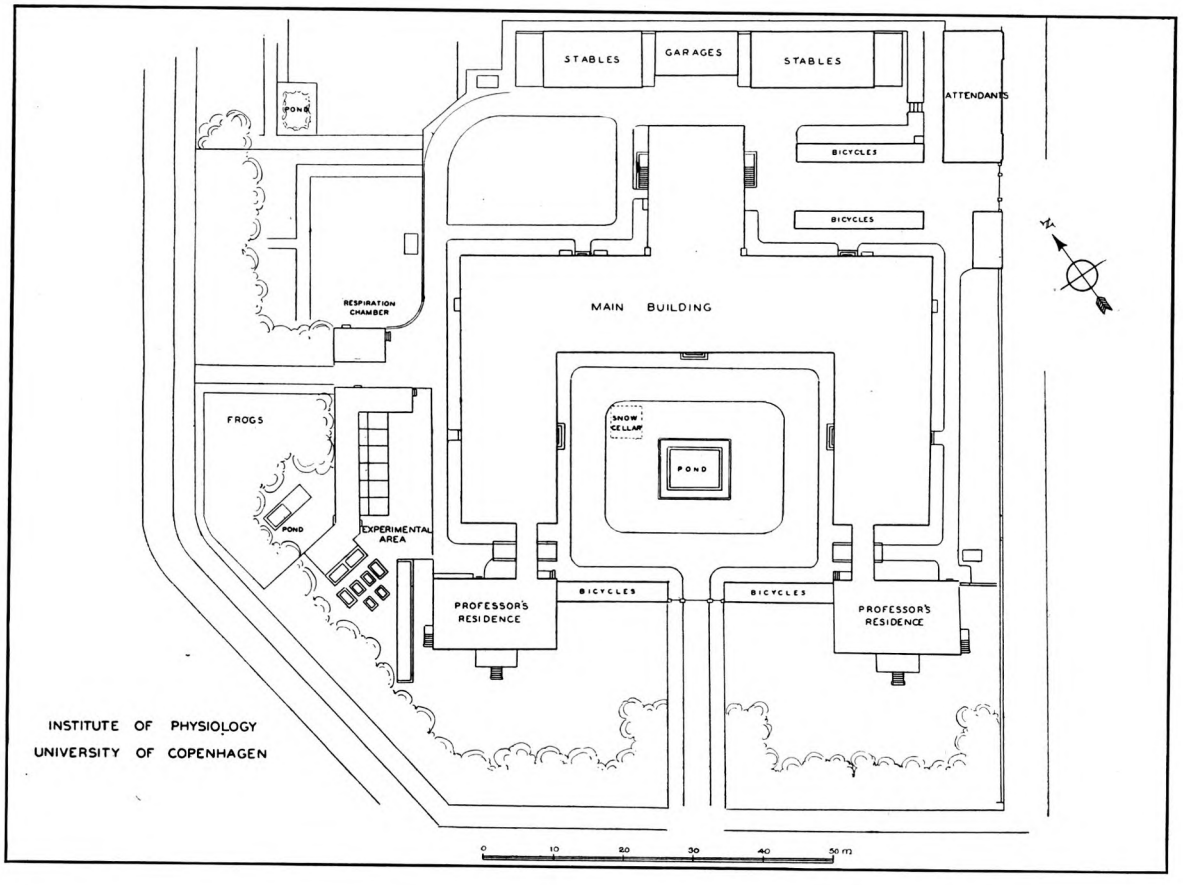

FIG. 2

electroosmotic plant of 25 liters capacity per hour was installed in a room in the attic. The water is collected in two hardware tanks each of 175 liters capacity and carried through aluminum pipes to a small number of taps in the different laboratories. The working of the electroosmotic apparatus has, however, been unsatisfactory and a steam-still with quartz cooling tubes has been installed instead.

Sinks are provided in most of the rooms. These are of several types, but in most cases large acid-proof sinks of white stoneware are installed. A new type of sink has been designed and appears to be very useful especially for cleaning purposes. It is made from "martinite" (artificial slate) in a framework of teak and the inside is completely covered with rubber vulcanized on to the martinite.

In addition to the sinks there is generally a waste pipe of 4 cm diameter with vertical tubes of 17 cm length and 2.7 cm in diameter at suitable intervals running along the wall at the level of the wainscoting, but with a slope of 1 in 300 and ending over a sink in the floor or in a room below.

Gas is provided from the city supply. As the gas pressure varies from 7 to 10 cm, pressure regulators have been put in, but have proved rather inefficient.

Electricity is supplied from the city as 220 volt direct current. The difference in price of electricity for light and power purposes has necessitated the installation of separate meters, wiring, and contact points which have to be different on the two systems. The availability of the current for laboratory purposes is thereby considerably reduced. From the laboratory of biophysics special circuits carrying current at 2, 4, and 6 volts are run to a certain number of terminals in the laboratories and on another circuit alternating current at 127–220 volts and with fifty periods per second, or accumulator current at from 10 to 120 volts in intervals of 10 V. can be supplied.

There is an automatic internal telephone system common to all the laboratories and a system of electric clocks driven from a central clock in the biophysical laboratory. This is arranged also to signalize seconds over the wires for variable current.

Air is compressed by the automatic machine described

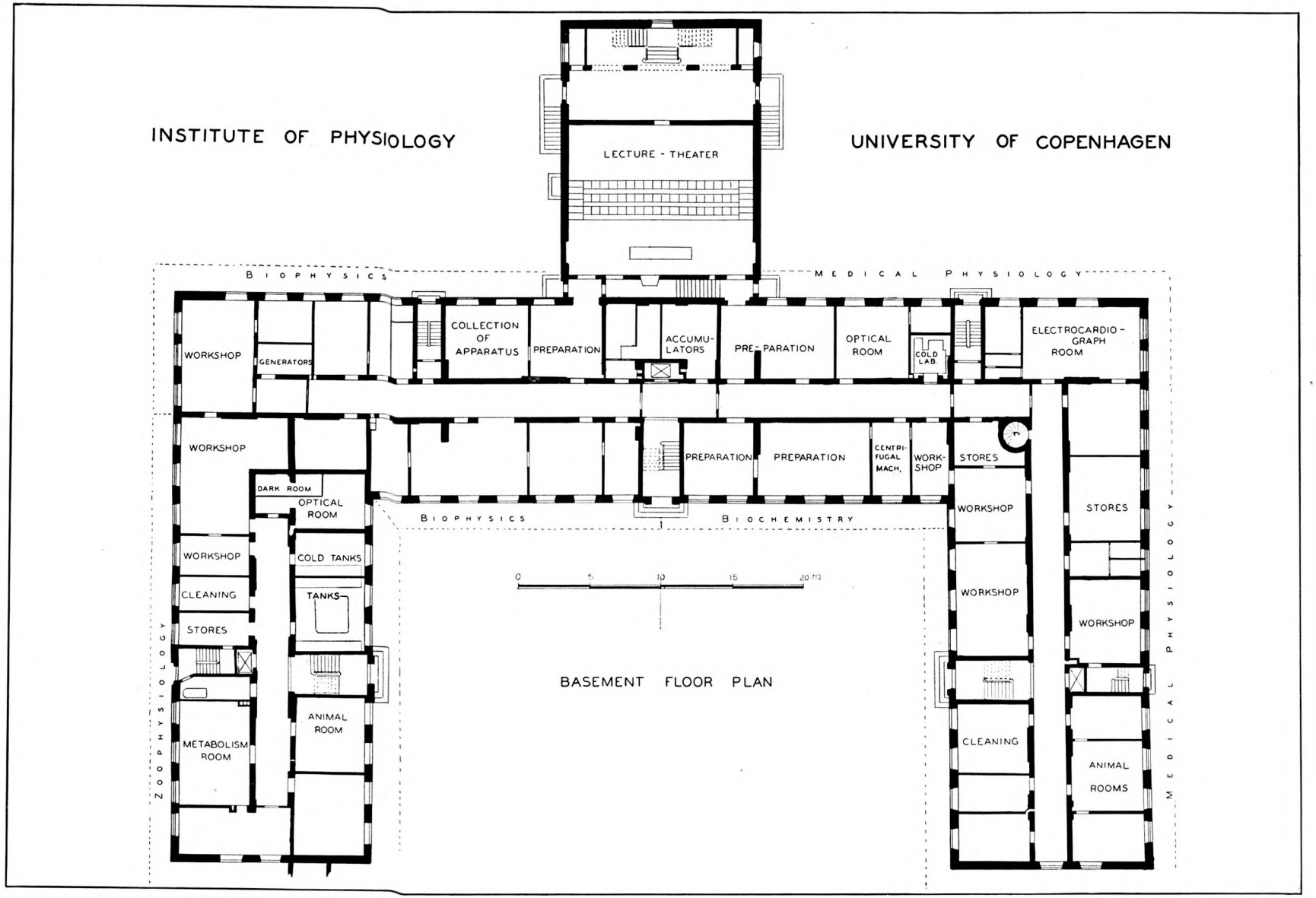
INSTITUTE OF PHYSIOLOGY
UNIVERSITY OF COPENHAGEN
LECTURE - THEATER
BIOPHYSICS
MEDICAL PHYSIOLOGY
WORKSHOP
GENERATORS
COLLECTION OF APPARATUS
PREPARATION
ACCUMU-LATORS
PRE-PARATION
OPTICAL ROOM
COLD LAB.
ELECTROCARDIO-GRAPH ROOM
WORKSHOP
DARK ROOM
OPTICAL ROOM
PREPARATION
PREPARATION
CENTRI-FUGAL MACH.
WORK-SHOP
STORES
WORKSHOP
STORES
BIOPHYSICS
BIOCHEMISTRY
WORKSHOP
COLD TANKS
CLEANING
TANKS
WORKSHOP
STORES
ZOOPHYSIOLOGY
ANIMAL ROOM
METABOLISM ROOM
CLEANING
ANIMAL ROOMS
MEDICAL PHYSIOLOGY
0 5 10 15 20 m
BASEMENT FLOOR PLAN

FIG. 3

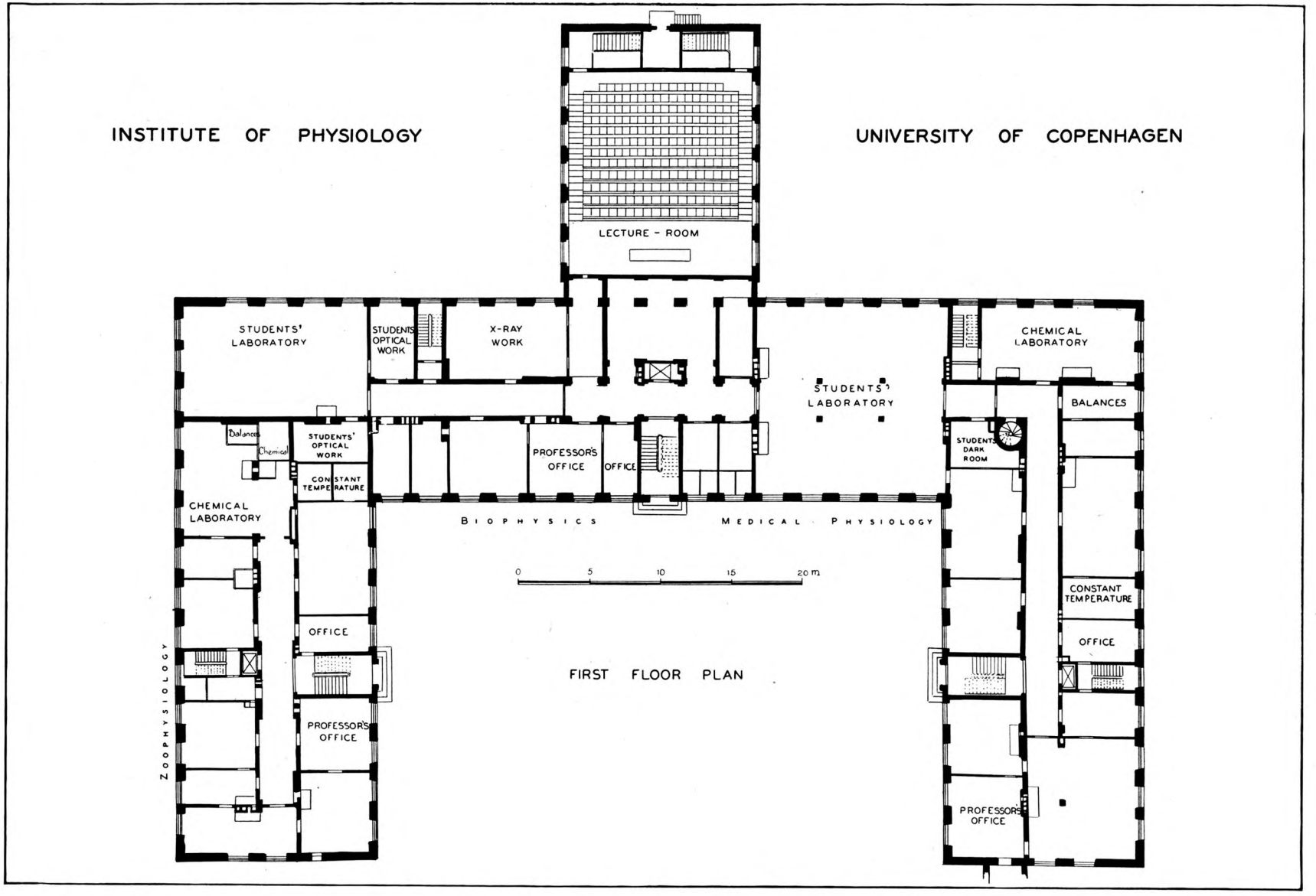
INSTITUTE OF PHYSIOLOGY
UNIVERSITY OF COPENHAGEN
LECTURE - ROOM
STUDENTS' LABORATORY
STUDENTS' OPTICAL WORK
X-RAY WORK
STUDENTS' LABORATORY
CHEMICAL LABORATORY
BALANCES
STUDENTS' DARK ROOM
Balances
Chemical
STUDENTS' OPTICAL WORK
CONSTANT TEMPERATURE
PROFESSOR'S OFFICE
OFFICE
CHEMICAL LABORATORY
BIOPHYSICS
MEDICAL PHYSIOLOGY
0 5 10 15 20 m
CONSTANT TEMPERATURE
OFFICE
OFFICE
FIRST FLOOR PLAN
PROFESSOR'S OFFICE
ZOOPHYSIOLOGY
PROFESSOR'S OFFICE

FIG. 4

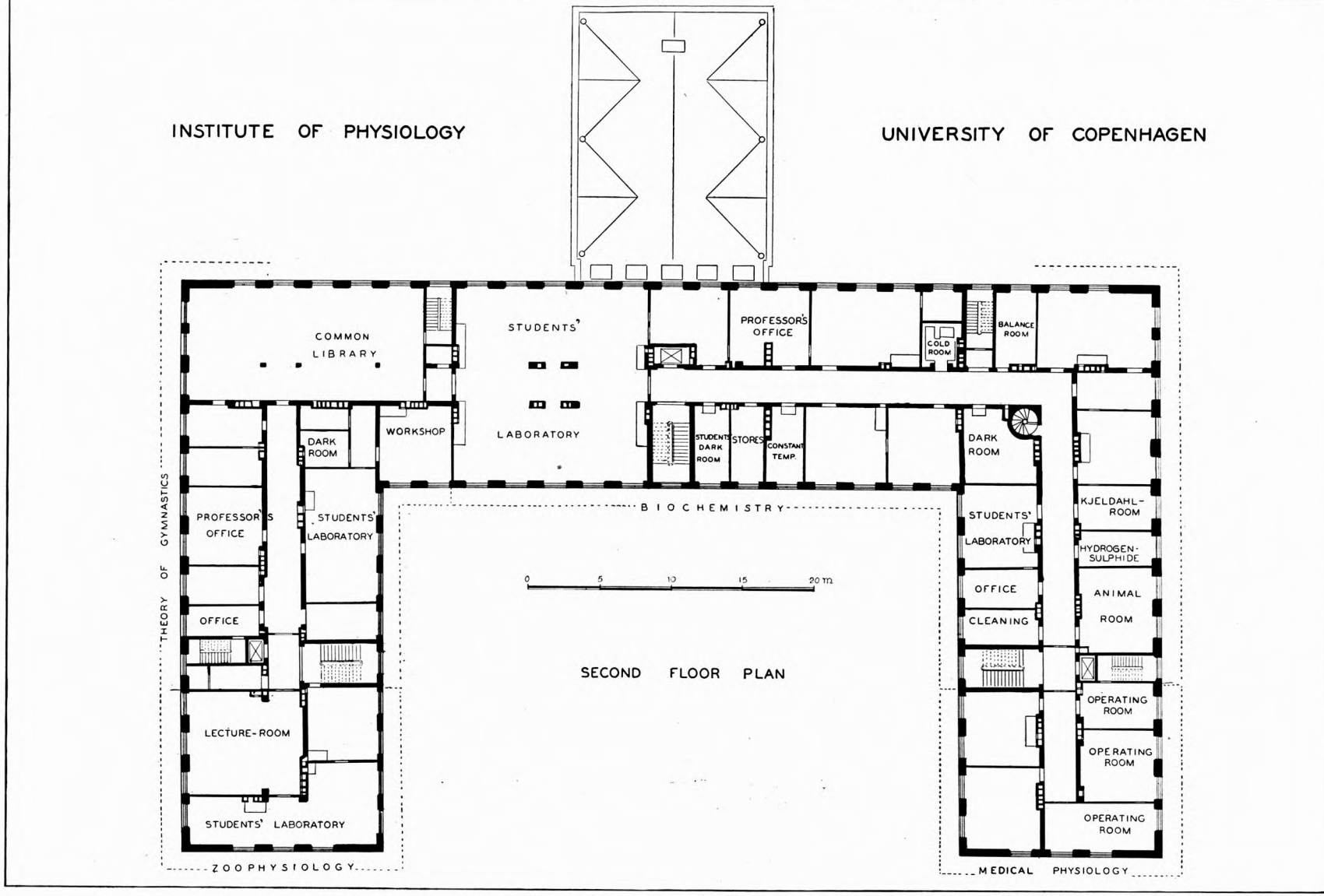
INSTITUTE OF PHYSIOLOGY
UNIVERSITY OF COPENHAGEN
COMMON LIBRARY
STUDENTS'
LABORATORY
PROFESSOR'S OFFICE
COLD ROOM
BALANCE ROOM
DARK ROOM
WORKSHOP
STUDENTS' DARK ROOM
STORES
CONSTANT TEMP.
DARK ROOM
PROFESSOR'S OFFICE
STUDENTS' LABORATORY
BIOCHEMISTRY
KJELDAHL-ROOM
HYDROGEN-SULPHIDE
STUDENTS' LABORATORY
OFFICE
ANIMAL ROOM
CLEANING
OFFICE
0 5 10 15 20 m
SECOND FLOOR PLAN
LECTURE-ROOM
OPERATING ROOM
OPERATING ROOM
STUDENTS' LABORATORY
OPERATING ROOM
THEORY OF GYMNASTICS
ZOOPHYSIOLOGY
MEDICAL PHYSIOLOGY

FIG. 5

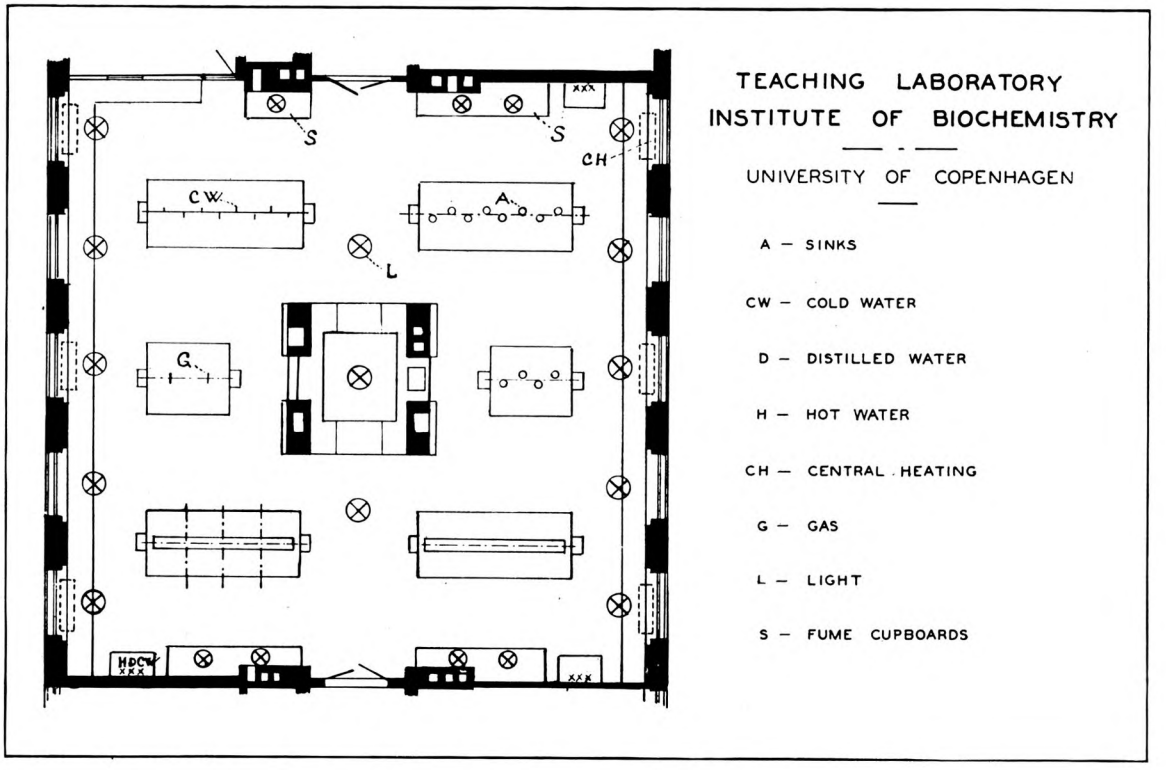

FIG. 6

by Krogh[1] to a pressure of 100 cm of water above the atmospheric and delivered through pipes to almost all the rooms in the laboratories. There are two machines, one supplying the laboratories of the Science School and another for the two medical institutes. In case of breakdown either of these can supply the whole building.

There is no general vacuum installation. We prefer to rely on local vacuum production and with the high water pressure (3–4 atm.) available, generally employ filter pumps.

The general equipment of the laboratory rooms is shown in Figure 7. It is arranged on the principle of easy adaptability to any laboratory purpose and only a comparatively few rooms have been designed and equipped for a definite and limited kind of work. Cold water, gas, and compressed air are carried in horizontal pipes along the walls at a height of 0.93–1.05 m above the floor. The water-taps are turned upwards and provided with interchangeable fittings. The vertical tube of a secondary waste-pipe is just below each water-tap and can be connected with a movable sink. The compressed air pipes, and in several rooms also the gas pipes, allow the insertion of extra taps which can be screwed directly into the wall of the pipe wherever required. The arrangement of the pipes is not entirely satisfactory. When the air is damp, moisture will condense on the cold water pipes and may drip on to the tables. The water pipes should therefore have been at a lower level below the bench tops with vertical side tubes connecting with the taps. The pipes for compressed air should have been the uppermost and the gas pipes just above the benches.

The rooms are lighted by Zeiss bell-shaped lamps (Fig. 7) which have been selected after an exhaustive trial. Generally there is one lamp for each unit placed in front of the window at a height of 3.60 m and 55 cm from the wall so as to give a maximum light on the bench which is normally placed here. Smaller lamps are placed over fume cupboards and over sinks placed at the back of the rooms. In each unit one electric point for light and one for power is generally placed near the window, while one or two more are distributed elsewhere in the room. The power points are provided with interchangeable plug fuses which can also be changed for carbon filament lamps acting as resistances.

Figure 7 shows also our "universal pendant" carrying down from the ceiling to 2.0 m above the floor in the

[1] Eine einfache automatische Druckluftinstallation und einige Anwendungen der Druckluft. *Zeitschr. f. biol. Techn.* 3, 1913.

center of the room electric power, light, gas, and compressed air, and generally also water, in which case a secondary waste pipe opens in the floor below.

The benches are movable and interchangeable. They are built up on unit cupboards. These are of two types differing only in height and giving benches 82 and 90 cm high respectively. The drawers are all interchangeable. In many of the laboratories drawplates are arranged between the bench top and the cupboards.

The large lecture-theater is used in common by the institutes of medical physiology and biochemistry whose preparation rooms are situated to the right of the theater and the laboratory of biophysics whose preparation and collection rooms are situated to the left.

The lecture-theater with an area of 12.8 by 13.9 meters and a height of 8 meters has accommodation for 228 students. It is situated in a special wing two stories high (basement and first floor) in the middle of the main wing of the building. The students' entrance is in the rear with cloakroom in the basement and entrance to the amphitheater one story up.

The lecture-theater has good facilities for every kind of demonstration. In the rear in a special room, separated from the theater to cut off a fire, is placed a lecture cinematographic apparatus with stop and back motion which can be controlled also from the lecturer's platform. Another projection apparatus (episcopic and diascopic) is placed in the front part of the theater where also are found arrangements for projecting experiments. The blackboard (4 by 2 meters) is moved hydraulically and the same kind of motion is used also for the darkening curtains and projection screen. The large blackboard is made of wood in an iron frame and covered with a special Danish blackboard covering. The wall behind the blackboard, which has the same covering, can be used as a supplementary blackboard.

The lecture-theater has every kind of electric supply with high-power resistances, large demonstration ammeters and voltmeters for direct and alternating current, and a sensitive galvanometer. The desk has, besides electricity supply, cold and hot water, steam, compressed air, gas; and behind the blackboard is a fume cupboard with artificial suction.

The acoustics of the lecture-theater have been corrected by covering part of the walls with "celotex" and the ceiling with a special porous plaster. Though for architectural reasons the covered area is somewhat smaller than demanded by the theoretical calculation, this has proved very effective.

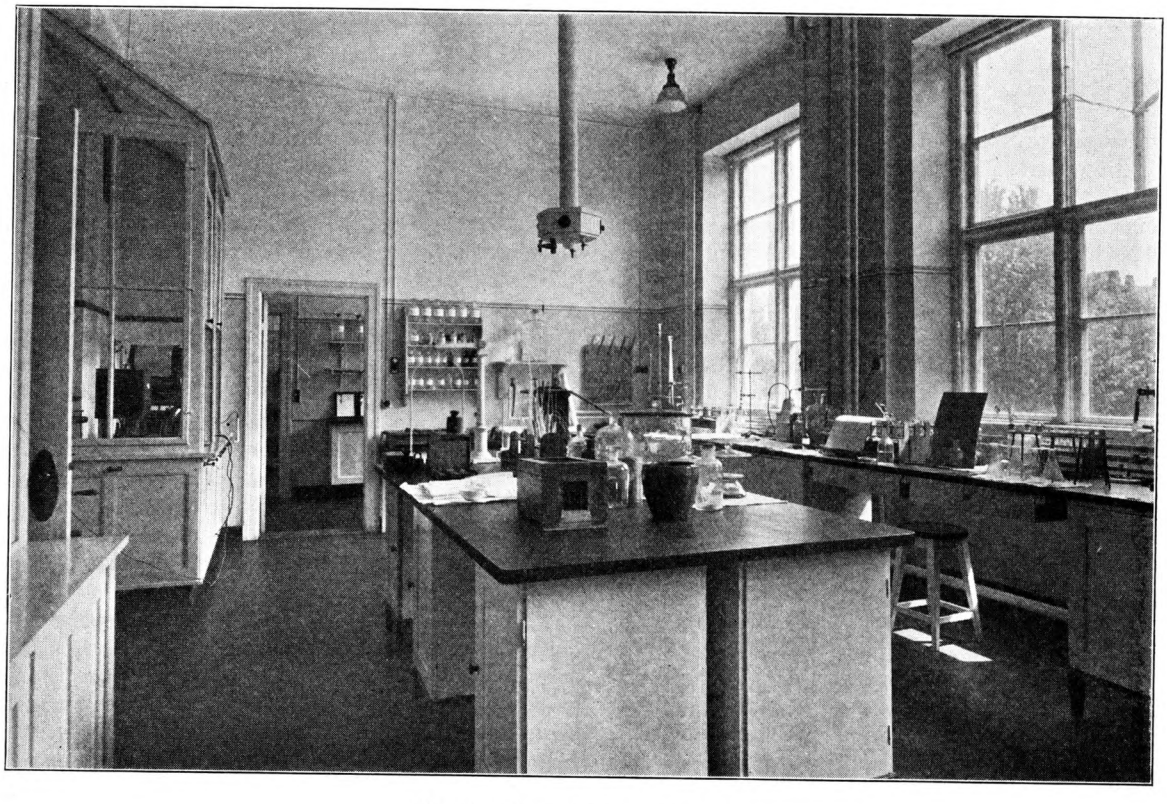

FIG. 7.—RESEARCH LABORATORY

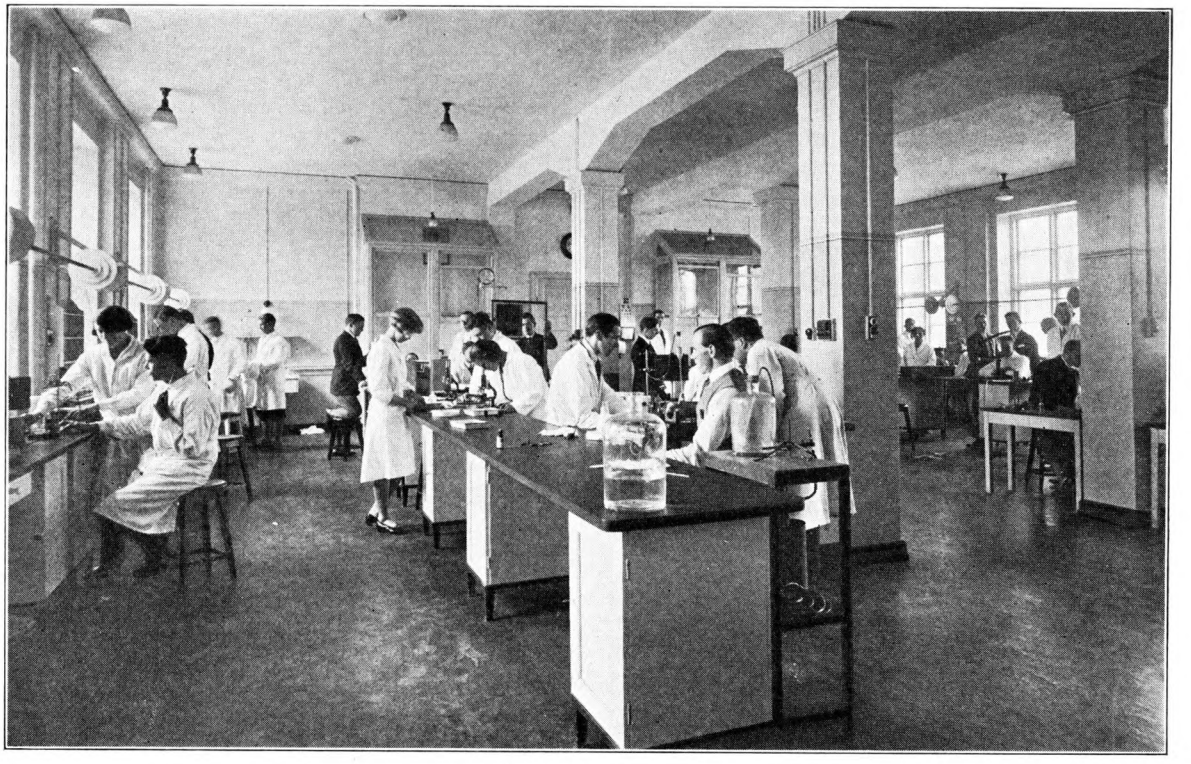

FIG. 8.—TEACHING LABORATORY, INSTITUTE OF MEDICAL PHYSIOLOGY

The small lecture-theater is on the second floor in the northwest wing and is used mainly by the laboratories for gymnastics and zoophysiology. It is 8 by 7.12 m and accommodates a maximum of fifty students. The desk is on a platform 0.32 m in height. It is provided with the usual facilities for demonstration of experiments and an apparatus for the projection of slides and microscopic preparations is built into it. Cinema projection is provided for by a portable apparatus.

The library and reading-room on the second floor in the main wing has a floor area of 7.75 by 10.75 m with 213 m of bookshelves. The library subscribes to current journals. All reprints received by the departments or their heads are put into circulation and reprints from journals which are in the library are given to the workers most interested in them, while all others are indexed and placed in the library. A bookbinding shop is placed in the attic.

INSTITUTE OF MEDICAL PHYSIOLOGY

The object which the Institute of Medical Physiology has in view is scientific research and teaching of physiology to medical students. The number of medical students who begin the study of this branch of science every year is about one hundred and twenty. As the time which the students devote to physiology generally amounts to three years, there will continually be about 360 students who partake in the instruction imparted in the department. This instruction consists, partly, in lectures and, partly, in practical experimental work. In the course of experimental physiology which is held every year, the students are given the opportunity of independent performance of a series of experiments within the different branches of physiology, partly in the form of animal experiments and partly in investigations which they can carry out with their fellow students as subjects.

Besides the professor, the staff of the department consists of three scientifically trained assistants, one office clerk, and two laboratory attendants, one of whom is a trained joiner and the other a trained mechanic.

The department provides room for scientifically interested young physicians and there are three guest rooms which can be placed at the disposal of foreign workers.

The annual budget of the department amounts to 8,000 kroner, besides the sums necessary for electricity and gas supply and for cleaning.

The Institute of Medical Physiology occupies the entire basement and first floor of the southeast wing besides the adjacent half of the first floor of the middle

wing and five rooms on the second floor of the southeast wing. These rooms are fitted up in the same uniform manner which characterizes the whole institute. With a few exceptions, the separate rooms are fitted up with a view to being used for more than one purpose, as occasion may require.

The basement contains both a joiner's and a mechanic's workshop, cleaning rooms, centrifuge rooms, distilling rooms, rooms for experimental animals, and, besides, an electrocardiograph room with an adjoining dark room. The basement also contains a few laboratories with the usual laboratory equipment.

Further, the basement contains a refrigerating room, consisting of two chambers, i.e. a smaller one resembling a locker in which the temperature can be reduced to 15° C. below zero, and in front of this, a larger one in which the temperature can be reduced to 5° C. below zero. The area of the latter measures 2 m², and it is provided with gas, water, and electric contacts and thus permits of carrying out experiments of various descriptions.

The first floor contains a large number of laboratories, but only a few of these are appropriated to certain particular purposes, such as, for instance, gas analyses, titration, and weighing. One of the smaller first floor laboratories is fitted up with thermostatic control in which temperatures varying between ordinary room temperature (about 20°) and 40° C. can be maintained. This laboratory, as well as several others, is fitted up with shafts driven by motors at a man's height along the walls so that the power for pumps, gas meters, or kymographs and the like, is easily accessible.

The middle wing of the first floor contains the large teaching laboratory (Fig. 8) in which are held experimental courses for the students. In connection with this laboratory, there is a large dark room which is used for polarimetry and colorimetry as well as for ophthalmoscopy and the like.

The teaching laboratory is provided with shafts driven by motors along the two longitudinal walls, where there is space for twelve kymographs. At each of these, two students work together. Each working place is provided with gas, compressed air, and electric power of 220 watts as well as of 2, 4, and 6 volts. The center of the teaching laboratory is occupied by tables on which are placed the instruments required for tests, which the students carry out on their fellow students as subjects, such as plethysmography, pulse tracing, determination of the basal metabolic rate, etc. The

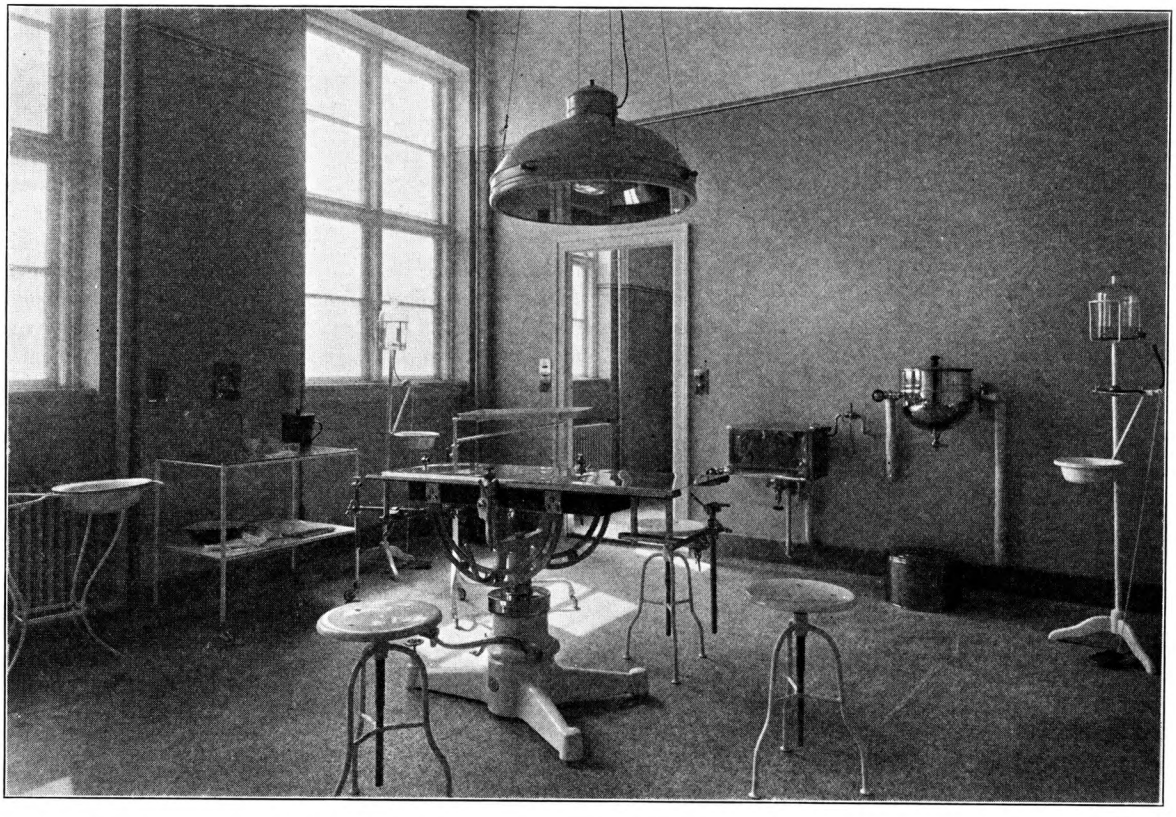

FIG. 9.—OPERATING ROOM, INSTITUTE OF MEDICAL PHYSIOLOGY

maximum number of students who can work simultaneously in this laboratory is forty.

The second floor of the southeast wing is occupied by the operation department. This consists of an anteroom for cleaning and narcotizing the experimental animals, the operation room proper (Fig. 9), and a sterilization room. The latter is provided with an autoclave, a dry sterilizing oven, and an oven heated by steam for the sterilization of instruments. The sterilization room is also provided with wash-basins for the operators.

The fitting up of the operation room corresponds to that of any of the larger surgical services. However, the operating table is constructed with a view to its particular purpose and its surface can be heated by means of electricity. In addition the operation room is fitted up with the ordinary electric installations used in most laboratories.

Besides the operation department, the second floor contains two laboratories, one of which is devoted to histological research, while the other, which is provided with a shaft driven by motor and the usual modern laboratory devices, is mainly used for metabolic research.

The department is provided with stables large enough to hold large experimental animals such as horses. In connection with the stables are pens for dogs and rabbits.

Professor V. Henriques is director of the Institute of Medical Physiology.

INSTITUTE OF BIOCHEMISTRY

The Institute of Biochemistry teaches biochemistry to the medical students who study physiology and anatomy simultaneously. The total number at any time is about 360.

The permanent staff consists of the professor, two scientific assistants, one of whom acts also as a clerk, and one attendant.

The annual official budget available for laboratory purposes is 6,400 kroner.

There are five rooms in the basement; namely, the mechanic's and the joiner's workshops, a room for the large centrifuge, and two preparation rooms. One of the preparation rooms is designated for the preparation of experiments to be demonstrated during the lectures; it is directly connected with the large lecture-room and the table on which the experimental fittings, etc. are placed can easily be rolled into the lecture-room. The other preparation room, which corresponds to three units, is designated for chemical work on a large scale.

The main biochemical laboratory is on the second floor. There is a large teaching laboratory with working places for forty students (Fig. 6). As the course is given four times a year 160 students can be accommodated annually. Each working place is provided with a set of chemicals, water, gas, and a sink. On tables along the window fronts special experiments can be performed.

In connection with the large teaching laboratory there is a weighing room and a dark room for the students; further a preparation room, where the preparatory work for the course is carried out.

A smaller laboratory with room for twelve students only, is used for advanced and special courses.

The rest of the rooms are equipped for research and are used by the staff and guests. They are furnished in accordance with the general design of the whole institute, special installation and special fittings being employed as an exception. The majority of the larger rooms have steam pipes which have proved very useful.

Among the rooms equipped for special purposes, such as weighing room, Kjeldahl and H_2S rooms, should be mentioned a refrigerating room fitted up like a small laboratory, with water, gas, compressed air, etc., so that one is able to carry out the entire experimental technic, centrifugations, etc., at a temperature of about 0°. Corresponding to this room, there is a larger one which can be adjusted to a constant, high temperature (37° C.).

Finally, there is a large dark room for polarization, colorimetry, etc.

To the Institute belong stables for animals; for the animals under experimentation, there are also rooms in the laboratory proper, and the large flat roof of the lecture-theater, which is directly connected with the rooms of the biochemical institute, is employed for animals under experimentation when it is desired to keep them in the open air.

Professor R. Ege is director of the Institute of Biochemistry.

LABORATORY OF BIOPHYSICS

The purpose of the Laboratory of Biophysics of the University of Copenhagen is to teach physics to students of medicine and to some students of natural history. The present enrolment is about 220 students of medicine and twenty students of natural history each year. The special facilities of the laboratory are also used for the teaching of advanced students of physics (four to five per year).

For research purposes the laboratory is equipped for most kinds of biophysical work, especially for work concerning x-rays, radioactive substances, and light. The laboratory is in close cooperation with the Finsen Institute of Medical Light Treatment and the Radium Institute of Copenhagen and thus has access to considerable quantities of radium emanation.

The laboratory is cooperating with the Danish x-ray therapists to secure the use of the international x-ray

unit of dosage all over the country by paying regular visits to the different x-ray departments.

The permanent staff comprises the professor, three scientific assistants (two full-time, and one half-time), one half-time clerk, one mechanic, and a boy in the workshop.

The annual budget available for laboratory purposes amounts to 6,400 kroner plus about 2,000 kroner from the students besides the sums necessary for electricity and gas supply and for cleaning.

The rooms (compare the plans) are situated in the basement and first floor in the western part of the middle wing. Besides the rooms shown in the plans the laboratory has two rooms in the sub-basement for work requiring very solid foundations or constant temperature.

The general equipment of the laboratory rooms is as described before. Of the rooms only a few present special features. The large teaching laboratory with two small adjacent dark rooms for optical work has accommodation for twenty-four students and is used every day. For research purposes eight to nine rooms are available.

The large x-ray room in the first floor (Fig. 4) is equipped with a special Siemens "Polyphos" apparatus which can give constant high tension from very low values up to 220 KV (the Greinacher arrangement with two condensers in series and two rectifying tubes) as well as rectified non-constant high-power tension up to 110 KV (four rectifying tubes). This apparatus is placed in an adjacent room from which the high tension can also be used in the large lecture-theater. As the switchboard table cannot be taken into the theater we have a special telephone connection to this table and ammeters in both places. In case of accident the circuit can be broken also in the theater. In the large x-ray room we have for the x-ray tube a wooden box 2.25 by 1 by 1 meters (Fig. 10) covered with 5 mm lead and with special suction for working with hard rays. From this box the rays can be used both horizontally and vertically. Other working places are arranged for radiographic work and for special work.

In the basement in a special large cupboard between two rooms is placed a smaller high tension apparatus ("Spectral-Konstant" with rotating rectifier) allowing in addition to the same arrangements as the Polyphos, the Hull arrangement with condensers parallel and one pole grounded.

In some of the rooms in the basement and sub-base-

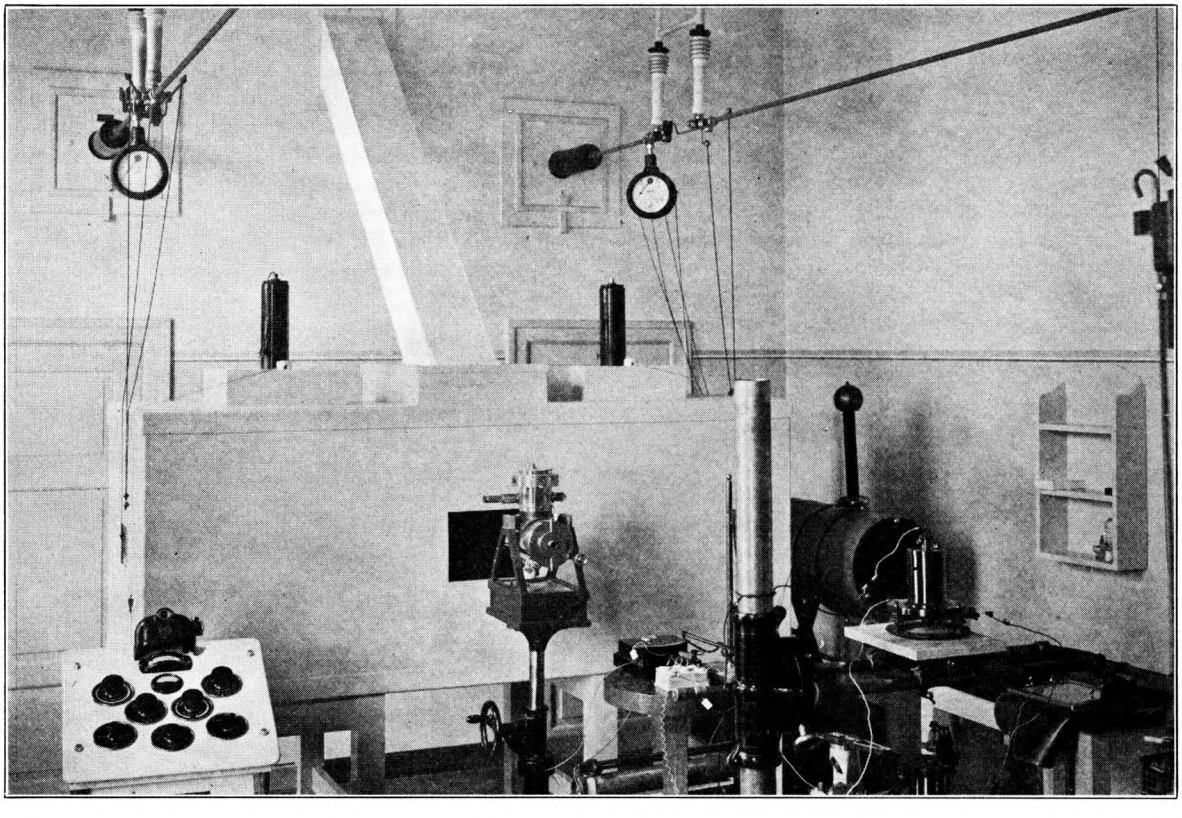

FIG. 10.—SECTION OF BIOPHYSICS LABORATORY

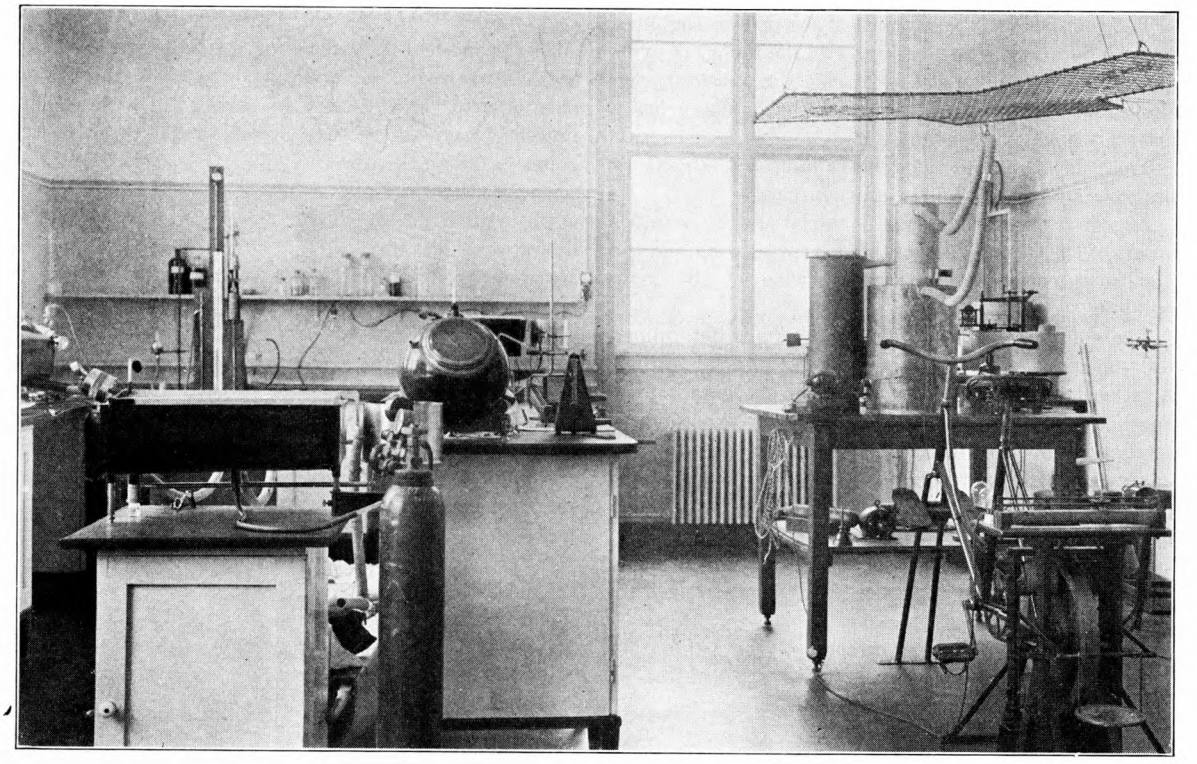

FIG. 11.—LABORATORY FOR EXPERIMENTS ON THEORY OF GYMNASTICS

ment concrete pillars isolated from the building allow non-shaking arrangements. A special room is intended for chemical work and glass-blowing.

Next to the workshop is a small machinery room with two D.C.-A.C. generators and two D.C.-D.C. generators. The former can give alternating current from 127–220 volts in each phase, the latter direct current from 40–120 volts. The current from these generators as well as from the batteries can be sent through the main switchboard to every room in the laboratory and to several rooms in the other laboratories of the institute. This main switchboard, which like the switchboard of the large lecture-theater has been designed and made in the laboratory workshop, uses the plug system. Every kind of regulation of the batteries and generators is made on the switchboard which also has all necessary measuring apparatus.

Professor H. M. Hanson is director of the Laboratory of Biophysics.

LABORATORY FOR THE THEORY OF GYMNASTICS

The purpose of the Laboratory for the Theory of Gymnastics is to teach a course in anatomy and general (physiological) theory of gymnastics to students belonging to the faculty of science and to the faculty of philosophy which will qualify them as teachers of gymnastics in the high schools. The teaching of students belonging to the faculty of science consists in lectures, examinations, demonstrations, and a practical course in experimental physiology of about one hundred hours. For the students belonging to the faculty of philosophy the entire course is less than for the former, and the practical course is omitted. The number of students in the first group is at present forty-two; and in the second, seventy-four.

The scientific purpose of the laboratory is to take up problems concerning the physiology of organs of locomotion and the influence of muscular exercises upon the entire organism. The purpose falls naturally in two parts: a general, and a special. The general part consists in studying the function of joints and muscles together with the influence of muscular work upon the organism. In this respect the work of the laboratory has essentially been concentrated about researches concerning the structure and function of the muscle and the influence of muscular work upon respiration and circulation, while the special part consists in analyzing the gymnastic exercises with respect to their mechanical conditions.

The permanent laboratory staff consists of the chief of the laboratory, who is professor of the theory of gymnastics at the University, one scientific assistant, one clerk, and one mechanic. Further the professor has a privately engaged assistant.

The official annual budget available for laboratory purposes amounts to 4,500 Danish kroner.

As seen from the plan (Fig. 5) the laboratory occupies a part of the second floor in the northwest wing and the northwest corner of the central wing of the main building.

The equipment of the different rooms is determined by the above mentioned purposes of the laboratory. A rather large room is equipped for the students' course, another larger room (Fig. 11) for work experiments, smaller rooms for histological research and for gas analyses. Moreover there are working-rooms for the professor and for the assistants, workshop, dark room, and cleaning room.

The corridor is partly equipped with cupboards and partly occupied by gymnastics apparatus arranged for experimental purposes.

Professor J. Lindhard is director of the Laboratory for the Theory of Gymnastics.

LABORATORY OF ZOOPHYSIOLOGY

The purpose of the Laboratory of Zoophysiology is to teach human and general physiology to students of natural history qualifying as teachers in the high schools, practical comparative physiology to students of zoology going in for a scientific career, and all branches of the science to those students who take up animal physiology as their main subject. The number of students in the first group is at present about thirty, in the second there are about two each year, while in the third there is only occasionally a single student.

For research purposes the laboratory possesses a small number of rooms equipped in a general way for any kind of work which it may be desirable to take up and special facilities along certain lines on which our activities have concentrated. These are: the gaseous exchange and respiration of man; capillary circulation; insect respiration; and the study of marine and aquatic animals in general.

The permanent staff consists of the professor, two scientific assistants, one clerk, one attendant, and a boy. There are further the professor's private assistant, Mrs. Krogh and her assistant, and two to four mechanics in the workshop. There is room for six or eight scientific

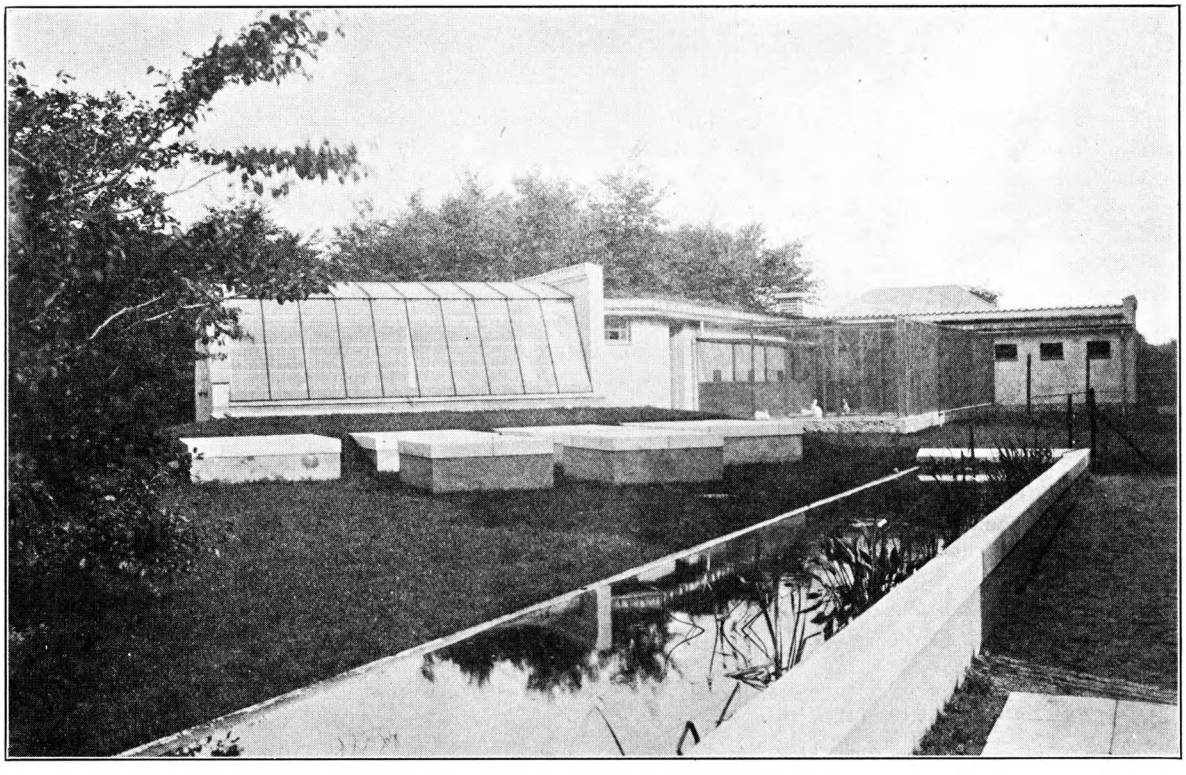

FIG. 12.—EXPERIMENTAL AREA, LABORATORY OF ZOOPHYSIOLOGY

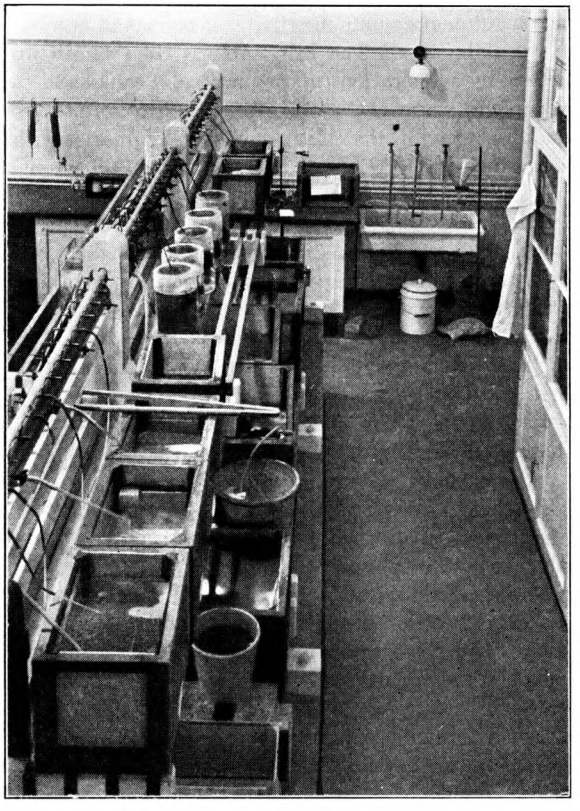

FIG. 13.—ROOM FOR EXPERIMENTAL ZOOLOGY

workers of whom two can ordinarily be accommodated in the guest rooms.

The official annual budget available for laboratory purposes amounts to 6,400 Danish kroner.

The laboratory occupies the basement, first floor, and part of the second floor in the northwest wing of the main building and possesses the ground adjoining on the northwest.

The distribution of the rooms can be seen on the plans. The basement is used mainly for technical purposes, the first floor for research, and the rooms on the second floor for teaching.

Outside the main building we have an "experimental area" (Fig. 2) partly shown in Figure 12, containing the animal house, a glass house, and a number of cement tanks. Behind this is an area of 500 m^2 enclosed by close-meshed wire netting and containing an additional cement tank of which one part is shallow while the other has a depth of 2 m. This area is used mainly for frogs which are here kept in practically normal surroundings. The roof seen in the background belongs to a wooden house (Fig. 2) containing a steel chamber for respiration experiments and for studies at low atmospheric pressure.

There is no need to describe the general equipment more or less common to all physiological laboratories, but I shall give some details regarding certain special features, which may be of interest to others.

The large respiration room in the basement towards the northwest contains respiration chambers of the Jaquet type for experiments during absolute rest and during graded muscular work. The air is taken from outside and sucked through the chambers by means of motor-driven wet gas meters. The analysis of the ingoing and outgoing air is carried out in a special apparatus accurate to 0.001 per cent by means of which CO_2, O_2 and combustible gases can be determined. In the adjoining room smaller apparatus for the determination of pulmonary gas exchange, lung diffusion, and circulation rate will be installed.

The steel respiration chamber located in its own building is a cylindrical structure 3.42 m in diameter, 1.82 m in vertical height, with a hemispherical dome. The chamber is connected with pumps which can maintain a very effective ventilation at any desired pressure below the atmospheric. The chamber is equipped as a living-room with a small separate toilet. A bicycle

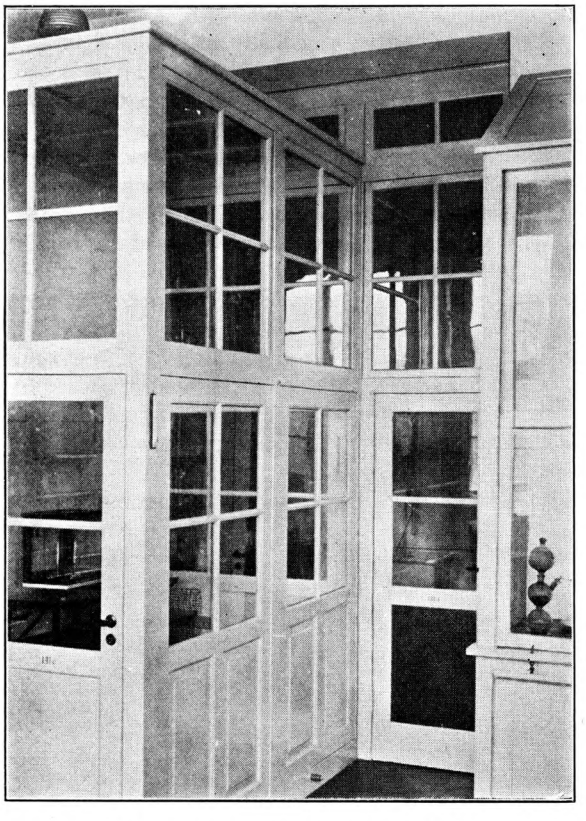

FIG. 14.—BALANCE ROOM AND CHEMICAL STOREROOM, LABORATORY OF ZOOPHYSIOLOGY

ergometer is provided for exercise. Subjects can remain in it for any desired length of time. It is our intention to use it also as a respiration chamber at ordinary pressure for the determination of the respiratory exchange of subjects during daily routine occupation.

The aquarium installation comprises two sea-water tanks below the basement with a capacity of 16 m^3 each. The water to fill these tanks has been brought by steamer from the middle of the North Sea. An automatic pump will take the water from either one of the tanks up to a reservoir of 60 liters placed 3.20 m above the floor level in the room for experimental zoology shown in Figure 13; from here it flows along pipes to supply a large number of aquaria placed on the stand. These aquaria are of a new construction, made from martinite and glass in teak-wood frames. They cannot give off any harmful substances to the sea water and do not rust. The water flows from them through the shallow tank on which the stand is built, down to other tanks for the storage of larger marine animals and to the filters in the basement, whence it returns to the storage tank. The sea-water pipes and taps are of vulcanite. The main pipe is carried down into the basement and from there the sea water traverses, in iron pipes covered with asphalt, an insulated underground cellar of 40 m^3 capacity in which snow is collected during the winter. The pipe lines are arranged in coils below the snow and the sea-water pipe returning from this cooling cellar will always carry water of nearly 0°C to supply aquaria at low temperature.

The cold sea-water pipe returns to the stand in the first floor shown in Figure 13. In a separate "cold" room in the basement we have an insulated tank which can be filled with sea water and connected as desired with the filters. This tank is divided into compartments of about 300 liters, each separated by double walls of thin corrugated martinite. Between the double walls cold fresh water from pipes below the snow can be circulated to maintain any desired temperature below that of the room.

Rain-water is collected from part of the roof of the main building. The corresponding roof gutter and drain-pipes are coated with tin. By means of an automatic arrangement the first rain only washes the roof and water is collected only after a fairly heavy shower. The rain-water is stored in a subterranean tank of 3 m^3 and an automatic pump distributes it to a small number of vulcanite taps. The rain-water is used to fill up the loss by evaporation from aquaria and tanks and to prepare sea water of diminished salinity to imitate the conditions round the Danish coasts. Aquaria with diminished salinity have their own filter and local circulation by means of air pressure.

In a glass house of 4.45 by 6.0 m experiments can be made which require a great quantity of light. Sea water and rain-water are available here but without circulation. One half of the glass house is covered with "ultra-glass" permeable to ultra-violet light, the other half with ordinary glass. It seems doubtful whether there is enough ultra-violet light available in the city atmosphere to make this arrangement really useful. The temperature in the glass house can be to a certain extent automatically controlled.

Figure 14 shows a corner of the chemical laboratory with part of the fume cupboard and two small rooms for balances and chemicals respectively. These rooms have been made dust-proof. The walls and doors are as nearly air-tight as possible and the unavoidable exchange of air due to temperature and pressure variations takes place almost entirely through felt filters. A dust-proof room for storage of instruments is provided in the attic. A similar dust-proof storeroom was used for three years in the old laboratory and has proved very satisfactory.

As seen on the plans of the floor the corridors in the northwest wing of the building are irregular on account of the air shafts. The irregularities have been filled out by cupboards which are utilized as a general storeroom for all such implements as are frequently used in the laboratory. These are therefore directly accessible to all workers.

It is desirable finally to mention the workshop which is conducted on business principles and which manufactures for sale a number of instruments which were originally designed and constructed in the laboratory, e.g. respiration apparatus for standard metabolism, recording spirometers, bicycle ergometers, microburettes, sea-water aquaria, etc. The workshop brings in a net profit of several thousand kroner a year which constitutes a welcome addition to the budget.

Professor Krogh is director of the Laboratory of Zoophysiology.

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