Medical education facilities / prepared by Public Health Service, in cooperation with the Ad Hoc Committee on the Design of University Teaching Hospitals of the Association of American Medical Colleges, the American Medical Association, the American Hospital Association, and the Public Health Service.

HOSPITAL AND MEDICAL FACILITIES SERIES
Health Professions Education
MEDICAL EDUCATION
planning

MEDICAL EDUCATION FACILITIES

planning considerations and architectural guide

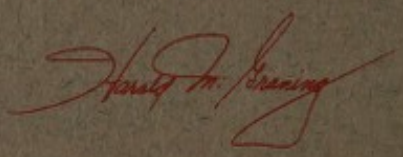
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

THIS REPORT outlines the role and responsibilities of the medical school complex including the hospital, discusses the composition of faculty and curriculum, presents planning considerations and space needs for the various elements, and gives cost estimates and engineering requirements.

Teaching methods and patient care concepts are constantly changing. This requires revisions in the various elements of the medical school complex.

Medical School Facilities—Planning Considerations and Architectural Guide, PHS Publication No. 875, has been revised, brought up to date, and expanded to include additional information on the university teaching hospital.

It is hoped that the information in this publication will be useful as a guide for those concerned with the planning and the design of medical education facilities.



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MEDICAL EDUCATION FACILITIES

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PUBLIC HEALTH SERVICE
in cooperation with the Ad Hoc Committee on the Design of University Teaching Hospitals of the Association of American Medical Colleges, the American Medical Association, the American Hospital Association, and the Public Health Service

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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STATEMENT OF EXECUTIVE COUNCIL OF THE ASSOCIATION OF AMERICAN MEDICAL COLLEGES, THE COUNCIL ON MEDICAL EDUCATION AND HOSPITALS OF THE AMERICAN MEDICAL ASSOCIATION, AND THE AMERICAN HOSPITAL ASSOCIATION

This document was produced by the joint efforts of the Public Health Service and 2 ad hoc committees: one on Medical School Architecture, sponsored by the Executive Council of the Association of American Medical Colleges and the Council on Medical Education and Hospitals of the American Medical Association; and the other on the Design of University Teaching Hospitals, sponsored by the Executive Council of the Association of American Medical Colleges, the Council on Medical Education and Hospitals of the American Medical Association, the American Hospital Association, and the Public Health Service. It is hoped that this book will serve a useful purpose in guiding those contemplating the institution of new medical schools and planning medical school and teaching hospital facilities.

Since it is generally conceded that improved curriculum, administrative structure, teaching methods and facilities should be sought continually, the suggestions in this book should not be used to discourage desirable innovations.

It is emphasized that these data are intended as guidelines and not as finished plans. While the figures may indicate desirable starting points, some institutions will find them more useful as a goal which they should plan to attain and even exceed during the first few years of operation. Just as more extensive and expensive programs could easily be justified under some circumstances, under others a satisfactory school could start with less and attain the dimensions suggested after several years of experience and growth.

The book expresses the consensus of the many individuals involved in its preparation. The committee members, while reflecting the policies of their parent organizations, are expressing their own opinions as modified by the committee deliberations. Although the 3 sponsoring organizations support the efforts of their representatives, it is not intended that the plans and proposals presented here be interpreted as established or rigid policy of the Association of American Medical Colleges, the American Medical Association, or the American Hospital Association.

Preface

The enactment into law of the Health Professions Educational Assistance Act of 1963 points up the Federal Government's concern for the need for an increased number of physicians, medical scientists, and members of related health professions. Factors that will contribute to the need for even more of these professional people are the increasing demands for medical service by the public, the increase in medical and scientific research, and the growth of the population.

Background information and guidelines on the planning and construction of medical centers have been limited. This lack and the cost of constructing medical education facilities has emphasized the need for guide material.

To help meet this need, a joint Ad Hoc Committee on Medical School Architecture of the Association of American Medical Colleges and the American Medical Association was formed in 1960. The committee members were George T. Harrell, M.D., Chairman, dean of the University of Florida College of Medicine; John Z. Bowers, M.D., dean of the University of Wisconsin Medical School; Augustus Carroll, business manager, Upstate New York Medical Center; Glen Leymaster, M.D., associate secretary, Council on Medical Education and Hospitals, American Medical Association; Lee Powers, M.D., associate director, Association of American Medical Colleges; John M. Stacey, director, the University of Virginia Hospital; and William R. Willard, M.D., vice president, University of Kentucky.

The staff from the U.S. Public Health Service who assisted the committee included: Division of Hospital and Medical Facilities: Jack C. Haldeman, M.D., Chief; Burnet M. Davis, M.D., Deputy Chief; George Ivanick; Robert T. Alker; John M. Jullien; Richard P. Gaulin; Noyce L. Griffin; and Julian Smariga. Division of Public Health Methods: William A. Stewart, M.D., Chief; Margaret D. West; Ruth M. Raup; and Marian E. Altenderfer. Division of Dental Public Health and Resources: Herbert H. Hollweg.

The committee and the staff reviewed pertinent literature, analyzed published programs, and examined architectural plans. The staff, with various committee members, visited 11 medical schools in metropolitan areas and small communities to inspect the physical plants and to analyze the functions of various units.

The staff reviewed medical school catalogs, annual reports, class schedules, and architectural working drawings. The results of these efforts were published in 1961 in *Medical School Facilities—Planning Considerations and Architectural Guide*, U.S. Public Health Service Publication No. 875, and *Medical School Facilities—Planning Considerations*, U.S. Public Health Service Publication No. 874.

In 1962 a Joint Ad Hoc Committee on the Design of University Teaching Hospitals was formed by the Association of American Medical Colleges, the American Medical Association, the American Hospital Association, and the U.S. Public Health Service.

The committee decided that the report, "The University Teaching Hospital," would be made a part of the medical school study and that this publication would be revised, brought up to date, and published as *Medical Education Facilities—Planning Considerations and Architectural Guide*. In the development of this report the staff visited 9 teaching hospitals of various sizes and types, and reviewed the literature and many plans.

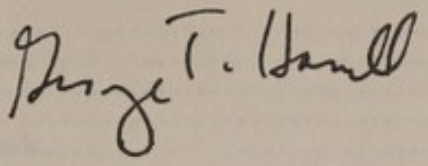
This guide discusses the role and responsibilities of the medical school, including the composition of its faculty and curriculum, and summarizes the general requirements for facilities, costs, and the elements in planning. The guide also translates into architectural and engineering terms the space requirements of the various medical school activities. The discussion reflects the committee's consensus on the essentials of a good medical school, based on the experience of the committee members in the field of medical education and on the material reviewed.

Requirements for an educational program for schools with entering classes of 64 and 96 medical students and hospitals of 500 and 700 beds have been considered. This document is intended as a guide and does not attempt to outline finished plans for any portion of the facility. The choice among the various alternatives is that of the school. The physical facility should reflect the philosophy of the school as adapted to local resources and problems. Too much emphasis cannot be placed on the necessity of developing the educational program before the architect begins to design the facility. Basic principles for planning a medical center are outlined and local planning groups should be able to extrapolate and adapt them to specific situations. Consideration should be given early in planning to the various types of laboratories, classrooms, study areas, library, and other teaching facilities so that advances and improvements can be incorporated into the new facility.

The committee would like to thank the faculty and administrators of the medical schools and teaching hospitals visited or otherwise studied in the course of its work. Appreciation is also due the staff of the Division of Public Health Methods for its assistance, and to the staff of the Division of Hospital and

Medical Facilities, which wrote and edited the report with the advice and guidance of the committee. The committee also thanks Mr. Augustus Carroll, assistant director, Division of Operational Studies, Association of American Medical Colleges, who developed illustrative operating budgets.

The committee is grateful to the Public Health Service for publishing this report.



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Contents

Tables

Figures

Chapter 1

SUMMARY

Medical education facilities provide space for 3 interrelated activities—teaching, patient service, and research. Teaching during the first 2 years is centered in the medical sciences buildings; during the third and fourth years it is centered in the patient-care facilities of the teaching hospital. Research is an integral part of the activity of faculty and students in all 4 years and requires special facilities. Schools should plan research facilities to accommodate the increasing growth in research activities.

Great variation exists among schools in the nature and extent of each of these activities. Teaching may be limited almost entirely to the instruction of medical students, perhaps only in the first 2 years, or may include graduate students in the basic sciences, postdoctoral fellows, hospital house staff, nursing and dental students, and others in related health professions. Research and service may be at a minimal level consistent with adequate teaching or may be so extensive as to occupy a major portion of the school's effort and the physical plant.

Increasingly the teaching of medical students is carried on in close conjunction with graduate teaching programs in the basic sciences, with the training of hospital house staff in the clinical years, and with other educational activities of the medical school and its parent university.

Although the extent of patient service varies among medical schools, a school with 64 students in the entering class (and 60 in each clinical year) requires about 350–500 beds available for teaching, and a school with an entering class of 96 (and 90 in each clinical year), between 500 and 700 beds. More effective teaching will usually result if these beds are in 1 hospital and contiguous to the clinical science facilities. The size of the outpatient clinic depends on the program of the school and the service commitments of the hospital and not on the number of beds in the hospital. Approximately 350 visits per day may be used for estimating the size of an outpatient department in a teaching hospital.

To insure a proper balance between clinical teaching activities and patient-service functions in a teaching hospital, it is essential that the medical school effectively control the appointment of hospital staff and the selection of patients for the teaching service. Although university or medical school fiscal control of the hospital has many advantages, such financial integration is not indispensable if hospital and medical school officials have common goals and mutual understanding.

Medical school research budgets have increased about sevenfold over the last decade; an increasing proportion of medical schools have strong programs of research and research training. In a typical school today, a third of the space in the basic science facility is used for research activities or related graduate training. In addition, there may be research space in the clinical department areas and in the teaching hospital. Recent studies have called for a doubling or more of national medical research expenditures over the next decade, which suggests that medical school research facilities must be planned for continued expansion.

Essential to each of the 3 major activities of a medical school is the existence of an adequate library. Most medical library collections have more than doubled over the past 20 years, and in the near future a typical collection will probably include some 100,000 volumes and about 1,600 periodical titles.

The size of the administrative staff will depend on the scope and magnitude of medical school functions. Variables affecting administrative staff needs are the size of the school, the breadth of teaching and research responsibilities, the com-

plexity of financing arrangements, and the relationship with the teaching hospital. Some administrative functions may be performed by general university administrative offices, where these exist; others will require separate staff and space in the medical school.

Teaching Responsibilities

The primary teaching responsibility of a medical school is the medical student. However, the school will probably participate also in training other groups of students in related fields of specialization. The extent of these additional educational responsibilities may substantially increase the needs for faculty offices, teaching laboratory space, and lecture and conference rooms in the school.

A 4-year medical school may have over 750 students in the course leading to the M.D. degree or fewer than 200. Average enrollment is about 375. The number of students in the first-year class averages about 100. Schools offering only the first 2 years tend to be smaller, having first-year classes of about 50 students each.

Graduate and postdoctoral students in the basic sciences are provided for in 84 medical schools today. The departments of biochemistry, microbiology, and physiology have the largest graduate enrollment. New teachers and research workers for medical schools and industry are provided by these programs as well as people who direct specific hospital laboratories.

Graduate and postdoctoral programs in the clinical sciences are growing rapidly . During 1962–63, 34 schools granted degrees in such programs, compared with 22 schools in 1961–62 and 21 in 1960–61. Facilities should be planned to accommodate this growth.

In some institutions the education of interns and residents is primarily the responsibility of the medical school; in others, of the hospital. The number of interns and residents for whom medical schools have teaching responsibility varies widely from a few to several hundred.

Students in other health-related professions such as dentistry, pharmacy, and nursing may be a responsibility of the medical school.

Continuation eduation courses may be offered to help practicing physicians keep up to date and expand their knowledge.

Faculty

One of the most important factors affecting medical school space needs is the size and character of the full-time faculty. Marked variation exists in the number of such faculty at schools now in operation, as well as in the kind of accommodations—particularly research laboratories—provided for them.

Most medical schools have comparatively large full-time faculties—the average in 1963 was 160, in relation to an average medical student enrollment of 375 and an average of approximately 400 additional trainees and other equivalent full-time students. This is a ratio of about 5 students per full-time faculty member. The many specialized subjects taught and the emphasis on small-group teaching explain in part the high staffing ratios. Other reasons include the heavy commitment of faculty time to research, the extent to which clinical faculty provide patient care, and the frequent use of medical school faculty for the education of other-than-medical students.

The schools having the largest faculties are not necessarily those with the largest enrollments. A pronounced research emphasis and a broad range of responsibilities for medical service and related teaching programs will result in a large number of full-time faculty. Another determinant of faculty size is the degree of reliance on part-time volunteer faculty.

Over the past decade, faculty size has increased in the basic science and clinical departments, with greater use of full-time as compared with part-time faculty. Increased availability of research grants has increased the proportion of faculty time spent on research. This may be expected to

continue in years to come. Also contributing to the growth in faculty size is an expansion in the teaching of graduate students, postdoctoral fellows, and students from related health professions. The advanced fellows are the fastest growing group in medical education.

Medical Curriculum and Teaching Methods

New methods of teaching the basic sciences, experiments with integrating the last 1 or 2 years of undergradnate college with the first year or two of medical school, increased introduction of students to patient care in their first and second years, increased use of comprehensive care clinics in the teaching of clinical sciences, and growing attention to individual study facilities affect space requirements of medical schools.

In the basic sciences, new medical knowledge and improved methods of measurement have brought new emphasis on laboratory facilities and equipment. Space requirements for teaching the basic sciences are affected by growing recognition of interrelationships among departments with teaching sometimes done by interdepartmental committees; the increased use of smaller laboratories, usually designed for 16 students and sometimes equipped for the teaching of several different disciplines; and the emerging stress on student research and special projects rather than routine experiments.

The development of comprehensive-care clinics reflects a growing concern with the problems of the patient as a person and as a family member, as distinct from the study of particular diseases. These clinics are usually under the general direction of the department of medicine with teaching participation by other clinical departments. In some schools teaching is conducted in separate clinics specially equipped to provide family health services.

Space Requirements

The assumptions upon which space requirements in this publication are based are: Two hypothetical schools, one with an entering class of 64 students, a full-time faculty of 95, and 40 graduate students and postdoctoral fellows; and the second with an entering class of 96 students, a faculty of 135, and 55 graduate students and postdoctoral fellows. It is assumed that the school with the 64-student class will be expanded eventually to accommodate 96 students in the entering class.

Each of the schools will be university based with its own teaching hospital and a library for 100,000 volumes, and will teach graduate students and postgraduate fellows in the basic and clinical sciences. Schools of dentistry or nursing are not included.

Space requirements for both schools are considered in 3 parts: basic science facilities, clinical science facilities, and teaching hospital. The clinical science facilities and the teaching hospital should be contiguous or combined insofar as possible.

Space provided for each *basic science* department includes teaching laboratories and offices and research laboratories for faculty and graduate students. Alternate space requirements are given for multidiscipline and for conventional teaching laboratories.

Space provided for each *clinical department* includes offices, research laboratories, and conference space for the clinical faculty, house staff, and fellows.

Among the spaces required in a *teaching hospital*, in addition to those needed in a community hospital, are: greater circulation space; larger work and conference areas on each patient-care unit; additional examination and consultation space in the outpatient department; more consultation and demonstration rooms, student laboratories, and procedure rooms. The teaching hospital will require 35–40 percent more overall space than a nonteaching hospital with the same number of beds.

In both the basic science and clinical departments, the size of faculty and spaces provided are for *teaching programs only*. Service requirements of the teaching hospital will necessitate additional personnel, who may also have faculty appointments but who may be housed in the hospital.

Among the teaching, research, and supporting facilities common to all departments are an auditorium and lecture room, medical illustration department, library, animal quarters, and technical shops. Study cubicles are provided for first- and second-year students in the basic science facilities and for third- and fourth-year students and house officers in the teaching hospital. In addition to space for administration, facilities such as a bookstore, student lounge, storage rooms, post office, and housekeeping facilities are provided.

Planning and Scheduling

The importance of long-range planning should be understood and emphasized from the very beginning of the project. To develop a well-thought-out, comprehensive program for medical education facilities, a university considering the construction of such facilities should utilize a planning committee, professional consultants, and if possible, full-time professional staff. In the case of a new school, the dean should serve as chairman of the committee.

The committee, in consultation with the project architect, should make basic decisions on the functions and responsibilities of the school and the relationship of the school to its parent university and related teaching programs. Wherever possible, departmental space should be planned with the advice of the department head.

If a new teaching hospital is to be constructed, its size should be determined with a view to the present and future needs of the students and to the service commitments to the area. Use of an existing hospital will require consideration of administrative relations between the hospital and the school and careful planning of alterations and additions to make the hospital suitable for teaching.

The possibility of future expansion of school activities should be constantly borne in mind in the planning of facilities. Such expansion could take the form of increased enrollment, additional teaching responsibilities, expanded research activity, or greater and more varied patient services.

The future expansion potential of every part of the facility should be stressed so that "growth in balance" of all departments and services will result. The overall long-range plan for the medical center should provide for growth in any department or service without interfering with contiguity of departments. The probability of the need for expansion of library and animal facilities should be considered.

The importance of traffic flow, both external and internal, should be emphasized so that as expansion occurs the circulation of masses of students and faculty through academic departments is kept to a minimum. The separation of carts and trucks from personnel should be maintained.

Specialized hospitals and specialized research units will undoubetedly become a part of the medical center complex and site provisions should be made for these facilities.

Starting with the appointment of a dean before any major planning is done, the construction of new medical education facilities may be scheduled as follows: Development of program—6 months to a year; design and construction of basic science and clinical science facilities—18 to 30 months; design of teaching hospital and clinics—12 to 24 months; construction of hospital—24 to 30 months, to be completed by the time the first class has reached the third year of the curriculum. Ideally the basic science facilities, clinical science facilities, and teaching hospital should be closely connected. Even though the basic science and clinical science facilities are separated, the clinical science facilities and the teaching hospital should be contiguous because of the interrelationship of these areas. The appointment of department heads should begin as soon as the program has been developed; basic science and a few key clinical heads should be in residence at least 1 year before teaching begins.

Site

In choosing a site, consideration should be given to future growth of teaching, service, and research responsibilities; to fostering an academic atmosphere; to the availability of transportation; and to avoiding such nuisances as noise, smoke, and vibration. Space should be available for the major teaching hospital and possibly for specialized hospitals. The minimum size of site recommended is 50 acres; if feasible, the site should contain 75 to 150 acres or more. Nearby space should be available for adequate housing for married as well as single students. A city location will in most cases severely reduce the amount of land available and probably will require a high-rise facility. An animal storage and breeding farm separate from the main physical plant should be considered.

Costs of Construction and Operation

Because the costs of constructing and operating a medical school will vary greatly in relation to the diverse programs and responsibilities of the schools, it is impossible to set a narrow range of estimates for these costs. However, to indicate orders of magnitude—to provide a guide for planning and not a precise measure—cost estimates are given in table 51, p. 174, for the two hypothetical schools described earlier with their entering classes of 64 and 96 students, respectively.

At current prices the average cost of constructing medical education facilities is about $33 per square foot including fixed equipment, but the range is from $30 to $45. Movable equipment may amount to 15 percent of the cost of construction. Regional location, differences in programing, the state of the construction industry, and type of construction are among the factors contributing to substantial variations in costs.

The cost of constructing a 400- to 500-bed teaching hospital would be about $15–$20 million depending on differing needs as well as on regional cost differences.

Sound planning of medical education facilities must give consideration to probable operating costs, as well as to construction costs. Based on various specific assumptions on size, the teaching and research program of the school, staffing patterns, departmental organization, salary levels, library and animal-care financing, maintenance requirements, and other pertinent criteria, estimates of the operating costs for the two hypothetical schools described in this report were developed and are given in tables 52–54, pp. 176–179. These budgets do not reflect the costs of operating teaching hospitals and clinics, but do include the cost of medical research conducted by the school. They are illustrative only; detailed schedules, comments, and explanations obtainable from the Association of American Medical Colleges and American Hospital Association will help a university engaged in planning a medical school to formulate its own detailed budget.

Chapter 2

MEDICAL SCHOOLS TODAY

". . . the ultimate objective of medical education is to assure the American people of the best possible medical care. To do this means (1) to carefully select and then to educate properly oriented, intelligent young people in the knowledge now available and to stimulate them to want to know more; (2) to continuously advance our knowledge of the prevention, cause, and treatment of disease; and (3) to train those we educate to apply what we now know to the sick patient and to develop incentives and methods of acquiring and applying new knowledge as it is developed." (*1*)

The medical school engages in three interrelated activities—teaching, patient service, and research. Each of these activities is essential to the medical school program. Each requires distinctive, but interrelated, physical facilities.

Teaching for the first 2 years of medical school is centered in a basic science facility. Patient service and the teaching of third- and fourth-year medical students are centered in the teaching hospital. Research, an integral part of the activity of faculty and students, requires special laboratory facilities in the basic science area and in the hospital, and often in additional structures

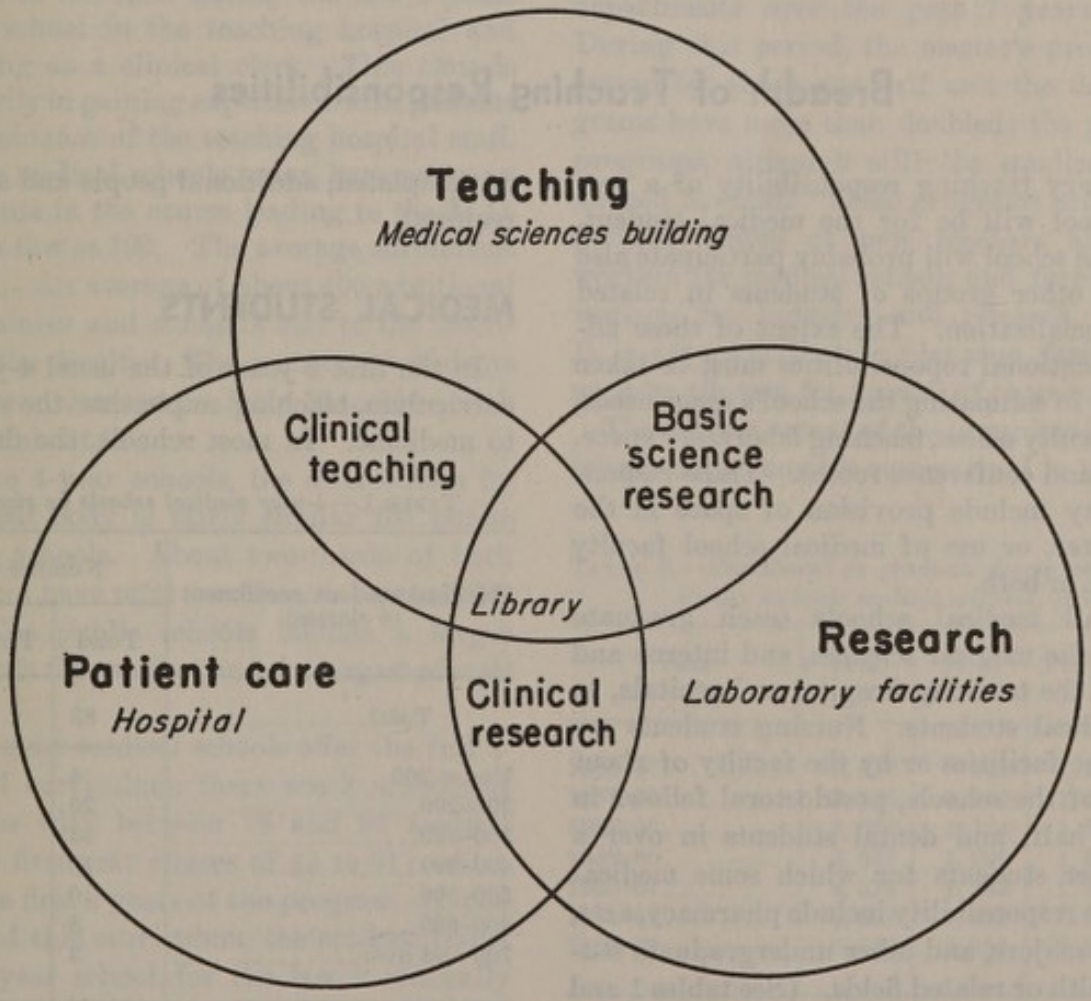

FIGURE 1.—Interrelationship among various medical facilities.

as well. These facilities and their interrelationships and the medical library which is essential to all these activities are diagramed in figure 1.

The extent to which the medical school engages in these 3 activities varies greatly from school to school and has little relationship to the number of medical students. For schools with average enrollment there is a tenfold range in the number of full-time faculty members. Expenditures for research in individual schools vary from less than $200,000 to more than $5 million annually. Patient-service activities range from responsibility for the patients of a hopital with less than 200 beds to one with more than 3,000. Many schools own their own hospital and have complete responsibility for their staffing; at the other extreme a few have almost no control of the staffing or selection of patients in the hospital used for teaching.

The total span of activity of the medical school may be limited to the provision of only the first 2 years of medical education (the school of basic science) or may be so broad as to embrace the operation of a medical center where the training of physicians and other health personnel, the operation of hospitals and clinics serving a broad geographic area, and an extensive program of research in the basic sciences and clinical disciplines are coordinated.

Of the 87 medical schools in the United States, all but 11 are components of universities. Although a medical school may be established apart from a university, the advantages of the broader academic affiliation and the opportunities for interrelationship of liberal arts and medical education and of graduate and postgraduate education in scientific areas give incontrovertible advantages to the university medical school.

Thus, successful planning for construction of the medical school requires a clear picture of the immediate and long-range plans for the development of the medical school and other professional schools, of the potential role of the school in providing patient services to the area, of the potential research program of the school, and of the working relationship with other parts of the university.

Breadth of Teaching Responsibilities

The primary teaching responsibility of a new medical school will be for the medical student. However, the school will probably participate also in training other groups of students in related fields of specialization. The extent of these additional educational reponsibilities must be taken into account in estimating the school's space needs, including faculty offices, teaching laboratory space, and lecture and conference rooms. These responsibilities may include provision of space in the medical center, or use of medical school faculty for teaching, or both.

Almost all medical schools teach graduate students in the medical sciences, and interns and residents in the teaching hospital or hospitals, as well as medical students. Nursing students are taught in the facilities or by the faculty of about two-thirds of the schools, postdoctoral fellows in more than half, and dental students in over a third. Other students for which some medical schools have responsibility include pharmacy, arts, and science majors, and other undergraduate students in health or related fields. (See tables 1 and 2.) If the teaching of such other students is contemplated, additional people and space will be required.

MEDICAL STUDENTS

In the first 2 years of the usual 4-year medical curriculum, teaching emphasizes the sciences basic to medicine. In most schools, the first year em-

TABLE 1.—*4-year medical schools by size, 1962–63*

Medical student enrollment (4 classes)	Number of schools		
	Total	Public	Private
Total	83	39	44
Under 200	4	3	1
200–299	20	7	13
300–399	33	16	17
400–499	10	4	6
500–599	10	4	6
600–699	3	2	1
700 and over	3	3	0

Source: Pp. 652–653 in reference (*2*).

TABLE 2.—*Teaching responsibilities of 87 medical schools, 1962–63* [1]

Type of students	Number of schools with specified program
Medical	87
Graduate (M.S. and Ph.D.)	84
Postdoctoral clinical fellows	73
Interns	83
Residents	84
Dental	33

[1] Including 3 2-year schools and 1 4-year school recently opened.

Source: Pp. 658 and 700–701 in reference (*2*).

phasizes anatomy, biochemistry, and physiology; in the second year major attention is given to microbiology, pathology, pharmacology, and an introduction to clinical medicine. The student spends most of his time during the last 2 years of medical school in the teaching hospital and clinics serving as a clinical clerk. This time is spent primarily in gaining experience with patients under the guidance of the teaching hospital staff.

Four-year medical schools today have as many as 770 students in the course leading to the M.D. degree, or as few as 190. The average enrollment is about 375. An average of about 400 additional full-time trainees and students add to the teaching load of the faculty. The number of students in the first-year class ranges from 53 to 210—with an average of about 100.

Among the 4-year schools, the distribution by size of student body is fairly similar for public and private schools. About two-thirds of both types of school have total enrollments between 200 and 400. The public schools include a larger number of both the smallest and the largest schools (table 1).

Although most medical schools offer the full 4-year medical curriculum, there are 3 schools of basic sciences with between 76 and 94 medical students (or first-year classes of 45 to 51) which offer only the first 2 years of the program. Upon completion of this curriculum, the student transfers to a 4-year school for the last 2 clinically based years of medical education. Two-year schools must be based in universities with strong graduate programs in the sciences. Because the teaching of the first 2 years must have a substantial clinical component, even the 2-year school must have at least a small clinical faculty and access to a hospital for teaching purposes.

GRADUATE AND POSTDOCTORAL STUDENTS

Basic Sciences

Of growing importance in medical schools are the students enrolled in work toward a master's or doctoral degree, or in postdoctoral study in the basic sciences; 84 schools have such programs. Biochemistry, microbiology, and physiology are the departments with the largest graduate student enrollment.

The sharp increase in interest in these programs is evidenced by figures on enrollment in graduate degree and postdoctoral studies in the basic science departments over the past 7 years (table 3). During this period, the master's programs have grown by about one-half and the doctoral programs have more than doubled; the postdoctoral programs, although still the smallest, have increased fivefold. These programs provide an important source of new teachers and research workers for medical schools and furnish research workers for industry and research institutions. It is apparent that in planning facilities, space must be allowed for growth of these programs.

The current extent of the programs in each basic science department is summarized in table 4.

TABLE 3.—*Enrollment in graduate degree and postdoctoral studies in basic medical sciences, 1956–63*

Year	Total	M.A.	Ph. D.	Post-doctoral
1956–57	2, 417	921	1, 304	192
1957–58	2, 754	1, 119	1, 416	219
1958–59	3, 073	1, 124	1, 590	359
1959–60	3, 663	1, 099	1, 961	603
1960–61	4, 279	1, 283	1, 971	1, 025
1961–62	4, 811	1, 531	2, 266	1, 014
1962–63	5, 166	1, 351	2, 754	1, 061

Source: P. 656 in reference (*2*).

TABLE 4.—*Advanced degree and postdoctoral programs in the basic medical sciences, 1962–63*

Department	Number of schools	Graduate and postdoctoral students per school	
		Median	Range
Anatomy	77	7	1–47
Biochemistry	78	14	1–59
Biophysics	13	6	1–24
Microbiology	73	10	1–36
Pathology	54	4	1–40
Pharmacology	73	7	1–36
Physiology	76	8	1–54
Other	13	4	1–92

Source: Pp. 702–705 in reference (*2*).

Clinical Sciences

Graduate programs leading to advanced degrees in the clinical departments are found in an increasing number of medical schools. During 1962–63, 34 schools granted degrees in such programs, compared with 22 schools in 1961–62 and 21 in 1960–61. There has also been considerable growth of postdoctoral programs, in which students or trainees with fellowship support receive clinical research experience either after or concurrent with their specialty training. Since the demands for teachers and research workers with advanced training in the clinical fields are steadily increasing, it can be expected that such programs will continue to grow.

The National Institutes of Health study of 20 medical schools in 1959 noted that those schools expected their number of clinical fellows and trainees to more than double in the next decade, increasing even more rapidly than the number of graduate and postdoctoral students in the basic sciences, which they estimated would nearly double (*3*).

INTERNS AND RESIDENTS

Interns and residents serve as the hospital house staff. They function primarily as postgraduate students, but also as teachers for medical and other students, and as physicians in rendering patient services in the hospital and clinics. In some institutions the responsibility for their education rests primarily with the medical school; in others, the hospital carries the major responsibility.

The number of interns for whom existing medical schools have teaching responsibilities ranges from less than 10 to more than 400; the number of residents from less than 25 to more than 500.

OTHER STUDENTS

Health Professions

Among the third of the medical schools having some responsibility for teaching dental students, some provide a high percentage of the teaching of those students in the first 2 years of their curriculum. These schools require nearly as much space for dental students as they do for first- and second-year medical students.

Pharmacy students receiving some of their basic science instruction from the medical school faculty, as they do in some 19 schools, often make use of the same laboratory facilities as the medical students.

In 1962–63, 66 medical schools had some responsibility for teaching nursing students. A number of these medical schools have responsibility for more than 300 nursing students—both for students in the university curriculum and for nursing students from other affiliated schools who receive part of their training in the teaching hospital. This teaching, in general, is limited to lectures and laboratory work in a limited number of subjects.

Clinical psychologists, medical librarians, X-ray technicians, medical technologists, speech pathologists, and physical and occupational therapists are among the many other groups of students in the health professions for which medical schools may have some teaching responsibility.

Undergraduate Students

In a number of medical schools there is some enrollment of liberal arts and other undergraduate students in courses, such as microbiology, taught by the medical school faculty. In a few schools the number of such students is quite large.

CONTINUATION EDUCATION

Courses designed for physicians who have completed their formal training are known as continuation education (or postgraduate or refresher) programs. Physicians are enrolled in continuation education courses in three-quarters of the medical schools. Usually no credit toward an advanced degree is involved. These courses may be as short as 1 day, or as long as 10 months, although typically they are quite short. They are usually lecture courses, with enrollments of about 20 to 30, and include patient demonstrations and occasionally laboratory demonstrations. The auditorium, if properly designed, could serve for patient demonstration; no separate laboratory would be necessary. Efforts are underway to develop more effective and practical ways of helping practicing physicians keep up to date and expand their knowledge.

Patient Service and the Teaching Hospital

Medical education requires extensive observation of, and experience in, the examination, diagnosis, and care of patients. Therefore the medical school must have a teaching hospital with an adequate number and variety of patients, and the faculty members must be able to make use of these patients for teaching purposes.

A teaching hospital has many facilities not required by a community hospital. In addition to the normal requirements for patient care, the teaching hospital provides special facilities for the student to observe and examine inpatients and outpatients, to read and prepare records, to confer with faculty and fellow students, to make laboratory tests, to do clinical research, and to study.

The teaching hospital serves as a major referral center for diagnostic and treatment services requiring extensive special staff and equipment, not only for the immediate community but also for a wider region. Within the limits set by teaching requirements, the hospital should also serve as the focal point for consultant services, public health programs, and postgraduate training programs for practicing physicians.

CONTROL OF HOSPITAL

Half the medical schools in the United States own their primary teaching hospital. Most of the rest make use of community hospitals which are integrated physically, administratively, and financially with the medical school. Many of the schools with their own hospitals make use of affiliated hospitals as well, to provide a greater number and variety of patients. Seventeen schools make primary use of hospitals that are entirely independent of the schools (table 5).

TABLE 5.—*Control of primary teaching hospitals of public and private 4-year medical schools*

Control of primary teaching hospital	Number of schools		
	Total	Public	Private
Total	84	40	44
University or medical school hospital	39	25	14
Community hospitals [1]	27	9	18
Public hospital	12	6	6
Nonprofit association	15	3	12
Affiliated hospitals	18	6	12

[1] Integrated physically, administratively, and financially with the medical school.

Source: American Medical Association, Directory of Approved Internships and Residencies, 1963.

Regardless of the manner of affiliation, medical school control of the teaching hospital staff and of the admission policy for patients is essential for maintenance of a suitable educational program. If the school does not own the teaching hospital, it should have the unquestioned right to appoint the attending staff, with clinical teachers appointed either on nomination by the school or by agreement in conference between the school and the hospital.

The medical school faculty should also have a reasonable degree of control over the selection of patients for the teaching service, to assure an adequate number and variety to meet teaching needs.

SIZE OF INPATIENT SERVICE

There is great variation in the size of teaching hospitals. Some educators hold that a large hospital is necessary to secure the requisite variety of cases, while others find that, with a careful selection of cases for admission, a relatively small hospital will provide adequate teaching material.

The principal teaching hospitals of medical schools today range in size from under 200 to over 3,000 beds, with a median of about 600. Teaching hospitals owned by the medical school or university are smaller on the average than community hospitals affiliated for teaching purposes (table 6).

For planning facilities, a rough rule of thumb is 3 to 4 beds in a teaching hospital for each medical student in the clinical years.

For the 39 schools with university or medical school hospitals, the present average is 3 beds per student in the clinical years when only the owned hospital is considered; the average is 8 beds per student in the clinical years when affiliated hospitals are taken into account:

Number of beds per 3- and 4-year student	Number of schools	
	Ratios based on owned hospitals only	Ratios based on owned plus affiliated hospitals
Total	39	39
Less than 2	7	1
2–2.9	14	1
3–3.9	7	4
4–4.9	8	4
5 and over	3	29

With 3 or 4 beds per student, a school with an entering class of 64 students (or 60 students in each of the 2 clinical years) would require a range of 350 to 500 teaching hospital beds. For a school with an entering class of 96 students (or 90 students per class in the clinical years) 500 to 700 beds would be needed. These beds do not have to be in 1 hospital, but greater efficiency in teaching will result if they are.

Some new schools have constructed an ambulant patient facility as a part of the inpatient service. This unit is used as 1 phase of progressive patient care and as a unit for research in the reduction of hospital cost. In such units, the student learns to approach patient care as the family physician would in the home. There is less responsibility of a traditional character on the nursing staff, but a greater responsibility for the education of patient and family, and for recreational and occupational therapy. An ambulant facility may supplement outpatient services for patients coming from a distance.

TABLE 6.—*Beds in primary teaching hospitals owned by medical schools or universities, by number of students*

Number of beds in teaching hospitals	Total schools	Number of students in school				
		Under 300	300–399	400–499	500–599	600– and over
Total	39	11	13	5	6	4
Under 300	5	3	1	1	-----	-----
300–399	8	4	2	1	1	-----
400–499	3	-----	2	1	-----	-----
500–599	6	2	2	1	-----	1
600–699	5	-----	3	-----	1	1
700–799	7	2	2	-----	2	1
800 and over	5	-----	1	1	2	1

Source: American Medical Association, Directory of Approved Internships and Residencies, 1963.

OUTPATIENT CLINIC

The outpatient clinic, educationally, is planned to serve as a counterpart of the physician's office where the student learns the management of ambulatory patients. Here the student may get the feel of what can be accomplished in his own private office after he is in practice.

The size of the clinic depends on the program of the school. Some schools accept only patients referred by the family physician or health and welfare agencies for diagnosis and/or for therapy. In this pattern, long-range definitive patient care remains the responsibility of the family physician at home. In other, usually larger, communities the clinic may assume definitive responsibility for patient care for some segment of the population and serve in place of the patient's family physician. Additional forms of outpatient activity include participation in home-care programs, the operation of family clinics, and the provision of special rehabilitation services.

The outpatient clinic facilities should contain classrooms, space for examination and conferences with patients and teaching staff, student clinical laboratories, and special educational facilities, depending on the program of the school. The physical arrangements should be such as to facilitate coordination and consultation among the various clinical departments, so that greater emphasis may be placed on treating the patient as a whole person rather than treating discrete disease entities.

The volume of outpatient visits required to support teaching programs will vary with the size of the medical school and the degree to which clinical experience in the outpatient department is emphasized. For estimating purposes, an average minimum daily volume of 350 clinic visits may be used in planning a teaching hospital outpatient department serving a medical school with an entering class of 96 students.

ADMINISTRATIVE RELATIONSHIPS

Although university or medical school fiscal control of the teaching hospital has many advantages, there are many satisfactory medical school-hospital relationships in which the hospital fiscal administration is largely independent of the school. It is essential that the governing body of the hospital understands the requirements of medical education and is willing to meet them. A satisfactory working relationship requires that both hospital and medical school officials have common goals and a high degree of mutual understanding.

If a medical school plans to make use of an affiliated hospital, it may be advisable to secure outside consulting help to assure that the working relationships and agreements are such that the interests of medical education are adequately protected.

Research

The quest for new knowledge is an integral part of good medical education because it develops a critical and inquiring mind and because it provides an excellent teaching tool. A strong research program is essential to stimulate faculty and students alike, as well as to fulfill a basic responsibility for the advancement of medical knowledge.

In the past decade the expansion of medical school facilities has been closely related to the growth of research activity. In 1941, medical schools had research budgets of $4 million. By 1948, research budgets had increased to $17 million, and by 1959 to an estimated $114 million.

The amount of money spent on grant-supported research varies widely among medical schools. In 1959, 19 schools spent over $2 million each for such research, while 13 schools each spent under $500,000.

These research programs make heavy demands for space, particularly for laboratory facilities and libraries. In a typical school today, a third of the space in the medical sciences building is used for research activities; in many schools the proportion is much higher.

The outlook for the future is for a further expansion of research activities in medical schools. Recent studies have called for a doubling or more of national medical research expenditures over the next decade (*4*, *5*). A large portion of any such additional research would be conducted in the medical schools.

With the increase in medical school research has come the expansion of training programs for graduate students and postdoctoral fellows in the basic medical sciences and in clinical fields. Although these graduate education programs may be centered in research laboratories, they must be closely related to both the basic science teaching facilities and the hospital.

The rapid growth of research and research training has required most of the existing medical schools to expand their research facilities in recent years. Many have had to build new wings or even separate buildings to house these activities. A new school would need to plan its facilities to meet an increasing responsibility for medical research.

Faculty

The size and character of its full-time faculty is one of the chief determinants of the amount of space needed by a medical school. Full-time faculty members in both basic and clinical departments must have offices; most of them also require laboratories for research either in the medical school building or in the teaching hospital. Adequate space is a necessary condition today for the recruitment and retention of a well-qualified faculty.

Marked variation exists among medical schools in the number of full-time faculty employed. There are wide differences also in the amount of research space provided for individual faculty members. However, certain general patterns and trends in staffing may be discerned, which can provide a guide for planning new medical school facilities.

Medical schools generally have much larger faculties, relative to the number of students, than do other institutions of higher education. Among 4-year schools in 1963 the average number of full-time faculty was about 160, in relation to an average enrollment of 375. This does not include part-time faculty.

The high average number of full-time faculty members is a reflection in part of curriculum patterns and methods of teaching. Each medical school must have enough faculty to provide instruction in the basic sciences and the specialty areas within the basic sciences, as well as in the various clinical specialties which are steadily increasing in number. Small group teaching, with a minimum of time spent in large lectures and demonstrations, is the pattern.

The close association between teaching and research in medical schools is another reason for the large numbers of faculty required. A recent survey by the National Institutes of Health showed that in the schools studied about two-fifths of all faculty time was devoted to research, with the proportion nearer three-fifths among faculty in the basic sciences (*3*).

Another factor accounting for large faculties is the amount of time which must be spent by clinical teaching staff in the provision of patient care and other clinical services.

Responsibility for the teaching of students other than medical students constitutes still another reason for the generally large faculties. Interns and residents often require as much clinical faculty time as do medical students. Graduate and postgraduate students in the basic and clinical sciences are large consumers of faculty time. In some schools the responsibility for dental students, student nurses, and many other groups of students is significant.

VARIATION AMONG SCHOOLS

Some medical schools have much larger full-time teaching staffs than do others. The number of full-time faculty ranges from less than 50 to more than 300 (including persons with the rank of instructor or higher engaged in teaching, clinical service, research, and administration).

The size of the medical student body in a particular school has some bearing on the faculty size, with the schools having the largest classes tending to be among those with larger faculties. However, many exceptions exist to this pattern. There may be a differential of as much as 10 times in the size of faculty of 2 schools having almost identical class sizes. A differential of 2 to 4 times is common. (See figs. 2–4.) Between 1959–60 and 1962–63, average full-time faculty increased 18 percent.

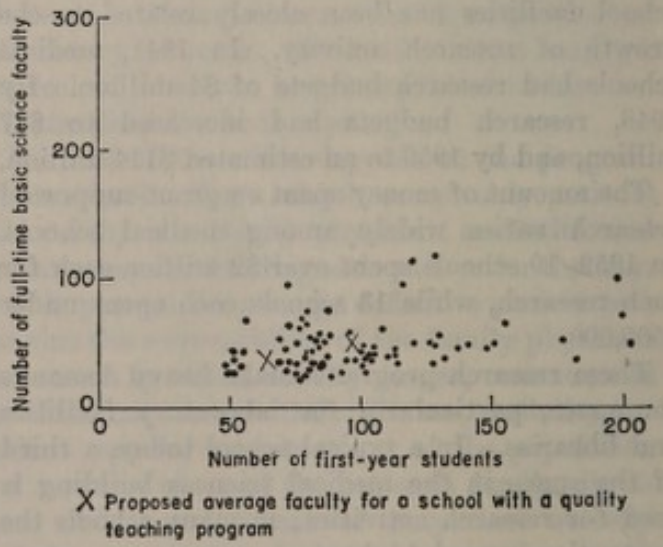

FIGURE 2.—Full-time basic science faculty of 4-year medical schools in the United States, by size of first-year class: 1959–60.

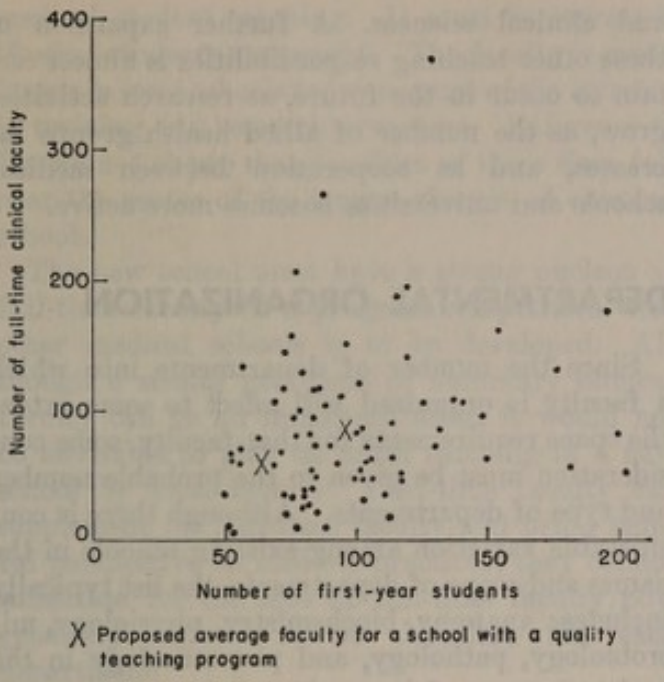

FIGURE 3.—Full-time clinical faculty of 4-year medical schools in the United States, by size of first-year class: 1959–60.

The variation in research programs is a major factor affecting the total number of teachers required. In some schools faculty members average as much as 75 percent or more of their working hours in research. These schools must have a considerably larger full-time faculty to provide a given number of hours of teaching than schools where the amount of time devoted to research is small.

Another important variable influencing full-time faculty requirements is the degree of reliance on part-time or voluntary faculty. In some schools—most of them older schools in large metropolitan areas—much of the clinical teaching is done by persons who are employed less than full time. In general, medical schools do not provide office and research space for part-time or volunteer faculty.

The relative responsibilities for teaching other-than-medical students and the varying demands made on clinical faculty for patient care and other clinical services also affect the number of full-time faculty used.

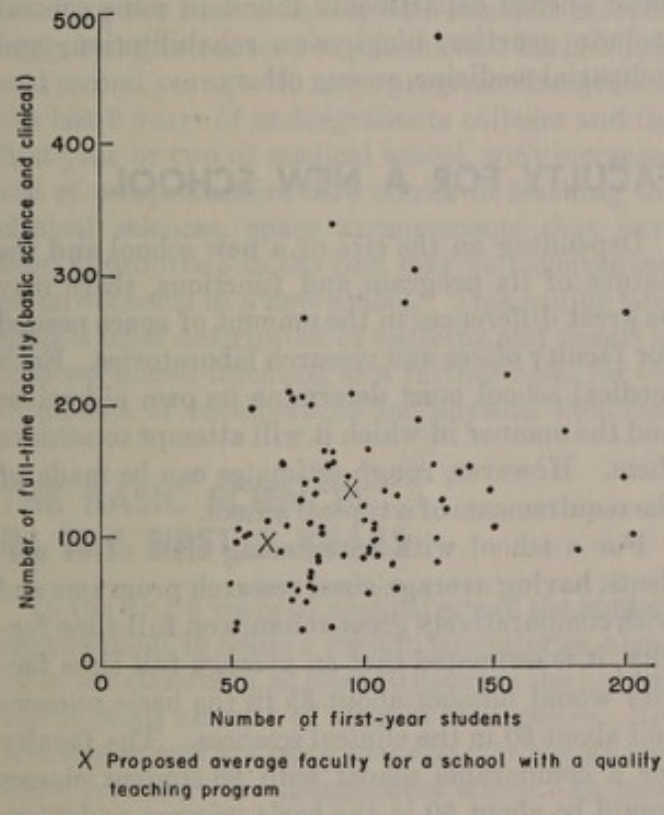

FIGURE 4.—Total full-time faculty (basic science and clinical) of 4-year medical schools in the United States, by size of first-year class: 1959–60.

INCREASING FACULTY REQUIREMENTS

The faculties of most medical schools have increased in size over the past decade. In the 20 schools studied by the National Institutes of Health in 1959, the full-time faculty had more than doubled since 1951, increasing from 947 in 1951 to 2,263 in 1959 (*3*).

Growth in faculty size has been concentrated especially in the clinical science departments, with the largest percentage increases in the fields of medicine, preventive medicine, opthalmology and otorhinolaryngology, neurology and psychiatry, and surgery. In the basic sciences, the greatest increases have been in biochemistry, pharmacology, and pathology (table 7).

Much of this growth in faculty has resulted from the increasing availability of research and research training grants, with teaching staff devoting a rising proportion of their time to research. The National Institutes of Health study showed that between 1951 and 1959 the total faculty almost doubled but the amount of faculty time spent in research increased 134 percent. In view of the present outlook for a continued increase in funds for research, this trend toward increased faculty research activity can be expected to continue and must be considered in planning medical school buildings. Particular need will exist for laboratories for the cooperative research involving faculty members and groups of grad-

TABLE 7.—*Increase in numbers of full-time faculty members, by department, at 10 public and 6 private medical schools, 1951–59*

Department	Full-time faculty		Percent increase
	1951	1959	
Preclinical	390	769	97
Anatomy	76	115	51
Bacteriology	65	107	65
Biochemistry	63	150	138
Pathology	82	175	113
Pharmacology	40	95	138
Physiology	64	127	98
Clinical	540	1,469	172
Ophthalmology, otorhinolaryngology	21	61	190
Medicine	141	446	216
Neurology and psychiatry	95	251	164
Obstetrics and gynecology	25	55	120
Pediatrics	68	160	136
Public health	35	106	203
Radiology	43	98	128
Surgery	112	292	161
Not classified	17	25	----

Source: Reference (3).

NOTE.—Between 1959–60 and 1962–63, average full-time faculty increased 18 percent.

uate students and postdoctoral fellows and assistants.

A trend has occurred toward employment of larger numbers of full-time faculty as compared with part-time or volunteer faculty. In the period 1951–59, in the schools studied by the National Institutes of Health, full-time faculty increased on the average by 140 percent, and part-time faculty by only 85 percent. This trend is likely to continue, as faculty salaries increase and as growing stress is placed on the value of having a strong nucleus of full-time faculty.

Responsibilities have grown for the teaching of students other than those working for an M.D. degree. During the past decade medical schools have assumed responsibility for training increased numbers of interns and residents. Expansion of research has brought many additional graduate students and postdoctoral fellows into the basic and clinical sciences. A further expansion in these other teaching responsibilities is almost certain to occur in the future, as research activities grow, as the number of allied health groups increases, and as cooperation between medical schools and universities becomes more active.

DEPARTMENTAL ORGANIZATION

Since the number of departments into which a faculty is organized will affect to some extent the space requirements for that faculty, some consideration must be given to the probable number and type of departments. Although there is considerable variation among existing schools in the names and scope of departments, the list typically includes: anatomy, biochemistry, physiology, microbiology, pathology, and pharmacology in the basic sciences and internal medicine, surgery, pediatrics, obstetrics and gynecology, psychiatry, and preventive medicine in the clinical sciences.

Departures from this pattern generally result from the establishment of departments for subspecialties in the clinical sciences: anesthesiology, neurology, ophthalmology, orthopedic surgery, physical medicine, urology, and so on. Additional basic science departments found in some schools include genetics, biophysics, rehabilitation, and industrial medicine, among others.

FACULTY FOR A NEW SCHOOL

Depending on the size of a new school and the nature of its program and functions, there may be great differences in the amount of space needed for faculty offices and research laboratories. Each medical school must determine its own objectives and the manner in which it will attempt to achieve them. However, rough estimates can be made of the requirements of a typical school.

For a school with an entering class of 64 students, having average-sized research programs and with comparatively great reliance on full-time faculty, it is estimated that an average full-time faculty would number about 35 in the basic sciences and about 60 in the clinical sciences. The faculty for a comparable school with 96-student classes would be about 50 in the basic sciences and 85 in the clinical sciences. (See table 11, p. 31.) The size of faculty suggested here provides only for

medical student teaching. It must be increased if other students are taught. The faculty is much larger in some schools today because of the increase in training and research programs. Reference to figures 2–4 shows that faculties of these sizes fall near the center of the largest clusters of existing schools.

The new school must have a strong nucleus of full-time faculty if a program competitive with other medical schools is to be developed. Although a strong part-time or voluntary clinical faculty can be an important asset, it would not be advisable to plan on much teaching in a new school by such faculty. Part-time faculty can supplement the full-time faculty and bring helpful perspective on medical practices; they cannot substitute for the core of full-time faculty now generally agreed to be desirable for each department.

In the early stages of a school's development, and probably later, it is desirable to keep the number of departments comparatively small. This can be accomplished by grouping the various subspecialities within such broad departments as medicine and surgery. Additional departments can be established, if necessary, as the school develops a particularly strong research or teaching program in one or another specialized field.

Because of the variety of specialized subjects that must be covered in the medical curriculum, and with few faculty members able to teach adequately more than 1 or 2 of these subjects, a medical school must have a certain minimum number of faculty in each department regardless of its enrollment. For a school with fewer than 64 students per class, for example, the number of full-time faculty would be very little smaller than the number required for 64 students.

The Medical Curriculum and Teaching Methods

Variations in curriculum and teaching methods profoundly affect the space and structural requirements of a medical school. With new methods of teaching the basic sciences, with students increasingly being introduced to patient care in their first and second years, with some programs integrating the last 2 years of undergraduate colleges and the first year or two of medical school, with increased use of comprehensive-care clinics in teaching the clinical sciences, space arrangements that have been appropriate in the past may be inconvenient or unworkable in a new school. This section presents a brief description of patterns and trends in medical school teaching, as a further basis for the discussion of requirements for physical facilities.

THE BASIC SCIENCES IN THE FIRST 2 YEARS

In the first 2 years of medical school the student spends about 25 hours a week in laboratories, about 10 in the classroom, at least 10 hours in the library, and a small amount of time in conferences. Increasing efforts are being made to give the student more free time for independent study. In most schools the first year emphasizes anatomy, biochemistry, and physiology; in the second year major attention is given to microbiology, pharmacology, and pathology. The total time given to these subjects is about 1,800 clock hours in the 2 years. Although the range in total hours is quite narrow, there is a wide range in the hours devoted to each of these areas. Although anatomy usually receives the largest segment of time, there is no consistent pattern in the proportion of time given to other basic sciences (table 8). This variation

TABLE 8.—*Clock hours in basic medical sciences in the first 2 years of medical school, 1959*

Department	Clock hours	
	Average	Range
Total	1,917	1,175–2,211
Anatomy	596	375–777
Biochemistry	241	150–372
Microbiology	202	36–295
Pathology [1]	348	180–498
Pharmacology	165	90–336
Physiology	266	165–432

[1] Including clinical pathology taught by the department of medicine. Since pathology is both a basic and a clinical science, its placement here is arbitrary.

Source: U.S. Public Health Service compilation from catalogs of 61 medical schools.

is accounted for in part by the fact that there are no rigid barriers between departments in subject matter and techniques. Hence, some subject-matter areas can be taught best in one department of a given medical school and in another department in a different school. This will depend in part upon the interests and competencies of faculty members in various departments.

The Subjects

In brief, the content of the basic science subjects is as follows:

Anatomy.—Thirty years ago teaching centered on the anatomy of the structural aspects of tissues and organs, the vascular and nervous systems of the human body, with gross dissection and microscopy as the major techniques used in learning. The total amount of time devoted to teaching anatomy has decreased since then, with much less emphasis on rote learning, and more on the functional aspects of anatomy.

In recent years, demonstration with X-ray, fluoroscope, and motion pictures have been added to the traditional anatomical dissection and lectures. The development of phase contrast and electron microscopes has opened a new world of anatomy, with increased emphasis on molecular structure and function of living tissues. These developments have required new emphasis on laboratory facilities which make possible more exact and detailed study of body structure.

Biochemistry.—In biochemistry (or physiological chemistry) the first-year medical student studies the chemical components and the metabolic processes of living matter. The rapid advances in biochemistry and the development and refinement of equipment have revolutionized its teaching. That the Bunsen burner has been replaced by the spectrophotometer is indicative of the change. Students today do experimental work with equipment that was not available a few years ago. High-speed centrifuges and radioisotopes have come into common use. Students may be brought into research laboratories for demonstrations or for special experiments. Much of the equipment available is more sophisticated than that which the practicing physician will use in his own work, but all of it is important in teaching the principles of modern science. There is no doubt that the use of such equipment in teaching will continue to grow. Molecular biology is among the disciplines whose increasing importance must be anticipated in planning new educational facilities.

Physiology.—Physiology is the study of function of normal living organisms. It explores the way in which each part of the body works to adapt the organism to its internal and external environments. Once the marks of the physiology laboratory were the smoked drum and other simple recording and measuring devices. Now, although the same organ systems and functions are under study, the experiments and measurements required are of a much higher order of quantitative exactitude. The student in physiology now uses a wide variety of electronic equipment which was not even in existence a few years ago. With new developments in medicine, the use of more elaborate equipment will continue to increase and facilities must be planned for the necessary rearrangement and remodeling in the future.

Biophysics is concerned with physical principles, techniques, and instrumentation applicable to medicine, and includes mechanics, sound, heat, thermodynamics, electricity, electronics, radiation, and nuclear physics. Usually biophysics is found as a specialty within the department of physiology or biochemistry, but it may be a separate basic science department or in the department of radiology.

Microbiology.—Microbiology is the science of microscopic organisms and their biological characteristics, chemical activities, and disease-producing mechanisms. It usually includes bacteriology, mycology, virology, immunology, and often parasitology. Microbiology to some degree effects the transition from the basic sciences to clinical medicine, since the teaching of fundamental aspects is increasingly blended with the teaching of applied knowledge in pathogenesis, diagnosis, or treatment of microbial infections. Increasing attention is being given to quantitative methods in biology, as ways have been developed to make precise physical measurements of microbiological and subcellular particles from other sources.

Pathology.—The study of pathology is the student's first introduction to disease. It is here that ". . . he sees the end results, the damage wrought by disease, and studies the natural history of disease" (*6*). The gross and microscopic study of diseased tissue and the understanding of pathogenesis obtained through experimental pathology builds a strong bridge between the laboratory

sciences and clinical medicine. Pathology is increasingly using an experimental approach to gain an understanding of disease processes, adopting the techniques of the other basic sciences in its teaching and experimentation.

The transition of the medical student from the basic science laboratory where a minimum number of variables is controlled as carefully as possible to the clinical situation where almost unlimited data must be evaluated and acted upon according to scientific principles constitutes the most difficult adaptation the student must make in his medical school. Thus, pathology must provide full opportunity for careful correlation of clinical data with pathologic anatomy and physiology by challenging the student with problems that are graduated in complexity until he begins to undertake the problems of active clinical management of patients.

Pathology, it must be remembered, is both a basic science discipline and a clinical discipline embracing clinical pathology and other laboratory types of patient-care services in anatomic pathology. Facilities for both types must be considered in the organization of this department.

Pharmacology.—Pharmacology is the study of drugs, chemicals, and biological products, their effects on living cell systems, and the general principles underlying their action. Pharmacology draws on biochemistry, physiology, and bacteriology in the study of drug action. At the same time it looks toward pathology, medicine, and surgery for its application. The laboratory work in this subject emphasizes experiments with animals to identify and measure the manner in which drugs are handled by the body. Some laboratory exercises are done on the human being, usually the student himself. The application of pharmacologic principles to the treatment of actual patients usually is taught in the clinical years as therapeutics.

Emerging Fields of Interest

Although the basic sciences usually are each a separate department, this is not always so. In a few schools, for example, physiology is combined with pharmacology; in others, with biophysics. Microbiology may be combined with preventive medicine or pathology.

The increasing importance of the quantitative approach to medicine and medical research is evident from the growing emphasis on such subjects as biophysics, genetics, and biostatistics. These disciplines are being given more attention in established departments of anatomy, physiology, biochemistry, and pathology; they also appear in some schools as independent departments.

Increasingly the several departments are borrowing from each other both tools and techniques and making joint contributions to common problems. Physical facilities should be such as to encourage these joint efforts.

Trends in Teaching Methods

The teaching of the basic sciences is increasingly done with small groups of students. Instead of using large laboratories for 50 to 100 or more students, an increasing number of schools teach the first- and second-year classes in smaller laboratories, designed for 16 to 24 students. One school has laboratories for 8 students. Laboratory work is designed around experiments to demonstrate principles rather than to teach analytical techniques or procedures. Emphasis is placed on special project work rather than routine experiments. There is less lecturing to large groups and more discussion in small groups than in years past. Students are encouraged to develop research projects of their own requiring extensive use of laboratory and library. Medical students are increasingly being taught as graduate students have been taught in the past, learning to develop their capacity for inquiry and balanced judgment (*7*).

A number of schools have replaced conventional departmental teaching laboratories with multidiscipline laboratories which provide each student with one laboratory area which he uses for all his studies in the basic medical sciences (except gross anatomy, which requires a different type of physical facility). Such multidiscipline laboratories can be used either for conventional departmental teaching, or for an integrated program.

Although in most schools the teaching of the basic sciences is organized on a departmental basis, a sharply different type of program has been developed in the past few years at a small number of schools. After a general orientation based on a study of the cell, the work usually covered separately by basic science departments has been organized into such units as the gastrointestinal system, the locomotor system, and the nervous system, with many departments cooperating in

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each teaching unit. A committee with overall responsibility reports to the dean or other administrative officer rather than to the departments, with interdepartmental subcommittees to plan and conduct each of the units in the program. The laboratory arrangement is student centered rather than department oriented; that is, each student has his own single work area in a multidiscipline laboratory, which he uses for all laboratory exercises except gross anatomical dissection. This general laboratory is the immediate responsibility, not of the individual departments, but of a laboratory manager.

Integration With Undergraduate College Years

A few schools have developed an approach to basic science teaching which involves integration of the last 1 or 2 years of undergraduate college with the first year or two of medical school. As yet these programs have relatively small enrollments, and their arrangements of physical facilities are still experimental. The new program of the Johns Hopkins School of Medicine—

> affords an opportunity for properly qualified students to save one or even two years between the sophomore year of college and the completion of medical school. It consolidates the teaching of premedical courses in the natural sciences, and thus avoids the unnecessary duplication of effort which now prolongs the combined college-medical school curriculum. It merges the teaching of liberal arts and medical science in the earliest years of the curriculum, thereby tending to break the barrier which has traditionally existed between colleges and schools of medicine. It creates better opportunities for students interested in teaching and research to obtain advanced training in the basic medical sciences during the formative years of medical school. And, by providing generous blocks of free time in every year, it gives all students an ample opportunity to pursue independent study and research, and thus acquire a thorough mastery of knowledge through the exciting process of discovery (*8*).

Although the Hopkins program admits students into a 5-year program at the end of the second or third college year, other schools have developed less far-reaching modifications of the usual curriculum pattern.

Students of Dartmouth College who are candidates for the A.B. degree, for example, may be admitted to the medical school at the beginning of the senior year. In this year the curriculum is essentially that of the normal first year of medical school, except that an added course, "Great Issues," is required, as it is for undergraduate seniors.

CLINICAL TEACHING IN FIRST 2 YEARS

Although most clinical teaching is done in the third and fourth years, all schools include some introduction to clinical techniques in the first 2 years. Instruction by the clinical departments in these 2 years now averages 400 hours, an increase of some 25 percent in the past 10 years. Present indications are that such teaching by clinical faculty will increase.

The range of clinical subjects now taught in the first 2 years, and the number of hours devoted to each of these subjects, varies widely among the schools. The departments most frequently offering courses are medicine, psychiatry, and preventive medicine (table 9).

There is a growing tendency to introduce clinical material or methods through conjoint courses, correlation clinics, and other interdepartmental programs. Thus the student learns that biological principles are equally true for bacteria, small animals, and human beings. In some schools all clinical teaching of the first 2 years is in interdepartmental programs; in others, medicine, or medicine and surgery, are taught separately, with other specialties presented in joint programs; in

TABLE 9.—*Clock hours taught by clinical departments in the first 2 years of medical school, 1959*

Department	Percent of schools	Clock hours	
		Average	Range
Total—all clinical departments	100	415	213–666
Medicine	97	186	20–366
Surgery	69	46	10–126
Obstetrics	52	26	9–64
Pediatrics	37	26	4–63
Psychiatry	100	76	160
Radiology	34	15	3–70
Preventive medicine	89	59	16–173
History of medicine	11	24	11–60
Conjoint courses	39	100	6–354

Source: U.S. Public Health Service compilation from catalogs of 60 medical schools.

still others, each department does its teaching independently.

Normal growth, development, and variation are introduced early in many of these correlated programs, often through joint presentations by basic science and clinical departments.

CLINICAL TEACHING IN THIRD AND FOURTH YEARS

The student spends most of the last 2 years of medical school in the teaching hospital and clinics where he serves as a clinical clerk (table 10). This time is spent primarily in gaining experience with patients, amplified by reading and by contact with members of the teaching and hospital staffs. His responsibility includes taking medical histories, doing physical examinations, making laboratory tests, and recording his findings on medical records. This work is supervised by instructors with responsibility for small groups of students. The teachers at various times may be members of the resident house staff, the visiting (part-time) medical staff, or full-time faculty. The work in preventive medicine and public health is concentrated most heavily in the first 2 years in some schools; in others, in the last 2.

TABLE 10.—*Weeks in clinical clerkships in the last 2 years of medical school, 1959*

Department	Weeks of inpatient training	
	Average	Range
Medicine	20	12–35
Surgery	17	8½–24
Obstetrics	9	3–15
Pediatrics	9	4–19
Psychiatry	6	½–13

Source: U.S. Public Health Service compilation from catalogs of 43 medical schools.

The medical student spends an average of 12 weeks on the outpatient services, usually in his senior year. Some schools offer much less outpatient service; a few have 20 weeks or more. In most schools each department is responsible for its own outpatient clinics; in some, the major service is based in a general clinic. Outpatients usually present more chronic disease problems of less severity than do inpatients, and illustrate the progression of disease over a period of time. The proper management of ambulatory patients is assuming increasing importance, especially as the practice of preventive medicine is emphasized.

One of the great problems of medical education has been that, with the heavy emphasis on disease, the problems of the patient as a person are often overshadowed or forgotten. To meet this problem, and to give the student an awareness of the patient as a person and as a family member, a number of schools have developed comprehensive or general care clinics. These clinics are usually under the general direction of a member of the department of medicine, with teaching participation by other clinical departments.

The clinical departments are described more fully in chapter 6.

Library

The medical library is an active educational instrument in modern teaching. For the student, the use of textbooks has been very substantially supplemented by reference to the recorded information in books and journals. For the faculty attempting to keep abreast of an ever-enlarging body of medical knowledge and for the research worker engaged in adding to that body of knowledge, the medical library has assumed ever-increasing importance.

Medical library collections tend to double in about 20 years. At the time of a 1934–39 survey, the median size of the 4-year medical school libraries was 20,000 volumes, with 272 periodicals currently received (*9*). Thus new libraries should provide space for at least 100,000 volumes.

Good medical school libraries today must be staffed to instruct student in the use of medical literature, to acquaint them with library resources, and to prepare them to draw upon such resources throughout their medical careers. Most schools do this by formal lectures to students, interns, and beginning research workers, or by group practice in library use worked out jointly by the library

and one or more of the teaching departments. The humanistic backgrounds of medicine are also stressed by the library, which frequently is cosponsor to the school's history of medicine society and "journal club," and which arranges for exhibits of medical literature pertinent to the segment of the curriculum being studied at the moment.

Medical schools with extensive research programs especially need expanded library resources in the subject matter collected (which must include the general biological and physical sciences touching on health and disease) and in the time-span covered by their journal files. Since research workers use the library so extensively, more library staff is also required. For these reasons, there tends to be a direct ratio between the research outlays of a medical school and the physical size and budget of the library.

Study Areas

Medical schools are increasingly recognizing the need for adequate study areas for students. In some schools extensive use is made of the library; in others—the majority— the library has neither space nor facilities for such purposes. Few medical schools provide dormitory or housing facilities for students which facilitate serious and systematic study. Laboratories are sometimes used for this purpose, particularly in those schools which have small multidiscipline laboratories.

Some of the new schools have experimented successfully with study cubicles—with each student assigned a small permanent workspace with a desk, cupboard, or locker, and bookshelves. The cubicles may be grouped in a central location related to library facilities and laboratories. They provide the needed quiet place to think and work. One recent study showed that, on the average, the students use such study space for more than 20 hours a week. Study cubicles have proved useful also for graduate students and house officers (*10*).

Administration

The breadth of teaching and research responsibilities, the staffing pattern, and the functional relationships with general university administrative offices will determine the scope and magnitude of administrative responsibilities of the medical school. The operation of the teaching hospital may also be an administrative responsibility of the medical school dean (or the chief administrative officer of the medical center). This decision must be carefully thought out in terms of the local situation to avoid administrative problems that may adversely affect the educational programs.

Inasmuch as research, teaching, and other medical school activities will continue to expand rapidly, the need for a growing administrative staff can be anticipated. Furthermore, the financing of medical schools and medical centers has become very complex; income is derived from a variety of sources, each requiring special administrative attention. For these reasons, medical school facilities must have adequate space for administrative functions.

There are many different organizational patterns by which administrative functions for a medical school are accomplished, each requiring space either in the medical school building, or elsewhere on campus as may be most appropriate. The major functions are as follows:

ACADEMIC

This unit administers the educational program for medical students, for graduate students in the basic medical sciences, and for interns, residents, trainees, and fellows of various kinds. The medical school may have responsibility for basic programs in one or more of the allied fields such as medical technology, physical therapy, and nursing. Most schools are affiliated with one or more hospitals, and these affiliations have academic and sometimes fiscal implications.

STUDENT AFFAIRS

These activities include relationships with colleges and universities for recruitment of students, appraisal and selection of applicants for admission, provision of various student services such as housing and financial aid (loans and scholarships), maintenance of adequate records on students, and writing letters of recommendation which continue for years after graduation. The increasing participation by students in research, during the school year and in the summer, the selection of work for elective courses, and the general problem of evaluation of performance in grades and in more subjective personal relationships requires almost day-to-day availability of trained administrative personnel. Student affairs also include general supervision of student activities and provision of counseling and guidance services.

Some of these functions may be performed by a general university admissions or registrar's office, some by university offices established for counseling and guidance, and a few by the dean of men and dean of women. However, the professional character of the medical school program and other factors usually require that these services be provided by the medical school staff.

BUSINESS AND FISCAL

Activities of this unit include budget preparation and administration, accounting, purchasing, receiving, and storerooms. Building and grounds maintenance and operation may be included. A large and growing segment of the financial management of medical schools lies in the field of research-grant administration which requires specialized attention. Substantial income may also be realized by fees for various kinds of services.

Although many services of the general university business office can usually be used, policies and procedures may require some adaptation to deal with the specialized problems that arise in medical school and hospital financing. Branch offices in a medical center will frequently be needed. The crucial point is that the dean or chief administrative officer must have a competent business officer responsible to him, and he in turn must answer to the university administration for compliance with policy and proper procedures in the business operation of the medical school or center.

PERSONNEL

The activities which relate to nonprofessional personnel include their recruitment, classification, and placement; establishment of salary ranges; orientation and on-the-job training; handling of grievances and complaints; and provision of various employee services. The professional or teaching staff are under the general administrative supervision of the dean.

Some universities have well-developed personnel services which can be used by the medical school. Many universities and medical schools provide little or no service in this area. The importance of this service is frequently overlooked. A personnel officer for the medical center is essential for efficient operation.

PUBLIC RELATIONS AND PUBLICATIONS

Public relations of a medical school are of great importance to the university since there will be a great public interest in the development and activities of a new medical school. Cordial relations with the practicing profession in the community and with organized medicine should be cultivated during the earliest planning phases.

The medical school also will issue a variety of publications ranging from a catalog or bulletin to public relations and fundraising pamphlets and brochures. Provisions for duplicating teaching material will be required. Many established medical schools rely upon the university's public relations and publications office to meet their needs. An increasing number of medical schools provide some or all of these services directly by trained personnel on the medical school or medical center staff. This is particularly true if the medical school operates a hospital.

INSTITUTIONAL RESEARCH AND LONG-RANGE PLANNING

Some schools are finding it advantageous to have on their staffs specially qualified people whose main task is institutional research and assistance in long-range planning and the formulation of policy to help the school reach its goals most

effectively. The medical school administrative office needs someone to prepare information concerning various trends on such matters as financial support, faculty staffing patterns, student applicants, facility needs, data collection for annual reports, and questionnaires.

FUNDRAISING

Some schools have one or more persons whose primary responsibility is in "development" or fundraising. This activity may, or may not, be considered a responsibility of a general university office, perhaps related to alumni affairs.

SIZE OF ADMINISTRATIVE STAFF

A review of these functions indicates that the administrative staff may be large in a well-developed school or medical center with a broad program. On the other hand, this staff may be quite small, especially in a small school without a university hospital. Certain administrative functions are assigned sometimes to members of the teaching faculty as part-time responsibilities. This is particularly true for certain aspects of academic administration, and for admissions and student services. The minimal administrative staff would consist of the dean and his business officer, with necessary secretarial and clerical services. Usually there is an assistant dean for admissions and student affairs. Increasingly, schools are appointing an assistant dean for continuing education. These latter 2 positions are often filled by members of the teaching faculty on a part-time basis. Gradually, more and more medical schools are establishing a public relations office with a trained director. In general, the space required for administrative staff will depend on the needs of the medical school program, present and projected, and the administrative philosophy of the institution and its parent university.

Chapter 3

SITE AND PLANNING CONSIDERATIONS

Site

The modern medical center is so large and so complex that it should be located on the edge of the university campus rather than within it. This location will emphasize the fact that the medical center is a satellite in the university orbit, but has a degree of autonomy. It is important that students and staff in the medical center have easy access to the main university campus, and that the medical center be accessible to all areas of the university. The location with respect to the campus and the community will influence to some extent the outlook of students, the reaction of the public, the cost of the plant, and efficiency of operation. The setting should create a relaxed, restful atmosphere with orderly, meticulous attention to detail.

The site should be large enough to accommodate growth of the school programs and concurrent parking for at least 20 years. The minimum size recommended for a medical center including a teaching hospital is 50 acres, and 50 to 150 acres is preferable. One new medical center is considering a site of more than 200 acres. A city location will in most cases reduce the amount of land available, probably will require a high-rise facility, and cause parking facilities to become expensive and difficult to achieve. However, many medical schools will be built or expanded on urban land made available through urban renewal or other programs. Financial assistance for planning can be obtained in some situations from the Housing and Home Finance Agency. Because of the ultimate concentration of buildings, any site should have an adequate base for foundations of high-rise buildings.

A long-range plan should be developed for programs and physical plant before the first building is located. Buildings should be placed on the site so that additions can be made as programs develop and as enrollment increases. For example, library stacks, laboratories for classroom teaching, and animal quarters for both teaching and research should be placed so that future increments can be added without disruption of traffic patterns inside or outside the physical plant. Long-range planning of this type will permit minimal disruption of movement, both horizontally and vertically within the plant, and avoid relocation of functions as additions are made.

The service functions of the medical school involve patient care in hospitals and outpatient clinics. Growth of research and service responsibilities frequently leads to the development of specialized hospitals, such as children's, veterans', psychiatric, chronic disease, rehabilitation, or others. The site should permit location of these facilities in relation to the major teaching hospital so that staff and students can be within a 5- to 10-minute walk. The teaching hospital and clinical science facilities should be placed on the site so that the educational functions relate to and connect with the basic science facilities. Outdoor facilities for rehabilitation of patients related to the clinic and recreation facilities for students related to housing should be provided. The extent of these facilities varies widely among schools.

The trend toward early marriage of medical students and the long hours spent in the school by students and house staff require that adequate space for housing be provided nearby. Apartment-type housing with play areas for children, within 5 minutes walking distance of the hospital, is preferable.

The site should have access by a major highway for ready transportaion of patients, as well as access by students, staff, and visitors, and should be at some distance from a major airport to avoid noise. Increasingly, patients from inaccessible

areas who develop medical emergencies are being evacuated by helicopter, and a landing site free of obstruction is desirable in some cases.

Transportation of students, staff, patients, and public is primarily by private automobile. Adequate parking facilities should be provided convenient to each element of the medical center including housing. This may take the form of divided shopping-center-type parking, preferably with trees, various types of paved surface parking, or multilevel parking garages.

If possible, the site should be sloping so that more than one level of entrance to the buildings can be obtained and horizontal movement of supplies can take place at one level, without conflicting with horizontal movement of people at another level. Since supplies are now delivered by truck, a railroad siding is not necessary. Indeed, a site away from a railroad for reduction of noise and vibration is desirable.

The direction of prevailing wind should be studied so that buildings can be placed in relation to each other and to the campus and community to avoid windblown odors from cooking and incineration of animal waste and trash, bacteria from infected patients, chemical fumes, and low levels of radioactive isotopes.

Site planning for a medical center may require extensive coordination with the State, county, city, and university engineering offices for utilities, service roads, bypasses, throughways, buffer green belts, and landscaping.

The site for the animal farm is not usually contiguous to the medical center site because of land cost and because of odors and sounds generated. However, a minimum site of about 25 acres should be provided; recent studies indicate that 120 acres may be required (*11*). It should be located for convenient transportation to and from the animal quarters.

Planning

The physical layout of a medical school requires more than relating one part to another. Equal in importance is the incorporation of flexibility in design to provide for both short-range and long-range goals. If this is to be accomplished, it is necessary to examine some of the problems now being experienced by existing medical schools to avoid making the same mistakes.

An examination of a cross section of medical schools throughout the Nation brought into sharp focus a number of problems stemming from short-sighted planning. Both historical evidence and current trends indicate inevitable expansion to meet increased demands for teaching, research, and clinical space. Failure to consider the requirements of a long-range program will result in increased construction costs and poor functional arrangements when expansion occurs.

The most important step in planning medical school facilities is the development of a well-thought-out, comprehensive, long-range program. For this purpose, a planning committee with a full-time chairman is needed. For a new school, the dean of the medical school should be appointed before any detailed planning begins and should serve as committee chairman. The committee should be kept small and the members should be selected for their objectivity in approaching such problems as curriculum, departmental structure, and space assignment. The university architect, as well as a financial representative of the university, should be included.

The project architect should be selected and should attend all committee meetings dealing with space problems. As an orientation to the problem, the committee members and architect will find it profitable to visit other schools, particularly those with buildings that are newly completed, under construction, or in the planning stage. The experience of other planning groups can help the committee to avoid some of the more common pitfalls. The various disciplines on the planning committee should visit other schools as a team rather than individually so that the same facilities will be seen from different points of view. The maintenance engineer should be employed as soon as possible, at the latest by the beginning of construction, so that he can familiarize himself with the nature and location of all mechanical facilities.

Initial planning should include basic decisions on educational philosophy, curriculum, departmental structure, and number and kinds of students to be taught. The relationship of the medical school to present or future schools of dentistry,

nursing, pharmacy, or other health-related sciences should be established. The educational philosophy and current and long-range objectives of the school should be set forth in a *written program* often referred to as the "medical program." *Space estimates* based on these objectives should be provided by the project architect.

The "architectural program" should be developed on the basis of the "medical program" and discussion with each department head on the space and equipment needs of his department. If no department head has been appointed, it will be necessary to use consultants from other schools. Under these circumstances the detailed layout of the rooms and the selection of equipment should be deferred, if at all possible, until the department chairman is appointed. Otherwise there may be many requests for changes which may be expensive. However, department facilities should not be so "personalized" that a change in department head will result in excessive physical changes in the department.

The committee must make decisions concerning departmental space allocations, student laboratories and their auxiliary rooms, lecture and conference rooms, faculty offices and laboratories, and secretarial space for both basic and clinical science facilities.

The requirements of each department in relation to the common teaching, research, and supporting areas should be determined and the areas sized accordingly. These common areas include medical library, animal quarters, medical illustration, isotope laboratories, lecture rooms, student lounge and lockers or study cubicles, and technical shops.

The requirements for supporting facilities, including administration offices, student activity space, bookstore, post office, snackbar, and general building services must be determined.

Preliminary planning should consider those areas of support that the university can furnish to back up the program in the medical school. Although it may seem more efficient to centralize housekeeping and maintenance, library, and technical shops in the general university administration, experience has shown that these functions for the medical school should be carried out in the medical school. Medical centers run on a 7-day-week, 24-hour-per-day schedule because of the nature of patient care and animal experimentation.

If a new teaching hospital is to be constructed, its size must be determined in relation to the needs of the students and the service responsibility of the school. If the hospital is to be built in a small community, major attention must be given to the sources of patients and the methods of referral and transportation.

If an existing hospital is to be used, there must be careful planning with the hospital on alterations and new construction necessary to make the hospital suitable for teaching, as well as on administrative control, staffing, and admissions policies of the teaching service.

Common-use elements such as lecture rooms, cold rooms, departmental animal rooms, and storage rooms should be designed on the basis of ultimate capacity and placed where they will not interfere with future expansion of research, teaching, or patient-care areas. The number of students a school can accept may be restricted by the number of seats in the lecture rooms.

Auxiliary rooms for teaching laboratories, cold rooms, and floor animal rooms should not be in a location that makes it difficult to expand without encroaching on adjacent areas, thus requiring extensive alteration.

Mechanical service installations should be sized for ultimate loads and capped connections should make provisions for future extensions. Utilities should be brought to or near office and other spaces so that they can be converted economically to laboratory use in the future if necessary.

SCHEDULING

The dean should be allowed at least 6 months to develop a program for a new school.

The design of the basic science building, on the basis of the program developed, may require 6 to 12 months; construction, an additional 18 months or more. It may be possible for students to enter 2½ years after the dean is appointed; usually it is safer to allow a minimum of 3 to 4 years.

The design of the teaching hospital and clinics may require 12 to 24 months. Construction may require a minimum of 24 to 30 months, so that students may be expected to start work in the hospital 4 years after initial planning is completed. In some circumstances an additional 1 to 3 years is required. The schedule should be established so that the hospital is available by the time the

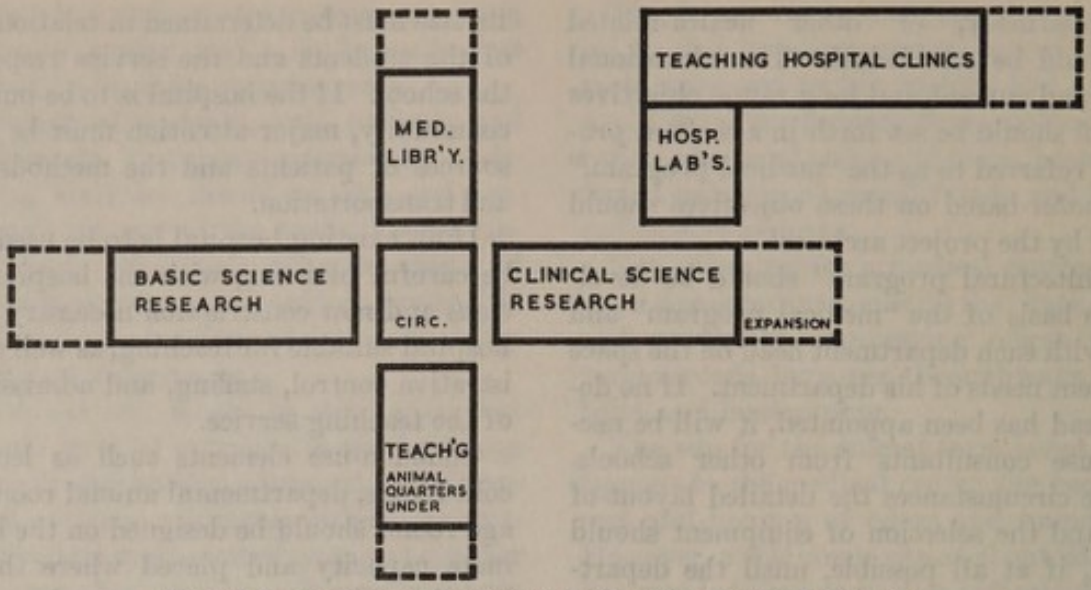


FIGURE 5.—Functional relationship of medical school elements.

first class is ready for the third year in the medical curriculum. Since it will usually take 3 to 4 years for the hospital to be reasonably full, it may be wise to admit smaller classes during the first 2 to 3 years than are anticipated when the program is fully developed.

The appointment of department heads should begin at least as soon as the dean has completed developing his program. It may require at least 6 to 12 months to recruit basic science and key clinical department heads, and they should be in residence at least 1 year before teaching in their disciplines begins. It may require 12 to 18 months to recruit the remainder of the clinical department heads and junior faculty members in all departments.

FUNCTIONAL RELATIONSHIPS

Of prime importance in planning medical schools is the relationship of its three major components: the basic science facilities, the clinical

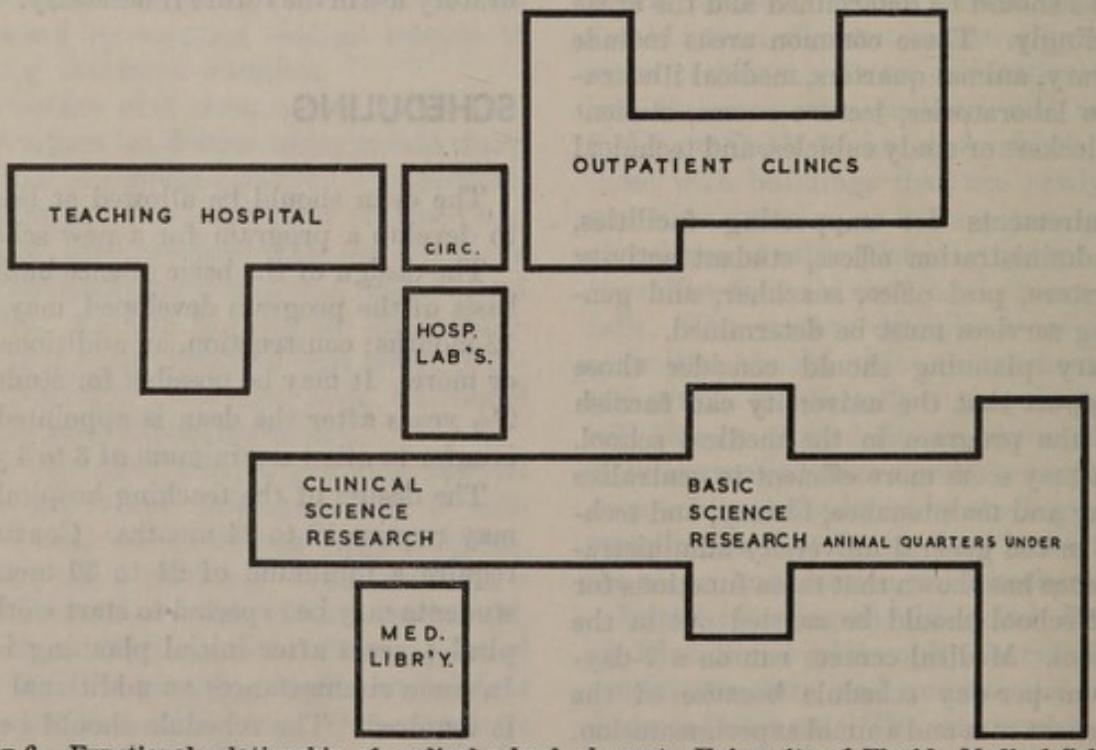


FIGURE 6.—Functional relationship of medical school elements, University of Florida Medical School.

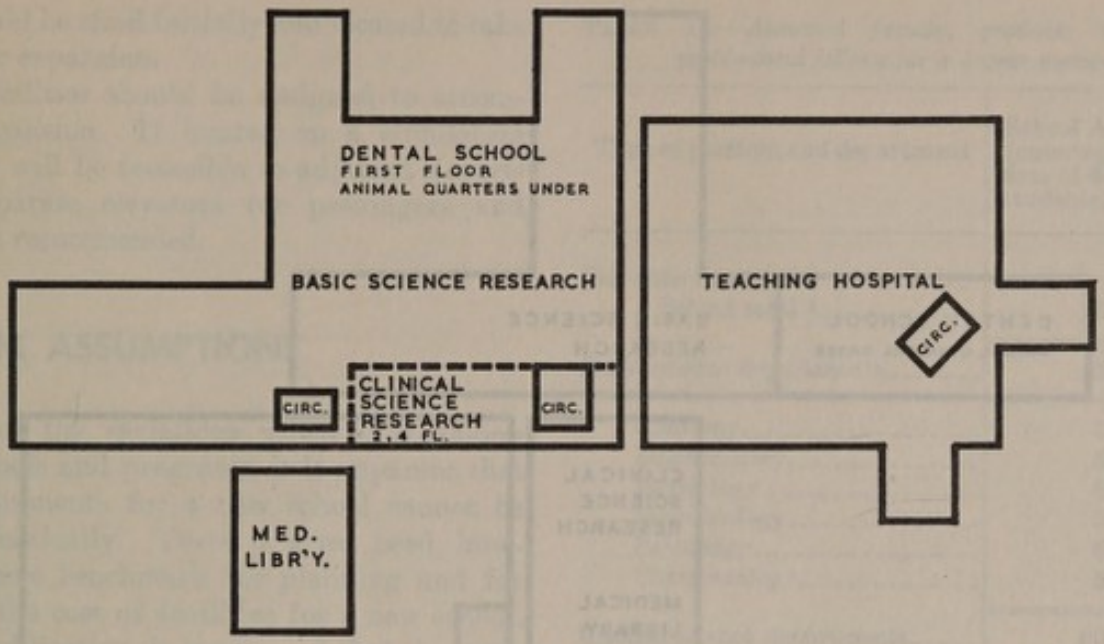


FIGURE 7.—Functional relationship of medical school elements, University of West Virginia Medical School.

science facilities, and the teaching hospital. For the most efficient movement of students, faculty, patients, and supplies, the three should be interconnected, but for maximum flexibility in expansion each should be an independent element. Figure 5 illustrates this relationship. The basic science and the clinical teaching and research facilities, in turn, should be attached to the hospital to permit easy access to patient units and other hospital facilities. The diagram also shows the possibility of expansion inherent in this relationship. Figures 7–9 show the relationships of components in 4 existing medical schools.

In the basic science facilities, the departments can be stacked above each other with teaching laboratories, faculty, research and office space, and lecture rooms for each department located on the same floor. The cadaver preparation and storage department is usually located on a floor accessible to grade for convenience in handling cadavers. Central animal quarters serve teaching and research areas for both basic science and clinical

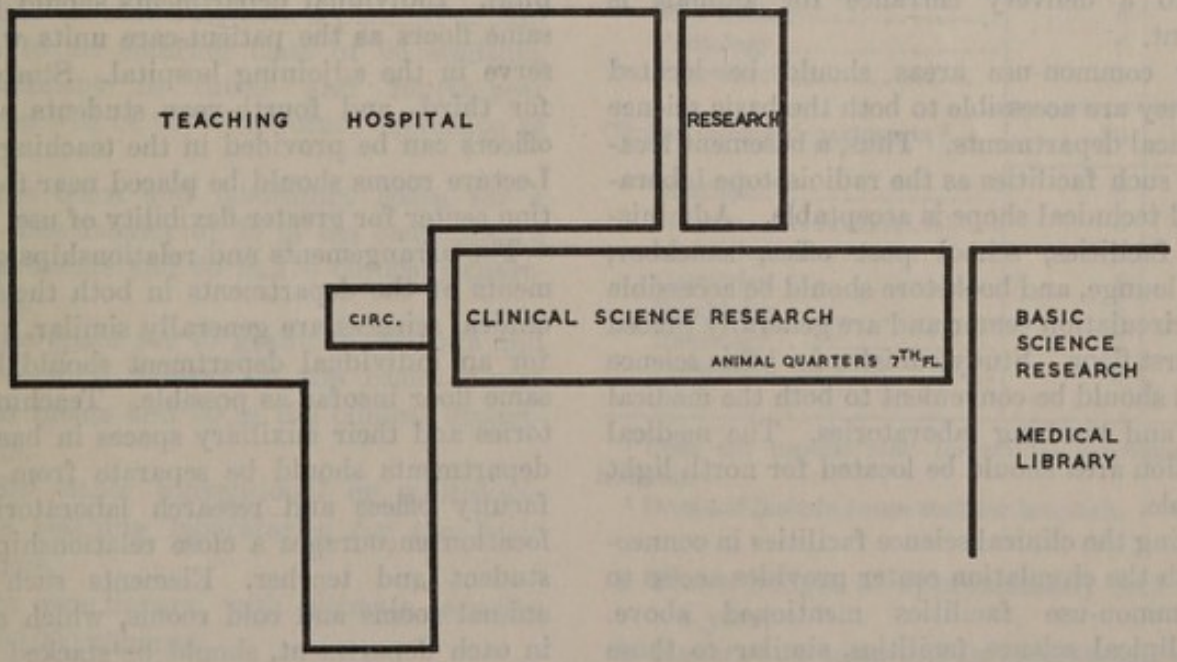


FIGURE 8.—Functional relationship of medical school elements, University of Washington Medical School.

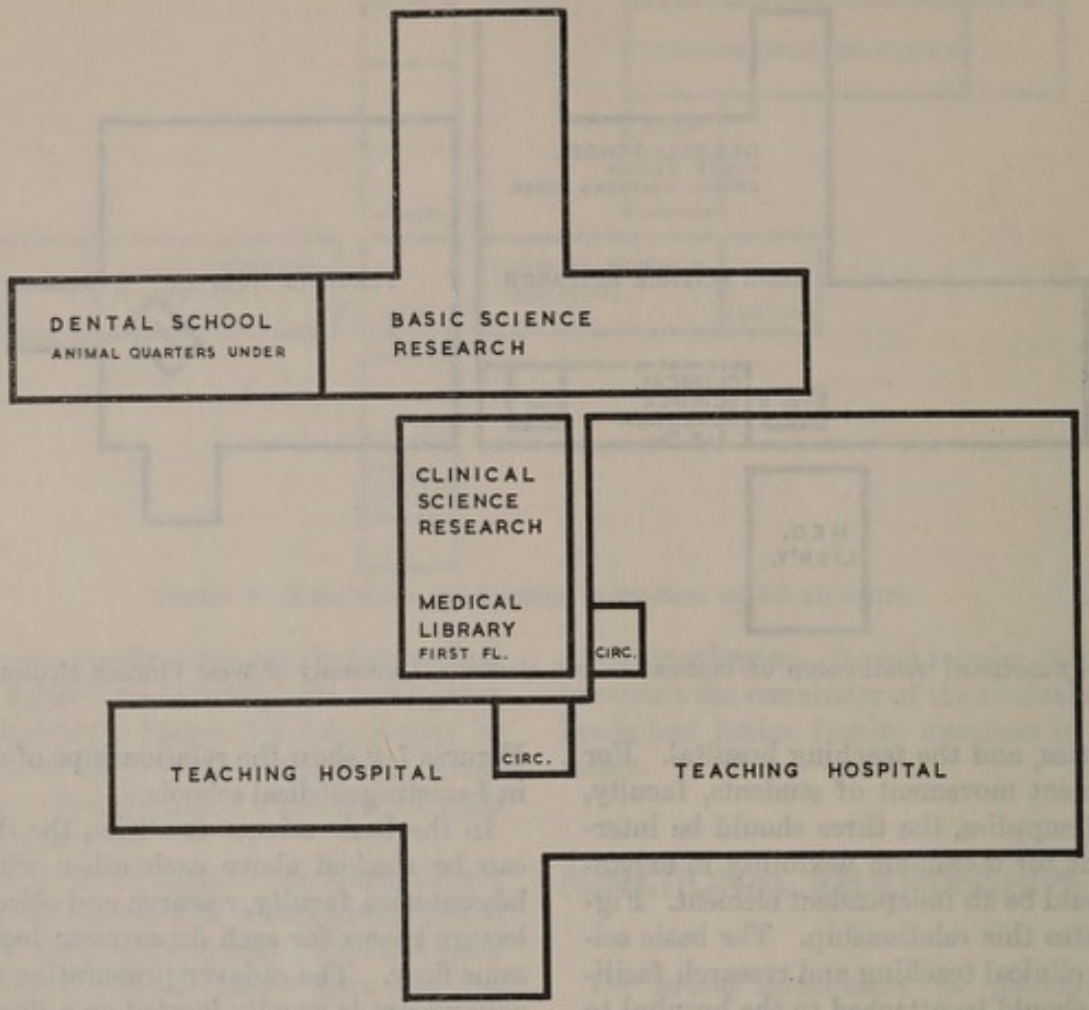


FIGURE 9.—Functional relationship of medical school elements, University of Kentucky Medical School.

departments. A location with direct connection to the circulation center and at grade level for access to a delivery entrance for animals is important.

Other common-use areas should be located where they are accessible to both the basic science and clinical departments. Thus, a basement location for such facilities as the radioisotope laboratory and technical shops is acceptable. Administrative facilities, school post office, snackbar, student lounge, and bookstore should be accessible from a circulation center and are generally placed on the first floor. Study cubicles for basic science students should be convenient to both the medical library and teaching laboratories. The medical illustration area should be located for north light if possible.

Locating the clinical science facilities in connection with the circulation center provides access to the common-use facilities mentioned above. These clinical science facilities, similar to those provided in the basic science departments, consist of faculty research and office space since third- and fourth-year students are taught in the hospital. Individual departments should be on the same floors as the patient-care units which they serve in the adjoining hospital. Study cubicles for third- and fourth-year students and house officers can be provided in the teaching hospital. Lecture rooms should be placed near the circulation center for greater flexibility of use.

The arrangements and relationships of the elements of the departments in both the basic and clinical sciences are generally similar. Facilities for an individual department should be on the same floor insofar as possible. Teaching laboratories and their auxiliary spaces in basic science departments should be separate from but near faculty offices and research laboratories. This location encourages a close relationship between student and teacher. Elements such as floor animal rooms and cold rooms, which are found in each department, should be stacked for economy. These facilities, together with lecture

rooms, should be sized initially and located to take care of later expansion.

Toilet facilities should be designed to accommodate expansion. If located on a circulation center they will be accessible to adjacent departments. Separate elevators for passengers and supplies are recommended.

PROGRAM ASSUMPTIONS

Because of the variations which exist among present schools and programs, it is apparent that space requirements for a new school cannot be stated dogmatically. There is great need, however, for some benchmark for planning and for estimating the cost of facilities for a new school.

In this publication, it is assumed that the basic science facilities, clinical science facilities, and teaching hospital are contiguous.

The space considerations and requirements presented in this publication are for 2 hypothetical schools including basic science facilities, clinical science facilities, and a teaching hospital. The first, School A, with an entering class of 64 students and a hospital of 500 beds; the second, School B, with an entering class of 96 students and a hospital of 700 beds.

School A

1. Is a 4-year, university-based school.
2. Provides space to house an entering class of 64 medical students, with a planned expansion to an entering class of 96 students. Enrollment in third- and fourth-year classes will be 60, with future expansion to 90.
3. Provides office and laboratory space for a full-time faculty of 35 in the basic science departments and 60 in the clinical departments.
4. Provides space for 40 graduate students and postdoctoral fellows in the basic science departments and 30 in the clinical departments.
5. Provides either conventional or multidiscipline teaching laboratories for the basic sciences.
6. Has its own library, with ultimate capacity of 100,000 volumes.
7. Has its own teaching hospital of 500 beds.

TABLE 11.—*Assumed faculty, graduate students, and postdoctoral fellows for a 4-year medical school*

Type of position and department	School A (entering class of 64 students)	School B (entering class of 96 students)
Full-time faculty:		
School total [1]	95	135
Basic science departments	35	50
Anatomy	7	10
Biochemistry	6	9
Physiology	6	8
Microbiology	5	7
Pathology	6	9
Pharmacology	5	7
Clinical science departments	60	85
Medicine	18	25
Surgery	15	21
Pediatrics	5	8
Obstetrics	3	4
Psychiatry	10	14
Radiology	5	7
Preventive medicine	4	6
Graduate students and postdoctoral fellows:		
School total	70	95
Basic science departments	40	55
Anatomy	7	10
Biochemistry	10	14
Physiology	6	8
Microbiology	6	8
Pathology	6	8
Pharmacology	5	7
Clinical science departments [2]	30	40
Medicine	8	11
Surgery	5	7
Pediatrics	3	4
Obstetrics	1	1
Psychiatry	8	10
Radiology	3	4
Preventive medicine	2	3

[1] Does not include staff for service functions in the hospital.

[2] Does not include house staff for hospitals.

8. Has a budget of approximately $3.4 million a year.
9. Has its own technical and maintenance shops, but heat is supplied from a central source.

10. Does not provide space for teaching students in other health professions such as dentistry or nursing.

School B

1. Is a 4-year, university-based school.
2. Provides space to house an entering class of 96 medical students with third- and fourth-year enrollment of 90 per class.
3. Provides office and laboratory space for a full-time faculty of 50 in the basic science departments and 85 in the clinical departments.
4. Provides space for 55 graduate students and postdoctoral fellows in the basic science departments and 40 in the clinical departments.
5. Provides either conventional or multidiscipline teaching laboratories for the basic sciences.
6. Has its own library with ultimate capacity of 100,000 volumes.
7. Has its own teaching hospital of 700 beds.
8. Has a budget of approximately $4.1 million a year.
9. Has its own technical and maintenance shops, but heat is supplied from a central source.
10. Does not provide space for teaching students in other health professions such as dentistry or nursing.

For both schools, the assumed minimum staffing for faculty and graduate students by department is shown in table 11.

Chapter 4

GENERAL ADMINISTRATION AND SUPPORTING FACILITIES

General Administration

The dean of the medical school is responsible for the formulation and execution of policies of the teaching programs and for the general administration of the basic sciences, the clinical sciences, and the teaching hospital. Because of the magnitude and complexities of these programs, the dean will require assistance from competent persons in these fields.

The scope and nature of a medical school's administrative activities and the facilities to accommodate them will depend on the school program, the size of enrollment and faculty, the staffing pattern, and the relationship with the university administrative office. If the program includes extensive postgraduate, resident, intern, continuing education, nursing, dental, and other programs, the responsibilities of administration are increased. Student assistance programs, including counseling and advisory service and scholarship and loan activities, may be included and space is required for personnel in these services.

Research activities in medical schools and teaching hospitals continue to increase and expand. Personnel and facilities for accounting and coordination of research grants may be required.

The dean's office with accompanying secretaries' offices and conference room are basic elements. Offices will be required for an assistant or associate dean and his secretary. In larger schools an office for another assistant dean may be needed. Graduate and postgraduate divisions may have their own officers and offices. The research coordinator may have an office. A registrar's office will be required to process applications for admission, to supervise registration, and to maintain student academic records. These documents are maintained indefinitely and fireproof storage facilities to house them will be required. The size of public information and publications facilities will depend on the activities involved and the type of equipment required. Space should be provided for accounting and fiscal operations and for storage of forms, punchcards, and other supplies. Facilities for public waiting will depend on the type and volume of visitor traffic. Public toilet facilities and pay phones should be conveniently located. The receptionist should be located so that she has a clear view of the waiting area and can be easily seen by visitors. Space for student interviewing and counseling is essential. A potentially acceptable student may be informally seen 3 or 4 times prior to acceptance, and the number of students formally interviewed is much

TABLE 12.—*Net area for general administration for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total	3,900	4,700
Dean's office	400	400
Assistant dean's office	200	(2) 400
Secretaries' offices	450	600
Conference room	500	500
Business offices	400	500
Registrar and alumni	250	300
Postgraduate office	250	300
Scholarship and grants	250	400
Records	200	300
Public information and publications	200	200
Public toilets	200	200
Waiting room	500	500
Storage	100	100

larger than the number accepted. Wives of students may also be interviewed.

The administrative department should feature hospitality, pleasant and attractive design, and ease of access for students, faculty, and the public.

If the medical school is distant from the university or if university policy so provides, some administrative functions such as purchasing, personnel services, and accounting and budgeting may be duplicated in the medical school. If the medical school and teaching hospital are separate, some administrative and service facilities may also have to be duplicated in the hospital.

Table 12 gives the net area for administration for hypothetical schools with entering classes of 64 and 96 students.

Medical School Library

The medical school library (*12*) includes the offices, work areas, stacks, carrels, vaults, reading rooms, alcoves, conference rooms, audiovisual rooms, and other related spaces required by the maintenance and service responsibilities connected with the care and use of recorded medical information (*13*). These responsibilities include the acquisition of medical books, periodicals, films, and related reference materials from suppliers throughout the world; cataloging and classifying them; providing an approach to them through a public catalog; providing a reference and bibliographical service; and maintaining and servicing reserve and browsing areas, general circulation, special collections, periodicals sections, and the audiovisual programs of the library (*14*). They also include the assigning of carrels and other reference-work areas to faculty, students, physicians of the community, and other users; fulfilling interlibrary loan service obligations, including micro- and page-size photoduplication services; and giving instruction in the use of the library (*15*). In programing and designing the medical school library, consideration should be given to the probable impact of future regional branches of the National Library of Medicine and the computer-based bibliographic retrieval and publication system called MEDLARS—Medical Literature Analysis and Retrieval System.

The medical school library should be located so that its resources are quickly available to students, research workers, faculty members, hospital staff, and practicing physicians. Unless there are large medical research collections nearby, the library should be equipped to accommodate 100,000 volumes and 1,600 scientific periodicals. However, the proximity of a large medical collection does not justify an inadequate medical school library.

A medical library should provide efficient accommodations for reference materials, readers, and library staff. The chief librarian should participate in the programing and planning of the library as early as possible, since libraries take longer to assemble than other departments of the medical school. Provision should be made from the beginning for all material in departmental libraries to be centrally cataloged.

Table 13 gives the net area for a medical school library of 100,000 volumes and 1,600 periodicals. Since medical library collections tend to increase rapidly, the library should be planned for future expansion.

In designing the library, maximum flexibility should be a prime consideration. Changes take place in the way a library is used, and new devices may in the future change conventional library operations. Therefore, the modern medical library provides open space with necessary divisions in the form of partitions which can be moved.

Shelving, whether in stacks or in reading areas, should be standard library equipment, with standard interchangeable parts. Standard sections, usually 3 feet long, should be used throughout, with only such exceptions as floor layout may demand. Those for medical books have a shelf depth of 10 inches. One 3-foot-long, single-faced section will accommodate approximately 100 volumes. The weight of bookstacks should be considered in the structural design of the building.

Service aisles between stacks should not be less than 3 feet wide. Main aisles should be at least 3 feet 6 inches wide. If bookstacks are on more than one level, or are not on the level where books are received, vertical transportation must be provided. A full-size self-leveling elevator to accommodate a book truck and the operator is more efficient than

TABLE 13.—*Net area for a medical school library of 100,000 volumes and 1,600 periodicals for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	Schools A and B (entering classes of 64 and 96 students)
	Square feet
Total net area	29, 560
Public services:	
Total	24, 950
Vestibule	100
Reception area and display	400
Charging and reserve areas	450
Card catalog area	150
Information and reference areas	400
Browsing collection	150
Main reading area	6, 070
Microreading area	200
Paging-reading area	400
Periodicals area including indexes	1, 200
Seminar-study areas	1, 350
Historical collection room	630
Sound demonstration room	450
Slides and movie room	450
Bookstack areas	10, 000
Unenclosed carrels	1, 200
Closed carrels	200
Audiovisual storage	400
Microfilm storage	200
Food vending machine area	300
Public toilets	250
Work area:	
Total	4, 610
Receiving and mailing room	500
Acquisitions department	600
Cataloging department	520
Preparation room	150
Photoduplication	800
Binding and mending	240
Serials work area	200
Chief librarian's office	200
Reception-secretary's office	200
Assistant librarians' offices	120
Historical librarian's office	120
Office storage	80
Staff room	400
Staff toilets and lockers	240
Housekeeping	240

dumbwaiters and booklifts. Elevators in the library should be all purpose and not designed for any specific use. Stairs should be provided between stack levels.

Students and faculty members should have free access to stack areas which should be provided with carrels for work and study. These are usually alcoves, preferably adjacent to windows, each equipped with a desk, reading light, and chair. They should be provided at the rate of 1 for each 10 students. However, fewer may be required if individual study cubicles for students are provided elsewhere. Provision of closed carrels for assignment to those using large amounts of assembled library material or for use as typewriter rooms will depend on the program.

Other rooms often associated with the stack area are a microfilm storage and viewing room and a room for the storage of motion-picture films and slides. A relatively soundproof room for photoduplication facilities is necessary.

The number of reading areas can be determined only by the needs of the individual school. An area for general reading and open-shelf reference work may be supplemented by a number of smaller reading areas, rooms, or alcoves. The main reading area should be near the main catalog and circulation desk. If individual student study cubicles are not privided in the school, student reading areas in the library should accommodate from 25 to 50 percent of the total enrollment of the medical school and students from other programs who require access to the collection. Students seated at tables require a minimum of 25 square feet of space each. Additional seating allowance should be made for faculty and research staff and other users.

A separate alcove with shelves, or a section of shelving in the main reading area, should be provided for unbound journals. If sloping display shelves are used for current issues of journals, open shelving underneath for housing unbound earlier issues are more convenient than closed compartments.

A room with paging facilities may be provided for the use of those on call. Small study rooms for group conferences of 4 to 6 persons each should also be included. An area should be provided in the lobby or near the reference desk containing nontechnical books for browsing. A film- and slide-projection room and a sound-tape room, each

to accommodate 16 students and an instructor, may be required depending on the program. Both rooms should be soundproofed and designed so as not to distract readers in other areas. A microfilm reading room is necessary. A medical history room may be required and may be a combined medical history and rare medical book room, in which case protected windows, doors with locks, a fireproof vault, and special air conditioning will be required. Well-lighted exhibit cases should be provided adjacent to the entrance to the library and its main lanes of traffic. Public toilets, restrooms, coatrooms, and janitor services should be convenient to the reading areas.

The book charging desk, located near the entrance, should control the exits from reading areas, workrooms, and stacks to minimize book loss. The card catalog should be close to the main entrance and near the circulation desk and the acquisition and cataloging rooms. A staff workroom with a sink should be provided. Provisions should be made so that noise generated by activities at these areas does not distract readers.

Acquisition and catalog rooms are needed to order, receive, classify, and catalog books, and prepare them for use. One workroom subdivided into alcoves by double-faced bookshelves may be provided for this activity instead of separate workrooms. These rooms should be near the public catalog and should have direct access to the stackroom; 100 square feet should be allowed for each staff member.

An office for the head librarian and one for an assistant should be provided as well as offices for the reference staff librarian and the circulation librarian. Offices for other administrative personnel may also be required. A reception-secretary's office should be provided adjacent to the head librarian's office. A departmental conference room may be required. A storage room for office supplies should be included. The head librarian's office should be accessible both to the staff workrooms and library clientele.

Usually the quantity of material coming into a medical library will warrant provision of a receiving room. Such a room is best located on the ground floor with access to an unloading platform. The room should be large enough to permit unpacking and sorting of materials. A worktable, shelving, and shipping equipment should be provided. Lift service, preferably an elevator which will hold loaded book carts, between the receiving room and the acquisitions department should be provided where these areas are on different floors.

Most medical school libraries rely upon outside services for binding and rebinding books, serials, and pamphlets. However, there is usually enough minor repair work to be done within the library to justify a repair room.

Vending machines for food and drink may be required for the convenience of library personnel, students, and staff members working late at night, on holidays, and on weekends. These should be located outside the library proper and be provided with space for tables.

Toilet and coatrooms should be provided for library staff and visitors. Janitor facilities should also be provided.

Air conditioning with special attention to humidity control is essential in a library, not only for the comfort of readers and staff, but for the preservation of the reference materials and the elimination of dust and fungi.

Controlled natural light is desirable. Whether artificial illumination should be incandescent or fluorescent, or both, and the type of fixtures, are matters of preference. Tabletops, other surfaces, and furniture should be matte finish to minimize glare. Floor, wall, and ceiling materials and colors should be carefully selected to promote quiet, pleasant and attractive appearance, and reduce maintenance. Special attention should be given to acoustics throughout the library; carpeting should be considered. (See also sections on Lighting and Materials and Finishes in ch. 8, pp. 168 and 170.)

Animal Quarters

The need for controlled care of animals to meet teaching and research requirements is reflected in the provision of a central animal service in an increasing number of medical schools. Through centralized operation under qualified professional direction, research projects can be more efficiently provided with animals of required genetic background and free of disease and with variables

under strict control. Centralized operation promotes better organization, resulting in proper animal care, and saves space and equipment (*16*, *17*).

The central animal service is responsible for the procurement and breeding of animals through the maintenance of breeding colonies and stock-animal pools required by the medical school, for housing the animals at all times under the highest standards, and for special care required during experiments. An adequate supply of food, bedding, and other supplies required for the operation of the service should be maintained. Cage and rack washing and sterilization, disposal of wastes and animal carcasses, and proper maintenance of equipment are also important responsibilities. Administrative functions include purchase of animals from approved sources, record-keeping, and inventory of animals, supplies, and equipment.

The central animal service should be directed by a specialist who works with an animal-care committee composed of members from the departments which use animals. The director should be a veterinarian, although he may be a medical scientist from one of the basic science departments.

The location of animal quarters on the ground floor, where direct-connected outdoor animal runs and truck unloading facilities can be provided with complete separation from any other function, has many advantages.

If the central animal quarters are on an upper floor or on the roof, vertical movement of animals and supplies is increased and additional service elevators may be required. This location can also produce unpleasant and hazardous conditions. Clogged drains which result in overflow of wastes have been responsible for ruined experiments and damage to books, records, and equipment. The ground-level location saves time and labor through direct delivery of supplies and animals and minimizes the danger of overflowing waste lines. A separate entrance to serve the animal quarters is essential. Space needs for animal quarters will increase with any increase in class size or in research activities. Provision should be made for expansion in the initial planning.

However, a vivarium in an adjacent wing with its own vertical transportation for animals, animal supplies, and personnel may serve the needs of research better than an animal facility at grade level. The floors of the vivarium should communicate with those of the adjoining structure so that animal rooms are horizontally contiguous to the research and teaching laboratories using them and so that animals can be transferred to the laboratories without traversing corridors of other areas. If a vivarium is provided, animal-holding rooms are not usually required within research areas.

Animal quarters are composed of a number of different kinds of areas. Each has its own requirements in space, finishes, temperatures, air changes, and location. In animal areas, provision must be made for the reception, quarantine, and isolation of incoming animals near the animal entrance; for housing different species; for exercising animals; and for specific research projects. Isolation rooms for infected animals, each with a vestibule containing facilities for gowning and scrubbing, are required. Special areas include operating rooms with related facilities such as scrubup, sterilizing and sterile supply, and recovery; treatment room; X-ray room; and autopsy room. Laboratory facilities should be provided for routine work concerned with receiving and quarantine and for the research activities of the director. A director's office separate from his laboratory and secretarial and record offices are required. Service areas consist of storage for bedding, food, and equipment; special diet kitchen with refrigerated storage; cage and rack washing and sterilizing facilities, including space for storage of reserve clean cages; facilities for disposing of wastes (incinerators and/or garbage disposals); staff toilet and locker rooms; and a separate receiving entrance. Cage and rack washing, sterilizing, and storage facilities should be sized to serve not only the needs of the central animal quarters but also those of the animal-holding rooms on the various floors. Interchangeable racks and carts of good quality should be used. Although better quality cages such as stainless steel represent a higher initial cost, they will actually be more economical since with reasonable care and maintenance they will last indefinitely. Purchase of racks and carts should be supervised by the director.

Table 14 gives the net area for animal quarters for the 64- and 96-student class hypothetical schools.

Animal rooms should be isolated from each other with no connecting openings and arranged to separate clean and contaminated functions. A service corridor may be provided in addition to the main access corridor to allow the removal of soiled

TABLE 14.—*Net area for animal quarters for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total net area	11,980	14,860
Animal rooms:		
Total	9,730	11,830
Coldblooded animals and aquarium	140	200
Guinea pigs, rabbits, hamsters, rats, and mice	1,800	2,700
Primate	280	400
Cats	250	370
Dogs	2,100	3,000
Animal reception-quarantine	(3) 300	(3) 300
Cage washing and sterilization	350	350
Cage storage	280	280
Bedding storage	300	300
Food storage and preparation	750	750
X-ray and fluoroscopy	400	400
Sterile isolation	(3) 600	(3) 600
Routine laboratory	200	200
Veterinarian's research laboratory	630	630
Veterinarian's office	250	250
Isolation	230	230
Autopsy	300	300
Animal morgue	70	70
Incinerator	220	220
Keeper's locker	280	280
Animal surgery rooms:		
Total	2,250	3,030
Operating	(3) 900	(5) 1,500
Scrubup	180	360
Recovery	200	200
Cleanup	300	300
Instrument	270	270
Central sterilizing	400	400

bedding and other material at the rear of a range of cages rather than through the main corridor. Borrowed light in corridor partitions and between rooms should be avoided since light bothers some animals. Windows, if used, should be placed at least 6 feet above the floor so that animal cages can fit below them. Each room should have a sink and soap dispenser. The size of animal rooms will vary with the species housed, but is usually limited by the number of animals one attendant can handle. A vestibule at the entrance to a block of rooms where the attendant can change clothes and shoes is recommended to help reduce infection.

The construction of animal quarters should be fire resistant, vermin- and insect-proof, and above all easy to clean. Recesses, cracks, and pockets should be avoided. Bases should be coved. Special attention should be given to such openings between rooms as pipes, conduit, and telephone wiring. Doorsills will prevent water from leaking into the corridor when floors are washed down, but are not as convenient for moving cage racks in and out of rooms.

Wall surfaces should be smooth, hard, and easily cleaned. Ceramic tile is often used, but is easily damaged by cage racks. For protection of wall surfaces from such damage, a 6-inch curb may be provided. Cinder- or concrete-block walls must be laid up with tight joints and covered with a moisture-resistant material.

Doors should be 3 feet 6 inches wide to permit easy passage of cage racks, and all hardware should be recessed.

Floors must be able to resist the disintegrative action of the organic salts and acids in animal urine. Quarry tile with acid-resistant joints is satisfactory, but should not be used in the corridor because of the noise created by cage carts as they bump along the joints. Concrete floors, well compacted and troweled, are also satisfactory. Asphalt, rubber, and vinyl tile floors are not recommended.

Floor drains are suggested for monkey and dog rooms. These should be 6 inches in diameter of the flushing type with special hair traps to avoid clogging. Use of floor drains in smaller animal rooms will depend on whether the rooms are hosed down regularly or swept and wet-mopped.

The provision of air conditioning in animal quarters is essential to good operation. Because of the varying needs of different animals, each animal room should have its own temperature and ventilation controls with negative air pressure in the room. Dual controls should be used to guard against failure. Twelve to 15 air changes per hour are required with no recirculation.

All rooms should have waterproof electric outlets installed 5 feet above the floor.

In addition to the animal quarters at the school,

an animal farm may be provided with outside pens or exercise runs for dogs and large animals, and provisions for quarantine of new animals, for breeding special strains of small animals required by specific projects, and for care of animals under long-term observation and experimentation (*11*).

Departmental Offices

Each basic science and clinical science department faculty member requires office space for his departmental activities and laboratories for research. The head of each department requires an office with a desk, reference table, and space for a conference of several persons located near his research laboratory and adjacent to a secretary's office.

The conference room, which will be used for meetings of groups of students, should accommodate about 20 persons. Shelving for departmental books and periodicals and storage space for slide projectors, models, and other visual-aid equipment, chalk boards, and roll-up projection screens should be provided. In the clinical departments, X-ray view boxes are required.

The secretary's office may handle the secretarial work for the entire department and should be sized for the ultimate expansion of the department, although some schools may prefer to distribute the secretarial personnel throughout the department.

Associate and assistant professors should be assigned smaller private offices. Instructors often share offices, or they may use the research laboratory in which they work. However, it is preferable to provide an office and laboratory for each faculty member.

For space estimating, a unit of 16 modules may be used as the primary unit for each department. As shown in figure 10, the unit provides office and research laboratory space for the department head, 3 or 4 additional faculty members, and 2 to 4 graduate students or postdoctoral fellows, as well as a conference room and secretarial space. The balance of the staff can be housed in additional 8-module units each accommodating 5 or 6 people and providing laboratory, office space, and supporting facilities. An additional 2-module space

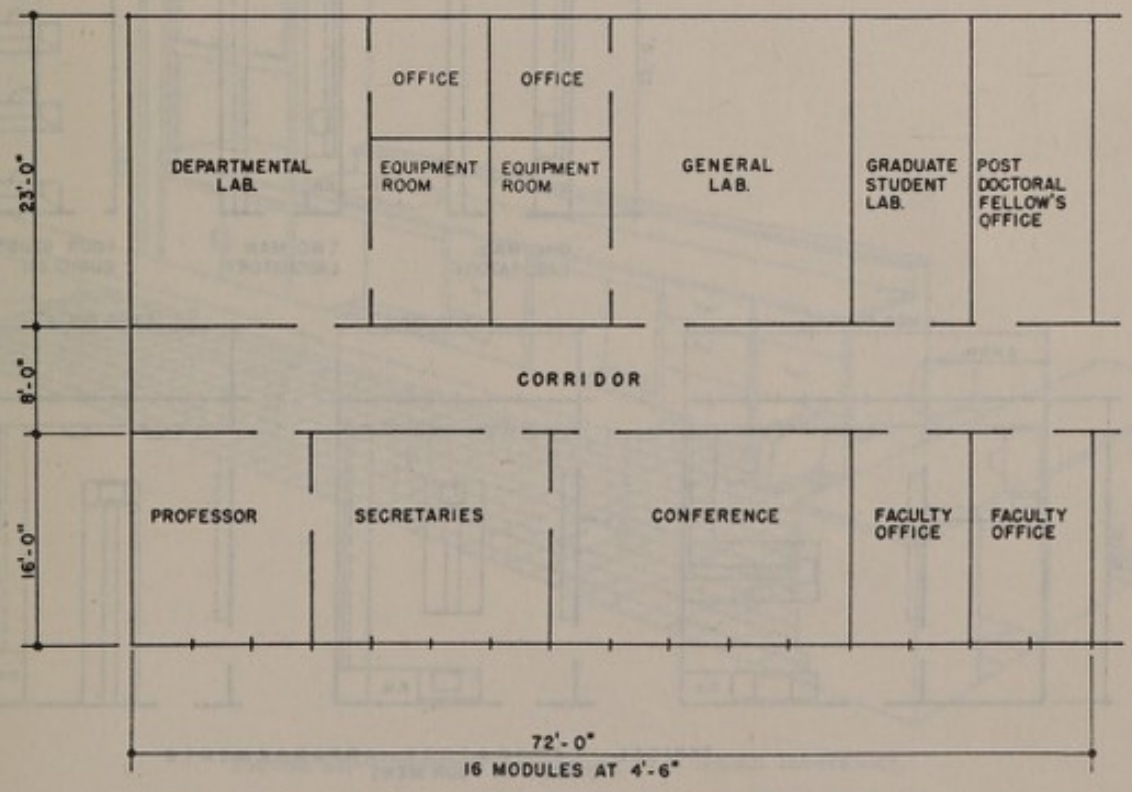


FIGURE 10.—Diagram for departmental office and research area.

is required for each additional faculty member.

Other facilities used in common in the department usually include animal rooms, cold rooms, storage rooms, and statistical or data-analysis workrooms. These spaces should be arranged to provide for expansion. Provision of rooms such as storage rooms, which are assigned interim functions, can be used for absorbing additional faculty or research projects. To be effective, such rooms should have all required utilities available.

Research Facilities

Research laboratories should be provided for faculty members, postdoctoral fellows, and graduate students in each department (*18*, *19*).

The use of modules in planning laboratory facilities permits flexibility in utilization of space where changes in space requrements are common. Utilities and duct connections should be so provided that when space is changed utilities are available without undue pipe runs or perforations of walls or ceilings.

The equipment of research laboratories will vary with the kind of activity performed in them. It should be possible to rearrange work counters, microscope benches, and sinks, and to vary the size of the room as required without undue labor, inconvenience, or expense. This is most easily accomplished if all utilities and ducts are properly sized and located in such a way as to make them available to all parts of the laboratory wing. This includes space not designed originally for laboratory use, because experience indicates that when the need arises any space—office, storage, or conference room—may be converted to laboratory use.

Some possible arrangements of research laboratories are shown on figures 11–14. The fume hood

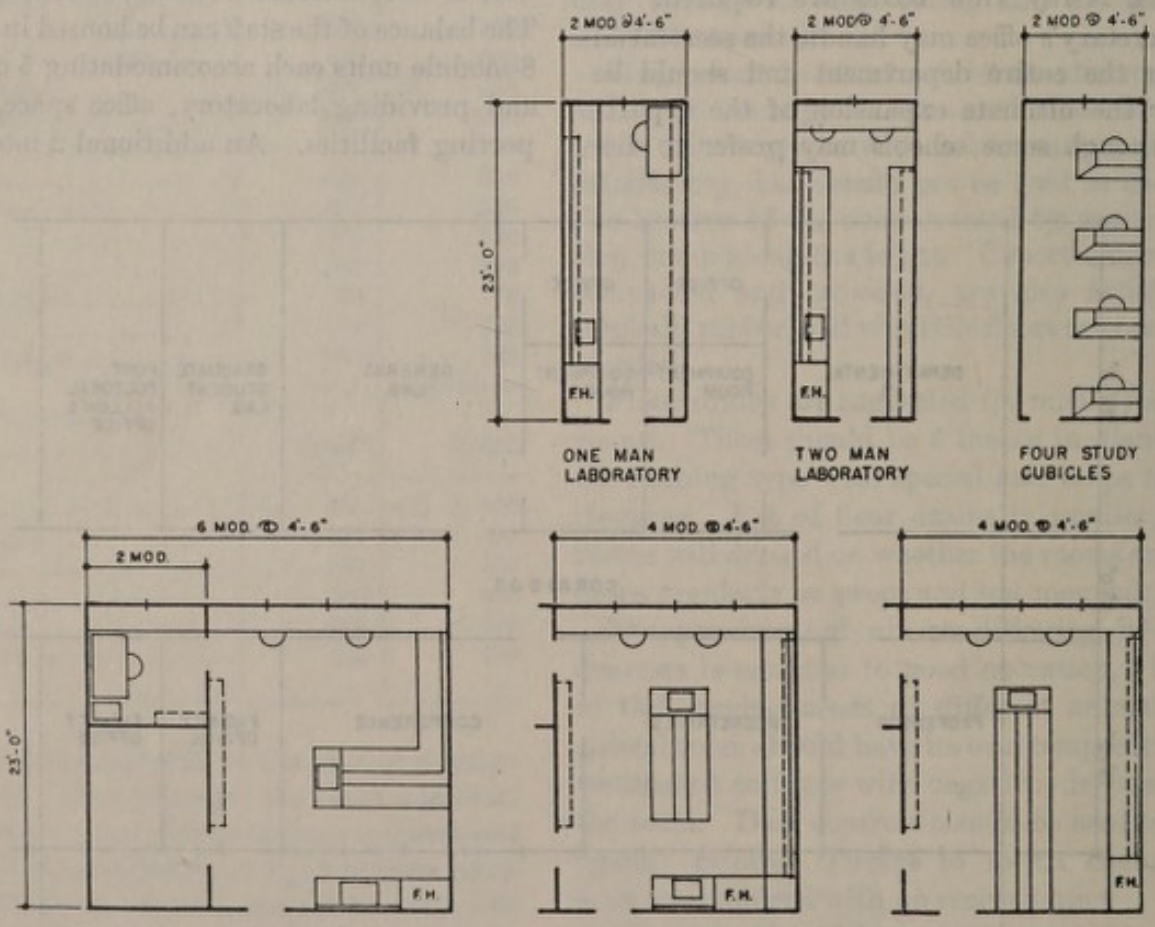


FIGURE 11.—Layouts for research laboratories.

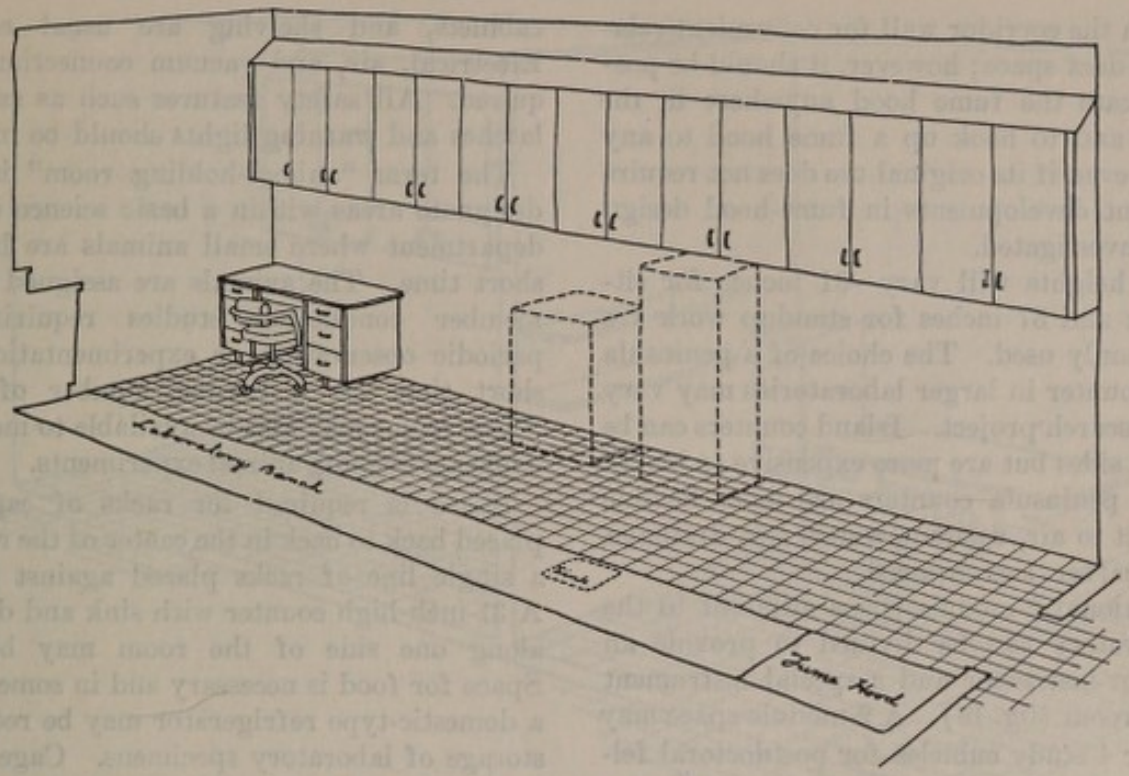


FIGURE 12.—Perspective drawing of a 1-man laboratory.

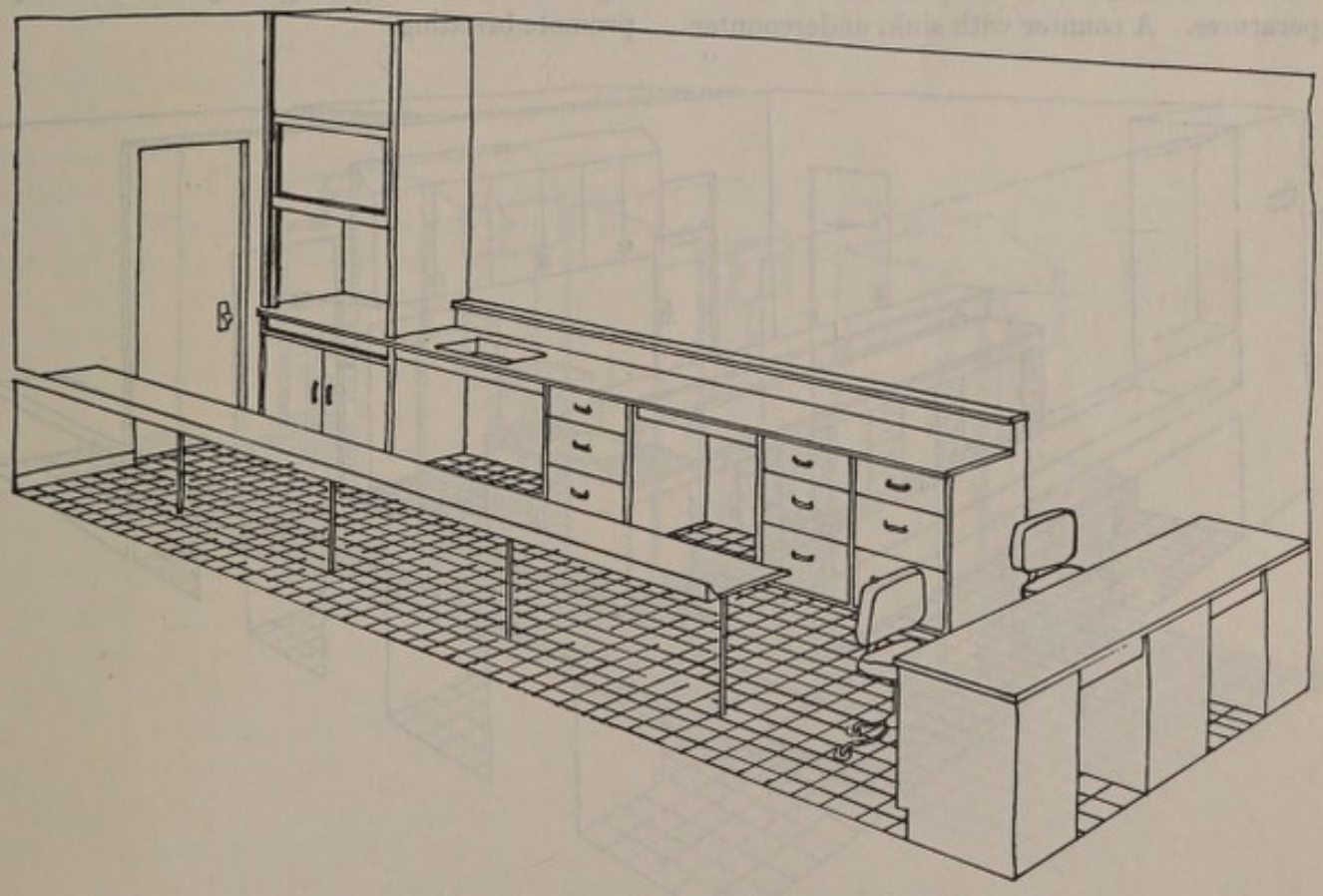


FIGURE 13.—Perspective drawing of a 2-man laboratory.

is shown on the corridor wall for convenient relation to the duct space; however, it should be possible to locate the fume hood anywhere in the laboratory and to hook up a fume hood to any laboratory even if its original use does not require one. Recent developments in fume-hood design should be investigated.

Counter heights will vary—31 inches for sit-down work and 37 inches for standup work are most commonly used. The choice of a peninsula or island counter in larger laboratories may vary with the research project. Island counters can be used on all sides but are more expensive to install and alter; peninsula counters are more flexible with respect to air, vacuum, water, gas, drainage, and electrical services required.

An additional 2-module space adjacent to the large laboratory can be divided to provide an office for an instructor and a special instrument or storage room (fig. 15). A 2-module space may be used for 4 study cubicles for postdoctoral fellows (fig. 16).

Cold rooms are required in the laboratory wing of each department. They are refrigerated rooms for several workers who do procedures at low temperatures. A counter with sink, undercounter cabinets, and shelving are usual equipment. Electrical, air, and vacuum connections are required. All safety features such as safety door latches and warning lights should be installed.

The term "animal-holding room" is used to designate areas within a basic science or clinical department where small animals are held for a short time. The animals are assigned to a staff member conducting studies requiring close, periodic observation or experimentation over a short time for a limited number of animals. These rooms may also be available to medical students performing animal experiments.

Space is required for racks of cages, often placed back to back in the center of the room, with a single line of racks placed against the walls. A 31-inch-high counter with sink and drainboard along one side of the room may be needed. Space for food is necessary and in some instances a domestic-type refrigerator may be required for storage of laboratory specimens. Cage and rack washing is usually handled in the central animal quarters; however, in some departments an autoclave is needed for sterilizing cages prior to washing. Controlled lighting may be necessary to promote breeding.

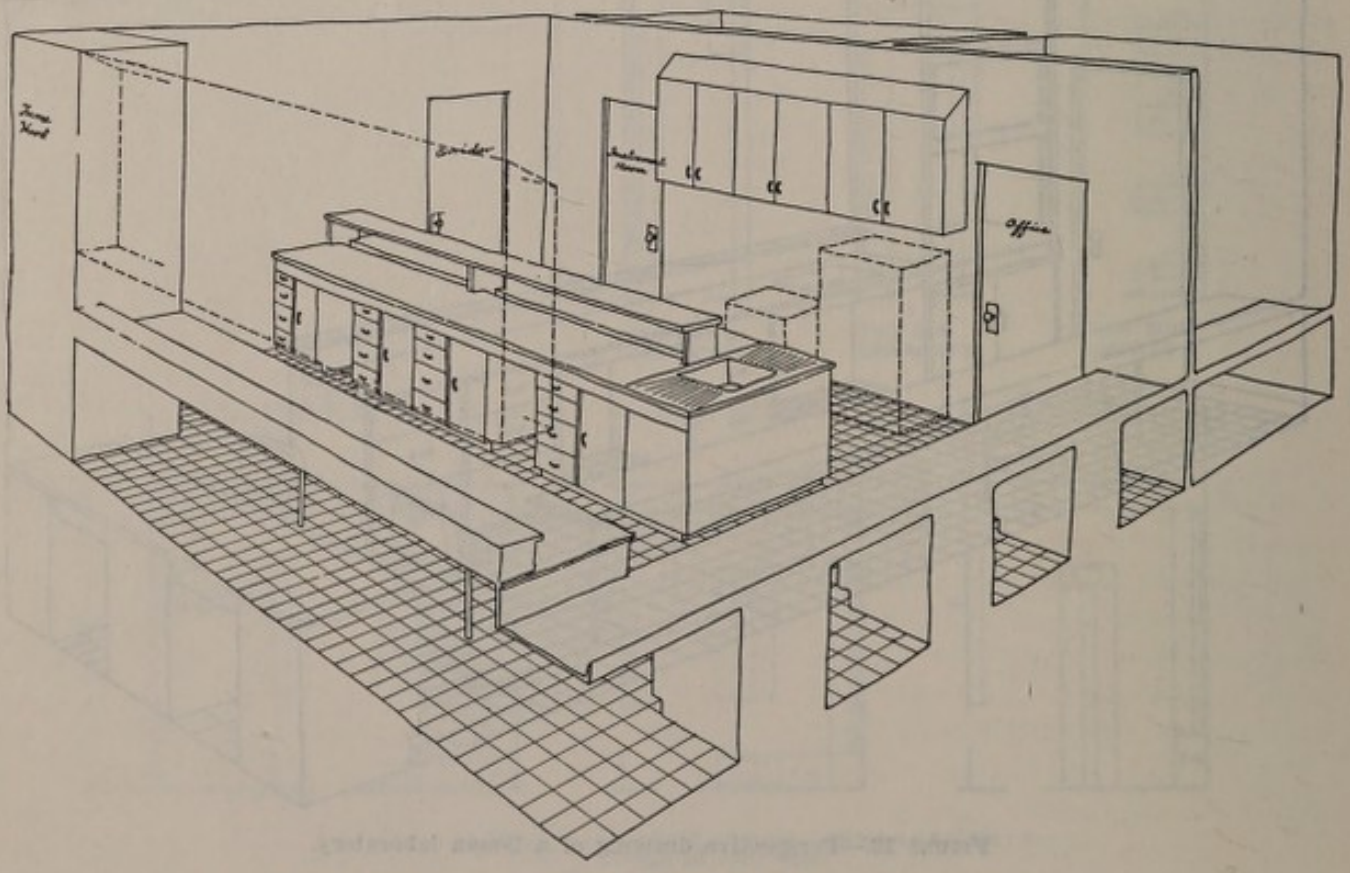


FIGURE 14.—Perspective drawing of a 3- or 4-man laboratory.

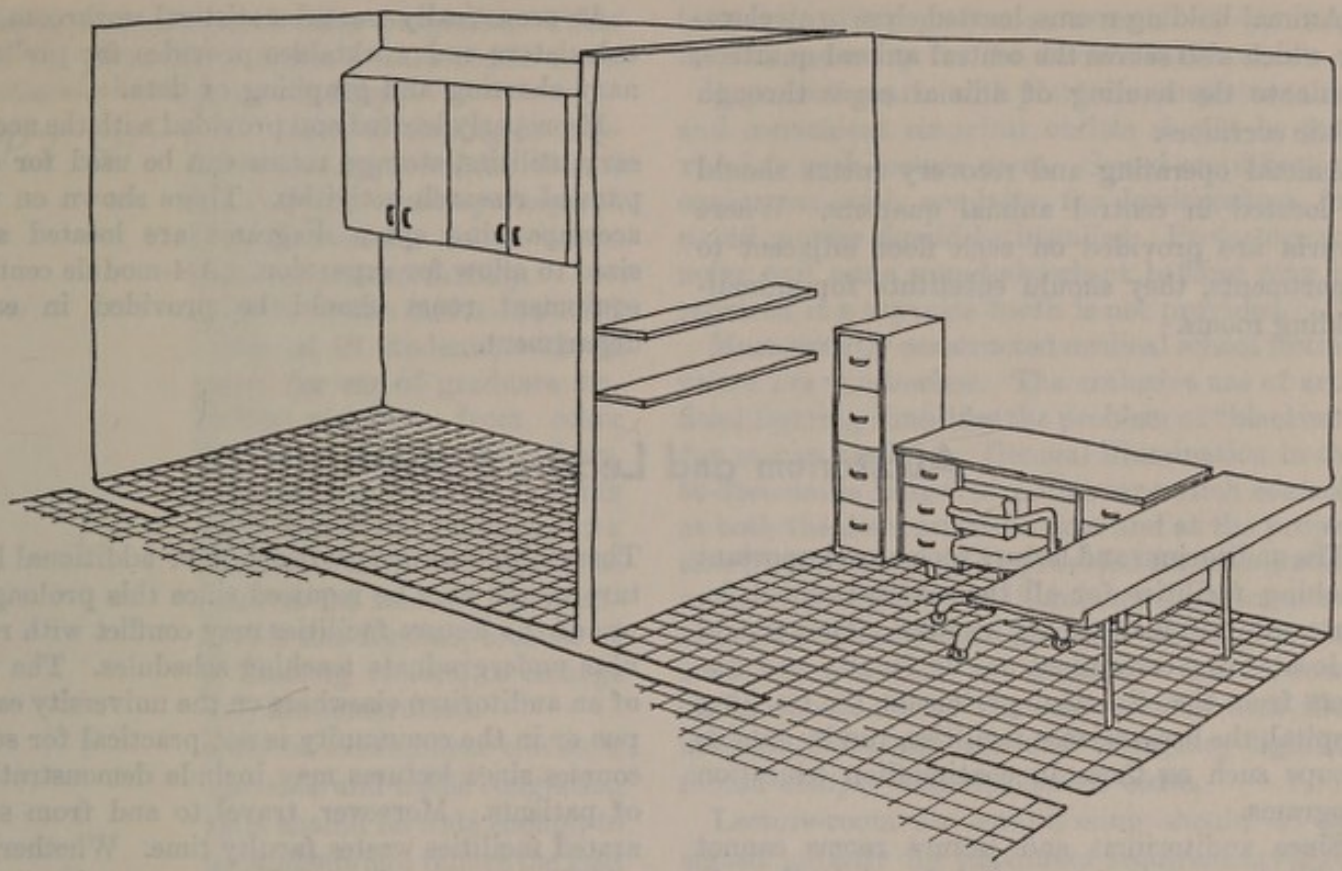


FIGURE 15.—Perspective drawing of an office and equipment room.

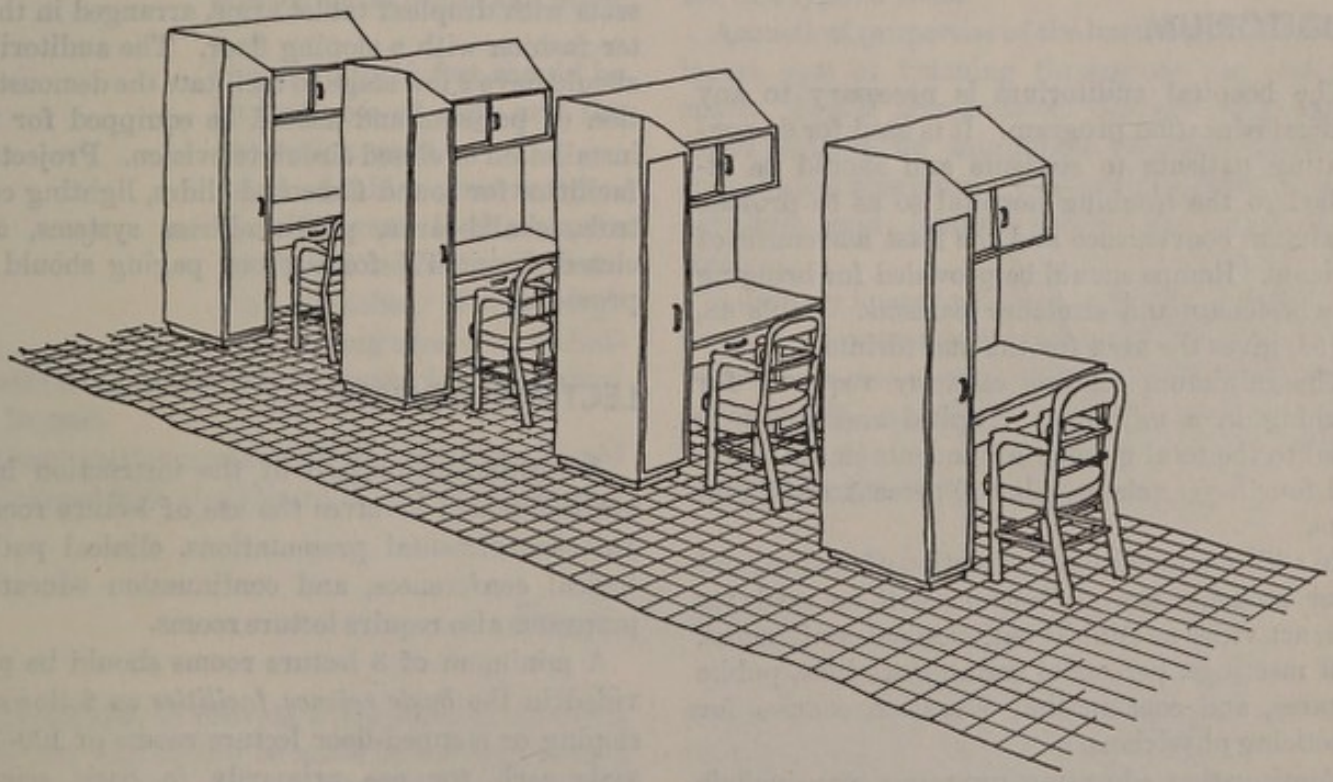


FIGURE 16.—Perspective drawing of study cubicles.

Animal-holding rooms, located close to an elevator which also serves the central animal quarters, eliminate the hauling of animal cages through public corridors.

Animal operating and recovery rooms should be located in central animal quarters. Where vivaria are provided on each floor adjacent to departments, they should substitute for animal-holding rooms.

An acoustically treated statistical workroom for calculators and worktables provides for preliminary charting and graphing of data.

If properly located and provided with the necessary utilities, storage rooms can be used for expanded research activities. Those shown on the accompanying space diagrams are located and sized to allow for expansion. A 4-module central equipment room should be provided in each department.

Auditorium and Lecture Rooms

The auditorium and lecture rooms are important teaching facilities for all the medical school departments and the teaching hospital. They should be located for convenient use by faculty and students from the clinical departments, the teaching hospital, the basic science facilities, and by outside groups such as those in continuation education programs.

Since auditoriums and lecture rooms cannot readily be expanded beyond their originally constructed size, they should be designed initially on the basis of utlimate capacity requirements.

AUDITORIUM

The hospital auditorium is necessary to any medical education program. It is used for demonstrating patients to students and should be attached to the teaching hospital so as to provide maximum convenience and the least movement of patients. Ramps should be provided for bringing in wheelchair and stretcher patients. Table 48, p. 154, gives the area for the auditorium.

The minimum seating capacity required for teaching in a university hospital auditorium is equal to the total number of students in the third- and fourth-year classes plus 50 percent additional seats.

In addition to regular instruction of medical and other students the auditorium will be used for such activities as clinical pathological conferences, staff meetings, personnel training sessions, public lectures, and continuation education courses for practicing physicians.

Continuation education programs may include a series of full-day lectures for a period of several consecutive days or 1 day a week for several weeks. Therefore, a second auditorium or additional lecture rooms may be required since this prolonged use of the lecture facilities may conflict with regular undergraduate teaching schedules. The use of an auditorium elsewhere on the university campus or in the community is not practical for such courses since lectures may include demonstration of patients. Moreover, travel to and from separated facilities wastes faculty time. Whether an additional auditorium or lecture room is needed will depend on the size and character of the programs contemplated.

For auditoriums most authorities prefer fixed seats with dropleaf tablet arms, arranged in theater fashion with a sloping floor. The auditorium should have a low stage to facilitate the demonstration of patients and should be equipped for the installation of closed circuit television. Projection facilities for sound films and slides, lighting controls, chalkboards, public-address systems, and closed-circuit TV for doctors' paging should be provided.

LECTURE ROOMS

A significant portion of the instruction in a medical school involves the use of lecture rooms. Interdepartmental presentations, clinical pathological conferences, and continuation education programs also require lecture rooms.

A minimum of 3 lecture rooms should be provided in the *basic science facilities* as follows: 2 sloping or stepped-floor lecture rooms of 120–150 seats each for use primarily in basic science courses, and 1 sloping or stepped-floor lecture room of 80 seats for graduate-student instruction, con-

tinuation education, and other programs. Table 26, p. 84, gives the area for lecture rooms for a hypothetical basic science facility.

Two 150-seat lecture rooms of sloping or step-floor type should be provided as part of the *clinical department facilities and the teaching hospital.* Table 48, p. 154, gives the area for lecture rooms for a hypothetical clinical science facility.

Lecture rooms included in the tables are sized to accommodate a class of 96 students, with 25 percent additional seats for use of graduate students, visiting faculty members from other departments, foreign-visitor groups, and others.

Although a class size of less than 96 students may be contemplated in the initial planning of a new medical school, it will be advantageous to construct lecture rooms on the basis of the maximum class size since it is not feasible, because of structural and other limiting factors, to enlarge lecture rooms after they are constructed.

Lecture rooms should be located near elevators and stairs to minimize noise and traffic congestion in the corridors. Stairs should be wide enough to encourage their use by students and relieve the load on the elevators. The main entrances to lecture rooms should be located at the rear, although corridor access to the demonstration areas of lecture rooms is essential for bringing in tables and other large equipment.

A minimum distance of 10 to 12 feet should be provided between the first row of seats and the back wall of the demonstration space.

Fixed seats with dropleaf tablet arms are generally preferred for lecture rooms. Such seats are usually 26 inches in width and require a minimum back-to-back spacing of 36 inches. For a rough estimate of lecture-room seating area size, including aisles and crossovers, 10 square feet per person may be used.

Demonstration areas in all lecture rooms should be equipped with chalkboard, X-ray film illuminators, and rollup projection screens. A lavatory may be necessary for the demonstration areas.

A projection area with platform, projector table, and convenient electrical outlets should be provided in each lecture room. Sound amplification equipment with conduits for loudspeakers for sound movies should be installed. Projectors are noisy and some sound-absorbent baffling may be required if a separate booth is not provided.

Most recently constructed medical school lecture rooms are windowless. The exclusive use of artificial lighting simplifies the problem of "blackout" for movies or slides. General illumination in the 50-footcandle range, with dimmer-switch controls at both the demonstration area and at the projection platform, should be provided for each lecture room. Spotlighting to illuminate the demonstration area is essential. Shielded step lights and aisle lights should be installed. Lecture-room clocks should be at the rear or side with illuminated dials, and exit and emergency lighting should comply with applicable codes.

Lecture-room air conditioning should be designed initially for maximum requirements since the rooms will be used to capacity as the student population increases. The system should be installed so as not to exceed noise levels recommended for this type of room.

Acoustical properties of the lecture rooms should insure ease of listening throughout the seating space. Sound transmission through walls and doors should be minimized. Floor coverings should minimize noise. Ceilings of adjacent main corridors and lobbies should be acoustically treated.

Auxiliary spaces which may be required for the use of the lecture rooms, such as storage rooms for visual aids and portable equipment, coatrooms, toilet rooms, and telephone booths, will be determined by the individual school. Public toilets should be convenient to lecture rooms.

Study Cubicles

The decision to provide *study cubicles* (*10*) is a major one and should be made in the early stages of planning as the area required will be extensive. Consideration should be given to the use of study cubicles within the basic science and clinical departments for postdoctoral fellows, and in the teaching hospital for the house staff.

Cubicles for medical students in the first 2 years should be located in the basic science area. For third- and fourth-year students, cubicles should

be in the teaching hospital. Tables 26 and 49, pp. 84 and 154, give the net area for cubicles for hypothetical schools.

Each cubicle contains a desk with drawers on one side; a cabinet above the desk for books with a built-in fluorescent study light underneath; and a locker which, in addition to hanging clothes, may be used for microscope storage. A duplex outlet is necessary to attach the microscope. The locker not only provides privacy by forming a barrier, but also eliminates the necessity for separate locker rooms. Figure 16, p. 43, shows a perspective drawing of 4 study cubicles.

An allowance of 50 square feet per cubicle is adequate. This includes desk, locker, chair space, and adjacent aisle. If aisles are double loaded (cubicles on either side), privacy for the student may be obtained by staggering the cubicles so that desks are not directly opposite each other.

Since study cubicles are a place for quiet and uninterrupted concentration, acoustics and sound transmission are important design considerations. Comfort air conditioning is recommended.

It is desirable to have a lounge area nearby where discussions among small groups can be held without disturbing students in the study cubicle. Chalkboards and tackboard should be provided in this area and vending machines should be available.

If the study cubicle-clothes locker combination is not used, separate *student locker rooms* for male and female students should be provided. To conserve students' time and to ease elevator traffic, locker rooms should be located close to the line of travel to teaching areas. The proximity of the hospital should determine the necessity for separate locker rooms for third- and fourth-year students.

A *toilet room* should be connected to each locker room or study cubicle area and showers should be provided in the basic science area. If study cubicles with lockers are installed, a dressing room is required adjacent to toilet and shower room in the basic science facilities. A restroom for women should be included.

Student Activity Facilities

Lounge.—A lounge for students and house officers should be provided for relaxation, indoor recreation, and as a place where they may meet their wives and friends.

Space may be provided for such activities as pingpong, billiards, and cardplaying. A recessed or screened area with vending machines is desirable. A kitchenette for preparing coffee and snacks is provided in some schools. Shelving for books and current magazines, an aerial for TV, and a storage closet adequate for card tables, phonograph records, and other equipment should be provided. Public and house telephones should be available.

Facilities should be provided for outdoor recreation.

Activities office.—A student activities office near the student lounge may serve as headquarters for such activities as student organizations, honor medical societies, student publications, and student council, and may be the center of inquiry regarding athletic, recreational, and social events. There should be space for typewriter desks, file cabinets, and shelving. If the activities office is to serve as an information center, a service counter and bulletin board would be desirable. If the office is to be used for student publications, space for duplicating machines will be required.

Laundry collection.—The medical student often wears more than 1 coat per day in the basic science courses. To maintain a supply of clean linen, a laundry collection station convenient to the student lounge or locker room should be provided with a pickup and delivery counter.

Bookstore.—The bookstore of a medical school offers the latest editions of medical and other related books and periodicals and may stock items usually found in drugstores. This combination is economical in space and clerical personnel. The bookstore may be a branch of a university campus store or a part of the administrative department of the medical school.

The bookstore, although primarily for students, should be available to all persons using the building. Its location on a main floor of the medical school is preferable.

Health office.—Many universities have some form of student health office for minor ailments

as well as an infirmary. If a medical school is attached to a university, the medical students may use the university health office. However, if it is remote from the rest of the university a separate office may be warranted.

A student health office will serve the entire 4-year student body, half of which will be studying in the basic science areas, the other half in the hospital. Locating the health office adjacent to medical school administrative offices may be desirable if they are near the hospital. Otherwise, a hospital location is suggested.

The health office should have a waiting area, an office area, and an examining room and should provide space for a medical cabinet, a small domestic refrigerator for storing pharmaceuticals, an examining table, a portable examining light, weighing scales, storage cabinet for incidentals, a clothesrack, and a lavatory.

TABLE 15.—*Net area for student activities for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total	1, 850	2, 400
Lounge and toilets	1, 000	1, 200
Student activities office	200	200
Laundry collection	200	400
Bookstore	450	600
Health office and examination area [1]	----------	----------

[1] May be in hospital or part of general university health service.

Medical Illustration Service

As the volume and complexity of medical knowledge grows, the need increases for visual material such as pictures and models to implement the preservation and communication of this knowledge. The demand in medical schools for visual material to implement teaching, research, and patient-care programs is so great that a centralized medical illustration service for the production of such material is required in a medical school (*20*).

Space required will depend on the extent of activities and number of personnel. The activities of a medical illustration service are divided into graphic arts, plastic arts, and photography. Closed-circuit television as a teaching aid is usually a separate service but may be a part of the medical illustration service. The medical illustration service usually is responsible for maintaining the slide and movie projectors used throughout the school and facilities for repair and storage of such equipment should be provided.

Table 16 gives the area for facilities for a medical illustration service for the 64- and 96-student class hypothetical schools.

Activities to be considered in planning the *graphic art section* include drawing, painting, and airbrush work, drafting for charts and technical diagrams, mechanical lettering, and general artwork required in preparing displays or scientific

TABLE 16.—*Net area for medical illustration for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total net area	2, 020	3, 170
Administration: Total	370	370
Chief's office	140	140
Secretary and files	140	140
Equipment and supply room	90	90
Medical illustration: Artists' work area	600	950
Photography: Total	1, 050	1, 050
Photo studio and dressing	420	420
Photomicrography room	90	90
Light lock	50	50
Darkrooms	(2) 140	(2) 140
Loading room	30	30
Mixing room	60	60
Laboratory	190	190
Finishing room	70	70
Audiovisual: TV studio (including control area)	----------	800

exhibits. A large, well-lighted room, subdivided into work areas, is usually satisfactory. If possible, the area should be provided with natural north light for true color values, although many departments rely entirely on artificial illumination.

The activities of the *plastic art section* include the skilled operations required to produce 3-dimensional models of the organs of the body in plaster, rubber, wax, plastic, or agar composition for demonstration purposes. The making of facial masks and casts as aids in plastic surgery and body restoration and the making of moulage prostheses such as an artificial ear or nose in connection with facial restoration may be required. These activities require a room for working with the patient in addition to the main work studio. Since the activities involve close color matching, both the studio and patient room should have north light.

Activities to be considered in planning the *photographic section* of the department are photographing patients, both still and cine, photomicrography, copying, film processing and printing, film and print drying, film loading, chemical mixing, print and slide finishing. Photostating is usually done by the photoduplication service.

Photographing human and animal specimens is a regular activity of a photographic section, but, because of the hazards involved in handling fresh specimens, this work should be done in or near the autopsy rooms.

A studio for photographing patients is required; two are preferable—a main studio for full-length studies and a "closeup" studio for photographing the head, extremities, eyes, and mouth. The wall of the main studio serving as a background should have a plain, smooth surface for at least 12 feet of its width. The adjacent floorspace or patient area should be the same tone as the wall with a 3-inch radius cove at the base of the wall to prevent a strong line of demarcation between the floor and wall in full-length studies. A height scale on the wall at 1 side of the background area is desirable. Thirty-ampere electric outlets should be provided at either side of the patient area for floodlamps and other portable lighting equipment. An adjacent patients' dressing cubicle, and a lavatory with wrist-action valves are necessary. The door for admitting patients to the studio should be at least 44 inches wide.

For making 16-mm. motion pictures about 35 feet between background and camera is required to prevent distortion. However, it is possible to back the camera into an adjacent work area to attain this distance. Sometimes a draw curtain is provided between the main studio and the "closeup" studio to facilitate this arrangement.

A separate room for photomicrography permits the photographer to work in the dark, which is frequently necessary, permits him to leave the equipment set up, and minimizes dust. The room should be near a darkroom.

Copying charts and drawings is frequently done in the main studio. Copying radiographs, however, requires a small room that can be darkened. Both types of copywork can be done in this room.

The smallest photographic section will require two darkrooms, one for films and one for contact prints, enlargements, and lantern slides. If color films are to be processed, a special darkroom for this purpose should be provided. The volume of color printing will indicate whether a special darkroom for this purpose is warranted. Darkrooms should have a sink along 1 wall and a bench along the other, with 3 feet of workspace between them for 1 occupant or 4 feet for 2. Film and print driers may be located in any open work area near the darkrooms.

A room for loading film holders reduces traffic. A small, well-ventilated room, with a sink for chemical mixing, is necessary to protect equipment and materials against chemical fumes.

It is desirable to provide a small room for motion-picture film editing and titling, and for binding slides. Other finishing operations such as spotting, trimming, and mounting may also be done in this room. If projection equipment is included, motion pictures and slides may be checked.

A storage room for supplies should be provided. At least 1 refrigerator should be included for storing color material.

Since a photographic section is made up of many interior rooms subject to chemical fumes and heat from lights and driers, particular attention to mechanical ventilation is essential. Another important consideration is the heavy use of water in the film-processing and print-washing operations.

A storage room should also be provided in the general storage area of the building for the service. Some of the material handled may be a fire hazard and protective provisions should be made.

Technical Shops

Central technical shops are required as a supportive facility to all departments of a medical school. However, specialized shops may be required in some departments. These shops are responsible for maintaining and repairing electronic equipment and fabricating and improvising the unique apparatus and special instruments required for research and educational experimentation. The use of shops elsewhere on the university campus is not usually satisfactory from the standpoint of time or accuracy. Building maintenance shops, although possibly adjacent, have neither the proper equipment nor the type of personnel required for precision instrument work of this nature.

Technical shops usually include separate areas for metalwork, woodwork, glassblowing, and electronics. A metalworking shop usually requires a metal lathe, a drill press, 2 milling machines (1 horizontal and 1 vertical), a metal-cutting band saw, a bench grinder, and a universal tool and cutter grinder. Storage racks for bar and plate stock, tool cabinets and racks, and a machinist's bench will also be required. The woodworking shop needs space for a table saw, a thickness planer, a jointer, a wood lathe, and a drill press. A heavy wood bench, lumber racks, and tool cabinets should also be included. The glassblowing and electronics shops may be similar to those described for the department of biochemistry but on a larger scale.

Each technical shop should have space for a desk and files to record stock purchases and maintain requisitions from individual departments. The area for technical shops is given in table 26, page 84, for hypothetical schools with entering classes of 64 and 96 students.

If the basic science facilities are not contiguous to the clinical department facilities and the teaching hospital, duplication of some shop facilities will be necessary.

Service Facilities

Telephone facilities.—Telephone requirements will differ among medical schools and the communication setup of an existing university campus will influence the system. The teaching hospital will need switchboards. If the medical school is close by, a central telephone system may be advantageous. Space and facilities provided for the central system should reflect the requirements of an expanding medical school complex, so that ultimate capacity may be accomplished with a minimum of alteration.

Combining the switchboard and information center is not recommended for a medical school complex. The necessary reliability of communications for hospitals and medical schools will require a number of switchboard positions, which would not be feasible in combination with an information center. The switchboard is therefore best located in an area inaccessible to the public. A doctors' call system will be required in the hospital.

The central telephone system requires a PBX switchboard room, a telephone equipment room, and toilet and lounge for operators. The telephone equipment room is most economically located adjacent to or directly below the PBX room for the shortest run of cables. It is often required to be dustproof. The lounge should be sized for a couch and chairs to accommodate one-third of the PBX personnel. Switchboard handling requires unusual physical exertion; therefore, good ventilation and comfort conditioning of the PBX room and lounge are important. The telephone company should be consulted before this area is designed.

Postal facilities.—A postal facility in the medical school may assume the normal duties of a post office and handle the distribution of interoffice correspondence. If the teaching hospital is adjacent, a central facility of this type will reduce duplication of mail handling and delivery.

The postal facility should be privately operated, with the medical school furnishing personnel and equipment because of the large number of notices to students. Incoming and outgoing mail should be handled by the campus post office or by arrange-

ment with local postal authorities. Space should be designed so that an increased load will not impair its efficiency. If the facility is near the general receiving area, the handling of oversized packages and the vast amount of second- and third-class mail will be facilitated. It should be accessible to faculty, students in the basic science and clinical areas, and to those assigned to the hospital.

The number of lockboxes provided will depend on the method of mail delivery to departments and faculty. Individual lockboxes should be provided for each student and for faculty members who desire them. A lockbox should be assigned to each department.

Central storage.—Storage areas are required and should be considered in the early planning. Those within the department are discussed under other headings, but, in addition, separate storage space should be provided for each department elsewhere in the building. The amount of space for departments should be determined by their needs and designed for expansion.

A general storage room near maintenance shops should be provided for fixtures and equipment required for building maintenance and operation.

Each department should have a partitioned space for bulk storage. Because of variable loads of stored items, it is preferable to locate storage areas on a basement floor to avoid special floor live loads. Temperature and humidity should be controlled in all storage areas.

Central areas for storage and dispensing of bulk supplies of gases such as acetylene, argon, and hydrogen, and flammable liquids such as alcohol, acetone, and xylene require specially designed space readily accessible to loading platforms and receiving areas. These areas must comply with applicable codes (*21*).

Locker and toilet facilities.—Locker and toilet facilities should be provided for male and female service personnel convenient to the employee entrance.

Snack bar.—Vending machines for food and drink is a convenient type of snackbar.

Another type includes facilities for short-order foods, a service counter with stools, a table seating area, and a preparation-storage room. Allocation of space for a cashier counter and vending machines may be desirable. The snackbar should be convenient to the center of activity.

TABLE 17.—*Net area for service facilities for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total net area	13, 700	16, 050
Total	6, 000	8, 350
Telephone equipment room	800	1, 100
Post office	550	1, 000
Personnel and purchasing [1]	400	400
Employees' lockers and toilet facilities	2, 000	3, 000
Maintenance shops	900	1, 100
Plant engineer	150	150
Housekeeping	600	600
Duplicating	200	400
Snark bar	400	600
Central storage: [2]		
Total	7, 700	7, 700
Basic science departments:		
Anatomy	1, 000	1, 000
Biochemistry	500	500
Physiology	500	500
Microbiology	500	500
Pathology	1, 500	1, 500
Pharmacology	500	500
Clinical departments:		
Medicine	500	500
Surgery	500	500
Pediatrics	500	500
Obstetrics-gynecology	500	500
Psychiatry	300	300
Radiology	600	600
Preventive medicine	300	300

[1] 2 offices and secretaries.

[2] Central storage spaces for each department are listed on the department tables. However, areas for this storage are grouped here.

Maintenance shops.—Maintenance shops required by the medical school and hospital usually include a mechanical and plumbing shop, an electrical shop, a carpentry shop, and a paint shop. Where the medical school and hospital are under 1 roof or in close proximity, a single set of maintenance shops may serve both.

The plant engineer usually has the responsibility for coordinating maintenance and repair activities. He should be employed during the early construction stage so that he may become familiar with the complex mechanical and electrical installations. He requires an office with space for a desk and correspondence files, a secretary's office suitable for 1 secretary, files, and waiting space, and usually needs a separate drafting room with tables and plan-filing facilities.

Duplicating room.—A central duplicating facility may be required if each department does not have duplicating facilities within the department. Some schools have set up a printshop in addition.

Chapter 5

BASIC SCIENCE FACILITIES

Ideally, basic science, clinical science, and teaching hospital facilities are contiguous because of the close interrelationship of their functions in the teaching of clinical medicine. Where basic science and clinical science facilities are separated and clinical science facilities are contiguous to the hospital, decisions must be made regarding the provision of auxiliary facilities which serve both units. Some of these facilities may have to be provided in each building. For example, both basic science and clinical departments use the medical illustration service. However, medical illustration activities include taking photographs of patients in the hospital. Because of the difficulty in transporting cameras, tripods, auxiliary lights, and other equipment and loss in personnel time involved, medical illustration service should be convenient to the hospital.

If the basic science building is remote, some medical illustration services, such as those relating to photomicrography, animal photography, model and chart making, and repair and maintenance of projectors will be required in the basic science facility.

The medical library is used for reference and study in connection with both basic and clinical science facilities. If basic and clinical science facilities are separated, the library should be located adjacent to the basic science departments and a branch library with some duplicates of books and journals should be provided in the teaching hospital for faculty and students.

Perhaps the most perplexing choice, regarding separate basic and clinical science facilities is the location for animal quarters. Since a supply of laboratory animals is essential to both basic and clinical science research, if the basic and clinical science buildings are remote, it is necessary to provide animal quarters in conjunction with each building. However, where the buildings are within convenient walking distance of each other, 1 centralized animal quarters may be satisfactory. Where there is a choice of location, they should be adjacent to the basic science facilities. Where feasible, covered surface passageways or underground tunnel connections should be provided between the animal quarters and the buildings served.

As outlined in chapter 4, each basic science department requires offices and research laboratories for department heads, faculty members, and postdoctoral fellows, and animal-holding rooms, cold rooms, data rooms, special-projects rooms, and basement storage areas. Each department will also use lecture rooms. The requirements for these areas will depend on the program.

Conventional and Multidiscipline Laboratories

Basic science departments have certain common elements, the most outstanding of which are the teaching laboratories. Two types of laboratories are in use in medical schools today: conventional laboratories, where each department has its own laboratories or shares laboratories with another department requiring similar facilities and students move from one laboratory to another; and multidiscipline laboratories where students are assigned workspaces and all disciplines except gross anatomy are taught in this laboratory.

With the exception of gross anatomy, the basic sciences may be taught in either conventional or multidiscipline laboratories. The type of laboratory chosen will depend on the type of curriculum the medical school proposes. The design of facilities should not dictate the mode of teaching. Conventional laboratories may be used to teach

undergraduate medical and other students such as graduate students, dental students, physical therapy students, and nursing students. Many authorities believe that the multidiscipline laboratory provides better integration of the study of the basic sciences and more independent research by medical students. As shown on the tables in the basic science departments, the area for conventional laboratories is somewhat greater than for multidiscipline laboratories. However, this difference will depend upon whether students are assigned on a full-time basis and upon teaching programs that may require additional laboratories.

Conventional laboratories.—If conventional laboratories are used, the following considerations must be taken into account:

Laboratories are usually sized to accommodate an entire entering class. They are sometimes arranged for division, by means of folding partitions, into groups usually of 16 students (figs. 17–19). One laboratory is usually assigned to each of the disciplines in the basic sciences, although in some instances several departments—for example, physiology and pharmacology, and pathology and microbiology—may use the same laboratory.

Laboratories are generally referred to as sitdown or standup laboratories. Sitdown laboratories are provided for microbiology, microanatomy and neuroanatomy, and pathology. In physiology, pharmacology, and biochemistry, most of the work is done standing up. In sitdown laboratories, however, some standup work is done, and it is customary to provide standup counters for special instruments and reagents which may be shared by groups of students.

Auxiliary rooms are required. These include preparation and issuing rooms, glassware processing rooms, storage rooms, and media-preparation rooms. Some schools place large and noisy pieces of equipment shared by groups of students in a separate instrument room.

Graduate students usually use the same laboratories as medical students for classroom laboratory work. If separate facilities are provided, they are located close to the auxiliary rooms. The design is similar but size will vary with the teaching program.

Multidiscipline laboratories.—The multidiscipline laboratory is sized to take the number of students assigned to 1 teacher. This is usually 16

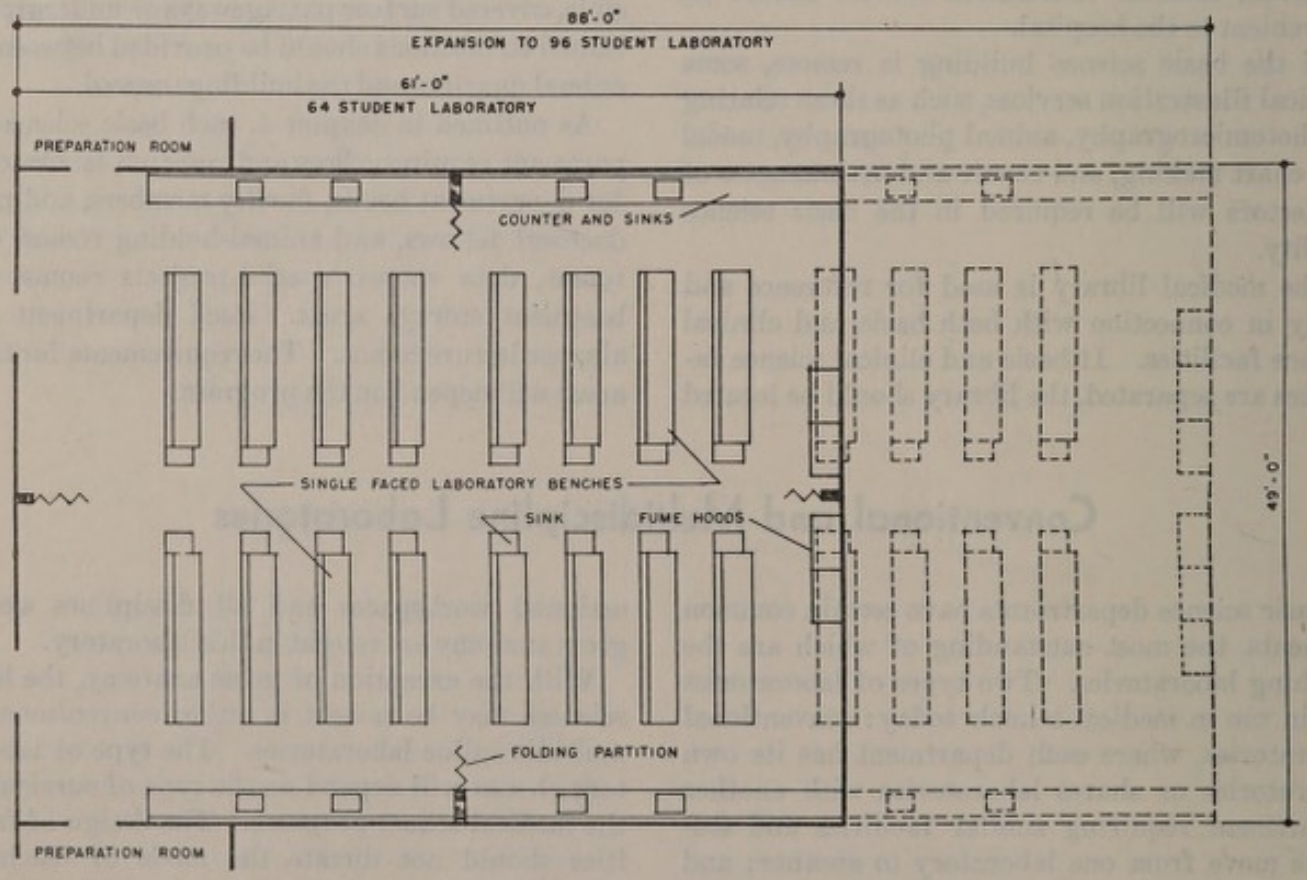


FIGURE 17.—Layout for a conventional teaching laboratory with single-faced benches.

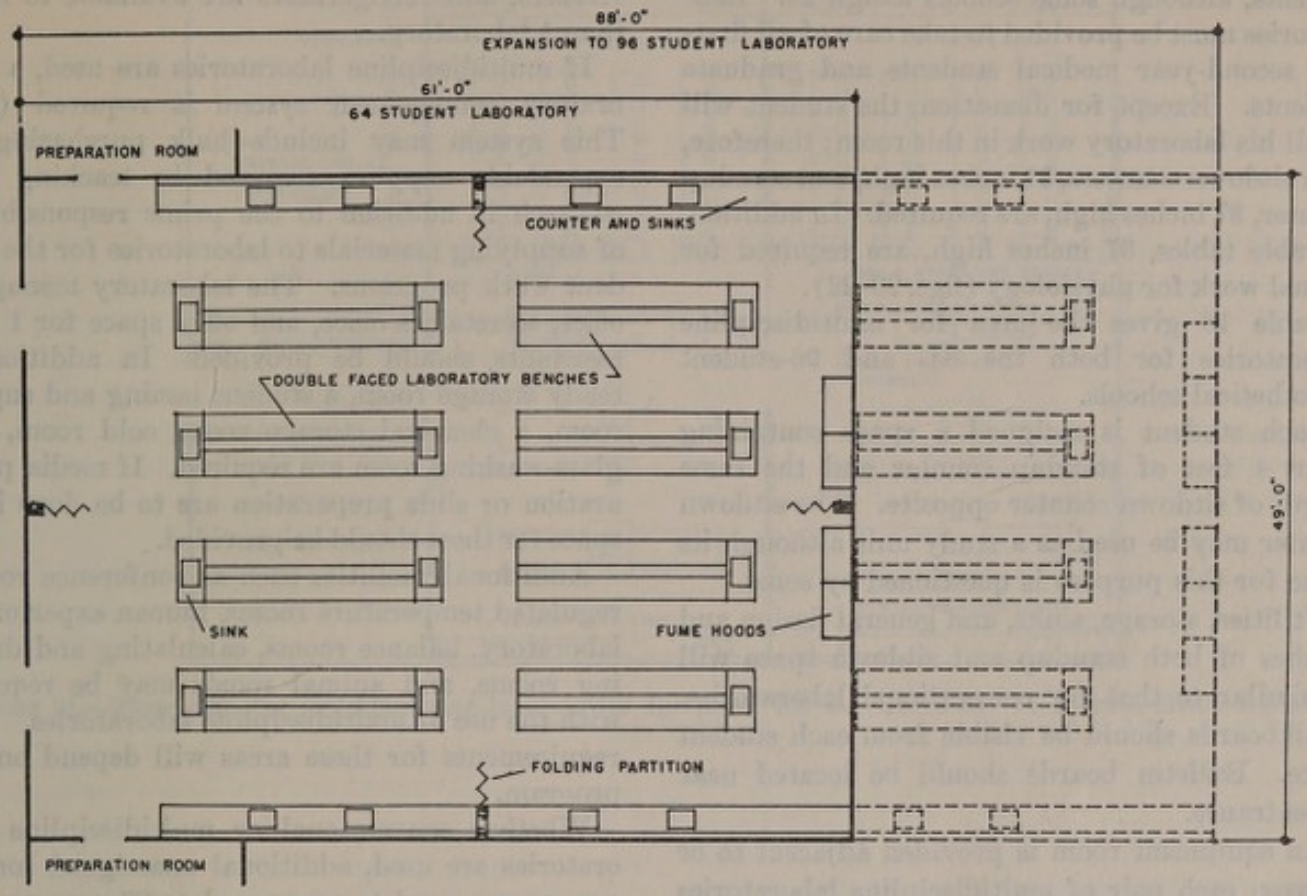


FIGURE 18.—Layout for a conventional teaching laboratory with double-faced benches.

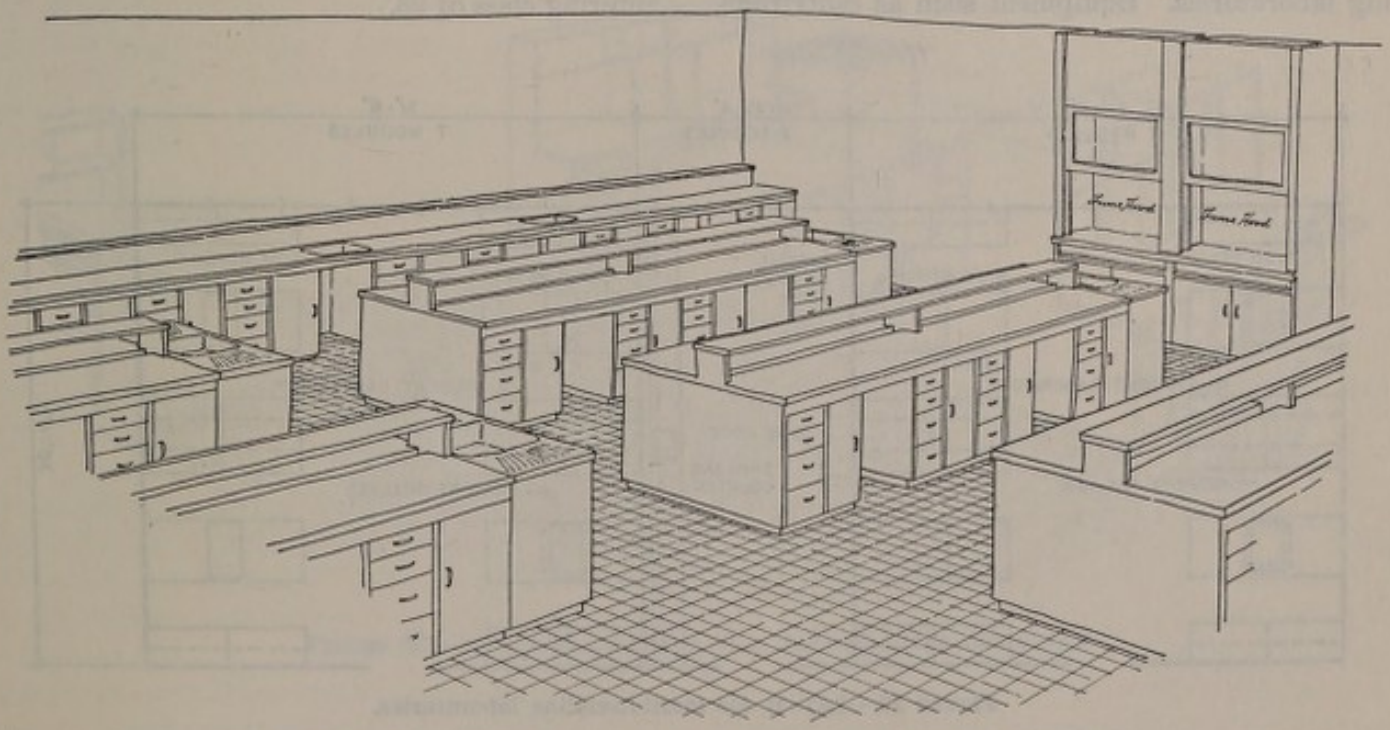


FIGURE 19.—Perspective drawing of a conventional teaching laboratory.

students, although some schools assign 24. Laboratories must be provided to take care of all first- and second-year medical students and graduate students. Except for dissection, the student will do all his laboratory work in this room; therefore, both sitdown counters, 31 inches high, and standup counter, 37 inches high, are required. In addition, movable tables, 37 inches high, are required for animal work for physiology (figs. 20–22).

Table 18 gives the area for multidiscipline laboratories for both the 64- and 96-student hypothetical schools.

Each student is assigned a space containing about 4 feet of standup counter and the same length of sitdown counter opposite. The sitdown counter may be used as a study unit although its value for this purpose is questioned by some.

Utilities, storage, sinks, and general design and finishes of both standup and sitdown space will be similar to that for conventional laboratories. Chalkboards should be visible from each student space. Bulletin boards should be located near the entrance.

An equipment room is provided adjacent to or between each pair of multidiscipline laboratories in some designs. Equipped with a fume hood, counter space with utilities and cabinet space, it houses equipment required for the work in adjoining laboratories. Equipment such as centrifuge, freezers, and refrigerators are available to more than 1 laboratory.

If multidiscipline laboratories are used, a laboratory management system is required (*22*). This system may include bulk purchasing of expendable supplies required in teaching and research in addition to the prime responsibility of supplying materials to laboratories for the student work programs. The laboratory manager's office, secretary's office, and office space for 1 or 2 assistants should be provided. In addition, a ready storage room, a student issuing and supply room, a chemical storage room, cold room, and glass-washing room are required. If media preparation or slide preparation are to be done here, space for these should be provided.

Additional facilities such as conference rooms, regulated temperature rooms, human experiments laboratory, balance rooms, calculating and drafting rooms, and animal rooms may be required with the use of multidiscipline laboratories. The requirements for these areas will depend on the program.

Whether conventional or multidiscipline laboratories are used, additional unassigned conference rooms sized to accommodate 20 persons may be provided in the basic science facilities for use by unscheduled groups—2 for the school with an entering class of 64 and 3 for the school with an entering class of 96.

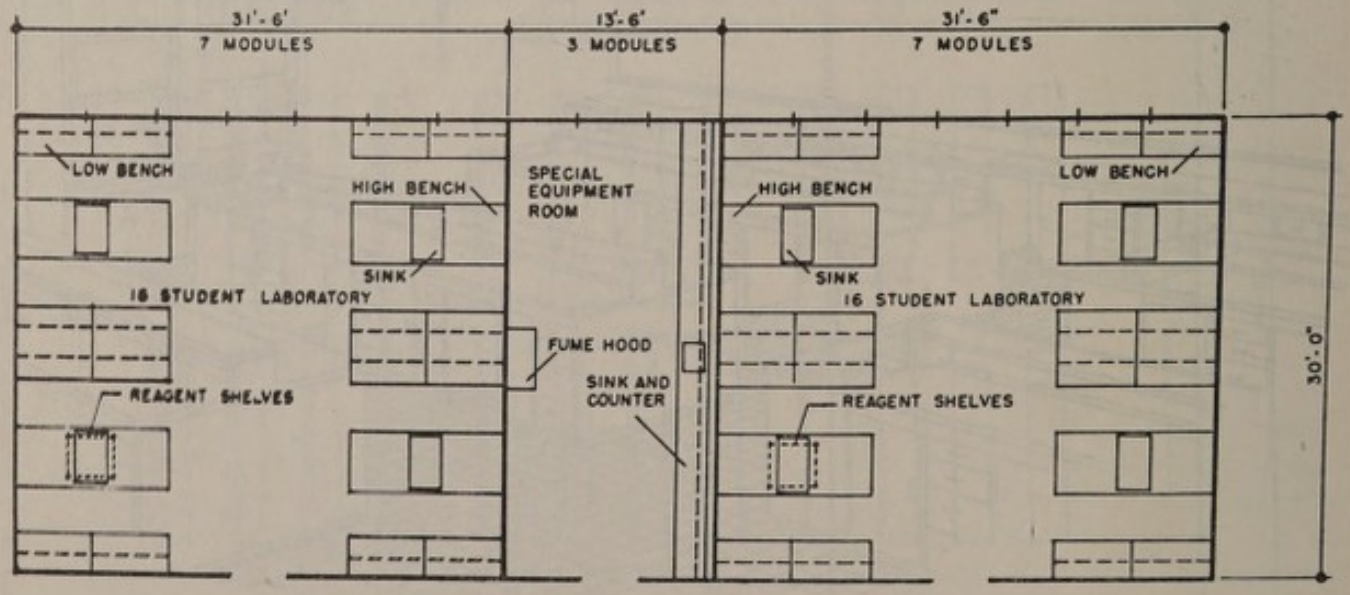


FIGURE 20.—Layout for multidiscipline laboratories.

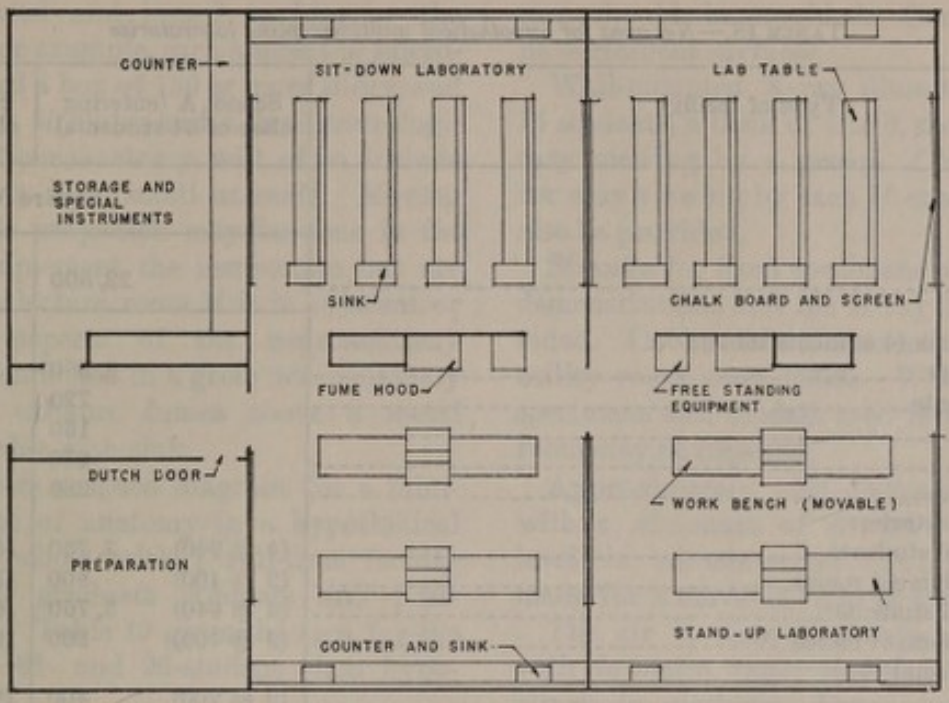


FIGURE 21.—Floor plan for multidiscipline laboratories (proposed for the University of Florida Medical School).

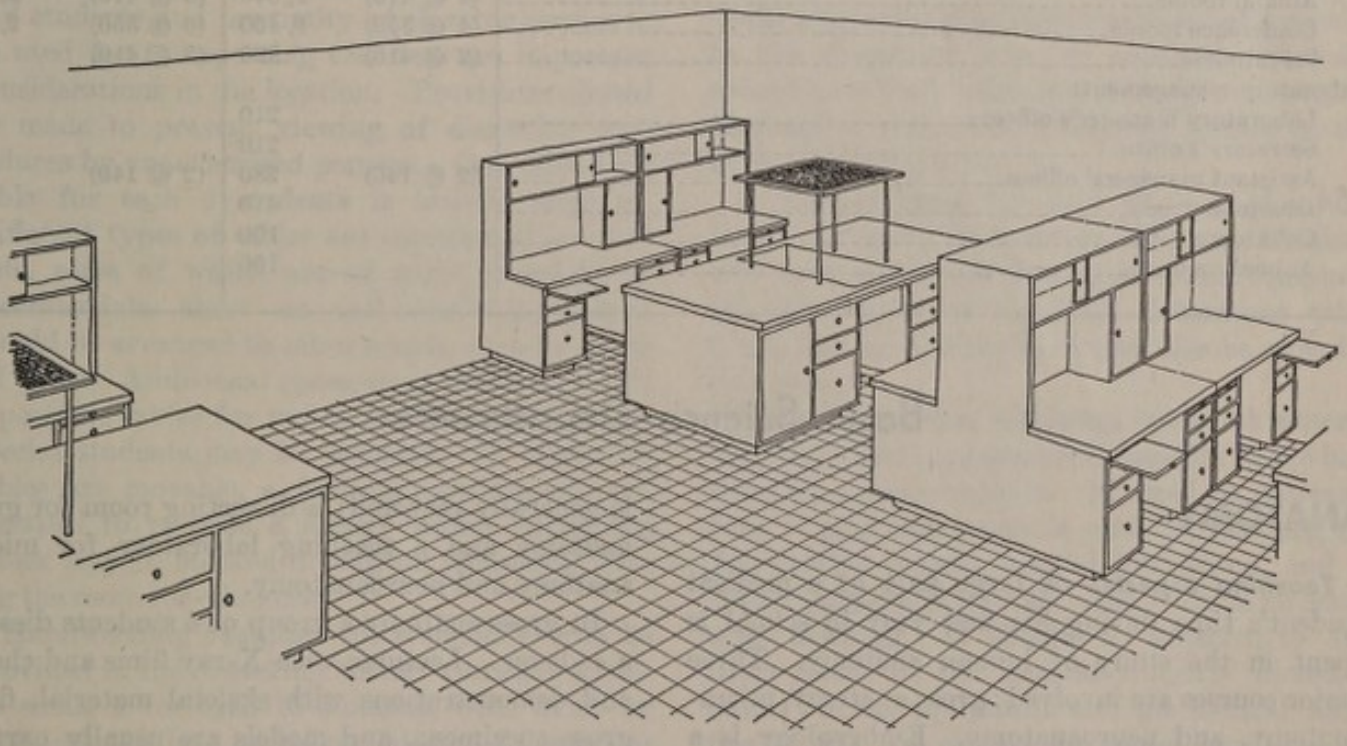


FIGURE 22.—Perspective drawing of a multidiscipline laboratory.

TABLE 18.—*Net area for hypothetical multidiscipline laboratories*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	Square feet			
Total		22,500		29,960
Gross dissecting rooms (4 students/table):				
Medical students		2,560		3,840
Graduate students		720		720
Utility room		160		160
Storage room		250		250
Neuroanatomy		280		280
Multidiscipline laboratories:				
1st year medical students	(4 @ 940)	3,760	(6 @ 940)	5,640
"Interlab" equipment rooms	(2 @ 400)	800	(3 @ 400)	1,200
2d year medical students	(4 @ 940)	3,760	(6 @ 940)	5,640
"Interlab" equipment rooms	(2 @ 400)	800	(3 @ 400)	1,200
Ancillary teaching facilities:				
Cold rooms	(2 @ 200)	400	(2 @ 200)	400
Regulated temperature rooms	(2 @ 410)	820	(2 @ 410)	820
Human experiments laboratory		780		780
Glass washing, sterilizing, and storage		630		630
Media preparation room		280		280
Clinical pathology issue room		570		570
Balance rooms	(2 @ 100)	200	(3 @ 100)	300
Calculating and drafting rooms	(2 @ 280)	560	(2 @ 280)	560
Animal rooms	(4 @ 410)	1,640	(6 @ 410)	2,460
Conference rooms	(4 @ 350)	1,400	(6 @ 350)	2,100
Stockrooms	(2 @ 410)	820	(2 @ 410)	820
Laboratory management:				
Laboratory manager's office		210		210
Secretary's office		210		210
Assistant managers' offices	(2 @ 140)	280	(2 @ 140)	280
Laboratory		410		410
Cold room		100		100
Animal room		100		100

Basic Science Departments

ANATOMY

Teaching aspects.—A large part of a medical student's time during his first year in school is spent in the study of human anatomy. Three major courses are involved: gross anatomy, microanatomy, and neuroanatomy. Embryology is a possible fourth course, depending on whether it is taught separately or is incorporated with another course such as gross anatomy. Some lectures and small group conferences are included in all the courses. A minimum of 2 separate teaching areas is generally required: a dissecting room for gross anatomy and a teaching laboratory for microanatomy and neuroanatomy.

In gross anatomy a group of 4 students dissects a cadaver. Lectures with X-ray films and charts and demonstrations with skeletal material, fixed gross specimens, and models are usually part of the instruction.

The principal activity in the microanatomy and neuroanatomy courses is microscopic study. Each student usually provides his own microscope although slides for observation and other mate-

rials are prepared and issued to him by the department. For example, each student in microanatomy is loaned a box of 150 or more slides, and in neuroanatomy, 50 slides and a fixed neurological specimen. Neuroanatomy will often include some experiments with small animals. Moving picture and slide projection may be done in the laboratory to implement the instruction but are best done in the lecture room if it is adjacent or nearby. Some aspects of the neuroanatomy course are best conducted in a gross neuroanatomy room fitted to exhaust fumes above a metal demonstration table with sink.

Figure 23 shows a space diagram for a minimum department of anatomy in a hypothetical 64-student-class school with 7 full-time faculty members and 7 graduate students and postdoctoral fellows. Table 19 gives the area for the department for 64- and 96-student class hypothetical schools.

New developments in teaching methods must be considered in designing these facilities.

Dissecting room.—The teaching area for gross anatomy is usually one large room with standup-height dissecting tables to accommodate all the students in the course. Convenience for faculty and students and proximity of elevator service to be used for transporting cadavers are important considerations in the location. Provisions should be made to prevent viewing of dissection procedures by unauthorized persons. One dissecting table for each 4 students is usually required. Different types of tables are commercially available, some of which are of variable height to accommodate short or tall students. Tables should be arranged to allow ample work space on all sides. Additional space to accommodate 1 or 2 portable tables for use in demonstrations or by special students may be required. If dissecting tables are movable, a folding partition may be installed to provide a screen behind which the tables may be stacked during off-semesters, freeing the room for other uses.

Handwashing facilities for students should be provided in the dissecting room. Surgical scrub-up sinks, 3 for each 16 students, with wrist- or foot-action valves or industrial-type fixtures are recommended. Counter units should have reagent ledges, knee spaces, and undercounter drawers and cabinets for storage of student's dissecting equipment and demonstration microscopes. Electrical service outlets for microscope illuminators should be provided. Counter tops should have resilient surfaces.

Wall-mounted X-ray illuminators, 1 for each 16 students, a bank of 4 to 8, should be located for easy viewing by a group. Chalkboards located for easy viewing by each 16-student group should also be provided.

Storage for fixed specimens and models used in demonstrations and for X-ray film should be provided. Cabinets in a connecting area, such as a utility room, may suffice. Where the number of specimens and models used is large, an adjacent room may be required.

Approximately 150-footcandle illumination with a minimum of shadows at the dissecting level is recommended. Provisions should be made for a movable light at each table.

The air in dissecting rooms becomes charged with formalin vapor that irritates the eyes and clings to clothing. Even small amounts may cause damage to instruments and experiments. Therefore, the dissecting-room system of mechanical ventilation should have no recirculation of air and should have negative pressure relative to adjacent spaces.

A *utility room* which may serve as a diener's workroom, with flushing-rim service sink accessible to the dissecting area, is required. The sink should have flush valve and wrist-operated valves. Mechanical ventilation should be similar to that of the dissecting area.

A *storage room* for such items as dissecting table bookracks, students' bone boxes, articulated skeletons, anatomical charts, and other equipment of this nature is required. Dissecting tables which can be disassembled may also be stored in this room.

Graduate student dissecting room.—A separate dissecting room for graduate students in the basic sciences is advantageous. If sized to accommodate 16 students, it can be used for teaching and for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be adjacent to auxiliary rooms of the medical students' dissecting room. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Microneuroanatomy teaching laboratory.—A conventional student teaching laboratory for microanatomy and neuroanatomy instruction usually requires a demonstration area with a table,

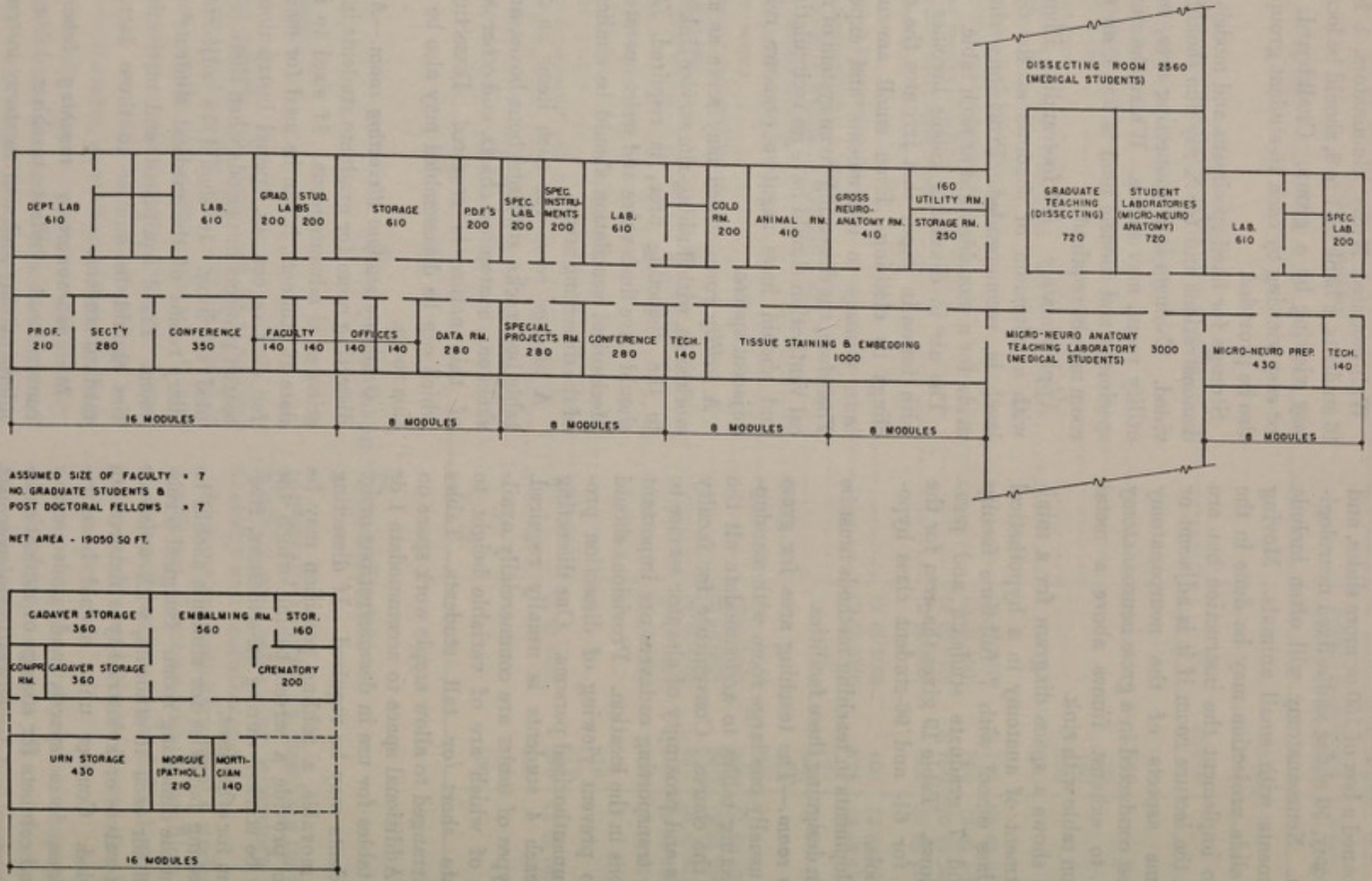


FIGURE 23.—Diagram for a department of anatomy for a medical school with a 64-student entering class.

TABLE 19.—*Net area for a department of anatomy for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty	7	7	10	10
Number of graduate students and postdoctoral fellows	7	7	10	10
	Square feet			
Total net area	19,330	[1]	22,950	[1]
Faculty offices, research laboratories, and related facilities:				
Total	11,640	11,510	12,660	12,530
Professor's office	210	210	210	210
Secretary's office	280	280	280	280
Conference room	350	350	350	350
Faculty offices	(4) 560	(4) 560	(4) 560	(4) 560
Postdoctoral fellows' office	200	200	200	200
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	610
General	(3) 1,830	(3) 1,830	(4) 2,440	(4) 2,440
Graduate students	(2) 400	(2) 400	(3) 600	(3) 600
Special	(2) 400	(2) 400	(1) 200	(1) 200
Electron microscopy rooms	610	610	610	610
Storage room	280	280	280	280
Tissue staining and embedding and technician's office	1,140	1,140	1,140	1,140
Microneuro preparation and technician's office	570	570	570	570
Special instrument storage	200	200	200	200
Coldroom	200	200	200	200
Animal room	(1) 410	(1) 410	(2) 820	(2) 820
Gross neuroanatomy and neurological storage room	410	280	410	280
Cadaver storage rooms (60 bodies) and compressor room	(2) 720	(2) 720	(2) 720	(2) 720
Embalming room	560	560	560	560
Embalming room storage	160	160	160	160
Crematory	200	200	200	200
Morgue (pathology)	210	210	210	210
Mortician's office	140	140	140	140
Urn storage room	430	430	430	430
Departmental central storage [2]				
Conventional teaching:				
Total	7,690	[1]	10,290	[1]
Gross dissecting rooms (4 students/table):				
Undergraduate students	2,560		3,840	
Graduate students	720		720	
Utility room	160		160	
Storage room	250		250	
Microneuroanatomy teaching laboratories:				
Undergraduate students	3,000		4,320	
Graduate students	720		720	
Conference room	280		280	

[1] For total net area for multidiscipline laboratories, see table 18, p. 58.

[2] For central storage areas, see table 17, p. 50.

chalkboard, projection screen, and sitdown laboratory benches to accommodate all the students of either course. Benches should seat 4 students on the same side to face in the same direction for an unobstructed view of the demonstration area. The class may be divided into groups of 16, and groups of 4 or 8 students may work together.

Each bench position should have knee space, drawers, and a cabinet for storing slides and microscope case. Water, air, gas, electrical outlets, and vacuum should be provided at each position. Liquid waste receptors in bench tops may be either lead cup sinks or continuous drain troughs with stone end sinks. Bench top material should be resilient and alcohol- and stain-resistant.

In addition to sitdown benches, some standup bench space should be provided for each 16 students. Bulletin boards and tackboards should be provided.

Although fume hoods are usually not required in this laboratory, space may be necessary for movable items such as refrigerators, incubators, centrifuges, and students' slide-projection boxes, depending upon the curriculum or other uses of the laboratory.

Graduate student teaching laboratory.—A separate microneuroanatomy teaching laboratory for graduate students is advantageous. If it is sized to accommodate 16 or more students, it may be used for teaching and for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be adjacent to auxiliary rooms of the medical students' microneuroanatomy teaching laboratory. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Gross neuroanatomy room.—This room is a supplementary teaching area where neuroanatomy students in groups participate in sectioning demonstrations involving fixed gross neurological specimens. Usually the area serves also as a departmental storage center for such specimens, in which case adjustable shelving for supporting a number of jars of formalin are required.

The demonstration table, located at the center of the room to accommodate 4 students on each side, is usually provided with a stainless-steel top with raised edge and an integral sink at one end. Lighting should be designed for close observation at tabletop level. Hand-washing facilities, an X-ray film illuminator, and a chalkboard should be provided. Storage for formalin should be considered.

The concentration of formalin fumes makes it essential that mechanical supply and exhaust ventilation systems provide continuous fresh air with no recirculation. To exhaust the fumes at the work area, an exhaust hood is sometimes installed over the demonstration table. However, the table may be constructed with a perforated metal top and plenum chamber below serving also as a drain trough. Air is drawn downward through the top into the plenum for discharge. This arrangement has the advantage of immediate removal of the fumes at their source, but the table is fixed.

Tissue staining and embedding.—Preparation of the microscope slides and staining materials required in teaching microanatomy necessitates a specially equipped unit for technicians engaged in these operations. This unit may be subdivided into a head technician's office, an embedding area, a sectioning and tissue-staining area, and a slide storage-and-issue area with access to the teaching laboratory, preferably by way of a dutch door for issuing slides and materials.

In the embedding room small tissue specimens are prepared, processed through a number of solutions by hand or in an automatic tissue-processing machine, then embedded in small cubes of paraffin or celloidin. Preparing the specimens requires the use of a refrigerator for gross tissue storage and a sitdown counter with sink. If some frozen section work may be done here, an undercounter cabinet for a carbon dioxide cylinder is needed.

For processing specimens and mixing solutions, a standup counter with sink, undercounter cabinets for equipment, and wall cabinets for chemicals and reagents are usually sufficient. If an automatic tissue-processing machine is used, a table to support it at a convenient working level may be required.

For embedding procedures, an island bench of standup height with paraffin oven at or near one end should be provided. The size of the oven will determine whether a separate table of special height will be needed. Cabinets with drawers for paraffin molds and mounting blocks and for filing embedments in frequent use should be provided. A storage room for embedments and for fixed gross tissue specimens not frequently used should be provided in the general storage area of the building.

In the sectioning and tissue-staining area the

paraffin or celloidin cubes and their embedded tissue are cut into slices or sections by means of a microtome and each section is mounted on a microscope slide. The slides are then processed through a series of staining solutions, either by hand or by an automatic staining machine, after which a cover glass is cemented over each stained section and identification labels attached. Glazed partitions may be installed to separate sectioning and mounting activities from the staining procedures.

Sectioning and mounting activities require sitdown counters with knee space and drawers for storing slides and equipment. A slide warmer may be set flush in the countertop at each position for positioning sections, drying slides, and for inspection.

Counters for tissue staining and stain mixing should be of sitdown height. Each work position should have a sink, kneespace, cabinets for equipment, and chemical storage. An automatic tissue-staining machine may require a low table. A stone sink for washing glassware used with strong acids may be provided. For attaching cover glasses and labels, a sitdown counter with kneespace and drawers is satisfactory. Hand-washing facilities should be provided. Countertop surfaces should be resilient and stain and alcohol resistant.

The slide storage-and-issue area requires standard microscope slide file cabinets designed for spaced filing of slides and cardboard boxes for paraffin blocks, and cabinets for storage of boxed sets of slides for loan to students.

Microneuro preparation.—To prepare microscope slides used in the neuroanatomy course, a microneuro preparation unit is required similar in design and equipment to the tissue-staining and embedding unit for microanatomy. The two should not be combined because the microtome is a different size and staining techniques vary. The microneuro preparation unit can be used for the preparation of slides in neuropathology and for research in neurosurgery. The head *technician's office* should have access to the unit and to the corridor.

Electron microscopy.—Electron microscopy is an important element in teaching and research programs in the department of anatomy. Space requirements for this facility will depend upon program and demand. In general, three main areas will be required: a preparation room, a room to house the electron microscope unit, and an adjacent darkroom.

Preparation-room activities include specimen fixing, embedding, sectioning, mounting and shadowing sections, preparing solvents for fixing, and periodic cleaning of parts of the electron microscope. Standup and sitdown counters and a fume hood are required for mixing solvents. Air, gas, vacuum, and electrical outlets should be available. A refrigerator is necessary for chemical storage.

The room size will depend on the type of unit selected and the space necessary for its operation and maintenance. Electron microscopes and power-supply units each weigh from 600 to 3,300 pounds; this must be considered in designing structural floors. Electron microscope operation is adversely affected by vibration, dust, electrostatic magnetic fields, and large fluctuations in temperature and relative humidity. The electron microscope should be located away from electric motors, elevators, fans, and other equipment that may generate vibration and stray magnetic fields. The room should be shielded and the power supply should be located at the distance from the miscroscope specified by the manufacturer. Electron microscopy is performed in an unlighted area; for this reason and to minimize dust, the room should be windowless.

Electron microscopy requires a darkroom next to the microscope room for loading cassettes and for developing negatives. In small installations, the same darkroom may be used also for making prints and enlargements; however, printing and enlarging may be done in the medical illustration department.

An electron microscope suite should be air-conditioned to dissipate the heat given off by the microscopes during operation, to protect their delicate mechanisms, to eliminate dust and humidity, and to provide comfort for the operators—electron microscopy is a painstaking procedure and requires hours of specimen preparation and observation time.

For convenience and economical use, 2 electron microscope units should be installed, or space should be allocated and mechanical services provided for future installation of a second unit. Two units can usually share 1 darkroom. Table 20 gives the area for an electron microscope suite for a hypothetical school with an entering class of either 64 or 96 students.

TABLE 20.—*Net area for electron microscope suite [1] for hypothetical schools with entering classes of 64 and 96 students*

Type of supporting area	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total	610	610
Electron microscope rooms	(2) 230	(2) 230
Darkroom	70	70
Preparation area	280	280
Entry	30	30

[1] See departments of anatomy, microbiology, and pathology.

Cadaver preparation and storage.—The cadaver preparation and storage unit receives incoming bodies, prepares them, stores them, and disposes of the remains. Where the teaching hospital is physically connected, the morgue for short-term holding of bodies of deceased patients may also be under the supervision of this section.

The unit should be so located and designed that no unauthorized persons may enter. Its location relative to the dissecting and autopsy rooms should not require transportation through any public areas. It should be located at grade with a receiving entrance accessible to a low loading platform. Where design permits, the platform may also serve the animal-receiving entrance.

The mortician's work area or *embalming room* should permit working on all sides of the embalming table and handling by stretcher cart, portable lift, or other means. An embalming table with built-in sink at one end is generally preferred. A combination instrument and scrub sink with knee- or foot-operated valve, service sink, and a floor drain should be provided. Floor and wall materials should be washable. Proper mechanical ventilation without recirculation of air is essential for this area. A connected *storage room* for supplies and equipment is necessary. Shower and dressing facilities for use of the mortician should be provided. A *mortician's office* should be adjacent to the area.

Cadaver storage should be adjacent to the embalming room. There are several methods of storing cadavers, some more demanding of space than others. An efficient method is storage on individual tray shelves on both sides of a service aisle. Thirty-five tray positions are usually adequate for a school with a 64-student entering class; provision should be made in the original planning for approximately 60 tray positions to accommodate enrollment increases up to 96 students. Most cadaver storage rooms are equipped to maintain a temperature of 40° F. Some authorities, however, believe that with present-day embalming methods and the use of plastic bags with solution inside, room temperature is satisfactory.

Although cadaver remains are frequently buried in a special cemetery, they are sometimes cremated within the medical school and the ashes held in urns for burial, or the urns held indefinitely, depending on the policy of the school.

A crematory, if provided, should be located in the cadaver preparation and storage unit. A properly ventilated room conforming to the requirements of the National Board of Fire Underwriters is required. Local and State regulations regarding the disposal of human remains are usually very specific. Therefore, plans should be cleared with the authorities having jurisdiction. The decision whether or not to provide a crematory should be made early, since the stack may affect the design of other floors.

The department will require storage space for tissue embedments and gross organs. The same type storage as that described for pathology should be provided.

BIOCHEMISTRY

Teaching aspects.—Biochemistry is usually taught during the medical student's first year. A typical curriculum occupies a total of 16 hours per week, including approximately 6 hours of lectures and discussion and 10 hours of laboratory work. As with other basic science courses, the class may be subdivided into units of 16 students. These units will have oral discussion or examinations, conferences, and laboratory sessions. Special demonstrations and experiments will be performed by 1 student or groups of 2, 4, or 8 students.

Figure 24 shows a space diagram for a minimum department of biochemistry in a hypothetical 64-student class school with 6 full-time faculty members and 10 graduate students and postdoctoral fellows. Table 21 gives the area for the department for the 64- and 96-student class hypothetical schools.

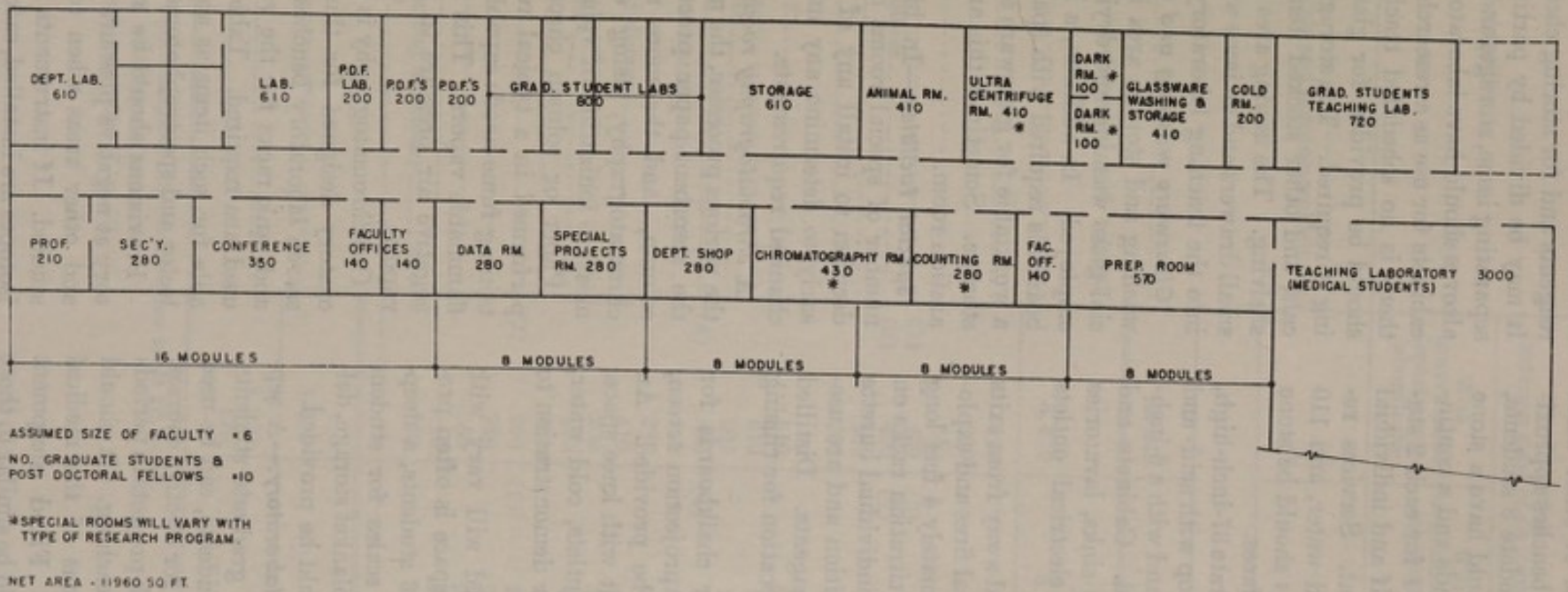


FIGURE 24.—Diagram for a department of biochemistry for a medical school with a 64-student entering class.

Teaching laboratory.—The conventional teaching laboratory is similar to those of other basic sciences. Island-type laboratory benches approximately 16 feet long will accommodate 8 students, 4 on either side. The bench should have a stone sink at one or preferably both ends and a continuous drain trough or cup sinks (1 for each 2 students), a continuous reagent shelf and individual service outlets for each student. Services required are gas, air, vacuum, cold water, and 110 volts a.c. electricity. Bench tops should be stone or acid-resistant composition surfaces.

For special instruments, a separate 37-inch-high, 24-inch-wide continuous countertop with acid- and stain-resistant resilient covering and with a 6-inch-wide reagent shelf is suggested. Cabinets and drawers for storage, countertop sinks, lavatories with wrist-action valves, and electrical outlets should be provided.

Fume hoods should be installed away from exits because of the hazards of chemical fires and explosions. One fume hood approximately 4 feet long should serve 8 students. Wall titration racks on stands will reduce the need for individual burette stands for titration at each position and are useful for dispensing special reagents. Distilled water should be provided in 1 location for rinsing glassware.

A large chalkboard, smaller chalkboards for each 16 students, a retractable projection screen, and a bulletin board should be provided. An instructor's table of desk height with knee space, cabinets, cup sink, electrical outlets, cold water, and gas should be provided for demonstration to the class.

Moveable equipment required will vary with teaching methods. However, space is often provided for 1 refrigerator per 16 students, a deep-freeze unit, centrifuges, and scales for student weighing. First-aid kits, fire blanket storage, deluge shower, and eye bath should be provided.

Graduate student teaching laboratory.—A separate teaching laboratory for graduate students, if sized to accommodate 16 students, can be used for teaching, and may be used for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be adjacent to auxiliary rooms of the medical student teaching laboratory. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Preparation room.—A preparation room adjacent to the teaching laboratory is used for mixing reagents and for storing chemicals and glassware. It may be divided by partitions into alcoves for separating issue, storage, and preparation. These alcoves should have laboratory benches, sinks, and cabinets for use as a research area in periods when there is no scheduled teaching. Sitdown space should be provided for glassblowing and soldering if required. The storage of glassware, chemicals, and other stocked items requires adjustable shelving. The issuing area requires cabinets with small drawers and an issue window or door opening into the teaching laboratory.

Glassware washing and storage.—A glassware washing and storage area is required. Commercial glass washing and drying machines are often employed. In addition, a large sink with drainboards is required with space for glassware carts, a worktable for glassware sorting, and shelves for storage. Sometimes this area is part of the preparation room.

Special facilities.—In biochemical research, a number of special rooms may be required. The decision to install any of these should be made early to determine any unusual features or mechanical requirements.

A *chromatography room* may be required. Of the various processes, the most commonly used are the absorbent-paper process, a glass or plastic column, and the more recently developed gas chromatography, using equipment which will measure ionization of volatile materials.

Paper or column chromatography is usually performed in a typical research laboratory containing fume hoods capable of exhausting toxic or flammable vapors. This laboratory should have negative air pressure to prevent spread of such vapors.

Gas chromatography is best performed in a laboratory designed for this purpose. Typical research laboratory benches with the usual services and tank racks for the various gas combinations used are required. Table space should be available for such items as an automatic fraction collector and spectrophotometers.

Provisions should be made to keep the laboratory at negative pressure with respect to corridors and other areas when toxic materials are to be studied. If instruments for counting radioactive isotopes are installed, safeguards must be provided in accordance with rules and regulations of the

TABLE 21.—*Net area for a department of biochemistry for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty	6	6	9	9
Number of graduate students and postdoctoral fellows	10	10	14	14
	Square feet			
Total net area	12,240	[1]	14,980	[1]
Faculty offices, research laboratories, and related facilities:				
Total	8,670	8,670	10,090	10,090
Professor's office	210	210	210	210
Secretary's office	280	280	280	280
Conference room	350	350	350	350
Faculty offices	(3) 420	(3) 420	(3) 420	(3) 420
Postdoctoral fellows' offices	(2) 400	(2) 400	(2) 400	(2) 400
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	610
General	610	610	(3) 1,830	(3) 1,830
Postdoctoral fellows	200	200	200	200
Graduate students	(4) 800	(4) 800	(5) 1,000	(5) 1,000
Storage room (future laboratory)	610	610	610	610
Storage room	280	280	280	280
Glassware washing and storage	410	410	410	410
Cold room	200	200	200	200
Special-equipment room [2]	430	430	430	430
Centrifuge room [2]	410	410	410	410
Darkrooms [2]	(2) 200	(2) 200	(2) 200	(2) 200
Counting room [2]	280	280	280	280
Departmental shop	280	280	280	280
Animal room	410	410	410	410
Graduate students' teaching laboratory	720	720	720	720
Departmental storage [3]	----	----	----	----
Conventional teaching:				
Total	3,570	[1]	4,890	[1]
Teaching laboratory	3,000	----	4,320	----
Preparation room	570	----	570	----

[1] For total net area for multidiscipline laboratories, see table 18, p. 58.
[2] Special rooms will vary with type of research.
[3] For central storage areas, see table 17, p. 50.

Atomic Energy Commission even though the level of radioactivity is low.

If an *ultracentrifuge room* is planned for research, selection of equipment will determine the requirements. All commercially available ultracentrifuges are electrically powered. Because of the high speeds obtainable, vacuum and cooling systems are contained within the equipment. In the analytical ultracentrifuge, analysis of material is obtained by a photographic process electronically controlled. Since at least part of the housing for this equipment is of heavy armorplate, the floor live load must be considered. To prepare material to be used in an ultracentrifuge, a wall bench with base cabinets, wall cabinets, and sink should be installed. Services should include gas, air, vacuum, water, and electrical outlets. The room may require additional cooling to offset heat produced by operation of the equipment.

A *counting room* will contain electronic equipment for the accurate measurement and counting of radioactivity. Equipment such as an automatic sample changer will require connection to gas cylinders and will be wired to automatic adding machines for counting work. If more equipment space is required, shelving should be provided above tables. Space between shelving and wall for gaslines should be provided. Most of the equipment used will have built-in radiation shielding and is quite heavy. Tables and shelving should be built to support this exceptional weight. If small gas cylinders are placed under the tables, gaslines to equipment will be shortened and height under the table to allow for upright cylinders and pressure-gage attachments will be necessary. All cylinders should be fixed in racks. Electrical outlets for both 110 v. and 220 v. should be installed at the wall above tables and at shelving so that extension cords may be avoided. Cabinets for storage should be provided. Humidity should be controlled to assure accurate results in counting.

Department shop.—Unless central shops can provide maintenance and repair of electronic equipment and the fabrication of unique forms of glassware, space may be required in the department to perform these services. A combination electronic and glassblowing shop will meet these needs. The electronic section requires storage bins, a tool cabinet, and racks for electronic tubes, transistors, condensers, test bench with power outlets, and space for testing electronic equipment. The glassblowing section should have storage racks for glass stock, a counter with gas and electrical outlets, and a glassblowing lathe. Countertops should be surfaced with asbestos board to reduce fire hazard.

PHYSIOLOGY

Teaching aspects.—Physiology, usually presented to first-year medical students, may be divided between the first and second year. It consists of lectures, demonstrations, laboratory exercises, and independent projects and may include 400 hours or one-third of the school-year program. By laboratory exercises the student is introduced to methods of studying functions of normal organ systems, including muscles, respiration, circulation, and body-temperature regulation. Animals are used for experiments, and in extended experiments the animal-holding room may be used. Increasingly, conferences among students, house officers, and fellows in clinical science departments are held.

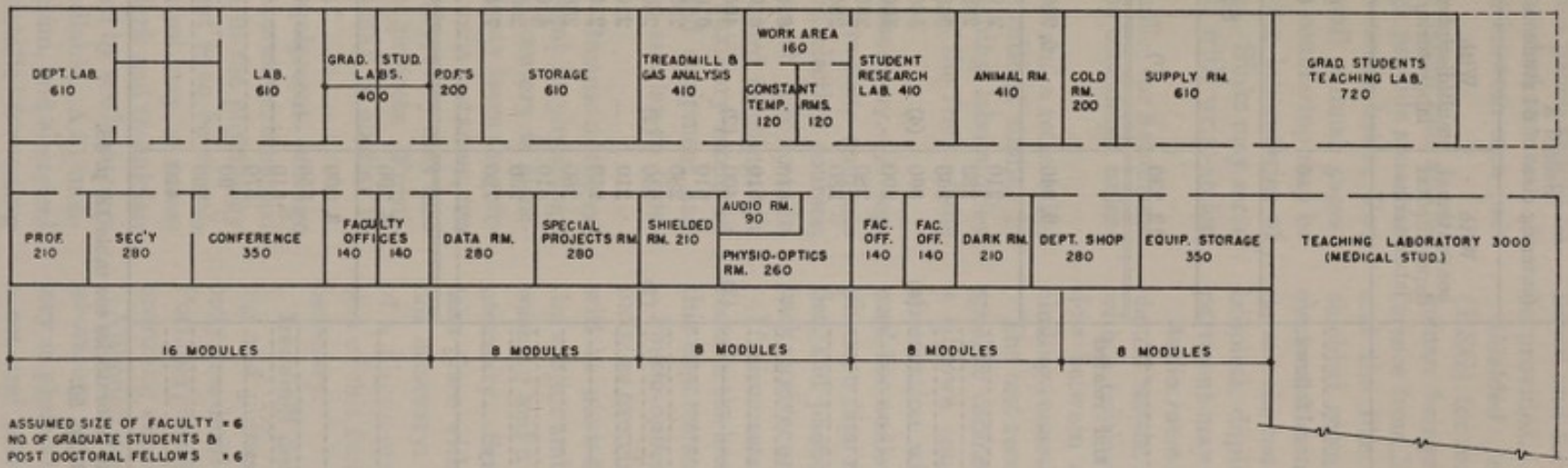
Figure 25 shows a space diagram for a minimum department of physiology in a hypothetical 64-student class school with 6 full-time faculty members and 6 graduate students and postdoctoral fellows. Table 22 gives the area for the 64-student and 96-student class hypothetical schools.

Teaching laboratory.—A conventional teaching laboratory may be used by more than one department. The success of this arrangement will depend on the suitability of laboratory equipment for both disciplines and the feasibility of scheduling laboratory use.

The laboratory described here is a conventional laboratory designed for specific use by the department of physiology. With only minimal additional equipment this laboratory is suitable for pharmacology teaching.

Many animals are used in physiology teaching and standup tables 37 inches high with casters to accommodate 4 students, 2 on each side, are suggested. A shelf under the top should be provided as storage space for animal boards. The remaining area may be used for enclosed pipette racks or cabinet shelving for instruments and paper supplies. Tabletops should be stain resistant.

A service island may be provided with gas, electrical, air, and vacuum outlets. Distilled water should be piped into *one place* in each laboratory or preparation area and carboys should be used



ASSUMED SIZE OF FACULTY = 6
NO. OF GRADUATE STUDENTS 8
POST DOCTORAL FELLOWS = 6

NET AREA - 11950 SQ. FT.

FIGURE 25.—Diagram for a department of physiology for a medical school with a 64-student entering class.

TABLE 22.—*Net area for a department of physiology for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty	6	6	8	8
Number of graduate students and postdoctoral fellows	6	6	8	8
	Square feet			
Total net area	12, 230	(1)	14, 160	(1)
Faculty offices, research laboratories, and related facilities: Total	6, 940	6, 940	7, 550	7, 550
Professor's office	210	210	210	210
Secretary's office	280	280	280	280
Conference room	350	350	350	350
Faculty offices	(4) 560	(4) 560	(4) 560	(4) 560
Postdoctoral fellows' office	200	200	200	200
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	610
General	610	610	(2) 1, 220	(2) 1, 220
Graduate students	(2) 400	(2) 400	(2) 400	(2) 400
Storage room (future laboratory)	610	610	610	610
Storage room	280	280	280	280
Constant-temperature rooms	(2) 240	(2) 240	(2) 240	(2) 240
Shielded room	210	210	210	210
Dark room	210	210	210	210
Departmental shop	280	280	280	280
Animal room	410	410	410	410
Cold room	200	200	200	200
Graduate students teaching laboratory	720	720	720	720
Departmental central storage [2]	----------	----------	----------	----------
Conventional teaching: Total	5, 290	(1)	6, 610	(1)
Teaching laboratory	3, 000	----------	4, 320	----------
Equipment storage room	350	----------	350	----------
Supply room	610	----------	610	----------
Student research laboratory and work area	570	----------	570	----------
Audio room	90	----------	90	----------
Physio-optics room	260	----------	260	----------
Treadmill and gas analysis room	410	----------	410	----------

[1] For total net area for multidiscipline laboratories see table 18, p. 58.

[2] For central storage area, see table 17, p. 50.

at work stations. An electrical panel for various voltages has been widely used in the past but is becoming less necessary. Access panels should be provided for plumbing and electrical services. A floor drain should be installed between each pair of service islands.

In addition to the movable tables and service islands, counters 37 inches high provide space for setting up equipment such as water baths, Van Slyke machines, and for small animal cages. Sinks, cabinets, and a resilient countertop may be similar to those in the teaching laboratories of other basic science departments. Sinks may serve for hand washing if equipped with wrist-action valves.

A 4-foot fume hood should suffice for 8 students. Space for incubators should be considered unless they can be placed on counters.

Chalkboards, a bulletin board, and a retractable projection screen should be furnished similar in size and number to other teaching laboratories. Space for an instructor's table at the front of the laboratory is required.

Graduate student teaching laboratory.—A separate teaching laboratory for graduate students may be used for teaching and elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be located adjacent to auxiliary rooms of the teaching laboratory. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Student research laboratory.—Because of the extensive use of portable equipment in physiology teaching, a student research laboratory is sometimes provided so that students may learn the purpose of the equipment and, in some instances, use it under staff direction. This laboratory may also be available for special student projects. Furniture and mechanical facilities may be similar to a typical research laboratory.

Equipment storage.—An equipment storage area, adjacent to the teaching laboratory, is needed because of the equipment used in the physiology course. If electronic equipment is to be stored, temperature and humidity control may be necessary. Desk space for a stock clerk and technician is needed so that equipment used by students may be accounted for, stored, and available. A 31-inch-high counter with gas, air, vacuum, and electrical outlets and cabinets should be installed for testing and preparing equipment. An issue window or door opening into the teaching laboratory is desirable. Space for assembly of equipment to be issued and for glassblowing and soldering should be provided.

Shielded room.—An electroencephalograph (EEG) for recording brain waves in animals and human beings is subject to electrostatic interference from X-ray transformers, elevator motors, and the like. If required by the program a shielded room is required distant from obvious electrostatic interference (*23*). If circumstances permit the use of a shielded room in the teaching hospital, duplication of this facility in this department may not be necessary.

Audio room.—If an audio room is provided, it should consist of a test room and a control room with a triple-glazed clear-glass observation window between and with acoustical treatment, including reduction of floor vibration.

The test room should have a microphone and a speaker cabinet. The control room should have a sitdown counter with cabinets located on the observation window side. The counter may be used for audiometric equipment such as a microphone, a tape recorder, a decibel meter, an amplifier, and phonograph equipment, as well as talkback receiver and speech audiometer.

If circumstances permit the use of the audio room in the hospital, duplication of this facility in this department may not be necessary.

Physio-optics room.—If the student curriculum includes exercises in physio-optics, a special room will be needed with 20-foot separation between the subject and the vision chart. A sink for hand washing and a sitdown counter for recording are necessary. Since many of the experiments will take place with the room darkened, windows are not necessary. If circumstances permit the use of a physio-optics room in the hospital, deplication of this facility in this department may not be necessary.

Treadmill and gas analysis.—To study breathing and pulmonary gas exchange in the human body, treadmill and gas analysis equipment is used. Portable gas-analysis equipment is used in various breathing experiments.

Although use of this equipment in the teaching laboratory is possible, a room close to the laboratory is preferable. The room should also contain a cot and table for recording. Comfort-conditioned air should be supplied to this room.

Supply room.—A supply room near the teaching laboratory is necessary for the storage, mixing, and issue of solutions and reagents. Shelving and racks for volatile solvent storage should be within a fire-resistive closet off the mixing and issue areas. Countertops, 37 inches high with gas, air, vacuum, and electrical outlets, cabinets with varying sized drawers, and a sink are required for mixing solutions and preparations for student use. Glassware washing and storage requires a large sink, drainboards, provision for distilled water, and base cabinets for glassware. An issue window is suggested. Space should be allocated for solution carts and assembly of materials to be issued. A head technician's office may be required depending on the quantity of material handled.

Department shop.—To maintain the mechanical and electronic instruments associated with the physiology department, a machine and electronic shop may be provided in addition to the scientific instrument shops serving the overall medical center.

Requirements vary, but a minimum machine shop should contain a drill press, a metal lathe, a milling machine, and wood and metal bandsaws. The size and weight of this equipment should be considered in designing the structural floor. A workbench, stock racks, and tool bin are required.

In the electronics area, a sitdown work counter with electrical outlets of appropriate voltages, drawers, and locked storage cabinets for electronic equipment and space to bring in floor-mounted equipment for testing will be required. Because of the increased use of electrical polygraphs, some schools may construct storage cabinets for these machines and their interchangeable amplifiers.

Noise and vibration associated with technical shops should be considered in their relation to other areas.

Constant temperature rooms.—Constant-temperature rooms (controlled-temperature rooms) may be required for the study of animals or human beings under constant temperature and humidity conditions and should accommodate a person on a cot. Animals are in cages on movable racks. The range of constant temperatures and relative humidities which this room may be required to maintain and ventilation required to remove animal odors are discussed in chapter 8. Since noise may be disturbing, sound control of motors and other mechanical equipment should be considered. Controlled lighting may be required. Prefabricated constant-temperature rooms are commercially available and economical installation may result from their use.

The constant-temperature rooms should have access to the corridor and to a work area. Doors from the corridor should accommodate beds or animal racks. Floor and wall surfaces should be similar to those suggested for animal quarters.

The work area associated with these rooms should have 31-inch-high work counters, a sink, and gas, air, vacuum, and electrical outlets.

MICROBIOLOGY

Teaching aspects.—Microbiology is usually scheduled during the medical student's second year. However, microbiology may be taught in the student's first and second years. In the first year the curriculum may include microbial physiology, structure, metabolism, and genetics. In the second year the curriculum may include immunology and pathogenesis of infectious diseases in conjunction with pathology. The design of laboratories should reflect the curriculum chosen. Although the microscope will be used extensively, this course also includes demonstrations, lectures, and experiments with animals which require the use of considerable laboratory equipment.

Figure 26 shows a space diagram for a minimum department of microbiology in a hypothetical 64-student class school with 5 full-time faculty members and 6 graduate students and postdoctoral fellows. Table 23 gives the area for the department for 64- and 96-student hypothetical schools.

Teaching laboratory.—The conventional teaching laboratory is usually designed to accommodate the second-year class. Each student is assigned a position at a laboratory bench. If there are 16 students to a group, with 4 or 8 students performing experiments together, satisfactory results can be obtained with the use of an island-type laboratory bench to position 4 students all on the same side facing demonstrations.

Laboratory benches may be 31 inches high for sitdown work with microscopes. Each student should have knee space, drawers for supplies, and a cabinet for microscope storage. Bench service outlets should be water, gas, air, vacuum, and electrical for each position. A cup sink at each position, or continuous drain trough, and a shelf for storing bottles above are required. Bench tops should be resilient and stainproof. As micro-

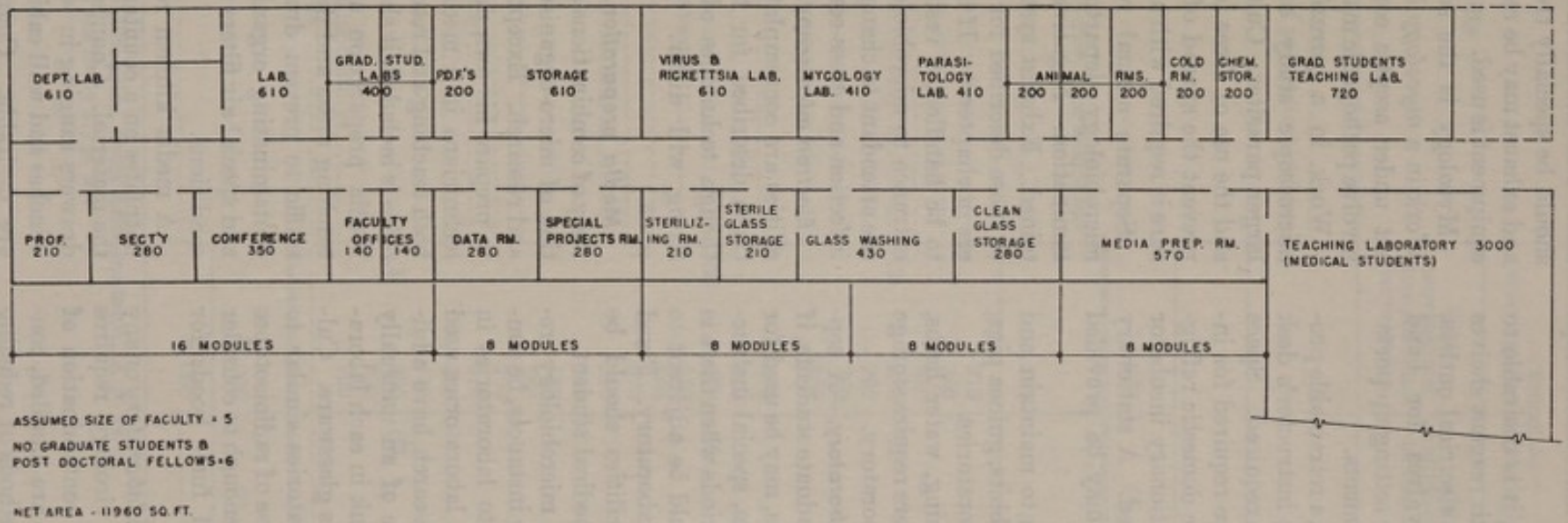


FIGURE 26.—Diagram for a department of microbiology for a medical school with a 64-student entering class.

organisms, pathogenic for man, are used in laboratory experiments, bench tops and countertops should be free of joints.

In addition to island benches, it is desirable to have counters 37 inches high with reagent shelves equipped with gas, air, vacuum, electrical outlets, and sinks with wrist-action valves for hand washing. They may be used for setting up portable equipment and animal experiments.

A chalkboard, a bulletin board, a retractable projection screen, and space for the instructor's desk at the front of the laboratory are required. Space in the teaching laboratory may be required for incubators and refrigerators. One domestic refrigerator per 16 students and 1 stationary incubator per 8 students should be provided. A stationary centrifuge, 1 per 16 students, may be provided depending on the curriculum.

Facilities should be available to maintain and observe such small animals as rabbits, guinea pigs, and mice close to the teaching laboratories.

Portable equipment for teaching, water baths, incubators, and spectrophotometers require storage areas adjacent to the teaching laboratory.

Graduate student teaching laboratory.—A separate teaching laboratory for graduate students, if sized to accommodate 16 students, may be used for teaching and for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be adjacent to auxiliary rooms of the teaching laboratory. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Research laboratories.—The microbiology research laboratories will, in many instances, be similar in equipment and design to laboratories in other basic sciences. However, laboratories used for bacteriological and virus research have additional requirements. Glassware of an unusually large size is often used. One sink in each laboratory should be sized to wash this glassware. Cultering requires dust-free laboratories similar to media preparation areas. The use of radioisotopes in microbiology is now common enough to consider the possibility of designing all fume hoods for radioisotope use.

A virus and rickettsia research laboratory or any laboratory used for work in virology requires negative air pressure to avoid contamination of other areas. As tissue cultures are handled, consideration should be given to methods of reducing contamination in laboratories to minimize danger to personnel but not adversely affect research projects. Air exhausted from virology laboratories should be specially treated. A special air supply and exhaust may be required if isolator laboratory equipment is used.

Mycology is the science and study of fungi. Work in a *mycology laboratory* should be carried out under aseptic conditions; the research may involve pathogenic material.

Work in a *parasitology laboratory* involves microscopic study of single-cell protozoa and larger parasites. Culture media will be prepared and the use of feces in this work is common. To prevent the spread of odors, a negative air pressure is required with a fume hood or other exhaust.

Separate animal rooms are provided in the microbiology department to prevent cross-contamination. Negative air pressure must be maintained. Exhaust system filters should be similar to those described for contaminated animal quarters in chapter 8. If highly contagious material is to be handled, a vestibule may be needed at the entrance to microbiology animal rooms to permit the attendant to change clothes and shoes to reduce infection and cross-contamination.

Electron microscopy.—If electron microscopy facilities are contemplated, they would be similar to those described for the department of anatomy though techniques of specimen preparation and fixing will differ. (See Electron Microscopy, p. 63.)

Media preparation.—Culture media are a variety of combinations of materials used for cultivation of micro-organisms in microbiology teaching and research. Except when an investigator wishes to prepare his own media, preparation is done by technicians in a media preparation area serving both teaching and research. If a head technician's office is included, it should be adjacent to this area. Media preparation areas should be adjacent to teaching areas and designed to eliminate through traffic to prevent drafts and the introduction of contaminating organisms. Positive air pressure and special air filters are needed to effect dust-free conditions.

A media kitchen requires a range, or portable hotplates on a counter 37 inches high, for cooking the material. Countertop sinks and cabinets with drawers ranging in width from 6 inches to 2 feet 6 inches and wall cabinets with shelves for storage are desirable. Counters should have air, gas, vacuum, and electrical outlets. Distilled water

TABLE 23.—*Net area for a department of microbiology for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty	5	5	7	7
Number of graduate students and postdoctoral fellows	6	6	8	8
	Square feet			
Total net area	12, 240	(1)	14, 170	(1)
Faculty offices, research laboratories, and associated facilities: Total	9, 240	8, 970	9, 850	9, 580
Professor's office	210	210	210	210
Secretary's office	280	280	280	280
Conference room	350	350	350	350
Faculty offices	(2) 280	(2) 280	(2) 280	(2) 280
Postdoctoral fellows' office	200	200	200	200
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	610
General	610	610	(2) 1, 220	(2) 1, 220
Graduate students	(2) 400	(2) 400	(2) 400	(2) 400
Storage room (future laboratory)	610	610	610	610
Storage room	280	280	280	280
Media preparation room	570	430	570	430
Sterilizing room	210	210	210	210
Sterile glass storage	210	210	210	210
Glass washing	430	430	430	430
Clean glass storage	280	210	280	210
Chemical storage	200	140	200	140
Virus and rickettsia laboratory	610	610	610	610
Mycology laboratory	410	410	410	410
Parasitology laboratory	410	410	410	410
Animal rooms	(3) 600	(3) 600	(3) 600	(3) 600
Cold room	200	200	200	200
Graduate students teaching laboratory	720	720	720	720
Departmental central storage [2]	----------	----------	----------	----------
Conventional teaching: Total	3, 000	(1)	4, 320	(1)
Teaching laboratory	3, 000	----------	4, 320	----------

[1] For total net area for multidiscipline laboratories see table 18, p. 58.

[2] For central storage areas, see table 17, p. 50.

should be piped to 1 location over a sink and distributed in carboys.

After the unsterile liquid culture media has been prepared in bulk quntities, it is dispensed into test tubes or plates. This requires counter space similar to the media kitchen, including wall and base cabinets and service outlets, and may require a burette stand.

An autoclave is required for sterilizing prepared culture media after it is poured into previously sterilized petri dishes. A flushing-rim sink near the autoclave is desirable for disposal of spoiled media.

An incubator may be used to test the sterility of prepared media prior to use. Until culture media is used, it is placed in a refrigerator in the teaching laboratory or issue room. The issue room will contain glassware and equipment storage, shelving and cabinets for glassware and equipment, and an issue window opening into the laboratory. The media preparation unit should have capacity to supply the needs of the hospital also if it is adjacent or connected.

If commercial media or disposable fully prepared plates are used, the size of the media kitchen may be reduced.

Glassware washing and storage.—An important function in the microbiology department is washing, sterilizing, and storing glassware for use by the students and research laboratories. If this is to be done as a central unit for the department, it should be divided into sterilizing, sterile storage, glassware washing, and clean glass storage.

An autoclave to sterilize glassware prior to washing, a sink and drainboard area, and space for chemical jars and for soaking extra dirty glassware are required. Commercial glasswashers and dryers may be employed and space for these should be provided beside the sink. Space should be available at sink and washer area for glassware and petri dish carts and cart storage.

After glassware has been washed and dried, pieces to be sterilized are placed in autoclaves in the sterilizing and work area. Some installations include a hot-air sterilizer in addition to the usual autoclaves. The work area should consist of tables or counters where sterile glassware is prepared for sterile storage. Distilled water may be used in this process. Cabinets are needed for supplies; other installations may include a countertop sink and counter with gas, air, and vacuum outlets.

Storage areas should be furnished with adjustable shelving. Some glassware may be exceptionally long or high. To control the issuing of sterile glassware, an issue window or door from sterile storage to corridor should be provided.

If disposable plastic vessels are used, the area for glass washing may be reduced.

Ventilation of the glassware washing and workroom areas should be given special attention because of the heat and high humidity.

Chemical storage.—Although bulk storage of chemicals should be in basement storage, a limited supply is often maintained within the department. In this event, a chemical storage room with metal shelving should be provided and, if the room is used for mixing chemicals, a stone sink and counter should be provided.

PATHOLOGY

Teaching aspects.—Pathology, scheduled during the medical student's second year, utilizes lecture rooms, teaching laboratories, microprojection rooms, gross pathology conference rooms, and autopsy rooms. Much of the activity is in microscopic study, but some time will be devoted to experiments with animals and to the study of diseased organs. Facilities for preparation, replacement, and storage of such items as histologic sections, slides, gross materials, chemicals, and records should be available.

Figure 27 shows a space diagram for a minimum department of pathology in a hypothetical 64-student class school with 6 full-time faculty members and 6 graduate students. Table 24 gives the area for the department for 64- and 96-student class hypothetical schools.

Teaching laboratory.—A conventional teaching laboratory similar to that described for micro- and neuroanatomy is usually adequate for teaching the second-year pathology course; however, fume hoods and incubators, 1 for each 16 students, may be required, depending upon the curriculum.

Graduate student teaching laboratories.—Separate facilities for residents and graduate students are required. These laboratories can be used for teaching, and for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. They should be adjacent to auxiliary rooms of the medical students' pathology teaching laboratory. Fixed equipment

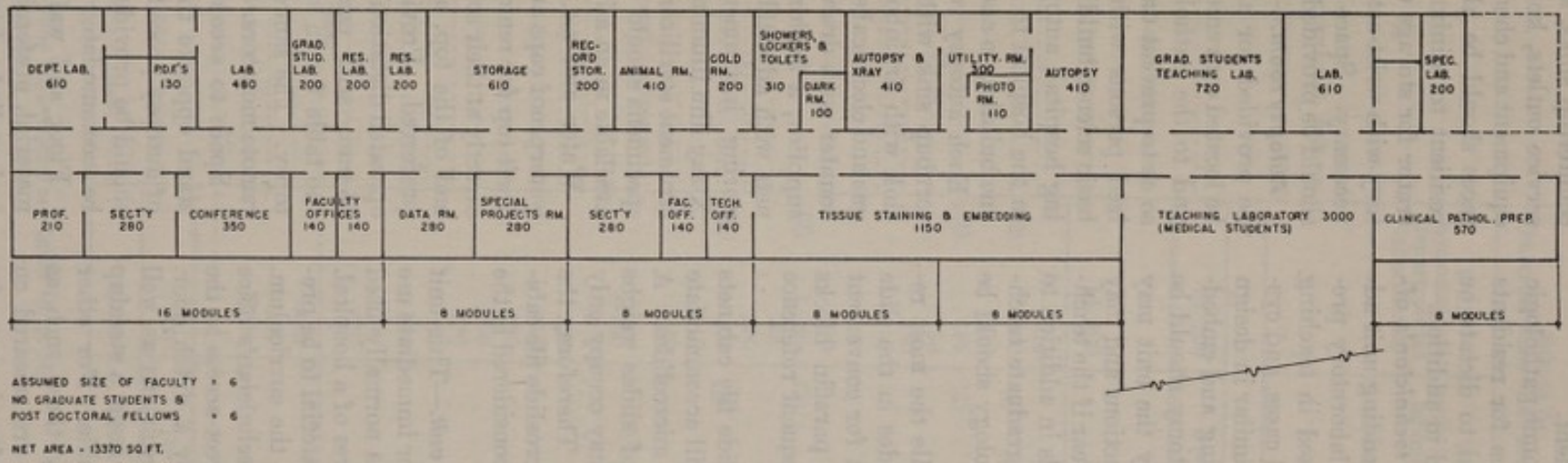


FIGURE 27.—Diagram for a department of pathology for a medical school with a 64-student entering class.

and mechanical facilities should be similar to those furnished the medical student.

If the department provides anatomic pathologic services to hospitals, work cubicles for residents to review microscopic sections and to dictate or prepare reports should be provided in addition.

Tissue staining and embedding, technician's office.—The tissue staining and embedding unit adjacent to the pathology teaching laboratory prepares collections of loan slides used in teaching and those from autopsies, surgical cases, and cystological screening tests. A unit similar in design and equipment to the tissue staining and embedding unit described for microanatomy should be provided. However, in pathology the unit may have responsibility for service functions and may prepare 50,000 or more slides per year if the teaching hospital approximates 500 beds in addition to the materials prepared for undergraduate teaching. Therefore, the unit in pathology should be larger.

Some pathology departments file the most recent 5 years' accumulation of slides in the slide storage-and-issue area of the unit for convenient reference, and store slides and paraffin blocks older than 5 years and of less frequent reference in basement storage.

Commercially available steel slide file cabinets designed for close-packed filing will accommodate 60,000 standard 3- by 1-inch microslides. A cabinet containing this number of slides weighs in excess of 600 pounds and yet may occupy only 2.5 square feet of floor area. Therefore, the maximum number and type of microslide file cabinets to be accommodated must be considered in the structural design of the floor.

Clinical pathology preparation unit.—This unit prepares and issues to students, for immediate use in laboratory exercises, specimens normally used in the clinical pathology procedures of a hospital. The variety and volume of the material to be prepared and issued will depend on the curriculum.

The unit usually has a head technician's office and a preparation room with direct access to the teaching laboratory preferably by a dutch door. For preparing some types of specimens as well as stains and reagents for direct issue, a standup counter 37 inches high is desirable. For other types of specimens, particularly those such as blood and bone marrow, which are smeared on microscopic slides and stained before issue, a sit-down counter 31 inches high is more convenient. Both counters should have reagent shelves, countertop sinks, air, gas, vacuum, and electrical service outlets, knee spaces, cabinets for storing equipment and chemicals and reagents. Work surfaces should be alcohol- and stain-resistant and resilient to minimize glass breakage. A refrigerator for storage of clinical material and a lavatory with wrist-action valves for handwashing are necessary. Space for parking a specimen cart should be provided.

Autopsy room.—At least 2 autopsy rooms should be provided for a medical school. They should be located convenient both to the teaching hospital and to the pathology department and arranged so as to prevent unnecessary contact of unauthorized persons with autopsy procedures. If the basic science building is separated from the teaching hospital, autopsy facilities should be located in the hospital to avoid transporting bodies from one building to another.

Each autopsy room should be equipped with a scrubup sink with knee- or foot-action valve; a sink with drainboards, cold-water manifold, and gas and electrical service outlets; an adjacent work counter with drawers and cabinets for storage of supplies; a flushing-rim clinical sink; wall cabinets with adjustable shelves and glazed doors for storing instruments; a wall-mounted, 4-bank, X-ray film illuminator; and a chalkboard. An instrument sterilizer and a storage cabinet for fixed specimens should also be provided if they are not available in an adjoining utility or cleanup room.

Water and a.c. electrical service outlets with waterproof caps are required. A table with downdraft top for removal of contamination and odors directly at their source, with an integral sink at one end of the top, and service outlets, is generally preferred. Provision should be made for foot-operated dictation equipment. A ceiling-mounted, 35-mm. still camera should be located over the table for in situ photographs during the autopsy. The same mount may provide for TV to remote monitors.

Space to accommodate a portable observation stand opposite the table for convenient viewing of autopsy procedures by students and house staff should be provided. The number of observers to be accommodated will depend on the program.

Floor and walls should be of water-resistant material, preferably tile, and a floor drain should be installed. Lighting, with a minimum of shadows at the autopsy table, is usually achieved by

TABLE 24.—*Net area for a department of pathology for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty [1]	6	6	9	9
Number of graduate students, postdoctoral fellows and residents	6	6	8	8
	Square feet			
Total net area	14, 100	([2])	17, 390	([2])
Faculty offices, research laboratories, and associated facilities:				
Total	11, 100	11, 100	13, 070	13, 070
Professor's office	210	210	210	210
Secretary's offices	(2) 560	(2) 560	(2) 560	(2) 560
Conference room	350	350	350	350
Faculty offices	(3) 420	(3) 420	(3) 420	(3) 420
Postdoctoral fellows' office	130	130	200	200
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	160
General	(2) 1, 099	(2) 1, 090	(3) 1, 830	(3) 1, 830
Graduate students	200	200	200	200
Special	200	200	200	200
Residents' laboratories	(2) 400	(2) 400	(3) 530	(3) 530
Electron microscope	610	610	610	610
Storage room	280	280	280	280
Tissue staining and embedding and technician's office	1, 290	1, 290	1, 290	1, 290
Clinical pathology preparation	570	570	570	570
Record storage	200	200	410	410
Autopsy rooms	410	410	(2) 820	(2) 820
Darkroom	100	100	100	100
Utility room	300	300	300	300
Photo room	110	110	110	110
Autopsy and X-ray	410	410	410	410
Gross pathology conference room	310	310	310	310
Dictation room	140	140	140	140
Showers, lockers and toilets	310	310	310	310
Morgue (see department of anatomy)	----	----	----	----
Animal rooms	410	410	(2) 820	(2) 820
Cold rooms	200	200	200	200
Graduate students teaching laboratory	720	720	720	720
Departmental central storage [3]	----	----	----	----
Conventional teaching:				
Total	3, 000	([2])	4, 320	([2])
Teaching laboratory	3, 000	----	4, 320	----

[1] For teaching responsibility only.

[2] For total net area for multidiscipline laboratories see table 18, p. 58.

[3] For central storage areas, see table 17, p. 50.

NOTE.—These areas do not provide for the permanent professional or resident staffs performing services for clinical pathology in the teaching hospital.

means of an operating light over the autopsy table. Mechanical ventilation to provide continuous fresh air changes within the room during use is essential. All air should be exhausted to the outside with no recirculation. Air pressure should be negative relative to adjoining areas, and air movement should be away from the pathologists and observers.

Showers, lockers, and toilets.—Shower and dressing facilities for pathologists and students are required.

Morgue.—If the morgue in the cadaver preparation and storage unit is convenient to the autopsy rooms, additional morgue facilities adjacent to the autopsy rooms may not be required.

Autopsy and X-ray room.—A mobile X-ray machine should be provided. X-ray protection should be in accordance with the recommendations of the applicable handbooks of the National Bureau of Standards.

Utility and cleanup room.—This room should be located between 2 autopsy rooms with direct access to each and to the corridor. Equipment for this area includes a sink with drainboard; a flushing-rim service sink; provisions for storage of glass jars, formalin, and alcohol; wall cabinets for fixed specimen storage; and an instrument washer-sterilizer unless provided in each autopsy room.

Disposal of pathological wastes such as tissue and organs requires incineration facilities capable of reducing the material to a completely inorganic state. The wastes are usually placed in containers with disposable waterproof liners and tight covers for transport to the incinerator or crematory.

Photo room.—Photographs and transparencies of tissue and organs are required for teaching, for anatomical pathology reports, and for scientific publications; a separate area or photo room for use of the pathologists within the department is necessary. To minimize hazards associated with handling fresh specimens, the photo room should adjoin the autopsy room.

Fixed equipment in a photo room usually includes a standup counter with sink and electrical outlets, a cabinet for instruments and supplies, and shelves for photographic accessories. The counter is used in preparing gross specimens and provides workspace for photographing minute specimens with the aid of a microscope and illuminator (photomicrographs).

For photographing gross specimens, a 3-foot-square light box is used. Electric outlets for table and floodlamps should be 30 amperes. This equipment can also be used for photographing X-ray films.

Darkroom.—Many schools provide a darkroom near the photo room for processing the gross photographs and photomicrographs. Facilities for processing X-rays taken in the autopsy room may be included in this darkroom if the radiographic facilities of the teaching hospital are not utilized for this purpose.

Wet and dry areas of the darkroom should be separated. A refrigerator for storing color film should be provided. Water supply at all processing sinks should be thermostatically controlled to maintain water at ±½° F. of the desired temperature.

Bench tops should be chemically inert, watertight, and wear resistant. Floor surfaces should be waterproof, resistant to chemicals, resilient for foot comfort, and not slippery when wet.

Air conditioning for removing chemical fumes, heat, and humidity from driers is essential to the health and comfort of personnel.

Cold room.—A cold room separate from the research cold room but adjacent to the autopsy areas for holding tissue and organs for later study is required. A deep-freeze unit and adjustable metal shelving may be provided for preservation of fresh gross material for class use. Standup counters with sinks and air, vacuum, and electrical service outlets are required. Floor surface should be smooth, waterproof, and wear resistant.

A separate room for storing gross pathological specimens at room temperature under solution in glass containers or in plastic bags should be provided in the general storage area of the building.

Gross pathology conference rooms.—Gross pathology conference rooms are a supplemental teaching area where pathology students and house officers in small groups can participate in demonstrations involving diseased tissue and organs. A standup table with sink at one end and downdraft top similar to that described for the gross neuroanatomy room is appropriate. Other equipment includes adjustable shelving, X-ray film illuminators, bulletin board, and scrub sink with knee or foot controls. Correct color illumination is desirable. Where possible this area should have direct access to the cold room.

Electron microscopy.—If electron microscopy facilities are contemplated for this department, they will be similar to those described in the depart-

ment of anatomy. (See Electron Microscopy, p. 63.)

Dictating room.—A small room equipped with desk and equipment for writing or dictating autopsy records is desirable. Acoustical treatment is recommended. This function may be decentralized in part by the provision of work and study cubicles for house officers.

Record storage.—Usually the written records of autopsy examinations (autopsy protocols) and surgical examinations (surgical pathology protocols) are provided with substantial jackets for filing, cataloging, and protection, since their legal status requires that they be retained indefinitely. Records are used both in teaching and research, and a record-storage room convenient for reference by students and staff members should be provided. Open-faced shelving with shelf dividers designed for vertical stacking of the records with a reference table and chairs should be provided. Shelf-spacing will depend on the jacket size contemplated. General illumination of 70 foot-candles is desirable. A storage room for records of less frequent reference should be provided in basement storage. The weight of stacked records should be considered in structural floor design.

The pathology department requires areas for storage of embedments, fixed tissue, gross organs, microscope slides, and protocol records not in frequent use. Some of this material may be stored in the hospital. Embedments are usually kept in boxes on shelves and are retained for a minimum of 5 years. This area should be kept cool so that the paraffin medium will not distort. Tissue in solution is kept in glass jars, paraffin sealed, and stored on wood shelving designed for jar height. Gross organs are immersed in formalin solution in ceramic crocks or sealed in plastic bags. Ceramic crocks are quite heavy and storage on wood racks may be necessary. If crocks are used, special ventilation to carry away formalin vapors should be provided. Microscope slides are usually contained in metal slide files and this area should be separated from areas where formalin vapors are present. If slides are to be kept indefinitely, the number of file cabinets to be stored per year should be estimated to provide adequate space. Protocol records are often bound and placed on shelving or in legal-size file cabinets. An estimate of space requirements per year should also be obtained for this storage.

PHARMACOLOGY

Teaching aspects.—Sixty percent of the time allocated may be spent in laboratory exercises, demonstrations, and small conferences, and 40 percent in lecture rooms. Students may work 4 to a group; thus, the unit of 16 students and the grouping of 4 to 8 students will be similar to the units and groups of other basic sciences.

Figure 28 shows a space diagram for a minimum department of pharmacology in a hypothetical 64-student class school with 5 full-time faculty members and 5 graduate students. Table 25 gives the minimum area for a department for 64- and 96-student class hypothetical schools.

Teaching laboratory.—The conventional pharmacology teaching laboratory may be similar to the physiology teaching laboratory. Space for burette stands or titration racks, 1 for each 16 students, should be included.

Graduate student teaching laboratory.—A separate teaching laboratory for graduate students may be used for teaching, and for elective courses, special instruction, and research projects in periods when there is no scheduled teaching. It should be adjacent to auxiliary rooms of the medical student teaching laboratory. Fixed equipment and mechanical facilities should be similar to those furnished the medical student.

Student research laboratory.—In pharmacology it is often desirable for student groups to participate in assigned projects or in research. A student research laboratory, if provided, should contain facilities similar to those in typical pharmacology research laboratories. Where possible, it should be located within the teaching area but adjacent to research areas.

Glassware washing and storage.—Glassware washing and storage facilities similar to those indicated for the biochemistry department are adequate in the pharmacology department; they should be located near the teaching laboratory.

Preparation room.—A preparation and stock room similar to that for the biochemistry department is required adjacent to the pharmacology teaching laboratory.

Anesthesia storage.—An anesthesia storage room should be provided with cylinder storage racks to lock cylinders in an upright position and shelving for pressure gages and other anesthetic equipment. This area should be kept locked. A limited supply of cylinders should be kept in the department. Space at ground level should be provided for bulk storage of cylinders.

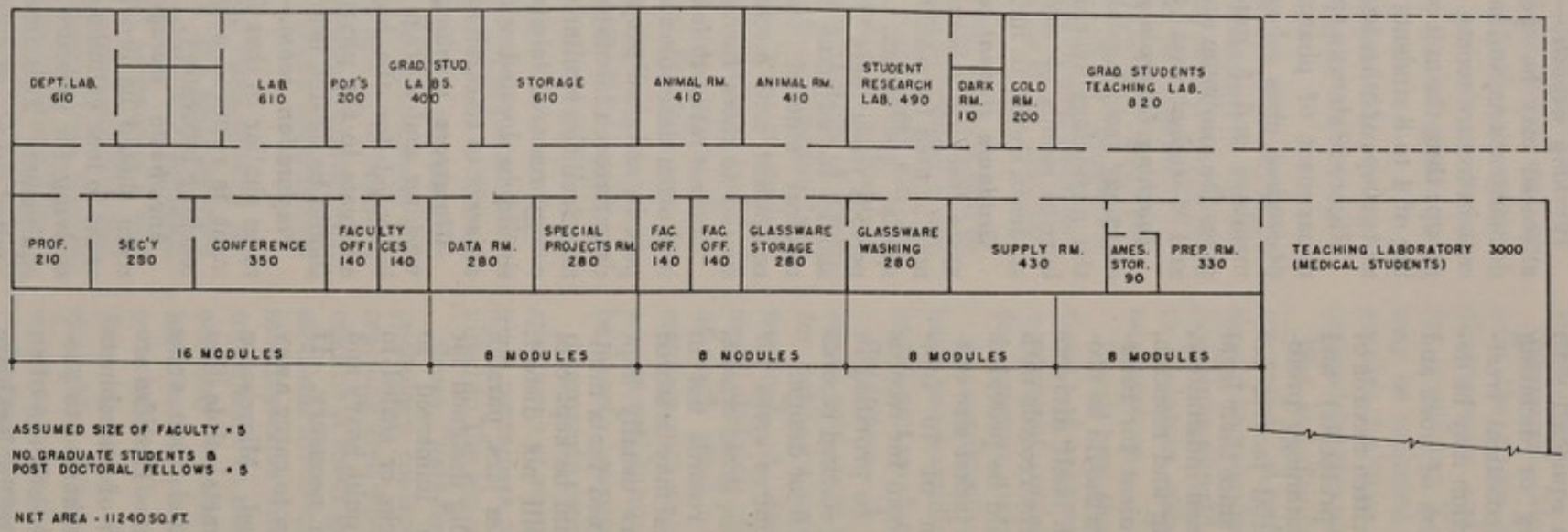


FIGURE 28.—Diagram for a department of pharmacology for a medical school with a 64-student entering class.

TABLE 25.—*Net area for a department of pharmacology for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
Assumed size of faculty	5	5	7	7
Number of graduate students and postdoctoral fellows	5	5	7	7
	Square feet			
Total net area	11, 520	(1)	13, 450	(1)
Faculty offices, research laboratories, and associated facilities: Total	7, 700	7, 700	8, 310	8, 310
Professor's office	210	210	210	210
Secretary's office	280	280	280	280
Conference room	350	350	350	350
Faculty offices	(4) 560	(4) 560	(4) 560	(4) 560
Postdoctoral fellows' office	200	200	200	200
Data room	280	280	280	280
Special-projects room	280	280	280	280
Research laboratories:				
Departmental	610	610	610	610
General	610	610	(2) 1, 220	(2) 1, 220
Graduate students	(2) 400	(2) 400	(2) 400	(2) 400
Storage room (future laboratory)	610	610	610	610
Storage room	280	280	280	280
Supply room	430	430	430	430
Glassware washing and storage	560	560	560	560
Anesthesia storage	90	90	90	90
Darkroom	110	110	110	110
Animal rooms	(2) 820	(2) 820	(2) 820	(2) 820
Cold room	200	200	200	200
Graduate students teaching laboratory	820	820	820	820
Departmental central storage [2]	----------	----------	----------	----------
Conventional teaching: Total	3, 820	(1)	5, 140	(1)
Teaching laboratory	3, 000	----------	4, 320	----------
Preparation room	330	----------	330	----------
Students research laboratory	490	----------	490	----------

[1] For total net area for multidiscipline laboratories, see table 18, p. 58.

[2] For central storage areas, see table 17, p. 50.

TABLE 26.—*Summary of space estimates for basic science facilities for hypothetical 4-year medical schools with entering classes of 64 and 96 students* [1]

Type of facility	School A (entering class of 64 students)		School B (entering class of 96 students)	
	With conventional departmental laboratories	With multidiscipline laboratories	With conventional departmental laboratories	With multidiscipline laboratories
	Square feet			
Total gross square feet (rounded) [2]	152, 000	135, 000	183, 000	158, 000
Total net square feet (rounded)	99, 000	88, 000	119, 000	103, 000
Departmental facilities:				
Anatomy	19, 330	11, 510	22, 950	12, 530
Biochemistry	12, 240	8, 670	14, 980	10, 090
Physiology	12, 230	6, 940	14, 160	7, 550
Microbiology	12, 240	8, 970	14, 170	9, 580
Pathology [3]	14, 100	11, 100	17, 390	13, 070
Pharmacology	11, 520	7, 700	13, 450	8, 310
Multidiscipline laboratories and adjunctive areas	----------	22, 500	----------	29, 960
Lecture rooms	3, 780	3, 780	3, 780	3, 780
Unassigned conference rooms	(2 @ 350) 700	----------	(3 @ 1,050 350)	----------
Study cubicles [4]	6, 110	(5)	9, 400	(5)
Technical shops	1, 500	1, 500	2, 000	2, 000
Departmental central storage	4, 500	4, 500	4, 500	4, 500
Toilets	1, 200	1, 200	1, 200	1, 200

[1] This table does not include the supporting facilities which are a necessary part of both the basic science and clinical science facilities. See table 51, p. 174, for areas for supporting facilities.

[2] To compute gross area, it is estimated that 65 percent of the total gross area is available as usable space, and the remaining 35 percent will provide space for exterior walls, partitions, corridors, stairs, elevators, and duct ways and chases for mechanical and electrical requirements.

[3] Space for service functions in the teaching hospital is not included.

[4] Study cubicles for 3d- and 4th-year students and for house officers in teaching hospital.

[5] Optional.

Supply room.—A supply room in pharmacology may be divided into 2 areas: one for instruments and general supplies and the other for chemicals used in research.

Some instruments require floorspace while others should be placed on shelving. A desk-high counter with drawers and file cabinet is needed for recording incoming supplies and issues. Since some instruments may be used here, electrical outlets should be provided.

Although the preparation room is used to store chemicals for the teaching laboratory, the pharmacology department usually maintains chemical storage for the staff. A chemical storage room similar to that for the department of microbiology should be provided.

If narcotics are to be stored, a built-in safe should be provided.

Space must be provided for the care of animals used in experimental work in pharmacology.

Chapter 6

CLINICAL SCIENCE FACILITIES

The clinical departments and the teaching hospital are intimately related in teaching, patient care, and research. The teaching programs are concerned with patients in the hospital or clinics and with the theoretical basis for the details of patient care. Fewer didactic exercises for an entire class are held than for the basic science courses. Teaching is more informal, approaching the tutorial method, and often is unscheduled since changes in a patient's clinical condition may be unpredictable. Faculty offices and research laboratories in the clinical departments should be immediately adjacent to the patient-care facilities to implement this type of teaching.

The faculty has responsibility for the medical professional care of patients on the teaching services of the hospital. Faculty members should be immediately available to give advice on diagnostic procedures or alterations in therapy. This is particularly true in emergency situations. For these reasons, the clinical departments should be contiguous to the patient-care facilities of the teaching hospital.

In some instances, clinical teaching is done in a hospital geographically separated from the clinical science facilities. However, this has many obvious disadvantages. The same amount of space will be required for the clinical departments wherever the facilities are located and, if they are separate from the hospital, some clinical departmental facilities will have to be duplicated in the hospital. Such factors as the ownership and support of the hospital may determine whether these medical school departmental teaching and research facilities are built as part of the hospital or elsewhere.

Research in the clinical departments revolves around problems encountered in the care of patients. It may involve only measurements on the patients themselves and their response to various drugs or regimens. Instrumentation is becoming more sophisticated and exact, so that it is sometimes easier to move the patient to the rooms where physiologic procedures and special measurements are made than to move equipment. Since many of these devices require minute-to-minute supervision and observation by the faculty member engaged in research, they should be close to patient areas.

Other research projects are concerned with measurements on body fluids or materials removed from the patient. The equipment and technique are often identical to those of basic science departments. As research approaches a more fundamental level, animals will be required. It is easier to provide for animals in a basic science facility than in a hospital.

Ideally, therefore, the offices and research laboratories for the clinical faculty should be located so that they can care for and observe patients, confer or collaborate with faculty in the basic sciences, and use common facilities. The physical separation of clinical and basic science departments from the university teaching hospital inevitably will lead to a less effective overall educational program.

The departments generally include internal medicine, surgery, pediatrics, obstetrics and gynecology, psychiatry, preventive medicine, and radiology. Pathology, although usually considered a basic science department, nevertheless has many of the characteristics of a clinical department and, therefore, functionally and structurally, usually bridges both.

The organization of the many recognized subspecialties of medicine varies from school to school. Neurology, for example, is sometimes considered a part of internal medicine, sometimes a part of psychiatry, and sometimes exists as a separate department. Similarly, anesthesia may be included in the department of surgery or may have independent status. Usually, however, the subspecialties of internal medicine, surgery, and the other major disciplines are not considered independent

departments but are included within the parent clinic specialty. Accordingly, the subspecialties usually associated with these departments are listed in the individual departmental descriptions that follow.

The major clinical departments have in common certain responsibilities. Each department will teach medical students, interns, residents, clinical postdoctoral fellows, and postgraduate students in its own clinical specialty; each department will care for hospitalized and ambulatory patients in the area of its special competence; each may train health-related professional and technical personnel in such ancillary medical services as electrocardiography, radiography, and clinical laboratory; and each department will carry on research programs in areas appropriate to the interests of department members.

Staffing patterns of clinical departments vary from school to school and even between departments within 1 school. A department may be composed completely of full-time faculty members who devote their entire effort to the department. On the other hand, part-time faculty members who are primarily engaged in private practice may carry a large part of the teaching and patient-care duties of 1 or more clinical departments. Part-time faculty members usually have personal offices geographically separate from the medical school and hospital and visit the school only for specific teaching and patient-care assignments. Space must be provided, however, for these part-time faculty members not only in the clinical science facilities, but also in the supporting facilities such as lockers, lounges, and work space for handling patient and academic records.

Space may be assigned on a modular basis as in the basic science building, with the head of each department given a 16-module unit and further increments of 8-module units or parts thereof added as required.

Space diagrams for the departments of medicine, surgery, pediatrics, obstetrics-gynecology, psychiatry, and preventive medicine are shown in figures 29–34 for a hypothetical school with an entering class of 64 students (60 in the third and fourth year). Tables 27–32 give the net area for a minimum facility for each clinical department for hypothetical schools with entering classes of 64 and 96 students. Table 33 gives a summary of space estimates for all clinical science departments. These areas are less than those in some existing schools of comparable size because of the recent growth of training and research programs. They are separated from the areas for the teaching hospital because it is recognized that some medical schools will be building or adding to either the clinical departments or the teaching hospital.

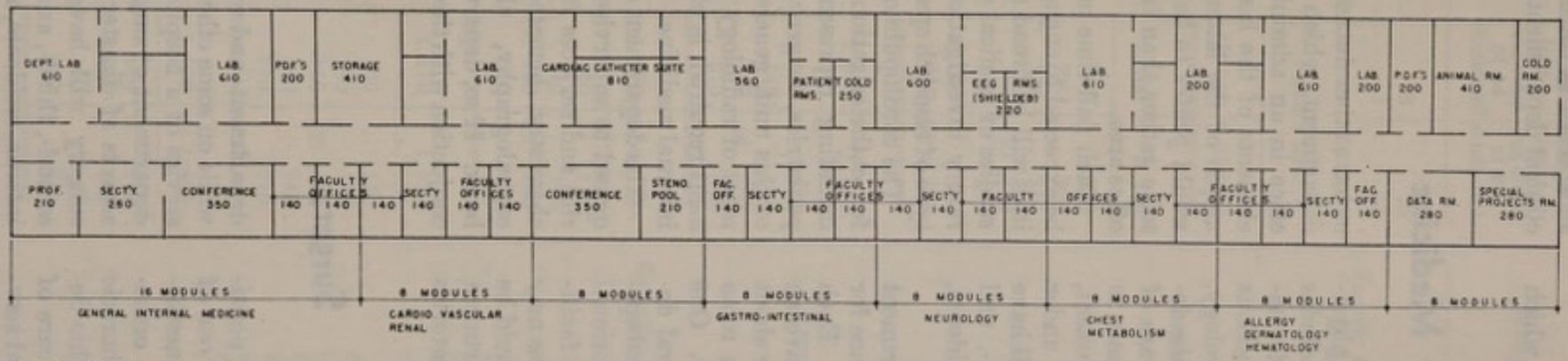
For convenience of operation, clinical department facilities should be located between, and connecting with, the basic science building and the teaching hospital. This allows for joint use of teaching, research, and supporting facilities provided in the basic science building and makes it convenient for the medical staff to take care of their hospital responsibilities. Departments should be located on the same floor or floors as the patient-care units they serve.

Office and laboratory space for each department should be arranged to promote close relationship among members of the same department and among departments. For example, close physical relationship should be planned for office and laboratory facilities of adult cardiology and pediatric cardiology. Each full-time member of the faculty should have an office with an adjoining secretarial office shared by secretaries of 2 or more faculty members to provide secretarial coverage throughout the working day. Office space will be used for deskwork, study, interviews, and conferences with as many as 3 to 4 individuals at a time. Larger groups would use departmental conference space.

For a discussion of departmental offices, lecture rooms, and research facilities, see chapter 4.

Research facilities in the form of laboratories, or similar to those described in chapter 4, should be provided for each department member. Location of the research space should be appropriate to the type of research anticipated by the individual faculty member. Laboratories for research of a basic biological nature should be related to the basic science departments and animal quarters of the medical school, whereas research projects involving patients should be adjacent to the hospital for convenience of patients in bed—ambulatory patients can come to this location. These same planning principles may even apply within these research facilities so that investigators from different departments requiring use of such common facilities as cold rooms, incubator rooms, and animal operating rooms may be appropriately located for mutual advantage.

Teaching activities of all departments will be



ASSUMED SIZE OF FACULTY = 18
POST DOCTORAL FELLOWS = 8

NET AREA - 12350 SQ FT

FIGURE 29.—Diagram for a department of medicine for a medical school with a 64-student entering class.

carried out, for the most part, in common lecture rooms, on the wards of the hospital, and in the outpatient department.

The specific departmental descriptions which follow are for a medical school and teaching hospital which have full-time staffs and with clinical subspecialties considered to be part of the major clinical departments.

Medicine

The department of medicine consists of physicians specializing in internal medicine and includes the subspecialties of allergy, cardiology, dermatology, gastroenterology, hematology, infectious diseases and immunology, metabolism, neurology, and pulmonary diseases. The members of the department will have responsibility for the care of hospitalized patients, for ambulatory patients in the medical clinics of the outpatient department, and for medical consultations on patients under the care of other clinical services. They will have major teaching duties for second-, third-, and fourth-year medical students, interns, residents, and clinical fellows.

The administrative duties of the department head will be extensive and adequate office space for this diversified function must be provided. Each full-time member of the faculty should have an office. A departmental conference room for about 20 people will be frequently used. This room might include a small departmental library. One conference room may be adequate for general departmental purposes but, as the various subspecialties are designated separately, additional conference space with departmental library facilities should be available. Departmental offices may be grouped in 1 area but the possibility should be kept in mind that some members of the department might prefer offices adjacent to their laboratories or have other duties, for example, in the outpatient department, which would make placement of an office in an administrative relationship to other elements of the hospital more desirable. An example of the latter may be the cardiologist who would prefer to be housed in the hospital's EKG suite rather than in a more remote departmental office area.

Each full-time member of the department may be expected to engage in research. Research activities will be broad and may range from sociologic studies of medical care to highly specialized laboratory investigations, each requiring a different type of research space.

The cardiopulmonary laboratory with facilities for catheterization is generally multidisciplined including representatives of internal medicine, pediatrics, surgery, and radiology. The location of this unit, generally near or within the department of radiology by nature of the special equipment required, is of interest to the department of internal medicine.

The department of internal medicine may be required to supervise operation of special laboratories and services for the hospital such as clinical chemistry, hematology, microbiology, electroencephalography, electrocardiography, or blood bank. If so, departmental offices may be needed in conjuction with these service facilities.

Surgery

The department of surgery consists of physicians specializing in general surgery or in one of the surgical specialties, which include anesthesiology, ophthalmology, otolaryngology, orthopedics, neurosurgery, plastic surgery, thoracic surgery, and urology. The members of this department will have responsibility for the care of patients who are hospitalized on the surgical service; who visit the surgical clinics of the outpatient department; and who require surgical consultation while on some other service. Often the emergency service of a hospital is under the direction of the department of surgery, as may be the professional aspects of disaster planning. The department of surgery will have teaching responsibilities for second-, third-, and fourth-year medical students, interns, residents, and surgical fellows. Each full-time member of the department may be expected to

TABLE 27.—*Net area for a department of medicine for hypothetical schools with entering classes of 64 and 96 students*

Subspecialty and type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	18	25
Postdoctoral fellows	8	11
	Square feet	
Faculty facilities:		
Total net area	13,440	15,490
General internal medicine:		
Total	2,400	3,150
Professor's office [2]	210	210
Secretaries' office	280	280
Conference room	350	350
Faculty offices	140	(2) 280
Postdoctoral fellows' office	200	200
Departmental laboratory	610	610
Additional laboratories	610	(2) 1,220
Cardiovascular-renal:		
Total	1,030	1,170
Professor's office	140	140
Secretary's office	140	140
Faculty offices	140	(2) 280
Laboratory	610	610
Gastrointestinal:		
Total	1,170	1,170
Professor's office	140	140
Secretary's office	140	140
Faculty offices	(2) 280	(2) 280
Laboratory	610	610
Neurology:		
Total	1,170	1,310
Professor's office	140	140
Secretary's office	140	140
Faculty offices	140	(2) 280
Office	140	140
Laboratory	610	610
Chest:		
Total	1,030	1,030
Professor's office	140	140
Secretary's office	140	140
Faculty offices	140	140
Laboratory	610	610

Subspecialty and type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Faculty facilities—Continued		
Metabolism:		
Total	480	690
Faculty offices	(2) 280	(2) 280
Laboratory	200	410
Allergy:		
Total	890	890
Faculty offices	(2) 280	(2) 280
Laboratory	610	610
Dermatology:		
Total	420	1,030
Professor's office	140	140
Secretary's office	140	140
Faculty office	140	140
Laboratory	[3]	610
Hematology:		
Total	340	340
Faculty office	140	140
Laboratory	200	200
Common-use facilities:		
Total	4,510	4,710
Special laboratory	610	610
Postdoctoral fellows' offices	200	(2) 400
Conference room	350	350
Steno pool	210	210
Data room	280	280
Special-projects room	280	280
Storage room (future laboratory)	410	410
Storage room	280	280
Cardiac catheter suite	810	810
Patients' cold room	(2) 250	(2) 250
EEG rooms	(2) 220	(2) 220
Cold room	200	200
Animal room	410	410

[1] For teaching responsibility only.
[2] Chairman of department.

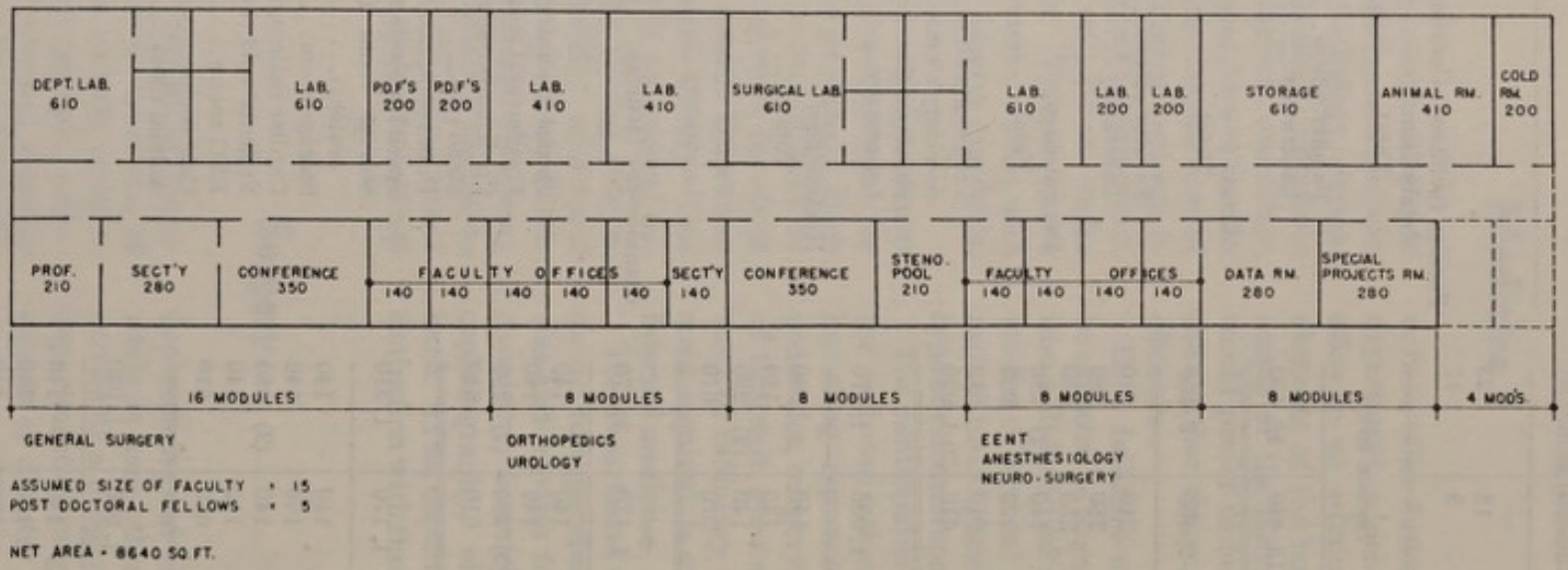


FIGURE 30.—Diagram for a department of surgery for a medical school with a 64-student entering class.

engage in research. Office and research space should be provided for each faculty member. A departmental conference room is required and a departmental reference library may be desirable. One conference room may be adequate for general departmental purposes but, as the various subspecialties are designated separately, additional conference space with departmental library facilities should be available.

TABLE 28.—*Net area for a department of surgery for hypothetical schools with entering classes of 64 and 96 students*

Subspecialty and type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	15	21
Postdoctoral fellows	5	7
	Square feet	
Faculty facilities:		
Total net area	8, 840	11, 120
General surgery:		
Total	2, 740	4, 300
Professor's office [2]	210	210
Secretary's office	280	280
Conference room	350	350
Faulty offices	(2) 280	(3) 420
Postdoctoral fellows' offices	(2) 400	(3) 600
Departmental laboratory	610	610
Additional laboratories	610	(3) 1,830
Orthopedics:		
Total	550	690
Faculty offices	140	(2) 280
Laboratory	410	410
Urology:		
Total	830	830
Professor's office	140	140
Secretary's office	140	140
Faculty office	140	140
Laboratory	410	410

Subspecialty and type of facility	School A (entering class of 64 students)	School A (entering class of 64 students)
	Square feet	
Eye, ear, nose, and throat (EENT):		
Total	1, 090	1, 230
Professor's office	140	140
Faculty offices	140	(2) 280
Laboratory	610	610
Laboratory	200	200
Anesthesiology:		
Total	340	690
Faculty offices	140	(2) 280
Laboratory	200	410
Neurosurgery:		
Total	340	690
Faculty offices	140	(2) 280
Laboratory	200	410
Common-use facilities:		
Total	2, 950	2, 690
Conference rooms	350	(2) 700
Steno pool	210	210
Data room	280	280
Special-projects room	280	--------
Storage room (future laboratory)	610	--------
Storage room	--------	280
Surgical laboratory	610	610
Cold room	200	200
Animal room	410	410

[1] For teaching responsibility only.
[2] Chairman of department.

Pediatrics

The department of pediatrics consists of physicians specializing in the developmental aspects of physiological processes and expressions of disease. They are as concerned about the long-term health effects of early disease and with their prevention, as with the immediate care of infants and children. In most university hospitals, the age range extends to the 14th or 16th year. Pediatrics is a nonsurgical specialty. Consequently, surgery on patients in the pediatrics age is generally handled by the department of surgery. As in internal medicine, a number of subspecialties generally based on organ systems such as cardiology, neurology, and endocrinology are usually represented in the department of pediatrics.

The general requirements for departmental offices, teaching spaces, and laboratories are the same in pediatrics as in other clinical departments. Teaching is generally concentrated within 1 or both of the last 2 clinical years. In addition, there are teaching responsibilities for interns, residents, and postdoctoral fellows in pediatric training.

TABLE 29.—*Net area for a department of pediatrics for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	5	8
Postdoctoral fellows	3	4
	Square feet	
Total net area	4, 260	5, 010
Faculty facilities:		
Total	2, 680	3, 430
Professor's office	210	210
Professor's office	140	140
Secretary's office	280	280
Conference room	350	350
Faculty offices	(2) 280	(3) 420
Postdoctoral fellows' office	200	200
Departmental laboratory	610	610
Additional laboratories	610	(2) 1, 220
Common-use facilities:		
Total	1, 580	1, 580
Data room	140	140
Special projects room	280	280
Storage room (future laboratory)	410	410
Storage room	140	140
Cold room	200	200
Animal room	410	410

[1] For teaching responsibility only.

Obstetrics and Gynecology

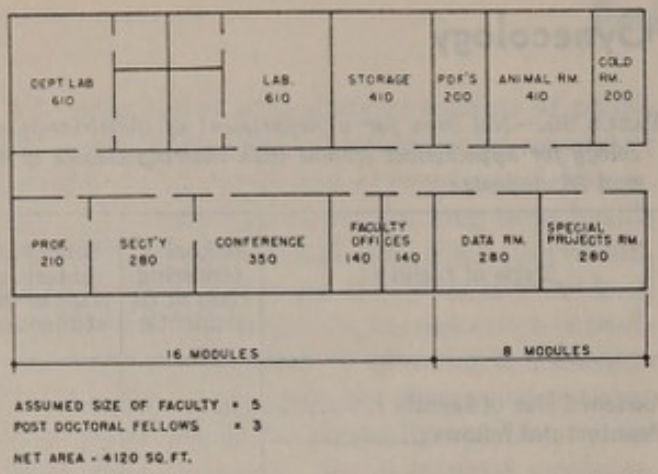
Although the department of obstetrics and gynecology consists of physicians specializing in the normal and disordered functions of the female reproductive system, many schools consider it their responsibility to teach the important features of the life cycle of women (*24*). Obstetrics concerns itself with the processes of conception, gestation, and delivery in women, whereas gynecology deals with the specific diseases of the female reproductive tract.

Requirements of the department of obstetrics and gynecology for administrative office, teaching and research space are not essentially different from those of any other clinical department. Usually this department confines its teaching activities to students in one or both of the third and fourth years. Teaching activities may expand to include such courses as reproductive biology. In addition, there are teaching responsibilities for residents and fellows. Interns are generally not assigned to this service except as part of a rotating program. Student groups may be smaller than in some services and, therefore, teaching space should be sized accordingly.

TABLE 30.—*Net area for a department of obstetrics-gynecology for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	3	4
Postdoctoral fellows	1	1
	Square feet	
Total net area	4,390	4,390
Faculty facilities:		
Total	2,540	2,540
Professor's office	210	210
Secretary's office	280	280
Conference room	350	350
Faculty offices	(2) 280	(2) 280
Postdoctoral fellows' office	200	200
Departmental laboratory	610	610
Additional laboratory	610	610
Common-use facilities:		
Total	1,850	1,850
Data room	140	140
Special-projects room	280	280
Storage room (future laboratory)	410	410
Storage room	410	410
Cold room	200	200
Animal room	410	410

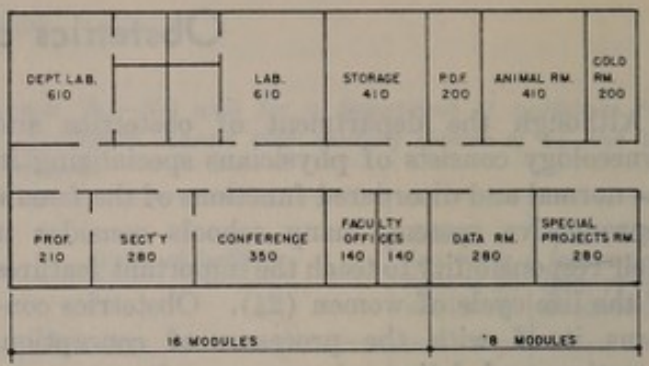
[1] For teaching responsibility only.



ASSUMED SIZE OF FACULTY = 5
POST DOCTORAL FELLOWS = 3

NET AREA - 4120 SQ. FT.

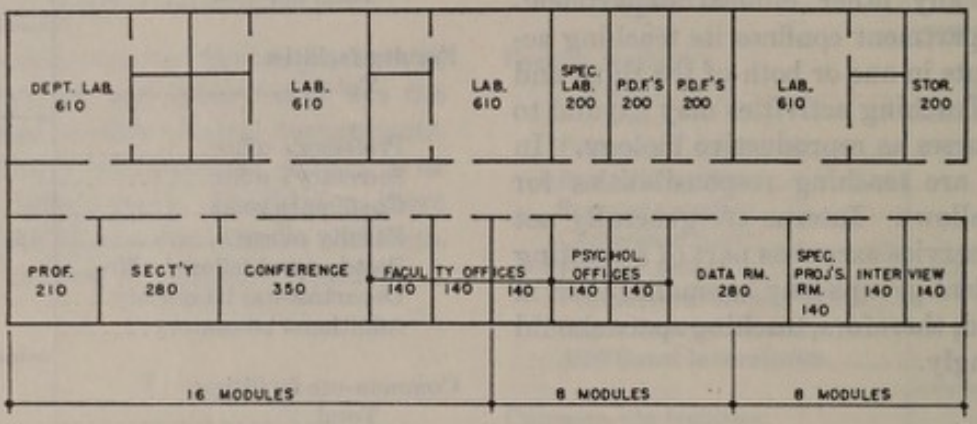
FIGURE 31.—Diagram for a department of pediatrics for a medical school with a 64-student entering class.



ASSUMED SIZE OF FACULTY = 3
POST DOCTORAL FELLOWS = 1

NET AREA - 4120 SQ. FT.

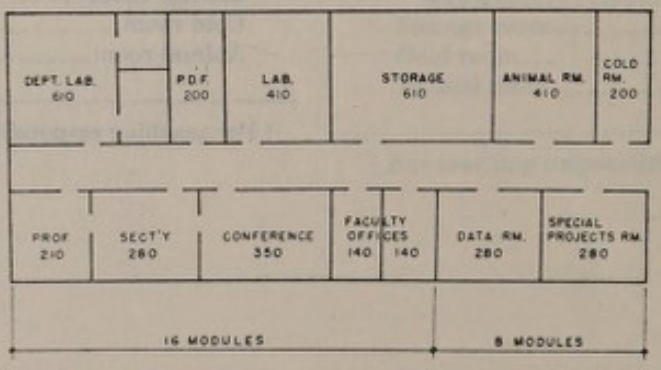
FIGURE 32.—Diagram for a department of obstetrics-gynecology for a medical school with a 64-student entering class.



ASSUMED SIZE OF FACULTY = 10
POST DOCTORAL FELLOWS = 8

NET AREA - 5480 SQ. FT.

FIGURE 33.—Diagram for a department of psychiatry for a medical school with a 64-student entering class.



ASSUMED SIZE OF FACULTY = 4
POST DOCTORAL FELLOWS = 2

NET AREA - 4120 SQ. FT.

FIGURE 34.—Diagram for a department of preventive medicine for a medical school with a 64-student entering class.

The above diagrams are for a medical school with a 64-student entering class.

Psychiatry

The department of psychiatry consists of specialists concerned with the functions and disfunctions of the mind and emotions. In many institutions psychiatry and neurology are combined as a single department. This description, however, is for a department of psychiatry in which this is not the case.

Offices for members of the department of psychiatry may be used for somewhat different purposes than staff offices of other clinical departments. For example, not only do psychiatrists use their offices for deskwork, study, and conferences with students and others, but they may also use them as interview rooms for psychiatric patients. Clearly, this will have an effect upon the design of the psychiatric departmental office suite in that it may be necessary to incorporate waiting rooms for patients and space for the administrative control of patients in addition to the usual departmental administrative space, teaching space, conference rooms, and reference libraries.

Teaching requirements for the department of psychiatry are similar in many respects to those of other clinical departments, but some special facilities are needed. Consultation rooms connected by a one-way viewing screen or TV with an adjoining observation area are frequently required. Teaching activities in the department of psychiatry will include not only medical students and residents, but also students in social work, psychology, social science, psychiatric nursing, and others.

Research facilities for the department of psychiatry must meet a wide range of interests. Social studies, human behavior, behavioral characteristics of animals, drug effects on emotions and physiological reactions, physiological effects of emotional stimuli, neurophysiological phenomena, and biochemistry of nervous tissue all may be subjects of study and demonstrate the range of interests to be expected. In general, studies involving psychiatric patients are best carried out in research facilities associated with the psychiatric bed area, and laboratory studies not involving patients are best carried out in departmental research laboratories.

The department of psychiatry may assume other responsibilities for community mental health in cooperation with other community and university groups.

TABLE 31.—*Net area for a department of psychiatry for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	10	14
Postdoctoral fellows	8	10
	Square feet	
Total net area	5,480	6,660
Faculty facilities:		
Total	5,000	6,100
Professor's office	210	210
Professor's office	140	140
Secretary's office	280	280
Conference room	350	350
Faculty offices	(3) 420	(5) 700
Postdoctoral fellows' offices	(2) 400	(2) 400
Interview offices	(2) 280	(2) 280
Psychologists' offices	(2) 280	(2) 280
Departmental laboratory	610	610
Additional laboratories	(3) 1,830	(4) 2,440
Special laboratory	200	410
Common-use facilities:		
Total	480	560
Data room	140	140
Special-projects room	140	140
Storage room	200	280

[1] For teaching responsibility only.

Preventive Medicine

The department of preventive medicine is a clinical department in some schools. The functions, organization, and the medical school and hospital relationships of this department vary widely among schools. Even its name varies, depending upon emphasis. Community, social, and environmental medicine, and public health are other names used. In general, however, the discipline of preventive medicine comprises physicians who are concerned with the natural history of disease and the factors in the environment which have an effect upon morbidity and morality. They are interested in reducing the incidence of avoidable disease and premature death through control of those factors which may contribute to disability and incapacity. Although this department is generally not concerned with every aspect of public health, it, nevertheless, concentrates on those areas of special concern to medical education. Accordingly, the department's teaching activities can cover many subjects including epidemiology, parasitology, tropical medicine, sanitation, social medicine, medical statistics, medical economics, and the various mechanisms involved in providing care to groups of people. Research activities may involve any of these special areas of interest and, accordingly, appropriate space should be provided.

Because of the variables enumerated above, space for the department of preventive medicine should be developed in keeping with the size, aims, and responsibilities of the specific department. Each faculty member should have an office. Secretarial space should be shared to assure coverage. Conference space is essential. There is usually a close relationship between the staffs of pediatrics, medicine, obstetrics-gynecology, psychiatry, and preventive medicine, and this should be borne in mind in the location and assignment of office space.

Although preventive medicine does not generally require inpatient facilities, or have clinical responsibility for hospitalized patients, many departments have varying responsibility with ambulatory care, family-practice units, or home-care programs. If one or more of these responsibilities are assigned to this department, appropriate facilities in or near the hospital and clinics should be provided.

Since prevention and other aspects of this discipline run through every clinical service, this department, in particular, has organizational and teaching relationships with many other units. In turn, it may have such close association with the local and the State health departments that the character of the department and its space requirements are influenced.

TABLE 32.—*Net area for a department of preventive medicine for hypothetical schools with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
Assumed size of faculty [1]	4	6
Postdoctoral fellows	2	3
	Square feet	
Total net area	4, 260	4, 870
Faculty facilities:		
Total	2, 340	2, 950
Professor's office	210	210
Secretary's office	280	280
Conference room	350	350
Faculty offices	(2) 280	(2) 280
Postdoctoral fellows' office	200	200
Departmental laboratory	610	610
Additional laboratories	410	(2) 1, 020
Common-use facilities:		
Total	1, 920	1, 920
Data room	140	140
Special-projects room	280	280
Storage room (future laboratory)	610	610
Storage room	280	280
Cold room	200	200
Animal room	410	410

[1] For teaching responsibility only.

TABLE 33.—*Summary of space estimates for clinical science facilities for a hypothetical 4-year medical school* [1]

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Total gross area [2] (rounded)	69, 000	80, 000
Total net area (rounded)	45, 000	52, 000
Departmental facilities:		
Medicine	13, 440	15, 490
Surgery	8, 840	11, 120
Pediatrics	4, 260	5, 010
Obstetrics and gynecology	4, 390	4, 390
Psychiatry	5, 480	6, 660
Preventive medicine	4, 260	4, 870
Auditorium [3]	----------	----------
Lecture rooms [3]	----------	----------
Central storage	3, 200	3, 200
Toilet rooms	1, 200	1, 200
Radiology [3]	----------	----------
Anesthesiology [3]	----------	----------
Pathology [4]	----------	----------

[1] This table does not include the supporting facilities which are a necessary part of both the basic science and clinical science facilities. See table 51 for areas for supporting facilities.

[2] To compute the gross area, it is estimated that 65 percent of the total gross area is available as usable space, while the remaining 35 percent will provide space for exterior walls, partitions, corridors, stairs, elevators, and duct ways and chases for mechanical and electrical requirements.

[3] In the teaching hospital.

[4] Preclinical pathology is taught in the basic science facilities. Space for clinical pathology may be provided in the teaching hospital.

Chapter 7

THE UNIVERSITY TEACHING HOSPITAL

The university teaching hospital is an integral part of the educational plant of the university medical center. In addition to being designed for patient care, it is designed as a laboratory for clinical instruction. Patient care which should be of superior quality in a teaching hospital is becoming increasingly complex and the teaching hospital design should anticipate evolving patterns of medical care.

This chapter is intended to serve as a guide. It is not a definitive treatise or manual for planning a teaching hospital. Areas shown are approximate, since programs and space requirements will vary. Each unit and its related circulation space should be designed for expansion and flexibility. The number of programs and the number of people in each will increase and their roles may change. The size of the patient-care load should be geared to the educational needs of the various teaching programs. The educational program should not be swamped by excessive demands for patient care.

The various disciplines of the medical school bring students into contact with patients at an earlier time than formerly. Increasingly, teams of professional and technical people are being used in patient care and educational facilities should be designed so that the role of each person in the team can be demonstrated. Ultimately, the people trained will work in local communities, not only in hospitals, but in other types of health facilities as well. It may be desirable to arrange the physical plant so that students may become familiar with different ways in which the physician cares for patients and cooperates with other members of the health professions.

Facilities for research are necessary for good educational programs and should be included in the university teaching hospital. Clinical research on patients has as its ultimate goal the application of its findings to improvement of patient care. In a sense, clinical research may be conducted on any patient in the hospital. However, in some instances, where rigid control of circumstances and environment is necessary, special facilities may be required.

Diagnostic facilities for the mentally retarded may become increasingly a part of university teaching hospital programs. It is here that the many disciplines required and the potential for research will be available. Interdisciplinary programs for child health and human development may be included in the teaching hospital.

Facilities for training nonacademic or nontechnical service personnel should be considered. Formerly all such training has been given through inservice work. However, today specifically designed areas to familiarize trainees with the use of equipment should be provided. Skills in the use of equipment should be taught at all educational levels.

The study cubicle has been found to be effective as a home base in the hospital for graduate students in the social and behavioral sciences and for house officers.

If the hospital is located at a distance from the medical school, some facilities in the medical school may have to be duplicated in the hospital. Certain facilities, such as the auditorium and morgue and autopsy, should be located in the hospital, and others, such as animal quarters, may have to be supplemented by facilities in the hospital.

Some medical schools use other affiliated hospitals in addition to the university hospital, such as municipal or county hospitals, and Veterans' Administration hospitals, in their overall program. When this is the case, the number of beds in the university hospital necessary for an adequate teaching program may be reduced significantly. The total number of beds under the *direct* control of the medical school should remain at a satisfactory level, however, and the degree of reduction in the size of the university hospital by the use of affiliated hospitals will depend upon a number of

factors pertaining at the affiliated hospitals, including:

(1) The degree of control by the medical school of staff and house staff appointments in the affiliated hospitals.
(2) The adequacy of the "teaching space" available.
(3) The type of patients seen and degree of control of admission.
(4) The accessibility of the medical school.
(5) Adequacy of financial support of the affiliated hospital.

Educational programs in community hospitals are primarily concerned with the training of interns and residents. The educational needs for teaching programs should be provided in specially designed facilities, scaled down from those described for university teaching hospitals in accordance with the specific programs of the hospital.

Administration

The administrative elements of a university teaching hospital included here are predominantly managerial in character, such as the patient admitting offices, the hospital administrator's office and those of his assistants, the business office, and the personnel director's offices. Communications, purchasing, or personnel may in some situations be in the medical school. Also included are those elements which are usually in close physical relationship with the above, such as the main entrance lobby and public waiting area, the public information center, public elevators, lobby, public toilets and telephones, coffeeshop, gift shop, and so on. The general outpatient waiting area, although it may have a separate outside entrance is usually also accessible from the main entrance lobby. However, it is considered a component of the outpatient department and is described elsewhere under that heading.

Due to the breadth of its teaching and research responsibilities in addition to those of patient care, the administrative spaces required for a university teaching hospital are somewhat more elaborate and extensive than those of a community hospital or similar bed capacity.

The various administrative components should be arranged into units and the units into groupings so that each component within a unit and each unit within a group is conveniently located with reference to the others. For example, the hospital administrative offices unit, the board room, the general business offices unit, the admitting offices unit, and the toilet facilities for these units could be grouped. The main lobby and waiting room, the information center, public-elevator lobby, public toilets and telephones, and the cashier-window alcoves are usually grouped. In preparing a program of administrative space needs, it will simplify matters to arrange the various components under proper unit headings and appropriate group headings.

To prepare such a program, a number of factors must be resolved: the volume of visitors to be accommodated at one time; the size of the volunteer part-time medical staff, if any; whether the same cashier facilities are to serve both outpatients and inpatients; whether the public relations department is to be located in the medical school or in the teaching hospital; whether trainee programs for student nurses are anticipated; whether a department of industrial engineering and a credit union are contemplated; and what provisions should be made for volunteer organizations, escort and hostess services, and others.

The lists of administrative components shown in table 34 are not based on a particular set of factors and are intended to serve only as a guide.

TABLE 34.—*Net areas for administration for hypothetical teaching hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		21, 240		26, 260
Public facilities:				
Total		5, 430		7, 410
Public lobby		1, 500		2, 000
Public telephone		30		40
Public toilets		260		320
Gift shop including storage		600		900
Coffeeshop	(40 persons)	1, 500	(60 persons)	2, 000
Reception-control desk	(3 persons)	300	(4 persons)	400
Waiting area	(20 persons)	400	(30 persons)	600
Retiring room	(8 persons)	160	(10 persons)	200
Cashier-windows alcove		200		250
Public-elevator lobby		400		600
Receptionists' lockers		80		100
Hospital administration:				
Total		2, 000		2, 240
Administrator's office		300		300
Secretaries' office		150		150
Reception-secretarial office		300		420
Assistant administrator's offices	(3 @ 100)	300	(4 @ 100)	400
Residents' office	(2 desks)	150	(2 desks)	150
Conference room	(30 persons)	600	(30 persons)	600
Coatroom and toilet		120		120
Storage room		80		100
Credit and inpatient admitting:				
Total		2, 360		2, 850
Reception-waiting area	(12 persons)	300	(15 persons)	400
Admitting booths	(4 @ 80)	320	(5 @ 80)	400
Admitting secretarial office	(2 desks)	200	(3 desks)	300
Addressograph room		100		100
Director of admissions office		150		150
Director's secretarial office		100		100
Central admitting and credit file room		180		200
Control room		100		100
Credit offices	(2 @ 120)	240	(2 @ 120)	240
Credit clerks' room		80	(2 @ 80)	160
Agency interviewing offices	(2 @ 100)	200	(2 @ 100)	200
Accounts collectors' interview rooms	(4 @ 80)	320	(5 @ 80)	400
Storage		70		100
Business office:				
Total		3, 690		4, 240
Comptroller's office		150		150
Secretary and typist		200		200
Cost accounting		120		120
Budgeting office		120		120
Auditing office		120		120
Hospital accounting (accounts payable, payroll, statistics, fund accounting, etc.)		1, 200		1, 500

TABLE 34.—*Net areas for administration for hypothetical teaching hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Supervisor		120		120
Data processing		300		300
Vault		100		100
Patient accounts:				
Supervisor		120		120
Cashier		140		140
Patient accounts records		800		1,000
Vault		100		100
Storage		100		150
Communications:				
Total		4,250		5,650
Telephone equipment rooms, toilets, and lounge		1,600		2,200
Pneumatic tube station		200		200
Duplicating		800		950
Mail and messanger service		1,650		2,300
Purchasing office:				
Total		1,230		1,270
Reception-waiting area	(8 persons)	80	(10 persons)	100
Purchasing agent's office		150		150
Secretaries' office		200		200
General purchasing office	(4 desks)	500	(4 desks)	500
Storage including library space		100		120
Toilets		200		200
Personnel department:				
Total		2,280		2,600
Reception-waiting area	(16 persons)	420	(20 persons)	500
Testing and photography room		150		150
Interview cubicle		100		100
Employment manager's office		120		120
Employees' benefits manager's office		120		120
General personnel office	(4 desks)	400	(6 desks)	600
Personnel director's office		150		150
Orientation and training classroom [1]	(25 persons)	500	(25 persons)	500
Storage and file space		120		160
Toilets		200		200
Credit union: [2]				
Waiting room				
Interview rooms				
Machine room				
Storage				

[1] Available to other administrative units.
[2] Optional.

Some university teaching hospitals provide for 1 or 2 residents in hospital administration (*25*). A few universities have a master's degree program which may be academically based in a college of associated health professions, a college of business administration, or other. However, the physical facilities will be located in the teaching hospital. Facilities required consist of a desk for each resident in an office convenient to the chief hospital administrator's office and to a conference-seminar room. Secretarial services should be available to these residents.

PERSONNEL OFFICE

Orientation and training of nonprofessional and nonacademic personnel is the responsibility of the personnel office. Various techniques are used, such as on-the-job training. A part of the instruction is by lectures and classroom demonstration, and a conference-classroom for 20 persons is often provided and arranged so that it can be used for other programs. It should be furnished with projection screen, chalkboard, tackboard, storage space, and bookshelves.

ADMITTING AND CREDIT

Some of the more important criteria which provide a basis for determining the scope and nature of the activities for admitting patients and the space necessary to accommodate these activities are clientele served, disease entity, teaching and research needs and interests, staff competency, and volume of patients.

"Clientele served" encompasses the various classification of patients seeking admission, such as patients referred by physicians, from the outpatient service, self-referred patients, medically indigent patients, private-practice patients, or others. "Disease entity" refers to patient classifications such as heart, psychiatric, and pediatric.

A university teaching hospital requires means of coordinating and balancing the various classifications of patients admitted with the hospital's particular teaching and research needs and objectives. How restrictive admission policies are, will have an effect on facilities required. The number of patients processed on any day within the prescribed hours for admission or treatment will determine the number of interviewing offices and the size of the waiting area for patients and their companions.

Other facilities provided with the admissions unit regarding financial appraisal, credit follow-through, medical record initiation, or other activities will depend on individual managerial policy and philosophy.

BUSINESS OFFICE

The hospital's accounting system is dictated by its organization and program. Various other functions and responsibilities may be incorporated with or assigned to the business office. The centralized accounting operations require most of the business-office space.

The organization and programs of a university teaching hospital are different in some respects from those of the community-type hospital. Among the differences are extensive teaching and research activities; relationships with the medical school and the parent university; the number of specialized departments; complicated financial activities regarding expenses and charges, and disbursement of funds from various government and private subsidies. Because of these and other differences the accounting operation for the university hospital requires more personnel, more sophisticated business machines and data-processing equipment, more elaborate communication systems, and more business-office space than would be required for the community hospital business office.

Other functions of the business office are credit and collections; preparation and maintenance of administrative reports and records; purchase and storage of supplies and equipment; transportation, messenger services, and related functions; reception and information; and admitting procedures. Whether these are incorporated with the business office or set up as separate functions will depend on individual programs and policy.

PURCHASING AND SUPPLY

If the teaching hospital is separate from the medical school, it may be necessary to duplicate some facilities for purchasing and supply.

COMMUNICATIONS

In an organization as complex as a medical center, it is essential that the systems of communication—namely, telephone and remote dictation systems, nurse call systems, paging systems, physician register, television, radio, departmental intercommunication systems, civil defense communication systems, radio system in connection with hospital-based ambulance or other transportation, pneumatic tube and other conveyor systems—remain operable at all times. Communication facilities and services are so diversified and vital that it may be necessay to provide for administration for operation and maintenance of these services (*20*).

Patient-Care Units

Because of the number of people to be accommodated and the education programs involved, modifications need to be made in the design of patient-care units for a hospital with organized teaching programs. In addition to basic requirements (*26*) for patient care, additional areas and facilities will be needed to meet teaching needs.

The patient-care space, particularly that devoted to ambulatory patients, should consider the natural relationships between departments. For example, study of a particular program might reveal a desirable physical relationship between obstetrics and pediatrics. Furthermore, study of teaching practices and student assignments may reveal similar relationships in educational space.

Patient-care units of 30–35 beds are generally considered an effective size for teaching as well as for operating efficiency. However, some areas also required in the community hospital may have to be increased in the teaching hospital. For example, a few authorities believe that the customary 8-foot-wide corridor should be increased in some areas to allow for the additional people and equipment moving about the unit and between units. Also, the treatment room should be larger in the teaching hospital to accommodate students, and more than one may be required. Some spaces, not required in the community hospital, such as a medical student room and a conference-demonstration room, will be needed to implement teaching programs. Tables 35 and 36 give the areas for patient-care units for 500- and 700-bed hospitals.

Patient-care units in the teaching hospital are generally separated according to clinical specialties, such as medicine, surgery, obstetrics, psychiatry, and pediatrics (with separate units for children and adolescents) to facilitate the teaching and patient-care programs in the hospital. In the teaching hospital, special consideration should

TABLE 35.—*Net areas for patient-care units for hypothetical hospitals of 500 and 700 beds*

Type of unit	500 beds	700 beds		
	Square feet			
Summary of areas:				
Total	114, 010			174, 400
Medical	23, 490			39, 150
Surgical	31, 320			46, 980
Intensive care	7, 830			7, 830
Maternity	7, 830			15, 660
Psychiatric	15, 680			15, 680
Pediatric	13, 240			19, 860
Long term	7, 830			15, 660
Self-care	6, 790			13, 580
Clinical research center [1]				
	Units	Beds	Units	Beds
Disposition of hospital beds:				
Total	17	500	25	700
Medical	3	90	5	150
Surgical	4	120	6	180
Intensive care [2]	1	30	1	30
Maternity	1	30	2	60
Psychiatric	2	60	2	60
Pediatric	2	60	3	90
Long term	1	50	2	70
Self-care	2	60	2	60
Clinical research center	1		2	

[1] Optional.

[2] Additional beds on medical or surgical unit may be used for intensive care.

TABLE 36.—*Net area for individual patient-care units*

		Square feet
Intermediate—Medical, surgical, maternity, long term—30 beds:		
Total		7, 830
Medical student room		200
Conference/demonstration room	½ of 450 sq. ft.[1] (25–30 people)	225
Consultation rooms	3 @ 90 sq. ft	270
Student laboratory	½ of 200 sq. ft.[1]	100
General toilets		100
Patient rooms		4, 800
Dayroom		300
Patient-tub room		100
Patient shower rooms	2 @ 32 sq. ft	65
Nurses' station		200
Chief resident's office—for each 2–3 units		100
Unit supervisor's office		90
Doctors' charting room		110
Medication room		50
Nurses' toilet		30
Conference rooms, nursing service, and nursing education	12–14 people	200
Treatment room		200
Supply		200
Soiled holding		150
Nourishment room	½ of 100 sq. ft.[1]	50
Equipment storage		100
Stretcher alcove		50
Janitor		40
Nurses' locker room	½ of 200 sq. ft.[1]	100
Nurseries—40 bassinets:		
Total		2, 870
Nurseries and workrooms		2, 550
Demonstration room		220
Equipment storage		100
Formula room [2]		
Clinical Research Unit [2]		
Psychiatric—30 beds:		
Total		8, 200
Medical student room		200
Conference-demonstration room	½ of 450 sq. ft.[1] (25–30 people)	225
Consultation and interview rooms	8 @ 90 sq. ft	720
Patient rooms		4, 000
Lounge		580
Dining and recreation		520
Nurses' station		180
Chief resident's office		100
Supervisor's office		90
Medication room		50
Nurses' toilet		50
Conference room	8–10 people	200
Treatment room		150
Supply		120
Soiled holding		80

See footnotes at end of table.

TABLE 36.—*Net area for individual patient-care units*—Continued

		Square feet
Psychiatric—30 beds—Continued		
Patients' laundry		150
Nourishment room		60
Occupational therapy		400
Waiting room		200
Nurses' lockers		75
Janitor		50
Pediatric—30 beds:		
Total		6, 620
Medical student room		200
Conference-demonstration room	½ of 450 sq. ft.[1] (25–30 people)	225
Consultation rooms	5 @ 90 sq. ft	450
Student laboratory	½ of 200 sq. ft.[1]	100
Staff toilets		100
Patient rooms	15 @ 240 sq. ft	3, 600
Playroom		300
Tubrooms		100
Nurses' station		200
Head nurse's office		90
Doctors' charting room		100
Medication room		50
Nurses' toilet		30
Conference rooms	8–10 people	200
Treatment room		150
Supply		200
Soiled holding		150
Nourishment room	½ of 100 sq. ft.[1]	50
Equipment storage		50
Stretcher alcove		50
Janitor		40
Nurses' locker room	½ of 200 sq. ft.[1]	100
Schoolroom	½ of 150 sq. ft.[1]	75
Self-care—30 beds:		
Total		6, 790
Consultation rooms	3 @ 90 sq. ft	270
Patient rooms		4, 800
Dayroom		300
Nurses' station		200
Head nurse's office		90
Doctors' charting room		110
Medication room		50
Nurses' toilet		30
Conference rooms	12–14 people	200
Treatment room		200
Supply		200
Soiled holding		150
Nourishment room	½ of 100 sq. ft.[1]	50
Equipment storage		100
Janitor		40

[1] 1 for 2 units.
[2] Optional.

be given to the need for patient-care units for long-term care, rehabilitation, clinical research, intensive care, self-care, and other special services. A clinical research unit, an intensive-care unit, or similar special areas serving more than one department should be located so as to serve interdepartmental participants.

The organization of the hospital should be such that where possible one or more entire nursing units can be assigned to a single clinical service since this concentration simplifies and improves admitting practices, patient care, and clinical teaching.

Experiments are being carried on in unit manager systems for the administration of patient-care and other functional units such as the operating suite. These systems free professional personnel from administrative duties (*27*). They may require an office on the unit.

Since medical and nursing students assigned to the units will spend much of their time in the patient-care areas, special facilities should be provided for them. These facilities will increase the space requirements to a significant extent. Students such as those in dietetics, medical social work, clinical psychology, occupational and physical therapy, who are present in small numbers and use the patient-care areas for a shorter period of time, do not materially affect the space requirements.

TEACHING PROGRAMS

Medical Students

The patient-care unit provides the opportunity for the medical student to observe and participate in the diagnosis and treatment of patients in a hospital environment.

Third- and fourth-year classes are usually divided into groups of about 4–8 students to a patient-care unit, and are rotated through the various clinical services. Time spent on each service will vary with the curriculum. The student receives instruction from the faculty, residents, and interns assigned to the service.

The student is assigned certain patients on whom he takes a medical history and does a physical examination. He may do some laboratory tests and certain other procedures directed toward arriving at a diagnosis. He prepares a detailed record of his "workup" with a summary of his conclusions and the diagnostic possibilities. He may perform diagnostic and therapeutic procedures and make notes on the progress of his patients and accompany his patient to X-ray, physical therapy, surgery, and to other areas of the hospital. This intensive investigation of the patient's condition serves as the basis for discussion with interns, residents, and faculty.

Groups of students make frequent bedside rounds with members of the staff. They may attend group conferences and demonstration clinics where cases are considered jointly by the various clinical and basic science faculty. As the student's knowledge and skill improve, he participates increasingly in the development and implementation of plans for patient care.

The student's schedule in the third and fourth years is usually worked out in blocks of weeks for each department (table 37). Although radiology is usually a separate department, medical student teaching in this discipline is often done during review of films by the radiologist for the clinical staff of the hospital service responsible for the patient under study.

TABLE 37.—*Weeks in clinical subjects in the last 2 years of medical school, 1959* [1]

Department	Weeks of inpatient training	
	Average	Range
Medicine	20	12–35
Surgery	17	8½–24
Obstetrics	9	3–15
Pediatrics	9	4–19
Psychiatry	6	½–13

[1] Source: U.S. Public Health Service compilation from catalogs of 43 medical schools.

Nursing Students

Student nurses are also assigned to patient-care units in groups of 10 or less under the direct supervision of an instructor in nursing. Student nurses may attend medical rounds. They will observe, singly and in groups, demonstrations of

nursing care by the instructor at the patient's bedside or in the treatment room. They will attend conferences to evaluate the patient's nursing-care needs and they are responsible for charting on the patient's record observations made and care given. They administer medications, give bedside care, do certain therapeutic procedures, and assist physicians and other nursing personnel in the examination and treatment of the patient.

Affiliated Students

Teaching hospitals may offer instruction to students from other affiliated programs. Affiliations in nursing are most frequently requested for instruction in pediatrics, psychiatry, and obstetrics. Other affiliations in associated health professions such as occupational therapy, physical therapy, medical technology, and clinical psychology may be included. Where affiliations are contemplated, provisions should be made for additional students and instructors on the patient care units and for additional patient care conferences.

Progressive Patient Care and Teaching Programs

Progressive patient care, by which hospital services are organized around the individual patient's medical and nursing needs, is consonant with the usual educational program but requires some administrative modifications and adjustment of schedules. The 6 elements, intensive care, intermediate care, self-care, long-term care, outpatient care, and home care (*28*), are compatible with a good educational program. The application of the principles will vary and will be modified in accordance with the program.

The number of patients in the university teaching hospital requiring intermediate, self-care, or long-term care facilities and services are usually large enough to make separate clinical units feasible.

Contiguity of some different type units, such as intensive care and intermediate care, will provide flexibility in the assignment of patients.

To increase efficiency of construction and operation, the size and design of patient-care units in an individual hospital should be as nearly the same as possible.

FACILITIES

Intensive Care

The teaching hospital is apt to care for a higher percentage of critically ill patients than the community hospital of comparable size. The requirements of a general intensive-care unit (*28*) may not vary significantly from that in the community hospital. However, because of the larger number of critically ill patients, it may be advisable to set up intensive-care units by clinical category, such as a medical unit, surgical unit (in addition to a postanesthesia recovery room), pediatric unit, and even such other specialty units as cardiac, neurosurgery, and orthopedics. However, less flexibility, efficiency, and economy in the use of personnel, equipment, and space may result unless patient volume is such that a high occupancy rate can be maintained in each unit.

Intermediate Care

Patient rooms.—Clearances around the bed should be sufficient to accommodate the extra equipment required; to permit the nurse to carry out nursing procedures; to move patients in beds, stretchers, or wheelchairs; to accommodate necessary furniture; and to facilitate housekeeping. Conventional rooms generally require a minimum of 12 feet 4 inches by 10 feet for 1-bed rooms, 12 feet 4 inches by 16 feet for 2-bed rooms, and 24 by 16 feet for 4-bed rooms.

As many as 8–10 persons (residents, interns, and medical and nursing students) may be in the patient's room with the physician and nurses during rounds.

The proportion of 1-, 2-, and 4-bed rooms planned for the patient-care unit will depend upon medical requirements, educational programs, community preference, and financial considerations in each circumstance.

Some advantages and disadvantages of various size rooms from the teaching point of view are:

The 1-bed room is the best accommodation for seriously ill, disturbed, or elderly patients; it also affords privacy during rounds for the patient and physician with respect to other patients. Crowding may result, but the group can distribute itself around the bed in the free space, which is greater than in the *2-bed* room. The 1-bed room provides maximum flexibility for use and for isolating pa-

tients of opposite sex and those with communicable diseases. If many patients with communicable diseases, such as tuberculosis, will be treated in the hospital, a separate isolation unit may be required.

In the 4-bed room the space between the bed ends and around the other 3 beds can be used during rounds. However, the saving of space is accomplished with a sacrifice of privacy which may inhibit interview and examination of the patient.

The *2-bed* room has limitations since rounds here may result in crowding so that many can neither hear the patient interview nor observe an examination and in the loss of privacy for both patients in the room and for those making rounds.

The 1-bed room is considered preferable for teaching purposes. However, socioeconomic considerations may indicate a combination of 1-, 2-, and 4-bed rooms.

Nurses' station.—A nurses' station containing 5 or 6 working positions plus a ward clerk position will usually be adequate in a teaching hospital if convenient charting facilities are provided for physicians, residents, interns, and students who are also concerned with patient charts.

An office for the unit supervisor should be provided adjacent to the station where plans for the unit can be made and guidance can be given to the staff in privacy.

Medication room.—An enclosed medication room adjacent to the nurses' station should accommodate 2 people for handling patient medications. Because of the need for quiet, teaching here should be on a 1-to-1 basis. Therefore, the room should be designed to accommodate no more than 2 people and should be located away from traffic.

Consideration should be given to accommodating newer trends in medication dispensing such as the unit dose and the use of individual patient cabinets.

Doctors' charting area.—Three to six charting positions should be provided in an area near the nurses' station for physicians, interns, residents, and medical students.

Unless a medical student room is provided, the doctors' charting area will be used by medical students to keep books and professional equipment and for writing and studying. If a separate room is not provided, the area must be provided with counter and storage space to accommodate the medical students assigned to the unit plus the interns, residents, and physicians working on the unit.

Medical student room.—A medical student room should be provided on each unit. This room, which will be used for writing up notes and histories and for informal group conferences, should have counter space for each student assigned to the unit at 5 linear feet per student assigned, usually 4–8 students. Sufficient storage and shelf space should be provided to accommodate personal books and equipment, and to hold necessary forms and reference material. If study facilities are distant, this room will be used for study and for storage of additional books and professional equipment. Facilities for hanging outside coats are desirable unless study cubicles or other locker facilities are nearby.

Conference and consultation rooms.—*A conference-demonstration room* seating 25–30 people with an area for patient demonstration should be provided for *each 2* patient-care units of each service. This room should have conduit installed to accommodate TV. Since patients will be involved on many occasions, a lavatory or sink is required for hand washing.

A conference room seating 12–14 people should be provided on *each unit* for the use of the nursing service and nursing education. A somewhat smaller conference room of this type is required in the community hospital.

Two or three *consultation rooms* accommodating a small desk and seating 3–4 people should be provided on *each unit* for use (1) by the resident for consultation with students, interns, other residents, physicians, patient and family; (2) by social service, dietary, and other personnel doing individual patient counseling or instruction; and (3) by the nursing instructor, unless provision is made for her in the school of nursing. The proportion of single rooms on the unit may affect the number of consultation rooms needed.

The pediatric service will require additional *consultation rooms* since more family participation occurs here. Several additional *consultation rooms* will be required on the psychiatric service in the teaching hospital. (For discussion of larger lecture rooms and auditorium, see ch. 4.)

If more than one nurse education program will be carried on in the hospital, all educational programs involved should be consulted concerning the possible need for additional conference space.

Floor laboratories.—In some education programs, third- and fourth-year students, interns, and residents may perform selected laboratory

procedures for patients assigned to them. Floor laboratories on each floor may be designed to serve one or more patient-care units. A minimum of 5 linear feet of counter space per person should be provided as a work area. Additional circulation space and additional counter and floor space may be required for equipment such as centrifuge, incubator, and acid-resistant sink, depending on procedures performed. This does not substitute for the central clinical laboratory, but is designed to enhance the educational experience provided.

Treatment room.—In a teaching hospital, medical and nursing students will observe their instructors examining and treating patients. Most authorities agree that certain examinations and treatments can best be done in a treatment room because of the need for a special table or equipment even though the patient may be in a single room. A treatment room should be provided on each unit, sized to accommodate 4–6 medical and nursing students in addition to the patient, his physician, and nursing-service personnel who may be assisting. This room is in addition to the conference-demonstration room and should contain a scrub sink and a counter sink. Provision for darkening the room is desirable. More than one may be needed on services such as pediatrics and surgery.

Equipment storage.—Because of more complicated cases, more clinical research, and more people involved in patient care in teaching hospitals, it is likely that more and a greater variety of equipment will be required than in community hospitals. This equipment would usually be kept in central service and delivered when needed, but some space should be provided for equipment that may need to be kept on the unit.

Ample space should be provided for wheelchairs, stretchers, and other wheeled equipment.

Supply.—In general, more supplies are used on the patient-care unit in a teaching hospital than in a community hospital since more people are involved in patient care and a high percentage of patients are apt to be seriously ill. Therefore, either the supply space must be larger or the replenishing of supplies must be more frequent. The use of automatic conveyors will speed supply activities.

Food service facilities.—Because of the high percentage of complicated cases in a teaching hospital, it is likely that more special diets, nourishments, and special services will be required. These usually should be provided by a central food-service system. The requirements of a nourishment room on the unit or units would not exceed those in a community hospital except on clinical research units.

On-call facilities.—Medical supervision of patient care at night may be provided on any service by assigning residents and interns to be "on call." Most hospitals provide some on-call sleeping facilities in or near the delivery and emergency suites. However, opinions vary as to the need, locations, and extent of these facilities on other services. Depending on the arrangement of the hospital, these facilities may be centralized for all services or located in or near each service involved, preferably on each patient-care unit. The provision and location of on-call rooms should be related to the speed with which people on call must be available. In some circumstances on-call rooms may be located and designed for use during the day as conference or consulation rooms.

Maternity Unit

Physical facilities for the care of maternity patients require special consideration. Inpatient areas should be planned to provide for the special medical and legal requirements of obstetrical care. The maternity unit should be isolated from any other patient unit and staffing should be separate to reduce the possibility of cross-infection. Maternity beds should have ready access to the labor-delivery unit with its labor, delivery, and recovery rooms. Nurseries for the normal newborn infants (*29*) are provided on each maternity floor but are generally supervised by pediatricians. Premature or deformed infants or those experiencing unusual postnatal difficulties are generally transferred to the pediatric service. Facilities for rooming in, a technique whereby newborn babies are placed in the room with the mother, may be provided. Separate waiting and visiting facilities for the husband and the families of new or expectant mothers are generally provided as part of this unit.

Psychiatric Unit

The acute inpatient phychiatric unit will usually have 24 to 30 beds. Each room should have a toilet and lavatory and ideally would have a shower. One or two rooms should be designed for quick

conversion to security rooms. These rooms should be provided with recessed ceiling light, switches outside the door, detachable wall lights (if any), proper door and window hardware, detention screens (if these are not generally installed), and radiant heating or protective covering for the heating element. For usual occupancy the rooms would be typical patient rooms.

In addition to the spaces normally required for medical-surgical patient care units in a community hospital, this unit will require:

1. A small lounge seating 8–10 for quiet activities.

2. Space for dining to accommodate all patients simultaneously at 12 square feet per person, a mobile cafeteria cart, and a kitchenette. This may be contiguous to the dayroom-recreation space area for multiple use. It may be equipped with square tables for 4 which may be combined or used for recreation when required. Recreation and lounge space should be adequate and should not depend on the moving of dining tables between meals. Movies may be shown here or in the conference-demonstration room. Facilities for light control should be considered.

3. Depending on the number of single bedrooms available, a minimum of 4 interview consultation rooms should be provided for use by the psychiatrist, psychologist, and psychiatric social worker. One pair should have either one-way glass between or should have conduit installed for TV monitoring equipment. In either case, an audio system is required. One or more of these rooms may be sized to accommodate group therapy sessions.

4. Occupational therapy facilities should usually be provided in a separate room because these activities may be distracting to other patients and the activity of other patients may distract those engaged in occupational therapy activities.

Outdoor recreation and lounge space should be provided either on the ground or on a roof. *The extent, design, and location of this facility will depend upon the policies and treatment programs of the hospital.* The space will need to be larger on children's and adolescent's units and should be designed to accommodate the activities included in the treatment program.

5. The treatment room may be used for physical examination and treatment as well as for electric shock therapy. Where electric-shock therapy is contemplated, provision should be made for recovery.

6. Two or more group therapy sessions may be held simultaneously. In some situations it may be possible, by scheduling, to use conference rooms, quiet lounges, and other areas. However, some psychiatric treatment programs will require 1 or 2 group therapy rooms seating 15 people or more. These should be equipped with comfortable, but not lounge type, chairs, chalkboard, tackboard, TV, and other visual aids, and may be equipped with one-way glass for observation from adjoining consultation rooms or from each other if adjacent. Some programs require that all patients on the unit be assembled for group therapy. In this case the conference-demonstration room should be sized to accommodate 35–40 people.

7. If facilities for children and/or adolescents are required, separate units should be provided for each group.

8. Patient laundry facilities should be provided with tubs, washer, and dryer.

9. Because of the special nature of their work, psychiatrists may require secretaries assigned to them exclusively and space for these secretaries to work may be required on the unit or in departmental space in the hospital.

Pediatric Unit

The teaching objective of grouping children is to permit students to see the multiple time-linked expressions of disease processes. The patient-care objective is excellence in the care of children. Therefore, age groupings such as infant, toddler, and adolescent are appropriate to the educational aims of the unit.

Like other areas of the university teaching hospital, the pediatric unit will have patients with more complex diagnoses than similar units in the community hospital. This fact, coupled with an increased staff and the presence of medical and nursing students, means that additional spaces will be required to care for the patients, accommodate the people working on the units, and permit grouping of patients either by age or diagnosis, or both.

Children, in general, are disturbing to adult units and are best cared for by personnel trained in the care of children. Consequently, pediatric beds should be consolidated. Adolescent patients seem to be misfits on both pediatric and adult nursing units, and, if the volume is sufficient, are best handled separately.

The physical facilities should be designed for the special needs of children. Single rooms are required primarily for isolation. Closer observation of infants and children is required and should be provided by specially designed features such as glass partitions between rooms and hallways and audiovisual monitoring devices. It is an increasing practice for mothers of seriously ill children to remain with them and to provide part of the care of the child. This requires patient rooms sufficiently large so that mothers may sleep in the room with their children. Infectious-disease control is a particularly important problem with hospitalized children, and pediatric units should be carefully designed with this in mind. Hand-washing facilities should be readily available in all areas. Because of the nature of many childhood diseases, the training of the pediatrician involves considerable active work in the clinical laboratory. Consequently, ample laboratory facilities, especially equipment for microbiology, are essential within the patient-care unit.

Since even a moderately ill child requires diversion, play-therapy facilities, both centralized and within individual rooms, is desirable. If long-term patients are admitted, some school facilities may be required. Although of little space consequence, except in the case of infant formula preparation, the special dietary needs of children must not be overlooked.

The department of pediatrics has the responsibility for the examination and care of all newborn infants in the hospital and is, therefore, closely related to the newborn nursery of the maternity service. The premature nursery is the responsibility of the pediatric service and, by nature of its special function, is usually contained within a special geographically separate unit on the pediatric floor.

In addition to the spaces required on each medical and surgical unit in the hospital are:

1. Four or five consultation rooms large enough to accommodate materials required in psychological and psychiatric testing since these procedures may be carried out here. These rooms may be used by physicians, residents, clinical psychologists, and social workers for consultation with parents, patients, students, and each other.

2. A playroom should be provided as part of the treatment program with storage for toys and equipment selected on a therapeutic basis and operated by trained personnel.

3. On a pediatric unit of 25–30 beds, there will usually be enough long-term patients to require a special room set up as a school room which may be shared by 2 units.

Long-Term Care Unit (*28*)

Patients assigned to this unit require the type of medical and related services which can best be provided in a hospital setting for a prolonged period. However, since the scheduling of care may and should be on a more flexible basis than is required for patients on medical and surgical units, separate units should be provided for these patients if the need exists.

While long-term patients can be housed in a unit similar to medical and surgical units, additional space is required for dining rooms, dayrooms, and training toilets. In the teaching hospital, spaces similar to those outlined to meet teaching needs on medical and surgical units will be required. A unit for physical medicine will have somewhat different requirements from the usual medical or surgical unit to accommodate its special needs.

Hospital policy on the education of patients and their families in long-term care should be considered. The understanding of the disease process by the patient and his family should be assured so that they may assume responsibility for continuing care in the home. The opportunity should be taken to design new types of teaching facilities for this purpose.

Self-Care Unit (*28*)

Ambulatory patients who are convalescing or require diagnosis or therapy may be cared for in this unit.

Rooms should accommodate 2 persons for relatives and patients who prefer not to be alone, and should have private toilets and showers. The unit should be convenient to the hospital cafeteria and the main hospital entrance. In most instances the patient will leave the unit for diagnostic procedures in clinics or laboratories, and the unit should be near circulation space or vertical transportation. In a teaching hospital, the self-care unit will normally be a part of the medical or surgical service, and spaces required for teaching will be located on units of these services. The confer-

ence-demonstration room is satisfactory for teaching on the self-care unit.

Clinical Research Units

Clinical research may be performed on any unit of the hospital. However, some highly organized clinical research in the teaching hospital may require a separate physical unit in the patient-care area of the hospital with its own nursing and dietetic staff, and with directly supporting specialized laboratory facilities and staff (*30*).

These facilities should be located convenient to faculty offices and laboratories of the clinical and basic science departments. Laboratory design should remain flexible so that alterations can be made as programs and projects change. In addition to the usual types of laboratories for basic research, large laboratories with free floorspace for movable equipment are being used increasingly for physiologic research studies on patients. Current trends in the development of discrete clinical research centers make possible a close relationship of beds with laboratories, physiologic procedure rooms, and offices for research on patients.

A multidisciplinary unit on which more than 1 service may carry out research projects is usually from 8 to 15 beds. A categorical unit on which research on a single category of disease such as cancer is conducted may have only 4–8 beds.

The area contained in the average 30–35-bed patient-care unit is usually sufficient when the number of beds is reduced to provide for special facilities as laboratories, physiological procedure rooms, study rooms, and metabolic kitchen. For greater efficiency, a clinical research unit, wherever possible, should be designed and built in a new space rather than converted from an existing patient-care unit. Consideration should be given to the provision of small laboratory units of this type in conjunction with each clinical service in all new teaching hospitals.

Outpatient Department

With the growing importance of ambulatory care in comprehensive medical programs, the outpatient services of university teaching hospitals are receiving increasing emphasis as an important element in medical teaching. Outpatient clinics are valuable teaching resources for developing ambulatory patient-care competence in the medical student, the intern, and the resident physician, and for training and orienting student and graduate nurses, social workers, and others. Because there are usually special facilities for such clinical services in outpatient areas as ophthalmology and otolaryngology that are not duplicated in inpatient areas of the hospital, an increasing number of the ambulatory and wheelchair inpatients are seen in the outpatient department for diagnostic or therapeutic services.

The number of outpatient visits required to support teaching programs varies with the size of the school and the degree to which clinical experience in the outpatient department is emphasized. However, the number for a medical school with an entering class of 64 students is in the range of 50,000–70,000 visits per year, and for one with an entering class of 96 students, 80,000–100,000 visits. Until recently, the number of outpatient visits has been about 8–10 times greater than the inpatient admissions. However, this ratio will vary according to the hospital's service commitment to the community and will probably increase in the future. The community service patient load may be in addition to the visits utilized for teaching. Thus, an outpatient department in a university hospital, which is larger than one of a comparable size community hospital, may have to be even larger to accommodate its teaching programs because of community service commitments.

A large proportion of outpatients have chronic disease problems. Many patients will be on crutches or in wheelchairs and stretchers, and many will be accompanied by friends, relatives, and parents; the usual ratio is 1 attendant to 1 patient.

In planning a new outpatient department special consideration must be given to the size and location of patient waiting areas and the control of patient traffic not only between the clinical areas and other sections of the department itself, but also between the department and the various elements of the hospital to which patients will be referred, such as X-ray.

The outpatient department should be readily accessible to the public. It may have a separate public entrance convenient to public transportation facilities. If it has a separate entrance, a lobby, public toilets, public telephones, reception control center, and waiting area should be provided. Physical proximity of the emergency and outpatient service is desirable so that outpatient facilities can be used for overflow of the emergency service and for temporary handling of mass casualties in a disaster. Outpatient departments of medical schools rarely function in the evenings, whereas the emergency service is an around-the-clock operation, and may be particularly busy during evening hours. The rehabilitation service should also be readily available to the outpatient department and to the inpatient areas of the hospital.

An important consideration in arrangement of the outpatient department is allowance for flow of patients through a reception space. Ideally this space should connect with the outpatient entrance, with the main outpatient waiting area, and with the various smaller waiting areas serving the clinics. It should also communicate with the main lobby of the hospital but should be arranged so that patients will not wander into the hospital area. In a multistory department, elevators or escalators for transporting outpatients to X-ray and other departments of the hospital and to outpatient clinics on other floors should terminate at this reception area.

The hospital pharmacy should be convenient for outpatients. If this cannot be done, provision of a separate dispensing pharmacy in the outpatient department may be required convenient to the outpatient reception area. An adjacent waiting space should be provided for patients waiting to have prescriptions filled.

A receptionist desk from which a clerk can direct and control patient traffic is required. Large concentrations of waiting patients create an impression of impersonal treatment and should be avoided. Waiting areas at the various clinics to which patients can be referred from the main waiting room and thus separated into smaller groups should be provided. An appointment system will reduce the number of persons waiting at any time and the waiting area required. The following figures are sufficiently accurate for roughly estimating space for outpatient waiting: ambulant patients and companions, 12 square feet per person; patients in wheelchairs, 15 square feet per patient; and patients on stretchers, 25 square feet per patient. The usual basis for computing the total square feet for a given waiting area is the anticipated scheduling of patients for that area plus a reasonable percentage of increase for unscheduled patients or those arriving early and for delayed patients.

OUTPATIENT ADMISSIONS

The outpatient admission and registration unit includes facilities for establishing the patient's eligibility for clinic care, for registration, and for initiating the medical record. It should be adjacent to the main outpatient reception area, and a separate waiting space should be provided. The size of the unit will depend on the outpatient load and on whether patients are preponderantly referred or unscheduled. Offices will be required for interviews. Facilities required for registration and initiating records will depend on hospital preference. Whether separate cashier facilities for outpatients are incorporated in the admitting unit or whether the main cashier facilities are used must be determined in each situation.

A unit record system combining both inpatient records and outpatient records is normally used. Means should be provided for conveying records from the record room or registration area to the control desk of the clinic or appropriate diagnostic and treatment area of the hospital. Usually the medical record department of the hospital is responsible for storing and delivering outpatient records to the outpatient department when required. Special consideration should be given to the functional relationship between the outpatient department and the medical record department. (See also Medical Record unit, p. 146.)

ADMINISTRATION

Outpatient administration should adjoin the main reception area and may be combined with admissions. The administrator's office should be accessible but should provide privacy. The director of clinical nursing service will require an office convenient to that of the administrator.

Provision of offices for psychologists, nutritionists, and social workers will depend on the extent these services are emphasized.

MEDICAL DIFFERENTIATION

If a medical differentiation facility is provided, an area with patient waiting space should be provided convenient to the main outpatient reception area and close to the point of outpatient registration so that patients can be more specifically allocated for diagnosis or treatment.

Facilities for such procedures as chest X-ray, urinalysis, hematology, and for such physical measurements as height, weight, temperature, pulse, respiration, and blood pressure should be available.

CLINIC AREAS

Clinic areas have a large number of identical patient examination rooms and a smaller number of consultation rooms, special procedure rooms, nurses' workrooms, conference-classrooms, and small clinical laboratories, usually grouped by clinic. The number of clinics varies with the program. Among those generally provided are medicine, surgery, obstetrics-gynecology, pediatrics, psychiatry, ophthalmology, and otolaryngology. These may be organized on the basis of representative cases of types of disease and should be designed so that they can be used jointly by several clinics on a scheduled basis. The surgery clinic may be divided into such units as orthopedic, genitourinary, and neurosurgical clinics and the medical clinic into cardiovascular, endocrine, diabetes, and other clinics depending on interest and demand. The number of these clinic divisions is usually greater for the medical and surgical clinics and consequently more examination rooms are needed in these areas.

Some teaching hospitals, depending on curriculum requirements, organize their medical and surgical clinics into "general," "group," or "comprehensive" clinics, and the design of the facility should reflect the method of handling patients.

Because of physical requirements and equipment some clinics are not interchangeable. The ophthalmology and otolaryngology clinics are surgical subspecialties, but, because of specialized fixed equipment and special areas such as refraction rooms, each requires an area apart from the surgical clinic, although they may share 1 patient waiting area.

Most obstetrical work in the outpatient department concerns the prenatal care of women in normal pregnancy and the facilities should be planned for the comfort and convenience of these patients. The usual outpatient teaching spaces and areas for instruction in infant care are required.

Dental-care facilities may be arranged to share a waiting area with the ophthalmology or the otolaryngology clinic, or both. However, dental facilities should be convenient both to inpatients and outpatients and sharing a waiting area may not be practical. Dental X-rays are usually performed in the dental area; however, some procedures are performed in the department of radiology.

If dental internship and residencies are offered, the dental staff conducts this phase of the education program and may introduce dental students to the fundamentals of hospital dentistry and offer training for auxiliary dental personnel. Medical students are also provided an opportunity to increase their awareness of the oral manifestations of systemic diseases. Student nurses may be given similar training, as well as instruction in proper oral hygiene practices for patients. In addition, oral surgery residents may use some areas.

Space for outpatient clinical areas depends on the type of procedures to be done. This is particularly true for surgical clinics. Some university hospitals provide facilities for such procedures as drainage of abscesses, cast removal, biopsy, removal of cysts, and minor plastic procedures within the outpatient area. Others provide an ambulant surgical suite for these procedures. (See Surgical Suite, p. 133.) Elective procedures should not be done in the emergency unit, and procedures requiring other than local anesthesia should not be done in either the emergency unit or the outpatient department.

Other facilities to be considered, such as for inhalation therapy and speech and hearing therapy, will depend on the hospital program.

Because of the large number of patients, students, nurses, house officers, and others in the various clinics at the same time, traffic problems are a major consideration. Clinic waiting rooms should

729-445—64——9

be provided with a control desk to accommodate clerks to supervise the flow of patients and coordinate patients' records.

Corridors used by patients should be wide enough to accommodate wheelchairs and stretchers. Some clinics provide internal corridors for the use of students and staff separate from patient corridor.

Table 38 gives the areas for outpatient departments for hospitals of 500 to 700 beds.

TABLE 38.—*Net areas for outpatient departments for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds (50,000–70,000 visits)		700 beds (80,000–100,000 visits)	
	Square feet			
Total		27, 040		34, 580
Main Reception and Waiting Areas				
Total		3, 410		4, 470
Entrance vestibule [1]		240		240
Reception area		600		800
Control center	(8 persons)	180	(4 persons)	240
Main waiting room		1, 700		2, 300
Public toilet rooms	(2)	300	(2)	300
Public telephones	(2)	30	(3)	50
Ambulant inpatient waiting		360		540
Outpatient Admitting and Registration Unit				
Total		1, 550		2, 060
Waiting area		360		540
Information and registration desk		150		200
Chief of admissions office		120		120
Clerical area	(2 desks)	200	(3 desks)	300
Credit clerk's office		100		100
Interview offices	(4)	320	(5)	400
Social workers' offices	(2)	200	(3)	300
Cashier's office [2]		100		100
Medical Differentiation Unit				
Total		800		1, 060
Waiting area		360		540
Reception clerk		100		100
Examination room or cubicles	(3 @ 80)	240	(4 @ 80)	320
Utility room		100		100
Outpatient Administration Unit				
Total		570		650
Administrator's office		150		150
Reception-secretarial office		100		100
Conference room	(10 persons)	200	(14 persons)	280
Nursing service office		120		120
Outpatient clinics				
Total		20, 710		26, 340

See footnotes at end of table.

TABLE 38.—*Net areas for outpatient departments for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds (50,000–70,000 visits)		700 beds (80,000–100,000 visits)	
	Square feet			
Medical clinic		3, 450		4, 430
Waiting area [3]		500		700
Public toilets [3]		80		80
Control center		120		120
Examination rooms	(16 @ 120)	1, 920	(22 @ 120)	2, 640
Consultation cubicles	(4 @ 40)	160	(5 @ 40)	200
Laboratory [4]		150		150
Utility room		120		120
Nurse's office		100		100
Nutritionist's office		100		100
Social worker's office		100		100
Storage		100		120
Surgical clinic		3, 350		4, 330
Waiting area [3]		500		700
Public toilets [3]		80		80
Control center		120		120
Examination rooms	(16 @ 120)	1, 920	(22 @ 120)	2, 640
Consultation cubicles	(4 @ 40)	160	(5 @ 40)	200
Laboratory [4]		150		150
Nurse's office		100		100
Utility room		120		120
Social worker's office		100		100
Storage		100		120
Obstetric-gynecology clinic		2, 350		3, 250
Waiting area [3]		300		540
Public toilets [3]		80		80
Control center		120		120
Examination rooms	(10 @ 120)	1, 200	(15 @ 120)	1, 800
Consultation cubicles	(2 @ 40)	80	(3 @ 40)	120
Laboratory [4]		150		150
Nurse's office		100		100
Utility room		120		120
Social worker's office		100		100
Storage		100		120
Pediatric clinic		2, 750		3, 790
Waiting area [3]		300		540
Public toilets [3]		80		80
Control center		120		120
Observation-playroom		200		280
Dressing and weighing room		100		120
Examination rooms	(10 @ 120)	1, 200	(15 @ 120)	1, 800
Consultation cubicles	(2 @ 40)	80	(4 @ 40)	160
Laboratory [4]		150		150
Nurse's office		100		100
Utility room		120		120

See footnotes at end of table.

TABLE 38.—*Net areas for outpatient departments for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds (50,000–70,000 visits)		700 beds (80,000–100,000 visits)	
	Square feet			
Pediatric clinic—continued				
Dietitian's office		100		100
Social worker's office		100		100
Storage		100		120
Psychiatric clinic		2,400		3,040
Waiting area [3]				
Public toilets [3]		80		80
Control center		120		120
Examination room		120		120
Interview offices	6 @ 80)	480	(8 @ 80)	640
Camera-observation rooms		100	(2)	200
Observation-playroom		200		280
Consultation cubicles	(2 @ 40)	80	(3 @ 40)	120
Nurse's office		100		100
Utility room		120		120
Staff conference room	(10 persons)	200	(12 persons)	240
Group therapy room		400		400
Psychologists' office		100	(2)	200
Social workers' offices	(2)	200	(3)	300
Storage		100		120
Otorhinolaryngology clinic		1,620		2,080
Waiting area [3]		200		300
Public toilets [3]		80		80
Control center		120		120
Examination-treatment rooms	(4 @ 80)	320	(6 @ 80)	480
Recovery room		80		80
Audiometric test and control room		180		180
Observation room		140		140
Medical history offices	(2 @ 70)	140	(4 @ 70)	280
Consultation cubicles	(1 @ 40)	40	(2 @ 40)	80
Nurse's office		100		100
Utility room		120		120
Storage		100		120
Ophthalmology clinic		1,390		1,680
Waiting area [3 5]				
Public toilets [3 5]				
Control center		120		120
Refraction rooms	(2 @ 200)	400	(3 @ 200)	600
Field of vision room		100		100
Treatment room		100		100
Orthoptics room		120		120
Eyeglass repair shop		120		120
Medical history offices	(1 @ 70)	70	(2 @ 70)	140
Consultation cubicle		40		40
Nurse's office		100		100
Utility room		120		120
Storage		100		120

See footnotes at end of table.

TABLE 38.—*Net areas for outpatient departments for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds (50,000–70,000 visits)		700 beds (80,000–100,000 visits)	
	Square feet			
Dental clinic		2, 200		2, 540
Waiting area		250		350
Control center		90		90
Dental operatories	(2 @ 150)	------	(2 @ 150)	------
	(6 @ 90)	840	(8 @ 90)	1, 020
Recovery		80		80
Darkroom		100		100
X-ray reading-conference room		160		160
Offices	(3 @ 140)	420	(3 @ 140)	420
Clinical research laboratory [4]		------		------
Dental processing laboratory		160		160
Storage		100		160
Conference space:				
Conference-classrooms	(4 @ 30)	1, 200	(4 @ 300)	1, 200
Home-care offices [6]				

[1] Includes wheelchair and stretcher storage space.

[2] May not be required if main cashier facilities of hospital are to be utilized for outpatients.

[3] These facilities may be combined among clinics depending on functional arrangement.

[4] Laboratories for use of staff and/or students to be determined for each clinic on the basis of specific program requirements. Some clinics may require 2 laboratories, 1 for staff use and 1 for use of students.

[5] Not required if the ophthalmology and otorhinolaryngology clinics share the same waiting area.

[6] Optional.

TEACHING ASPECTS

Students are usually rotated through outpatient clinics in small groups; in the larger general or specialty clinics, 10–20 students, and in the subspecialty clinics, 2–6. The total number of students assigned to all the clinics at one time may vary from one-fourth of the class to the entire class.

Each student will require an examination room when seeing patients. Patients not assigned to students (including any community-service cases and private patients not a part of the teaching load) are seen by house officers and faculty. Therefore, additional examination rooms are required, the number depending on the scheduling of students and the volume of outpatient visits, on the proportion of first-visit patients, and on the time available for examining patients compared to instruction time. A student assigned to a clinic for a full day may spend 2 hours in conferences and instruction; an intern or resident may spend only 1 hour. A faculty member may spend 5 or 6 hours of his clinic day in instruction. Examination time for students is usually about 2 hours for a new patient and about 45 minutes for a followup patient, although third-year students will usually require more time than fourth-year students. Examination time for house officers and faculty members is usually about 45 minutes for a new patient and about 20 minutes for a followup patient.

Therefore, the number of examination rooms required can only be determined on the basis of the program: the anticipated daily volume of new and followup patients; the number of students, house officers, and faculty available each day on the clinics; and the time available to each for examining patients. However, other factors must be considered in determining the number of examination rooms required. Some of these factors are as follows:

Future expansion.—Unless provisions are made in the initial planning, it is not usually possible to add more examination rooms without disrupt-

ing the relationship of the clinical units. Therefore, to provide for future increase, the eventual number of students, staff members, and patients should be used as the basis for estimating the number of examination rooms required. Since ambulatory care is increasing, it seems likely that there will be increases in the future in all areas.

Physical arrangement.—There are wide variations in the arrangement of outpatient clinics among university hospitals. Clinics may be located on 1 floor and consolidated into 1 unit or a number of contiguous units; they may also be located on several floors or otherwise separated.

If the general medical, surgical, and obstetric-gynecology clinics are located on different floors or are so remote from each other as to preclude joint use of examination rooms, some examination rooms in addition to those for normal operation should be provided in each clinic. Additional examination rooms should be provided in the pediatric and psychiatric clinics.

Other teaching program.—Comprehensive-care programs in which the medical student assumes the central role of a family physician may require examination rooms separate from the medical and pediatric clinics. This may also be true in a family-care program.

Most university hospitals have nurse education programs and utilize the outpatient clinics for teaching nursing students and for orienting graduate nurses. Such programs would not affect the number of examination rooms required.

FACILITIES

Examination Room Characteristics

Medical, surgical, obstetric-gynecology, and pediatric.—The design requirements of examination rooms in medical, surgical, obstetric-gynecology, or pediatric clinics essentially are the same. They should be identical for flexibility of use and large enough to accommodate the patient, the student, an instructor, and a family member or nurse—a minimum of 10 by 12 feet. They should be equipped for taking and recording the patient's medical history, with an examination table and light, lavatory, and patient dressing facility which may be a cubicle curtain or separate dressing rooms. A playroom should be provided in the pediatric clinic.

Psychiatric.—The relationship between patient and physician in the psychiatric situation usually does not include a general physical examination. Treatment is by verbal consultation. The atmosphere of the consultation room should encourage relaxed communication between patient and psychiatrist. Comfortable chairs or couches should be provided with more attention paid to decoration than in the usual clinic examining room. Control of sound from the interview room to adjacent rooms is important because of confidential nature of the discussions. Necessary auxiliary clinic facilities include offices and interview rooms for psychiatric social workers, group therapy rooms, offices for social scientists and psychologists, and laboratory facilities for psychological testing. Access to general outpatient examining rooms and to laboratory and radiology facilities may be required.

Psychiatric clinics of teaching hospitals usually require interview offices which may serve also as regular offices for residents in psychiatry if offices are not provided elsewhere. Some medical schools also provide offices similar to interview offices for staff psychiatrists, psychologists, and social workers in the psychiatric clinic, the number depending on the needs of the program. However, 1 or 2 typical examination rooms should be available for medical examination of psychiatric patients.

Interview offices may be arranged in pairs with one-way mirrors and audiocommunications so that a group of students or the instructor stationed in one room can observe and hear a patient being interviewed in the other. However, if monitoring or recording of patient interview sequences by television or cinecamera is contemplated, a room should be provided between each 2 student interview offices to accommodate the camera and operator. Special consideration should be given to ventilation and to sound transmission.

Observation-playrooms should be provided in the psychiatric clinic for evaluating children.

A conference room seating 16 people should be provided with shelves for journals and other reference material. A group therapy room, which may serve as a conference-classroom, should be available for teaching and group therapy.

Otorhinolaryngology.—Examination rooms here do not require examination tables and dressing facilities. They require special examining chairs and may be smaller than those of the medical or

surgical clinic, but should accommodate the same number of persons.

Position of equipment is an important consideration in planning otorhinolaryngology examination-treatment rooms. Special equipment for each such room includes a dental-type cuspidor with water supply and drain connections, suction and compressed air, electrocautery apparatus, examining light, charting desk, a table for accessories, and a lavatory. Rooms with windows should be equipped with blackout facilities. One room equipped with couch, supply cabinets, and lavatory may be used as a patient recovery room and for tests and procedures when it is necessary for the patient to lie down.

Audiometric procedures cannot be performed effectively in the usual examination-treatment room. For precise hearing tests and for research and investigation a relatively soundproof test room and an adjacent control room with soundproof window between are required. The control room should be large enough to accommodate two persons. Office space for the audiologist, storage space for equipment, and a therapy room for the child undergoing treatment should be provided. If hearing aids are to be prescribed, testing and fitting space will be required. Space for a speech pathologist may be required.

At least one and possibly several consultation offices for medical history interviewing and recording and patient consultation should be provided. The number will depend upon the number of students, usually small, assigned to the clinic at one time.

Ophthalmology.—Among the examination facilities provided in ophthalmology clinics are refraction rooms which require a special examining chair, and other equipment, such as a vision chart, examining light, trial lens, cabinet refractor, ophthalmoscope, tangent screen, and slit lamp. Because of the 20-foot distance to be maintained between chair and vision chart, refraction rooms should be at least 23 feet long.

Another examination room required is a field-of-vision room, or perimetry testing room.

Refractions and field examinations although important are by no means representative of the entire clinical activity, and the extent to which the medical student may be required to engage in them will depend on the curriculum. In most situations refractions are performed by the resident with little student participation. However, the student is usually required to take and record patients' medical histories and perform certain gross examinations as part of the clinical experience. Separate medical history rooms and examination rooms may be required for this purpose. The number of such rooms is usually small since only a few students at a time are assigned to the ophthalmology clinic.

In some diagnostic procedures or treatments such as ocular tension the patient will lie down, and a room equipped with a table or special chair designed for positioning the patient horizontally may be provided. Other items usually included are an eye operating light, adjustable stool, instrument cabinet, and lavatory.

In some university hospitals, the ophthalmology clinic employs a full-time technician for corrective training of cross-eyed children. For such a program a separate orthoptics room is necessary.

Some clinics have "eyeglass shops" of varying complexities for fitting and repair of glasses.

Dentistry *(31)*.—Teaching activities in the dental clinic are carried out in the patient-service areas or separate dental operatories. The largest of these is the section devoted to operative or restorative dentistry. The dental chairs are usually located in cubicles with low partitions to insure privacy and to maintain ease of supervision by the instructing staff. The diagnosis section requires chairs for oral examinations, screening, charting, and consultation. The radiology section adjoining the examining operatories must be protected by lead lining with controls outside the rooms. A small darkroom and X-ray mounting and reading room are required.

The prosthodontic section requires a dental processing laboratory accessible both to the prosthodontic and the operative chair positions.

The oral surgery section, utilizing local anesthesia, includes a scrubup area, preparation area, and sterilization area. A small recovery room should be provided. A research laboratory may be located in this unit for clinical research by staff and for the instruction of dental students in clinical research techniques.

Closed-circuit television is particularly useful for demonstration of dental procedures and the manifestations of disease in the oral cavity. One operatory should provide space for use of a portable television camera and lights.

Conference rooms, locker rooms, and toilet rooms should be available for patients and staff.

Consultation Areas

Review of each patient's workup by a student while on the clinic requires the assignment of faculty and house staff members as instructors. The ratio of instructors to students is not uniform for all clinics. In general, 1 instructor to 2 students gives the instructor time to review each student's findings, and call for consultation by available specialists if this is desired. Discussion between student and instructor should be conducted out of the patient's hearing. For this purpose small consulation cubicles convenient to the examination rooms are appropriate. These may be used also for graduate students in the social or behavioral sciences to interview patients, or for a nursing instructor to confer with one of her student nurses. A ratio of 1 consultation area to each 4 examination rooms is usually accurate enough for a preliminary space estimate.

Student Laboratories

If the curriculum calls for laboratory tests to be preformed by medical students, laboratories equipped for selected laboratory work should be provided. The number will depend on how convenient they are to examination rooms and the extent their use is emphasized. One or two laboratories may suffice if clinics are contiguous. However, if clinics are on different floors or are otherwise remote from each other, a laboratory may be required in each. Some medical schools have found it advantageous to provide small laboratories in some clinics for the use of house officers and faculty members—particularly for the urology, hematology, and pediatric staffs. Whether these laboratories can serve as student laboratories will depend on hospital policy.

Conference-Classrooms

In addition to working with patients, the medical student participates in conferences with his group and instructors. The group also attends lectures of the more formal classroom type presented by the clinical staff. These conferences and lectures are an essential phase of the clinical instruction and occur frequently in all clinics. They require a number of conference-classrooms convenient to the clinical area.

These rooms are used also for group instruction of student nurses and for orientation of graduate nurses. If a home-care program is provided these rooms may be used for coordination conferences. These rooms provide a setting which a member of the house staff, nurse, public health nurse, nutritionist, social worker, or volunteer can instruct patients in matters of health and hygiene. In specialty clinics emphasis may be placed on the disease process involved, and a discussion centered around the patient's role in the management of his disease.

The location and arrangement of the clinics may determine the number of conference-classrooms needed. If clinic units are adjacent and conference-classrooms are convenient to all units allowing flexibility of use, 3 or 4 may suffice. However, if clinic units are widely separated, a conference-classroom should be available to each. Conference-classrooms should not be assigned to a clinical department solely for its own use.

Conference-classrooms should accommodate a student group of about 16 with space for demonstrating a patient. As a basis for preliminary space estimating an allowance of 10 square feet per student and 100 to 150 square feet for the patient demonstration space is adequate. Each should be provided with chairs, chalkboard, tackboard, projection screen, lavatory, X-ray film illuminator, shelves for reference books, and conduit for future television circuits.

Lockers for Students and House Officers

Some authorities prefer to have individual lockers provided in each of the outpatient areas, based on their experience that a remote location for lockers discourages their use. However, if study cubicles with integral lockers are provided convenient to but not in the outpatient areas, locker rooms are not required on the clinics.

Home Care

Some university hospitals have instituted home-care programs for selected patients for whom treatment in their home environment is feasible. The hospital usually provides a range of coordinated services such as medical, social service, physical therapy, and nursing. Some programs provide housekeeping service and drugs and special equipment required. Some of the services may be provided through community participation.

Office space for the administrative staff is required in the hospital.

Accommodation Housing

Some university teaching hospitals find it advantageous to have available motel-like accommodations nearby for the convenience of outpatients and their relatives or friends. Such accommodations have particular significance for patients referred from a distance or for physically handicapped patients and others for whom going home and returning during the interval between clinical appointments is not feasible. This housing is not to be confused with a hospital inpatient self-care or ambulatory unit.

Emergency Service (*32*, *33*)

The emergency service receives, examines, and treats ambulatory and stretcher emergency patients and provides training and experience to undergraduate medical students, interns, residents, and nursing students. The size of the unit bears no relation to the size of the outpatient service nor to the size of the hospital but to the patient load it is required to accommodate. This can be predicted only on the basis of statistical data for the area to be served.

Unfortunately, the emergency service cannot be planned on the assumption that all cases will be true emergencies. Some hospitals find that more than half their emergency caseload consists of routine medical, surgical, pediatric, and obstetric problems, and less than 40 percent true emergencies. Since every patient must be examined promptly, screening and examination rooms are required.

In a mass disaster, the emergency unit may be responsible for receiving, identifying, evaluating, and forwarding to treatment areas of the hospital a large number of emergency patients. Direct availability of the outpatient examination and treatment rooms to the emergency area is therefore important. Emergency examination rooms may be arranged in groups and provided with facilities so they can be opened into one or more large areas such as a surgical area, an orthopedic area, and a medical and obstetric-gynecologic area. An outside "decontamination shower" adjacent to the emergency entrance for use in case of a civilian or military nuclear accident may be considered.

One medical examination room should be equipped with a treatment chair for ophthalmology and otorhinolaryngology cases. X-ray and laboratory facilities must be available either within the unit or convenient to it. History cubicles with space for 3 people may be provded in the examination area.

The emergency unit should be located at grade level, accessible to pedestrian and vehicular traffic, with a separate entrance and reception area. Elements to be considered in relation to the reception area are a receptionist's desk which may function as a cashier facility; a waiting area and pediatrics alcove; an office for police officials, chaplains, and staff interviews; a quiet room; offices for any emergency service administrator or coordinator and his secretary depending on hospital policy; a social service office; and a nursing service supervisor's office. The central medical record facilities of the hospital should be used for storage of emergency patient medical records.

Rooms for short-term patient observation should be provided. A minimum of 3 on-call rooms for house staff, technicians, and medical students assigned to night duty should be provided for assigning male and female house officers or students.

Table 39 gives areas for emergency service units for hospitals of 500 and 700 beds.

729-445—64——10

TABLE 39.—*Net areas for emergency service units for hypothetical hospitals of 500 and 700 beds* [1]

Type of facility	500 beds (50,000 visits)		700 beds (70,000 visits)	
	Square feet			
Total		6, 930		8, 370
Emergency entrance vistibule		200		200
Stretcher-wheelchair alcove		150		150
Reception area		350		400
Public toilets		80		80
Reception and registration desk	(3 persons)	250	(3 persons)	250
Waiting room	(25 persons)	400	(35 persons)	560
Police and press room		200		200
Quiet room		200		200
Social service office		100		100
Nursing service supervisor's office		120		120
Doctors and nurses station		200		200
Screening rooms	(3 @ 80)	240	(4 @ 80)	320
Examination rooms	(12 @ 120)	1, 440	(18 @ 120)	2, 160
History cubicles	(3 @ 60)	180	(4 @ 60)	240
Psychiatric isolation room [2]		150		150
Workroom		130		130
Utility room		120		120
Doctors laboratory		120		120
Emergency operating rooms	(2 @ 300)	600	(2 @ 300)	600
Subutility room		100		100
1-bed observation rooms	(3 @ 130)	390	(4 @ 130)	520
Multiple-bed observation rooms	(4 beds)	400	(6 beds)	600
Nourishment room		60		60
On-call rooms [3]	(3 @ 130)	390	(3 @ 130)	390
Staff lockers and toilets		260		300
Storage		100		100

[1] The visits shown are based on annual emergency patient census of approximately 50,000 and 70,000 visits per year with approximately ⅓ of the patients arriving on Saturday and Sunday.

[2] Space for shower and toilet facilities included.

[3] Each on-call room has connecting toilet.

Radiology

Radiology is the specialty of medicine which deals with the use of X-rays and radioactive isotopes in the diagnosis, treatment, and investigation of disease. Radiologists require highly specialized and expensive appartus and instrumentation. In turn, special training and control of the personnel and special supervision of the facilities used are required to protect patients and personnel from the potentially harmful effects of radiant energy. For these reasons, it is advisable that all radiologic equipment and material be located in 1 departmental area. Virtually all patients coming to a teaching hospital require X-ray services, and the radiologic facility should be located in the hospital and planned for expansion. The design of the department demands careful consideration of the impact of teaching and research and the increase in patient examinations which at the present time are doubling every 8 years.

The relation of the department of radiology to other elements of the hospital is extremely important. From the outpatient department come patients who require X-rays which must be seen by the physician caring for the patient on the day the

films are made. From the inpatient floors, patients come by wheelchair, bed, and stretcher for radiologic services of varying complexity. From the X-ray department, portable machines must be sent to the patient floors or the emergency room to make films of patients who cannot be moved. In the operating room, X-rays are required in the course of actual operations, particularly in neurosurgery and orthopedics. From the hospital's emergency facility, critically ill patients come who urgently require X-ray diagnosis. Thus, traffic to and from X-ray department is heavy and complicated and calls for thoughtful planning with corridors of greater than usual width.

Teaching responsibilities include programs not only for medical students, residents, interns, and X-ray technicians, but also for graduate students. Research is conducted in the diagnostic, therapeutic, and nuclear medicine facilities of the department. The large proportion of complicated cases requires more films per patient and increases the number of diagnostic procedures and radiation treatments. An additional significant factor is in the large number of outpatients.

TEACHING PROGRAMS

Medical Students

Staff members give lectures to the first- and second-year medical students on the basic concepts of X-ray diagnosis and the radiographic appearance of normal and pathologic anatomy. The third- and fourth-year medical students attend radiologic conferences held with the clinical departments of the hospital. Lectures on physical principles and effects of radiation on living matter are conducted with emphasis on therapy, radioisotope procedures, radiation hazards, and radiation protection.

Residents and Interns

The staff of the radiology department usually conducts a residency program for physicians interested in becoming radiologists. This program includes participation in diagnostic and therapeutic procedures and attendance at staff conferences and consultations. Interns may also be given training in radiology.

Graduate Students

The radiotherapy and nuclear medicine staff may conduct research and give lectures and laboratory demonstrations in radiobiology, radiation physics, and health physics to graduate students. The activities related to nuclear medicine may be conducted in departments other than radiology.

X-Ray Technologists

A school of X-ray technology may be conducted by the radiology department of a teaching hospital. The curriculum includes lectures on basic physics and experience with patients, operation of diagnostic and radiation therapy equipment, radiation protection, and film processing. All procedures are performed under supervision of the department of radiology staff.

FACILITIES

Departmental Offices

Departmental offices for the director and his staff may be planned as part of the radiology unit or may be contiguous to it in the clinical science areas of the medical school.

Diagnostic X-Ray

The increased volume of patient examinations requires more rooms than in a community hospital in which to carry out the usual diagnostic procedures.

Special procedures rooms.—Procedures such as angiocardiography and neuroradiography are more frequently performed in teaching hospitals and require rooms in addition to those used for routine procedures. Two or more rooms should be designed to provide adequate space to operate the more specialized equipment and for additional personnel needed to perform these procedures. Facilities for scrubup are required since many of these procedures are done aseptically. These rooms may be used for routine procedures when not required for special procedures. One or more rooms are also required for use of remote television and cinefluoroscopy.

Facilities for performing cardiopulmonary and cardiac catheterization procedures are located in

or adjacent to the radiology department. These include diagnostic and testing areas, sterile procedure rooms, laboratory, and instrument and supply storage.

Film processing.—Facilities for film processing should be designed for use of the rapid processing equipment in which the film is automatically released from the darkroom dry and ready to read. Film sorting, film filing, and viewing rooms should be adjacent to the darkroom so that films may be read immediately. Small automatic or hand processing equipment should be provided to handle emergency films to avoid using the large automatic equipment for emergency work and in case of breakdown of the large equipment.

Viewing.—Small viewing rooms or cubicles should be provided for the staff. In addition, a larger viewing room is necessary to accommodate the patient's physician, the resident, the intern, and medical students assigned to the patient when his film is discussed with the radiologist. As many as 3 or 4 groups of 8 or 9 people may be involved simultaneously in conferences in this room. Some radiologists believe this room should be of sufficient size to permit the viewing of all films processed in a single day. Special film-viewing equipment is required. This method of viewing is considered a more effective utilization of films as a teaching tool.

Film filing and storage.—A room for active film files and teaching films should be located adjacent to the film-viewing room. The range of the number of film envelopes which can be filed in a linear foot of shelf space is 50–80.

Since patient's films for legal reasons must be kept on file for as long as 7 years in some States, it is essential that sufficient additional space be provided for storage of inactive film. An early determination of the type of files to be used, and the extent of microfilming, is essential in estimating the space required.

Library.—A departmental library for films and books for residents and students adjacent to the film-filing area is conducive to review of films and better control of teaching films.

Research.—At least one room should be provided for research and development of new diagnostic procedures and technical improvement of equipment. Research in the fields of electronics and physics as they apply to diagnostic radiography requires additional space which need not be in the hospital. Provision should be made for research laboratory space for radiation biology, radiation physics, and radiochemistry where animal facilities are available.

Radiation Therapy

A significant number of patients are given radiation therapy and more different types of radiation therapy are usually available to patients in a teaching hospital. The source of radiation may be external, internal by implantation, or by injection of radioactive material.

Equipment used may include (1) X-ray therapy in the form of deep therapy (250 to 300 kv) or superficial therapy (100 to 140 kv); (2) high voltage equipment such as the Van de Graaf, betatron, and other kinds of accelerators; (3) radium and other isotopes (plaques or needles); and (4) teletherapy which may be rotational (cobalt or cesium). Individual rooms must be provided for each of the above types of equipment. It may be necessary to provide an operating-type room for implantation or application of radium or radioactive isotopes unless a surgical operating room is used. The design and radiation protection requirements will vary with each room depending on the type of equipment and therapy used.

A room large enough for 4–6 people to enable the physicist, radiologist, residents, and students to work together on patient treatment planning should be provided. Patient examination rooms should be provided.

The use of TV for observation instead of heavy density lead-glassed windows may be desirable in the supervoltage rooms.

Nuclear Medicine

The use of radioisotopes in diagnosis and treatment of patients is a rapidly changing and expanding field. When nuclear medicine such as radiobiology, radiation physics, and health physics is included in a teaching curriculum, provision should be made for patient examination rooms, counting or scanning rooms for measuring the radioisotope uptake in patients, a laboratory with special hoods for preparation of radioisotopes to be used on the patient, and an isotope room.

If only 1 radioisotope laboratory is to be provided, it should be located centrally and accessible to the basic science departments.

A radioisotope receiving, storage, and holding room may be required. This room should have a ventilating hood, a counter, and shelving. A vestibule with self-closing doors opening out, a deluge shower, and space for low file cabinets with work counter should be provided. The installation of this facility, preferably on a grade-level floor, should be in accordance with the rules and regulations of the Atomic Energy Commission and/or the State health department.

Prior to final disposal, radioactive isotope waste must be stored until a proper level of decay has been reached. Disposal procedures must be in accordance with the rules and regulations of the Atomic Energy Commission and/or the State health department.

A laboratory is required for teaching techniques and instrumentation to residents, graduate students, and technicians in nuclear medicine. This room could be in the clinical departmental facilities. A room for whole-body counting, which requires equipment weighing up to 50 tons, may be needed. Structural provisions must be made for this equipment, which is usually located at ground level.

Conference-Classrooms

A conference-classroom to accommodate 15–20 people is required for lectures and consultation. This room would be utilized for lectures to X-ray technicians, residents, house staff, graduate students, and medical students. It should be equipped with movable chairs, chalkboard, tackboard, and film illuminators. A lectern with a light, a projection screen, and a table may also be required.

The radiation therapy and nuclear medicine staff will require a similar room of equal capacity within their own area if the above room is inaccessible. This room may serve for multidiscipline conferences of the tumor clinic.

A larger general-purpose conference room with a capacity for 40–60 people should be available for radiologic conferences with the medical staff. Third- and fourth-year medical students may also attend these conferences. Provision should be made for viewing remote TV fluoroscopy, cineradiography, and closed-TV presentations for educational purposes. Film illuminators are needed for films used in the presentation of cases at staff conferences.

Research Laboratories

Research deals principally with the biological effects of radiant energy and with improvement in the application of radiant energy to diagnosis and treatment. Therefore, facilities for these activities should be provided. A remote location of a clinical radiologic research facility would require costly duplication of equipment. Animals, however, are best housed in the central animal-care facilities. In some situations research laboratories and offices for the department head and staff may be located with other clinical department facilities rather than in the hospital.

Table 40 gives the areas for radiology departments for hospitals of 500 and 700 beds.

TABLE 40.—*Net areas for radiology departments for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds	700 beds
	Square feet	
Total	25, 140	32, 780
Faculty facilities: Total	1, 060	1, 060
Director's office	150	150
Secretary's office	100	100
Postdoctoral fellow's office	200	200
Departmental laboratory	610	610

TABLE 40.—*Net areas for radiology departments for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Diagnostic X-ray:				
Total		11, 850		16, 050
Waiting, reception desk, clerical and control area		400		600
Stretcher waiting		150		300
Chief's office		150		150
Secretary's office	(2 @ 100)	200	(3 @ 100)	300
Staff offices	(7 @ 120)	840	(9 @ 120)	1, 080
Residents' cubicles	(6 @ 75)	450	(8 @ 75)	600
Chief technician's office		90		90
Conference-classroom	(20 persons)	400	(30 persons)	600
Clinical staff conference room	(40 persons)	800	(60 persons)	1, 200
Film-viewing cubicles	(6 @ 50)	300	(8 @ 50)	400
Film-viewing rooms		600		800
Automatic film-processing area		750		750
Film file room; active, inactive		1, 200		1, 600
Film library		300		300
Radiographic rooms	(2 @ 270)	540	(4 @ 270)	1, 080
Control	(2 @ 30)	60	(4 @ 30)	120
Dressing	(4 @ 20)	80	(8 @ 20)	160
Radiographic-fluoroscopic room	(6 @ 325)	1, 950	(8 @ 325)	2, 600
Control	(6 @ 30)	180	(8 @ 30)	240
Toilet	(6 @ 25)	150	(8 @ 25)	200
Dressing	(12 @ 20)	240	(16 @ 20)	320
Barium preparation		30		30
Special procedures rooms	(2 @ 325)	650	(2 @ 325)	650
Controls	(2 @ 30)	60	(2 @ 30)	60
Remote TV and cineradiography		330	(2 @ 325)	650
Male staff toilets		130		160
Female staff toilets		100		130
Men's locker room and toilets	(10 persons)	140	(15 persons)	200
Women's locker room and toilets	(50 persons)	450	(60 persons)	550
Storage		100		100
Janitor's facility		30		30
Radiation therapy:				
Total		6, 210		8, 150
Waiting, reception and control areas		300		400
Stretcher waiting		150		200
Chief's office		150		150
Staff offices	(3 @ 120)	360	(5 @ 120)	600
Secretary's office	(2 @ 100)	200	(3 @ 100)	300
Records and statistics		250		350
Clerical staff		300		400
Residents' cubicles	(4 @ 75)	300	(5 @ 75)	380
Conference-classroom	(20 persons)	400	(30 persons)	600
Treatment planning room		120		120
Examination rooms	(6 @ 110)	660	(8 @ 110)	880
Utility room		160		160
Therapy rooms	(6 @ 250)	1, 500	(8 @ 250)	2, 000
Patients' rest rooms	(4 @ 80)	320	(6 @ 80)	480
Dressing	(8 @ 20)	160	(10 @ 20)	200
Toilets	(4 @ 25)	100	(6 @ 25)	150
Radium storage		50		50

TABLE 40.—*Net areas for radiology departments for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Radiation therapy—Continued				
Patient procedure room		200		200
Physics laboratory		400		400
Storage room		100		100
Janitor's facility		30		30
Nuclear medicine:				
Total		2, 960		4, 060
Waiting and receptionist		200		300
Staff offices	(3 @ 120)	360	(5 @ 120)	600
Secretary's office	(2 @ 100)	200	(3 @ 100)	300
Conference-classroom	(15 persons)	300	(20 persons)	400
Examination rooms	(3 @ 110)	330	(5 @ 110)	550
Patient counting room	(3 @ 110)	330	(5 @ 110)	550
High-level laboratory		400		400
Low-level laboratory		400		400
Isotope vault		60		80
Isotope waste storage		50		50
Equipment storage		300		400
Janitor's facility		30		30
Cardiopulmonary:				
Total		1, 570		1, 570
Angiocardiography		330		330
Controls		30		30
Vascular and catheterization procedures		500		500
Laboratory		250		250
Storage		100		100
Utility and scrubup room		160		160
Pulmonary function testing		200		200
Common-use facilities:				
Total		1, 490		1, 890
Research laboratories	(3 @ 200)	600	(5 @ 200)	1, 000
Data room		280		280
Cold room		200		200
Animal room		410		410

Clinical Diagnostic Laboratories

The planning of the clinical pathology diagnostic laboratories in a teaching hospital differs from that of a nonteaching hospital because of the variety of teaching programs, more research, a greater variety of tests, and an increase of as much as 100 percent in the volume of laboratory tests. A teaching hospital has more patients who are critically ill and who require more freqent laboratory tests, and many patients with undiagnosed illnesses who require extensive laboratory studies and more accurate quantitation of data.

Since the volume of work in all these sections is expected to continue to increase—the present rate is about 10 percent per year—the importance

of locating the clinical diagnostic laboratories in an area of the hospital which permits expansion should be emphasized.

An understanding of the functional relationship between the various laboratory areas is a primary consideration in planning a teaching hospital since the educational programs and research become an integral part of the clinical laboratories and must be coordinated with the patient-service activities. All areas should be planned for flexibility and expansion.

Requirements for student and staff laboratories on the patient-care unit are discussed in the section on patient-care units.

TEACHING PROGRAMS

Medical Students

The professional staff as faculty members give lectures to the second-year medical students on the use of clinical laboratory procedures as diagnostic tools. These classes are usually held in classrooms in the basic science facility. Informal teaching to third- and fourth-year medical students is done on the wards in conference-classrooms

Residents

The staff of the clinical diagnostic laboratories are responsible for that part of the pathology residency program pertaining to clinical pathology. Residents rotate through the major laboratory sections of the clinical laboratories, such as hematology, blood bank, chemistry, and microbiology. A workspace (office) approximately 120 square feet in area equipped with a desk, chair, bookcase, file cabinet, laboratory workbench, and stool should be provided in these sections for residents.

Medical Technologists

Provisions for a curriculum in medical technology should be considered. The curriculum includes lectures and demonstrations by the laboratory staff. The students obtain their practical experience by rotating through the various laboratory units on a planned schedule. Some schools may prefer to provide special teaching laboratories for beginning students. More advanced students may be assigned in the general laboratories. In this case, additional space may be required.

FACILITIES

Laboratory Areas

Administration.—The administrative area should include facilities for the administrative director and his secretary and clerical personnel and reception and waiting space for patients. The space requirements for data-processing equipment in this area will vary according to the method of collection, storage, and retrieval of the laboratory data. Since methodology and equipment are rapidly changing, the department should know the system to be established in the university so that the clinical laboratory will have adequate space for the equipment required for the service. The large number of laboratory personnel employed in teaching hospitals requires that provisions be made for lounge and locker room facilities.

Technical.—The clinical diagnostic laboratory area is divided into various sections according to the type of laboratory procedure performed. They are usually identified as hematology, chemistry, and microbiology, which includes bacteriology, serology, parasitology, mycology, and virology. The virology unit may be used for tissue culture and virus isolation requiring special equipment and may be located in the basic science facilities.

The blood bank and transfusion service is located in a separate area easily accessible to the public and to the hospital areas it serves. A pullman-type kitchen with refrigerator is provided for nourishment for the donors.

Office and research laboratory space for the heads of the various sections may be provided within the unit for which they are responsible. The supervision of these may be decentralized so that the members of the departments of medicine, biochemistry, or microbiology are responsible for the operation of the hematology, clinical chemistry, and microbiology sections of the clinical laboratory. In any event, office and research space should be provided in the hospital diagnostic laboratories or in the clinical department space.

The application of automation to clinical laboratory procedures is making considerable progress, resulting in increased productivity and more rapid reporting, freeing personnel for other work, and freeing space for new procedures. The teaching hospital has pioneered in the development and application of these methods. In hematology it is used in the counting and sizing of cells. Several of the more common chemical procedures also have been successfully automated. Microbiologic procedures appear to have the least adaptability to this type of mechanization. Automatic pipettes and tissue-processing equipment have been in use for some time. The introduction of automated procedures in the clinical laboratories will be major consideration in the determination of space requirements especially in the teaching hospital.

Facilities for performing tests, such as basal metabolism, electrocardiograms, electromyograms, and electroencephalograms are often provided in rooms adjacent to the clinical diagnostic laboratories.

Some of the medical staff will probably specialize in metabolic, pulmonary, cardiac, and neurologic diseases, which will result in an increased number of requests for the physiologic procedures related to their specialty. Under these circumstances they prefer to do these tests with their own technicians and equipment in facilities provided near their clinical areas.

Auxiliary Service Units

Auxiliary service units, such as glass washing, sterilizing, and media preparation unless provided in microbiology (see page 72), should be located as close to the technical units they serve as possible to provide a smooth flow of material to and from the units. The amount of space is related to the workload and the number of personnel required to handle it. More and more disposable equipment is being used, so careful consideration should be given to the glass washing and sterilizing equipment requirement, as their size may be considerably reduced if the present trend continues. Storage provisions for chemicals, glassware, and apparatus are more complicated in teaching hospitals because of the larger volume and specialized nature of these items. Most of the items must be stored in the immediate area for efficient operation. This is particularly true in the research laboratories. Common glassware such as pipettes, beakers, and cylinders are used in greater volume and, therefore, provisions should be made for a large central storeroom where the bulk of the supply is kept and requested as needed. This is also true for storage of chemicals.

Animal Holding Rooms

Small animals used for diagnostic tests may be housed adjacent to the clinical diagnostic laboratories, but they are best kept in special facilities designed for this purpose in the basic science facility.

Utility Services

The increasing use of equipment requiring electrical power for its operation should be anticipated in teaching hospitals. Many of the instruments used are sensitive to voltage variation and care should be taken to assure that constant voltage is provided to the clinical laboratory area and that all outlets are properly grounded. Because types of equipment vary, flexibility of the current characteristics and location of the electric-power outlets are primary considerations. The need for complete flexibility of clinical laboratory facilities in a teaching hospital is of considerable importance, and provision should be made for water, waste, gas, vacuum, distilled water, and compressed-air lines in all areas, particularly research areas, since program changes often convert an office or storage room into a laboratory.

Conference-Classroom

The medical technology training program requires a room within the laboratory area large enough to accommodate 25–30 people for lectures and demonstrations. The room should be equipped with a lectern with a light, table, chalkboard, projection screen, and movable chairs with writing arms. A small laboratory workbench with electric, gas, air, and vacuum outlets and a sink with running water may be needed, depending on the type of demonstration.

Morgue and Autopsy

If the basic science facilities are not contiguous to the hospital, morgue and autopsy facilities should be located in the hospital to avoid transporting the body from one building to another.

Guidelines for planning these facilities are given in the section on Department of Pathology, p. 76.

Table 41 gives areas for clinical diagnostic laboratories for hospitals of 500 and 700 beds.

TABLE 41.—*Net areas for clinical pathology diagnostic laboratories for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		19, 820		25, 380
Administrative facilities:				
Total		2, 980		4, 050
Waiting, reception desk, record files and clerical area		500		800
Director's office		150		150
Secretary's office		100		100
Associate director's office	(2 @ 120)	240	(3 @ 120)	360
Secretary's office	(2 @ 100)	200	(3 @ 100)	300
Resident's office		120	(2 @ 120)	240
School of medical technology office		120		120
Data processing [1]		----		----
Office supply closet		40		50
Conference-classroom	(30 persons)	600	(30 persons)	600
Blood specimen booths	(5 @ 40)	200	(7 @ 40)	280
Urine specimen toilets	(5 @ 30)	150	(7 @ 30)	210
EKG, EEG, and BMR rooms	(3 @ 120)	360	(5 @ 120)	600
Male staff toilets		100		130
Female staff toilets		70		80
Janitor's facility		30		30
Technical facilities:				
Total		14, 530		17, 780
Chemistry:				
Routine procedures		1, 300		1, 500
Special	(4 @ 200)	800	(6 @ 200)	1, 200
Toxicology		400		500
Solution preparation room		300		400
Balance room		150		200
Instrumentation		400		500
Chief's office and clerk		200		200
Resident's office		120		120
Graduate-student laboratory		200		200
Storage		100		100
Microbiology:				
Bacteriology		1, 000		1, 200
Mycology and tuberculosis		200		200
Special	(2 @ 200)	400	(3 @ 200)	600
Parasitology		300		300
Virology		400		600
Serology		400		400
Culture media preparation		300		400
Chief's office and clerk		200		200

See footnote at end of table.

TABLE 41.—*Net areas for clinical pathology diagnostic laboratories for hypothetical hospitals of 500 and 700 beds*—Con.

Type of facility	500 beds		700 beds	
	Square feet			
Technical facilities—Continued				
Microbiology—Continued				
Resident's office		120		120
Graduate-student laboratory		200		200
Storage		100		100
Hematology:				
Routine procedures		1,000		1,200
Chief's office and clerk	(2 @ 200)	200		200
Special	(2 @ 200)	400	(3 @ 200)	600
Resident's office		120		120
Graduate-student laboratory		120		120
Storage		100		100
Clinical microscopy:				
Routine procedures		600		800
Chief's office and clerk		200		200
Graduate-student laboratory		200		200
Storage		100		100
Janitor's facility		30		30
Blood bank and transfusion service:				
Waiting		300		400
Chief's office		200		200
Control area, secretary, clerks, files		600		800
Office and examination		200	(2 @ 200)	400
Donor interview		250		350
Blood storage and matching		500		600
Blood collection		600		700
Immunology		200		200
Processing room		300		400
Plasma processing		300		400
Special		200		200
Resident's office		120		120
Graduate-student laboratory		200		200
Storage		100		100
Auxiliary facilities:				
Total		2,310		3,350
Glass washing and sterilizing		800		1,000
Animal room		400		600
Storage		500		800
Male locker room	(10 persons)	140	(15 persons)	200
Female lounge and locker room	(50 persons)	470	(90 persons)	750

[1] Optional.

Surgical Suite

The department of surgery in a teaching hospital usually includes most of the surgical specialities, not only for the benefit of the community, but for educational purposes as well.

Some surgical procedures require special operating rooms and a variety of electronic monitoring and recording and pressurizing devices for patient care. Other electronic equipment and laboratory facilities may well be considered to further clinical research.

Wide variation exists in the number and size of educational programs in the surgical suite be-

cause of differences in curriculum and the instruction of graduate personnel in new or specialized techniques. Teaching programs require such facilities as a conference-classroom, an instructor's office, and student lockers.

The facilities for education and research have a significant effect on the size and complexity of a surgical suite and emphasize the importance of initial programing and planning.

TRAFFIC CONTROL

The importance of functional arrangement and adequate corridor space cannot be overemphasized. A large number of patients, house staff, visiting staff, operating-room personnel, medical students, and technicians may be in the surgical suite at one time, and there is need for area zoning to control traffic and reduce the possibility of cross-infection. The operating-room area should be separated from other areas by a buffer or interchange zone.

An ambulant surgical unit located within or adjacent to the surgical suite requires special consideration in traffic control as it serves both inpatients and outpatients. Connecting corridors from major surgery to ambulant surgery should be restricted to surgical personnel and should have the same degree of cleanliness as corridors leading to operating rooms.

A control center similar to a nurses' station should be provided to control traffic and perform administrative functions, located, if possible, at the entrances to surgery and the ambulant surgery unit with communication with the surgical supervisor's office. Some arrangements may require separate control centers for surgery and ambulant surgery.

TEACHING PROGRAMS

Residency programs in general and specialized surgery and anesthesiology instruction for interns are usually included. Medical students in their clinical years may be assigned to assist or observe in the operating room.

Instruction in operating-room and recovery-room nursing and a course for surgical technicians may be offered. Nursing students may receive general instruction in the surgical suite. (Teaching programs in anesthesiology are discussed on p. 138.)

FACILITIES

Operating Rooms

The teaching hospital has a high proportion of complicated surgical cases that require extended operating periods. Additional time per operation may also be necessary for instruction.

These factors indicate the necessity for a greater number of operating rooms than is required in hospitals with minor teaching responsibilities and a lower proportion of complicated cases. Operating rooms should be large enough to accommodate students in surgery and anesthesiology, visiting staff, and others under instruction, without sacrificing the space normally needed for the attending staff and operating-room personnel. The least dimension of any operating room should be 20 feet and a minimum room size of 400 square feet is recommended.

Television.—Many teaching hospitals have installed closed-circuit television in operating rooms as an educational medium of instruction. Hospitals not contemplating immediate use of television should, in any event, install conduits for future cables in each operating room and provide a control room for monitoring and video tape recording. (See section on hospital supporting services p. 153.)

Electric power.—The increasing number of electronic devices in operating rooms results in a heavy power load. Separate power and lighting circuits should be provided for each operating room or operating- and equipment-room unit. Conduit space and power panels large enough for future circuit needs should be provided.

Viewing galleries.—The provision of operating-room viewing galleries for educational purposes is a controversial subject. However, it is generally agreed that at least one operating room should have a viewing gallery of some type.

Induction rooms and research laboratory.—(See section on anethesiology, p 138.)

Specialty Operating Rooms

The size and type of the surgery caseload controls the need for specialty operating rooms. In the teaching hospital, the requirements of surgical residency programs and clinical research necessitate provision for most surgical specialties. Emphasis should be given, for example, to special

rooms for thoracic and cardiac surgery, neurosurgery, and orthopedics in the surgical suite. Other specialty rooms may be included in the ambulant surgical unit.

Both cardiac and neurosurgery require operating rooms of 500 and 600 square feet to accommodate large surgical teams and special equipment. Additional monitoring and recording devices may be located in an adjoining room of not less than 200 square feet. These devices may need to be seen by the surgeon or anesthesiologist.

The orthopedic operating room is usually between 450 and 500 square feet and is furnished with overhead X-ray equipment. An adjacent room of about 200 square feet is needed for plaster, splints, and fracture materials. The room should be equipped with a plaster sink and counter.

Recovery Room

The postanesthesia recovery room is required for patient care, and is an important educational area for those specializing in recovery-room nursing and for residents, interns, medical students, and nursing students. An allowance of 1 recovery bed per operating room has generally proved to be satisfactory.

Frozen Section Laboratory

A laboratory for frozen section processing and microscopic examinations may be required. Pneumatic tubes and adequate communications may enable this work to be done in the pathology department; otherwise, a 100-square foot laboratory should be located close to operating rooms. Closed-circuit TV from the pathologist's microscope to a monitor in the operating room may be used.

Darkroom

A darkroom may be required unless the darkroom in radiology is conveniently located.

Nurse Instructor's Office

An office should be provided for the nurse-instructor of nurses and/or technicians near the surgical suite entrance equipped with a desk, file cabinet, and chairs for 2 students.

Conference-Classroom

A conference-classroom to accommodate 30 persons should be provided for discussions on scheduling cases and for preoperative and recovery-room teaching programs. The conference-classroom should be located in a nongowning zone and made available to those not necessarily concerned with activities within the surgical suite.

Equipment should include chairs, film illuminators, chalkboard, projection screen, television monitor, and a lavatory. Storage space may be required for demonstration equipment. Shelves should be provided for reference books.

Lounge

A lounge should be provided outside the suite for faculty, house staff, and visiting staff adjacent to locker facilities and available to female physicians. Dictating facilities should be available and a couch should be provided.

Waiting Areas

Waiting areas should be provided outside the suite for outpatients and those accompanying them and for families of outpatients and inpatients undergoing surgery.

Locker and Toilet Facilities

Locker and toilet facilities should be provided for the surgical faculty, visiting staff, house staff, nursing personnel, and orderlies. Teaching hospitals need additional facilities for male and female medical students, nursing students, and technicians.

Whether student facilities are separated or combined with those of the faculty, house staff, and nursing personnel will depend on hospital policy. Student lockers and toilets are shown separately in the space estimates.

Radiation and Explosion Protection

Specialty rooms, such as orthopedic, neurosurgery, and cystoscopic, use X-ray extensively and should have built-in protection against radiation hazard. Other operating and examining rooms may require similar protection if continuous use of X-ray is anticipated. Occasional use of

portable X-ray machines in operating and examination rooms may require only portable-screen shielding for protection of personnel.

Flooring of rooms in which explosive agents are used or handled and adjacent connecting areas should be conductive and installation should comply the recommendations of the National Fire Protection Association (*34*).

Ambulant-Patient Surgical Unit

Hospitals have various methods of providing for surgical procedures for ambulant patients. An ambulant-patient surgical unit, where most such procedures may be carried out, is preferred. It should be located adjacent to the surgical suite so that surgical and anesthetic personnel are concentrated in one area, resulting in greater efficiency in the use of personnel. Locker and toilet facilities need not be duplicated and equipment such as portable X-ray machines may be shared.

The range of service elements included within the unit is dependent on hospital policy. Space estimates for an ambulant-patient surgical unit in table 42 list facilities frequently provided. A patient waiting area with a reception clerk's desk should be located at the entrance to the unit. Allowance for stretcher patients is necessary in addition to seating space. Separate dressing rooms with individual booths and toilet facilities for males and females are required. A recovery or observation room with cots to accommodate post-examination and postoperative patients should be provided. Direct access from the observation room to patients' dressing rooms is desirable. The control center of the surgical suite should handle control and administrative functions for the ambulant-patient surgical unit; otherwise, a separate control center will be required.

TABLE 42.—*Net areas for surgical suites for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		22,210		28,420
		16,150		20,950
Major operating rooms	(8 @ 400)	3,200	(12 @ 400)	4,800
Scrub and substerile	(4 @ 300)	1,200	(6 @ 300)	1,800
Induction rooms [1]				
Cardiac operating room		550		550
Scrub and substerile		250		250
Induction room [1]				
Electronic equipment room		200		200
Viewing gallery				
Neurosurgical operating room		550		550
Scrub and substerile		250		250
Induction room [1]				
Electronic equipment room		200		200
Orthopedic operating room		500		500
Scrub and substerile		250		250
Induction room [1]				
Fracture equipment and plaster room		200		200
Darkroom and film viewing		160		160
Stretcher holding area		200		300
Frozen section laboratory		100		100
Mobile X-ray		50	(2 @ 50)	100
Clean supply storage		300		400
Instrument processing and storage area		1,000		1,400
Cleanup and soiled holding room		300		400

See footnotes at end of table.

TABLE 42.—*Net areas for surgical suites for hpyothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Nurses' station		150		200
Doctors' charting		200		250
Nurses' toilet		30		30
Surgical supervisor's office		120		120
Secretarial office		170		170
Nurse instructor's office		100		100
Control center		200		250
Dictation booths	(6 @ 30)	180	(10 @ 30)	300
Equipment		250		300
TV and monitoring control room [1]				
Recovery room	(15 beds @ 110)	1, 650	(19 beds @ 110)	2, 090
Isolation recovery rooms	(2 @ 120)	240	(2 @ 120)	240
Utility and control section		220		220
Patient holding area		250		400
Conference-classroom	(20 persons)	400	(30 persons)	600
Doctors' and residents' lounge [2]		500		600
Doctors' locker room [3]	(80 persons)	520	(110 persons)	710
Doctors' toilet and shower room [3]		220		300
Nurses' lounge		150		200
Nurses' locker room [4]	(80 persons)	520	(110 persons)	710
Nurses' toilet and shower room [4]		220		300
Orderlies lockers, toilet and shower room		200		250
Student lockers, toilet, and shower room		200		200
Nourishment facilities [1]				
Ambulant patient surgery unit:				
Total		6, 060		7, 470
Waiting area		380		500
Control center		120		120
Nurse's office		100		100
Observation room		300		400
Dressing room and toilet (male)		200		250
Dressing room and toilet (female)		200		250
Clean supply storage		40		40
Soiled holding area		120		120
Instrument room		270		270
Operating rooms	(4 @ 280)	1, 120	(4 @ 280)	1, 120
Fracture room		320	(2)	640
Plaster room		160		160
Cast change room		220		220
Darkroom		40		40
Cystoscopy room [5]	(4 @ 350)	1, 400	(6 @ 350)	2, 100
Patient dressing booth	(2 @ 25)	50	(4 @ 25)	100
Patient toilet and vestibule		80		100
Scrub and substerile—also for endoscopy		250		250
Endoscopy room	(2 @ 270)	540	(2 @ 270)	540
Stretcher alcove		50		50
Equipment storage		100		100

[1] Optional.
[2] For men and women doctors, visiting staff, residents, and undergraduates.
[3] For male faculty, house officers, and visiting staff.
[4] For nursing staff and women doctors.
[5] Includes control and darkroom.

The service, research, and educational responsibilities of the anesthesiologists require offices, laboratories, and other areas usually located within the surgical suite. Instruction in the use of anesthetics is given to medical students, interns, anesthesiology residents, and in some programs nurse-anesthetists. Instruction in inhalation therapy may also be included if this service is under the administration of anesthesiology. The departmental staff may perform both basic and clinical research.

TEACHING PROGRAMS

Second-year medical students may receive instruction by the anesthesiology staff either in the hospital or in the department of pharmacology. In the third or fourth year, medical students are assigned clerkships and observe anesthesia procedures in induction, delivery, or operating rooms. Usually not more than 2 students are present at any 1 procedure. They may also have classroom instruction in applied physiology and pharmacology, ventilation, and anesthetizing agents. Some schools offer an elective program to fourth-year medical students. This program may include actual administration of anesthetics under supervision and basic research requiring the use of laboratory facilities such as those described under clinical departments.

Residency training in anesthesiology covers a period of 2 or 3 years. Residents perform anesthetizing services as members of the house staff; attend conferences; and may be assigned to instruct interns and medical students.

A program for nurse anesthetists requires instruction in anesthetizing procedures and is taught in the induction, operating, and delivery rooms. The operation and care of various types of anesthesia equipment may be demonstrated in the surgical suite conference-classroom.

FACILITIES

Induction Rooms

The use of induction rooms in surgery is controversial. Some anesthesiologists believe that a number of factors may make such rooms desirable in the teaching hospital. They provide a location for instruction away from the sterile setups of the operating room. Slow and difficult inductions may take place here while the operating room is still occupied or while cleaning is in progress. The induction room may serve as a holding area for patients on stretchers. Induction rooms may require an additional corridor entrance to the operating room for movement of supplies and personnel. They should accommodate the patient stretcher, anesthesia instructor, 1 nurse, 2 students, and induction equipment. (A room of 120 square feet is usually adequate.) Conductive flooring and finishes should be the same as those in operating rooms.

Research Laboratory

For some types of research a laboratory adjacent to the surgical suite may be desirable. This laboratory may conduct chemical analyses on blood and body fluids removed from patients during operating procedures. A 400-square-foot laboratory is suggested for this type of research. Research involving animals will be conducted in the basic science facility.

Storage Space

In the teaching hospital anesthesiologists use a number of monitoring and other devices for patient care and research. In addition to the usual anesthesia clean-up, storage, and workroom, an equipment storage room with 200 to 250 square feet is required. It should contain shelving for spare parts and floorspace for movable equipment. If this room is located near operating rooms, it will reduce the movement of large equipment. It will require outlets for water and compressed air.

Department Facilities

Offices and research laboratories for anesthesiology are similar to those provided for other clinical departments. Facilities should include a library-conference room, offices for the department head and his staff, a secretarial office, and an office for the chief resident. Office space for other residents may be combined in 1 room with 1 desk

provided for each 2 or 3 residents. Research laboratories should be adjacent to department offices.

These department facilities should be located either adjacent to surgery, or in a clinical department area directly connected with the hospital and convenient to the surgical suite.

Table 43 gives areas for anesthesiology for hospitals of 500 and 700 beds.

TABLE 43.—*Net areas for anesthesiology for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		860		1,050
Anesthesiology offices	(2 @ 100)	200	(2 @ 100)	200
Preparation room		260		300
Equipment storage		300		400
Gas storage		100		150
Research laboratory [1]				
Research equipment storage [1]				

[1] Optional.

Inhalation Therapy

Inhalation therapy is receiving increasing emphasis as an important hospital service. It is a relatively new field, with responsibilities in patient care, research, and training of personnel. This service may be provided by the department of anesthesiology or any one of several clinical departments depending on the organizational pattern of the hospital.

An equipment cleanup and work room is required to function as home base for the therapists and trainees and as a storage and maintenance area for equipment. Requirements include space for oxygen tents, a workbench, small parts storage, a writing table for 3 or 4 persons, and a work area. An office for the chief inhalation therapist is required and should be located adjacent to the equipment room. This facility may be placed in a service area of the hospital, but should be close to elevators that service the patient-care units.

Trainees in inhalation therapy receive lectures and bedside demonstration and instruction in breathing treatment, oxygen concentration testing, and the cleaning and handling of inhalation equipment. Eight or nine high school graduates may be accepted for this 1-year, inservice instruction.

Table 44 gives areas for inhalation therapy services in hospitals of 500 and 700 beds.

TABLE 44.—*Net areas for inhalation therapy services for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds	700 beds
	Square feet	
Total	800	900
Office for chief inhalation therapist	100	100
Equipment cleanup and workroom	600	700
Storage room	100	100

Labor-Delivery Unit

The labor-delivery unit (*35*) in the university teaching hospital is an important area for the education of residents, interns, and medical and nursing students. It is a self-contained unit and does not draw upon the various clinical specialties in the hospital in the way some services such as X-ray and the surgical suite do. Therefore, the impact of teaching programs is not so great there,

and the requirements for additional facilities to accommodate teaching programs are not as extensive as in some other areas. Most of the teaching in obstetrics and gynecology takes place on the patient-care units so that the number of residents, interns, or medical students present in the labor-delivery unit at one time seldom exceeds the number of patients in the labor rooms.

The equipping of specific labor or delivery rooms for research should be considered in the early planning stages because of the extra space required and special requirements for electronic monitoring, television, or other devices.

TEACHING PROGRAMS

Residents in obstetrics perform deliveries as members of the house staff; attend conferences; and may be assigned, along with the faculty, to instruct medical students and interns. Some medical and nursing students may follow assigned patients through labor, delivery, and recovery periods. Nursing students may observe deliveries and receive instruction in obstetrical nursing.

FACILITIES

Student Charting Area

Medical students assigned to the delivery suite need access to patients' charts. A medical student charting room prevents overcrowding at the nurses' station and facilitates the duties of the professional staff. The charting room should be located adjacent to the nurses' station and should be sized to accommodate the number of students expected on the unit at one time. The chart rack may be placed in a central position available to staff and students.

Conference-Classroom

A conference-classroom to accommodate at least 12 people should be provided for conferences with medical and nursing students. Equipment should include chairs, film illuminators, chalkboard, projection screen, television monitor, bookshelves, and a lavatory.

Student Locker and Toilet Facilities

The locker and toilet facilities provided for the faculty, house officers, and the nursing staff should be increased to accommodate undergraduate students, or separate facilities should be provided.

Lounge

A residents' lounge or readyroom should be provided in addition to the staff lounge. This provides a place for residents and interns to discuss problems without leaving the suite.

On-Call Rooms

Medical students assigned to the delivery suite need sleeping facilities. An on-call room for male students and one for female students should be provided in addition to sleeping accommodations normally provided for the obstetrical staff.

Admitting and Preparation Unit

Such a unit may be desirable in hospitals where a large daily patient load and hospital policy makes it desirable after observation, to divide patients into groups: those to return home; those to go to the patient-care unit; and those to be admitted to the labor-delivery unit (*35*).

Table 45 gives areas for labor-delivery units for hospitals of 500 and 700 beds.

TABLE 45.—*Net areas for labor-delivery units for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		5, 575		7, 030
Delivery rooms	(2 @ 310)	620	(3 @ 310)	930
Special delivery room		400		400
Scrub and substerile areas [1]	(2 @ 180)	360	(2 @ 180)	360
Cleanup and soiled holding room		150		150
Clean supply storage		400		400
Medication preparation		80		80
Anesthesia equipment and workroom		130		160
Anesthetists' on-call room		100		100
Anesthetist's office		100		100
Gas storage		70		70
Equipment storage		100		150
Stretcher alcove		90		150
Nurses' station		200		200
Labor rooms, single bed [2]	(5 @ 130)	650	(8 @ 130)	1040
Recovery room	(2 beds @ 110)	220	(4 beds @ 110)	440
Doctors' lounge		200		250
Doctors' sleeping rooms	(2 @ 80)	160	(3 @ 80)	240
Doctors' locker rooms [3]	(15 persons)	170	(35 persons)	230
Women doctors' lounge and sleeping rooms		225		300
Nurses' lounge		160		200
Nurses' locker rooms [4]	(20 persons)	130	(20 persons)	200
Nurses' toilet and shower		180		200
Student charting area				
Conference-classroom	(12 persons)	300	(12 persons)	300
On-call rooms	(2 @ 100)	200	(2 @ 100)	200
Fathers' room and toilet [5]		180		180
TV control and monitoring room [6]		---		---

[1] Usually 1 for each 2 delivery rooms.
[2] Including private toilets.
[3] For male faculty, house officers, visiting staff, and undergraduate students.
[4] For nursing staff, women doctors, and undergraduate students.
[5] Locate outside suite.
[6] Optional.

The university teaching hospital is expected to play a key role in providing rehabilitation services and facilities to restore disabled persons to optimum physical, mental, social, vocational, and economic usefulness. With its dynamic and progressive environment, the availability of medical consultants, and its training and research programs, it is the primary place for training physicians, physical therapists, occupational therapists, nurses, vocational counselors, psychologists, social workers, orthopedic technicians, and others.

Organizational patterns vary widely. However, to meet service, research, and educational responsibilities the rehabilitation service requires offices, laboratories, and a number of service and teaching areas. Except for inpatient beds which may be assigned to rehabilitation, the elements that comprise the department are usually located near each other and convenient to outpatients and inpatients. The services are usually subdivided into sections such as medical (which includes the inpatient beds), physical therapy, occupational therapy, speech therapy, social service, vocational counseling, psychological services, prevocational laboratory, rehabilitation nursing, and prosthetic and orthetic devices.

Social service and psychological services are the responsibility of their respective departments, which may delegate key personnel on a full-time basis to become members of the rehabilitation team.

TEACHING PROGRAMS

Fourth-year medical students may rotate through the various sections of the services in groups of 4 to 5 students. The rotation period is usually 5 full days a week for 2 or 3 weeks. The ratio of students to instructors is 2 to 1. Informal group conferences and classroom demonstration are included as part of the clinical sequences.

Rehabilitation nursing as a graduate program of the school of nursing may require 16 hours of didactic teaching and 2 months of supervised clinical training involving the care of patients with severe disabilities and long-term illnesses in their hospital rooms and in their homes after discharge from the hospital. It also involves working with therapists and counselors, nursing staff, and family. The number of student nurses assigned at any one time will depend on the program and the clinical facilities available.

Physical Therapy

Physical-therapy students are generally prepared in a program leading to a bachelor's degree. During the first 2 years, requirements of general education are met. During the third and fourth years, students study sciences basic to physical therapy such as anatomy, physiology, and pathology. The course also includes at least 600 hours of clinical experience in the care of patients, supervised and instructed by physical therapists. This clinical experience is provided through the physical-therapy department and its affiliated units.

Occupational Therapy

Instruction in the use and application of occupational therapy is given to residents in neurological, orthopedic, physical medicine, and psychiatric programs; and to undergraduate and graduate students in nursing, occupational therapy, physical therapy, and vocational counseling.

The curriculum for the undergraduate occupational-therapy student is in general a 4-year degree program supplemented or followed by a supervised program of clinical practice in psychiatry, orthopedics and neurology, and medicine and surgery. During the third and fourth years the program is directly concerned with the acquisition of theoretical knowledge and practical skills to prepare the student to treat the broad range of patients referred to occupational therapy. Clinical experience in the treatment of the psychiatric, orthopedic, neurological, medical, and surgical patient is provided through several types of programs; a clerkship in the third and fourth year usually taken 1 afternoon per week; a 3-month affiliation between the third and fourth years (to be followed by a 6-month affiliation upon completion of the fourth year); or a combination of didactic and practical experience in a 9-month clinical practice period following the fourth year.

Other Teaching Programs

Courses for speech pathologists and audiologists are provided by some medical centers. These courses are usually postgraduate programs requiring up to 2 years. Courses in vocational or rehabilitation counseling and case management are offered by some medical centers at the postgraduate level.

Traineeships for prosthetists and orthotists are available in a few medical centers. The requirements for these programs are usually established by the sponsoring institution and vary widely.

FACILITIES

For administration of rehabilitation services, offices for the director and his staff, and a conference room for meetings and staff conferences are required.

The teaching and service areas of physical therapy should be near occupational therapy since there are certain common elements. Some of the courses are given to combined classes of physical-therapy and occupational-therapy students, and the patient-treatment programs of these 2 services require coordination in planning. Since a large number of outpatients will be treated, facilities should be accessible both to inpatients and outpatients and details should be carefully planned (*37*).

Table 46 gives areas for rehabilitation services for hospitals of 500 and 700 beds.

Conference-Classroom

A conference-classroom for physical therapy primarily for physical- and occupational-therapy student programs should be provided sized for tablet-armchair seating to accommodate the largest student group, depending on the size of the hospital, and program emphasis. The lecture area should be equipped for X-ray film and chalkboard presentation, film projection, and patient demonstration.

Laboratory

A laboratory-classroom for physical therapy equipped with demonstration tables, and with floor area for mats and chairs is required. Those shown in table 46 for 500 and 700 beds are sized to accommodate 10 tables and 10 mats, and 14 tables and 14 mats, respectively. The space for mats should serve as seating area and as a crutch-walking demonstration area.

Locker and shower facilities for male and female students should be provided within or adjacent to the physical-therapy teaching area.

Facilities required for the occupational-therapy curriculum include a classroom, 2 activities laboratories for the acquisition of creative and manual skills, offices for the director and staff, and a study area for the students.

Sixteen may be considered as the initial number of students to enter the course, with an anticipated increase to 24-per-class level.

Some activities in occupational therapy require separate rooms because of the need for more concentrated work with patients, or because of noise and dust generated by the activities. Activities such as weaving, printing, and leatherwork can be taught in a single room.

A room is required for the preparation of materials used in the treatment of bed patients. This should be self-contained with supplies and equipment used on the ward kept here in adequate quantity.

A supply room for the clinic is essential. Occupational-therapy programs require a number of items and these should be ordered in quantity and stored in the clinic.

Training in Self-Care

Training in activities of daily living is an important part of rehabilitation. Many physically handicapped persons must be retrained in such activities as getting in and out of bed, application and removal of prosthetic appliances, dressing, cooking, feeding, use of toilet and bathing facilities, and other essential self-care needs. Training patients in such activities is a responsibility of both the physical and occupational therapist, and a unit for this purpose should be provided convenient to the physical- and occupational-therapy sections. Many of these activities can be carried out on the patient-care units in the hospital or in the outpatient clinics.

A brace shop for fitting and/or fabricating prosthetic devices may be required depending on the program and the availability of these services in the community.

TABLE 46.—*Net areas for rehabilitation services for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		19, 190		22, 240
Administration		1, 960		2, 630
Reception-waiting area		400		600
Public toilets		80		80
Receptionist's desk		60		60
Director's office		180		180
Secretarial office	(2 desks)	200	(3 desks)	300
Staff office	(2)	240	(3)	360
Residents' offices	(2 @ 150)	300	(3 @ 150)	450
Examination rooms	(2 @ 100)	200	(3 @ 100)	300
Conference room		200		200
Janitor's room		100		100
Physical-therapy clinic		6, 080		6, 720
Waiting area		200		250
Control desk		80		80
Public toilets		80		80
Chief physical therapist's office		100		100
Assistant chief's office		100		100
Staff offices or chartroom		100		100
Physician's office and examining room		120		120
Secretary's office		100		100
Main treatment room	(14 plinths)	1, 380	(16 plinths)	1, 570
Private treatment room		100		100
Electro testing room		100		100
Hydrotherapy:				
Whirlpools	(5 @ 60)	300	(6 @ 60)	360
Hubbard tank		270		270
Paraffin	(2 @ 50)	100	(2 @ 50)	100
Moist air cabinet		100		100
Therapeutic pool [1]				
Patient lockers, showers, and toilets		450		540
Therapeutic exercise area		1, 800		2, 000
Storage and utility areas		300		330
Staff lockers, showers, and toilets		300		320
Occupational-therapy clinic:				
Total		4, 070		4, 390
Waiting area		200		250
Control desk		80		80
Public toilets		80		80
Chief occupational therapist's office		100		100
Assistant chief's office		100		100
Educational coordinator's office		100		100
Staff office	(4 persons)	200	(6 persons)	300
Physical capacities evaluation room		100		100
Woodworking, plastics room		800		800
Leather, mirror crafts, art area		500		500
Weaving area		400		435
Printing area		120		140
Metalworking room		200		200

See footnotes at end of table.

TABLE 46.—*Net areas for rehabilitation services for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Ceramics room		200		200
Activities of daily living unit		550		550
Ward preparation room		130		175
Supply room		100		150
Staff lockers and toilets		110		130
Speech clinic:				
Total		870		1, 040
Waiting area		150		200
Control desk		60		60
Public toilets		60		60
Speech pathologist's office and therapy room		120	(2 @ 120)	240
Audiometric screening room		60		60
Group therapy room		360		360
Storage		60		60
Other clinical:				
Total		800		800
Psychologist's office		100		100
Social service office		100		100
Vocational counseling office		100		100
Prosthetist's office		100		100
Bracemaker's room [2]		400		400
Physical therapy education:				
Total		3, 680		4, 930
Physical therapy director's office		150		150
Teaching staff offices	(3 @ 100)	300	(5 @ 100)	500
Reception-secretarial office		300		300
Storage		100		100
Student Lounge and study		100		100
Conference-classroom [3]	(30 students)	510	(50 students)	750
Multipurpose laboratory and research room		450		600
Laboratory-classroom	(30 students)	1, 210	(50 students)	1, 690
Laboratory-classroom storage		100		100
Lecture room [4]				
Student locker shower, and toilet rooms	(2 @ 230)	460	(2 @ 320)	640
Occupational-therapy education:				
Total		1, 730		1, 730
Occupational therapy director's office		150		150
Staff office	(2 desks)	200	(2 desks)	200
Secretarial office		100		100
Student lounge		200		200
Lecture room [4]				
Activities' laboratories	(2 @ 400)	800	(2 @ 400)	800
Student locker and toilet rooms	(2 @ 140)	280	(2 @ 140)	280

[1] Optional.

[2] A room for fitting prescriptions may be required instead of a bracemaker's room, if outside bracemaking services are available.

[3] Serves also for occupational therapy education.

[4] May not be required if a lecture room for general use is conveniently available.

University teaching hospitals generally exceed the 2.4-per-100-bed average for full-time personnel, not including medical staff, in non-Federal, short-term, general hospitals. Thus, for university hospitals of 500 and 700 beds, the number of nonmedical personnel required may be in the range of 800 to 1,000, and 1,200 to 1,400, respectively.

Services included here represent a large proportion of total hospital personnel. Each service has some teaching responsibilities—inservice, student, or both—in addition to its primary concern for patients. Each will require a director, who may require one or more assistants. Offices for each director and his secretaries and assistants should be arranged as a unit. The director will hold conferences with departmental supervisors. However, each service does not need a conference room if a common-use room is convenient and available. Hospital policy, exigencies of planning, and individual requirements will determine the location for each services' administrative offices.

Table 47 gives areas for patient services for hospitals of 500 and 700 beds.

NURSING SERVICE

More and more complex nursing service is needed in a university teaching hospital than in a community hospital. Therefore, more space for the nursing service will be required on the patient-care unit. In addition to their work on the patient-care units, nurses are involved in clinical research.

A conference-classroom should be available for inservice training programs for nursing-service personnel and for meetings of larger nursing-staff groups. A conference-classroom for 30 persons, and space for demonstrations, is usually adequate for inservice programs. The room should be provided with a lavatory, projection and X-ray viewing facilities, chalkboard, tackboard, and storage space for teaching equipment. If facilities for student-nurse programs such as a multipurpose demonstration room are provided adjacent to the nursing education unit, a separate conference-classroom may not be required. Frequently, the multipurpose demonstration or other classrooms within the education unit serve not only for teaching student nurses but also for the inservice orientation of graduate nurses and meetings, conferences, and similar larger group functions of the regular nursing service.

Where there is a school of nursing associated with a medical school, the dean's office will be in the nursing education unit within the university. However, if the hospital controls a diploma or practical nurse program, educational facilities for nursing will be required.

MEDICAL RECORD UNIT *(38, 39)*

Medical records of inpatients, outpatients, and emergency patients should be kept in a central medical record unit. A consolidated record system including the patient's complete record of diagnosis and treatment filed under one unit number is recommended. A good filing system together with a rapid transportation system to move records to and from the using areas is essential in a well-functioning service.

A variety of statutes and regulations require hospitals to retain records. Although the retention of records has some legal implications, they are retained primarily for the purpose of medical care and research.

Where space is limited, microfilming has been employed with varying degrees of success to relieve the space problem. Research is being done in the field of medical records to develop new storage techniques and transportation systems. Basic to this research is a reevaluation of medical record content to meet current and future needs. Such techniques as memory drums or other electronic devices should be investigated.

Requirements described in this guide are based on presently employed procedures and equipment. This involves open-shelf files for medical records and vertical, visible, or drum files for secondary records.

Movement of records may be accomplished by using dumbwaiters, pneumatic tubes, basket or belt conveyors, or handcarts.

Such methods as intercommunication systems and mechanical writers promote more efficient movement of records between services.

The record room should include space for clerks for the following sections: Coding and indexing, insurance, incomplete records control desk, discharged records, patient master index file, and completed records control desk. Space for punchcard operators should be provided for hospitals where disease indexes will be maintained on IBM or similar equipment. The work area in the records storage room or adjacent to it should be large enough to accommodate 5 filing clerks for a 500-bed hospital and 10 for a 700-bed hospital.

Dictation and reproduction equipment is needed to record and summarize records.

A data-processing room with equipmcent for retrieval and analysis of charted information should be available to the medical record department. (See hospital supporting services for data processing facilities.)

Planning of the medical record department should be based upon a study of the use of records for research, and the readmission rate of patients; both influence the space required for active and retired records.

Based on the experience of a number of existing university hospitals, the average thickness for all records, inpatient, outpatient, and emergency, collectively, is approximately one-fourth inch per record or 50 records per linear foot of shelf, or approximately 760 records per 3-foot single-faced metal shelving unit, or section, 6 shelves high. In computing active record storage room area, including access aisles and related workspace, a factor of 11.7 square feet per 3-foot section is usually sufficient, and for inactive record storage, 10 square feet per section.

A 20-year period is generally accepted as the time to retain medical records in their original form. If inactive records must be maintained in a separate building, this should be located so that information from them can be retrieved within 24 hours.

If a separate building for housing inactive medical records is contemplated, its utility for storage of infrequently used microslides, pathology protocols, tissue specimens in jars, paraffin-block embedments, and records of this nature should be considered.

Research activities, unusual diagnostic or treatment programs, rehabilitative procedures calling for additional reporting by specialists and paramedical personnel, and long-term confinement must be considered in estimating the average thickness of clinical records.

The use of medical records is greater in the university teaching hospital and a conference-reading room should be provided. Individual study space may be provided for long-term study projects.

Some university teaching hospitals sponsor education programs in medical record library science. These programs require library, classroom, and equipment demonstration space, and desk space for the 2–4 students usually assigned to the medical record department at one time.

PHARMACY

The pharmacy department in the university teaching hospital dispenses more prescriptions and drug orders than a community hospital. The medical staff more often requests the pharmacists to prepare drugs in forms which are not commercially available. To be able to render this service the pharmacy must have equipment and trained personnel readily available.

The scope of the bulk compounding or pharmaceutical manufacturing program is expanding and may vary from the simplest procedures to much more complex operations demanding intricate and specialized equipment and facilities.

In teaching hospitals affiliated with universities that have a college of pharmacy, the pharmacy department may have certain teaching responsibilities for undergraduate pharmacy students who elect hospital pharmacy as a specialty and for pharmacy internships. A pharmacy internship in a hospital is a postgraduate program of organized training.

The education and training of pharmacy interns includes assignment to and supervised instruction in the following specific activities: Outpatient dispensing, inpatient and general dispensing, bulk compounding and preparation of sterile products, bulk compounding and prepackaging of nonsterile products, and pharmacy administration.

These programs may require a conference room-

library within the pharmacy area for use in lecturing, demonstration, and study.

Consideration should be given to the need for a research program in the university hospital pharmacy. The pharmacist may perform research related to improving the usefulness of pharmaceutical preparations; developing methods of preserving and stabilizing drugs; developing better methods of sterilization; improving vehicles and bases; improving taste; and increasing therapeutic effectiveness. When a drug is first developed or is being initially evaluated, the pharmacist may develop additional dosage forms or means of administration. He may also develop various bases, vehicles, or combinations for comparison of degree of absorption of medicinal components and the speed of complete absorption of active ingredients of internal and external preparations. A room approximately 12 by 15 feet is minimum for such research.

The pharmacy may serve as the base for a formulary committee which may review journals, brochures, and other information on drugs. The pharmacy may serve as the repository for information and forms on drugs used in clinical investigations or testing.

SOCIAL SERVICE

Social service in a university teaching hospital functions in direct services to patients and teaching. Provision should be made for centralized offices for the director and 2 or 3 assistants. Offices for social service staff assigned to the clinical services should be accessible to the patients and their families, to physicians, and to other personnel. This applies to both inpatient and outpatient areas. Privacy for interviews, conferences, telephone calls, and dictation is required. Space should be provided for secretarial help and waiting space for patients.

Social group work is a new and developing program in many university teaching hospitals and the special needs for this type of program should be considered in planning.

The social service teaching program in a university hospital will include (1) teaching social-work students in the program of a graduate school of social work and inservice training of social service staff, (2) teaching medical students, interns, and residents in the social aspects of health and disease, and (3) teaching other disciplines such as nursing and dietetics in the social and emotional components of illness.

All social-work students assigned to the hospital will have received their bachelor's degree and be working toward a graduate degree. The number of students assigned will depend upon the number of factors such as the number of schools of social work in the area and the number of social service staff available for student supervision. Workspace for students should be planned near the units to which they will be assigned.

A conference room should be available for student seminars for teaching social-work students, staff, and the other disciplines. Offices to be used by social workers on patient-care units are covered in the patient care section, page 109.

VOLUNTEER SERVICE

The services of volunteer workers enhance inpatient and outpatient care. Volunteers may serve as messengers or hostesses, as receptionists, as supplementary clerks and typists in the admitting process and in patient rehabilitation and welfare activities; they may maintain a small library and perform other services for patients; or they may operate gift shops and coffeeshops for visitors.

Volunteer workers should be organized into groups under the supervision of one person who is responsible to the hospital administrator. Volunteer workers require a locker room with dressing and toilet facilities, office space for the supervisor, and storage space for mobile equipment and supplies.

CHAPLAINCY SERVICE

Graduate programs for hospital chaplains or orientation and lecture programs for local clergymen, seminary students, or medical students in the university teaching hospital are not very common to date. However, such programs are developing. Where a graduate program is contemplated, a conference room large enough to accommodate a desk

for each hospital chaplain candidate is desirable. Access to classroom facilities is also required. Whether or not it is necessary for the conference room to be near the permanent chaplain's office is debatable. If a chapel is provided, the chaplain's office should be adjacent to it. If the chapel is to be used for religious services, provision should be made for separate storage of vestments, symbols, and altar services for various faiths.

DIETARY DEPARTMENT

The responsibilities of the dietary department, administrative, therapeutic, and educational, require more personnel and facilities than in the community hospital. This need is due to the higher percentage of patients with complicated diseases, many of whom will require therapeutic dietary management; a larger number of dietetic consultations per patient due to the larger numbers of medical and paramedical personnel available; greater emphasis on clinical research; and dietetic teaching programs.

Administrative responsibilities are shared among the dietitians and dietetic specialists in the inpatient units, clinical-research units, outpatient clinics, food-production center, and cafeteria. The department head will require one or more assistants. The offices of the director, assistants, and secretaries should be located together. A conference-classroom should be available for staff conferences.

Therapeutic aspects include planning menus for patients, maintaining patients' dietary records, consulting with medical, nursing, and social-work staff on patients' dietary needs, and instructing patients and their families individually or in groups in normal and therapeutic nutrition. They may include supervision of the preparation of infant or adult formulas, and participation in clinical patient research where metabolic considerations are involved. Dietitians and dietetic clerks involved in these activities require the use of offices convenient to their areas of operation.

Dietitians assigned to patient-care units may participate in ward rounds, plan menus, and instruct patients.

Offices for dietitians assigned to the outpatient services should be located there for consultation with the staff and for individuals and group dietetic instruction for outpatients and their families. The number of offices required will depend on the outpatient program. A group nutrition clinic is similar to a conference-classroom. However, the demonstration space is usually furnished with domestic-type kitchen equipment. Space is required for storage of teaching materials.

With increasing emphasis upon therapeutic diets, medical students, interns, residents, faculty members, and nurses and practicing physicians should understand the principles of nutrition and diet therapy. Much of this teaching in the university teaching hospital is the responsibility of the dietary department in the form of demonstration lectures and seminars.

The same criteria for programing, planning, and equipping dining areas are applicable to both the university teaching hospital and the community hospital. However, in teaching hospitals 4 to 6 general-purpose conference-dining rooms are required contiguous to the cafeteria. These rooms, which may be separated by folding partitions, are usually heavily scheduled for meetings of many and varied groups.

HOUSEKEEPING

A classroom for instructing and orienting groups of housekeeping employees in cleaning procedures and sanitation techniques should be available convenient to the employees' locker facilities. It may also serve as an employees' lounge. A classroom with seats for 30 persons and teaching space for instructors and demonstrators is usually adequate. A chalkboard, tackboard, projection facilities, and storage space for teaching supplies should also be provided (*40*, *41*).

TABLE 47.—*Net areas for other patient services for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		45, 530		60, 160
Nursing:				
Total		2, 260		2, 420
Reception area		160		200
Secretarial office	(3 desks)	300	(4 desks)	400
Office of director of nursing		200		200
Nursing offices	(5)	600	(5)	600
Conference room	(16 persons)	320	(16 persons)	320
Inservice conference-classroom [1]	(30 persons)	600	(30 persons)	600
Storage room		80		100
Medical records:				
Total		11, 480		15, 880
Chief records librarian's office		150		150
Assistant records librarian's office	(2 @ 100)	200	(4 @ 100)	400
Central stenographic pool	(12 persons)	960	(16 persons)	1, 280
Conference room		300		300
Record room	(15 persons)	1, 200	(22 persons)	1, 700
Active records storage room	(562,000)	7, 600	(791,000)	10, 700
Inactive records storage room [2]				
Tumor registry secretarial staff and clerks	(6 persons)	480	(6 persons)	480
Chart summary area	(4 cubicles)	100	(6 cubicles)	150
Research offices	(4 @ 100)	400	(6 @ 100)	600
Storage supplies and forms		90		120
Microfilm room [2]				
Pharmacy:				
Total		3, 800		4, 540
Dispensing and compounding [3]	(1)	400	(1)	500
Prepackaging and inpatient medications:				
Filling and labelling floor stock	(1)	300	(1)	400
Ward requisition filling	(1)	300	(1)	350
Storage of finished pharmaceuticals	(1)	200	(1)	250
Sterile preparations:				
Small volume parenteral solutions, antibiotics, and collyria	(1)	250	(1)	250
Large-volume parenteral solutions [2]				
Medium-volume parenteral solutions [2]				
Allergy preparations [2]				
Flask and vial washing [2]				
Sterilizations [2]				
Storage [2]				
Administration:				
Chief	(1)	150	(1)	150
Assistant chief	(1)	120	(1)	120
Inventory control	(1)	150	(1)	150
Conference room-library (12 people)	(1)	280	(1)	280

See footnotes at end of table.

TABLE 47.—*Net areas for other patient services for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Pharmacy—Continued				
Manufacturing:				
General manufacturing including ointment, suppository, tube filling	(1)	200	(1)	300
Bulk fluids preparation and filling	(1)	400	(1)	600
Supervisor's office	(1)	100	(1)	100
Tablet manufacturing [2]				
Control laboratory	(1)	180	(1)	180
Research laboratory [2]				
Storage (active and receiving):				
Dry chemicals	(1)	300	(1)	400
Flammable liquids	(1)	200	(1)	200
Narcotic vault	(1)	40	(1)	60
Cold storage room	(1)	80	(1)	100
Toilets and locker rooms: Male and female	(1)	150	(1)	150
Social service:				
Total		1, 150		1, 420
Social service director's office		150		150
Assistant director's office		120		120
Secretarial-reception office	(3 desks)	400	(4 desks)	500
Social service educator's office		120		120
Social work students' office	(4 desks)	300	(6 desks)	450
Storage		60		80
Chaplaincy:				
Total		650		800
Chapel [2]				
Family room		100		100
Chaplain's office		150		150
Secretarial office		100		100
Student chaplain's office	(4 desks)	300	(6 desks)	450
Volunteers:				
Total		960		1, 190
Director's office		150		150
Secretarial and workroom		360		540
Storage		200		200
Locker room (coats and smocks) and toilets		250		300
Dietary: Total		23, 350		34, 030
Administration:				
Total		590		810
Director of dietetics office		150		150
Assistant director's office(s)		120	(2)	240
Secretarial office	(2 desks)	200	(3 desks)	300
Educational director's office		120		120
Conference-classroom				

See footnotes at end of table.

TABLE 47.—*Net areas for other patient services for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds		700 beds	
	Square feet			
Food production:				
Total		11, 640		14, 830
Office of dietitian in charge		120		120
Offices of staff dietitians, supervisors, and clerks	(5 desks)	450	(6 desks)	540
Food-production center and associated preparation and storage areas		9, 000		11, 800
Food-service personnel lockers, showers, and toilets		2, 000		2, 300
Janitor facilities		70		70
Food service:				
Total		9, 380		13, 410
Office of dietitian in charge		120		120
Offices of supervisors and clerks	(3 desks)	270	(4 desks)	360
Cafeteria serving lines and main dining areas		6, 700		9, 600
Conference-dining rooms	(4 @ 500)	2, 000	(6 @ 500)	3, 000
Public toilet facilities		220		260
Janitor facilities		70		70
Dishwashing:				
Total		1, 000		1, 200
Central dish and tray washing and associated areas		1, 000		1, 200
Therapeutic dietary facilities:				
Total		480		720
Office of dietitian in charge and clerks [4]	(4 @ 120)	480	(6 @ 120)	720
Patient-care nourishment rooms [5]				
Patient-care dining rooms [5]				
Patient-care tray area [5]				
Metabolic kitchen [5]				
Outpatient dietitian's office [5]				
Outpatient nutrition clinic [5]				
Housekeeping:				
Total		2, 140		2, 940
Director of housekeeping office		150		150
Secretarial office		100		100
Assistant director's office	(2 desks)	160	(2 desks)	160
Housekeeping training room		350		350
Housekeeping personnel lockers				
Showers and toilets		1, 080		1, 780
Stockroom		300		400

[1] May not be required if a student nurses' classroom or nursing-arts room is provided.
[2] Optional.
[3] If the pharmacy is not located convenient to the outpatient department, a subpharmacy may be required in the latter.
[4] May not be required if offices for general use are available on the patient-care units.
[5] Included in patient-care and outpatient sections.

TELEVISION

Television in black and white and in color as a teaching tool in the university teaching hospital has many possibilities when properly used. However, its use is still in an experimental stage and the temptation to assume that it will solve all visual communication problems should be resisted. Color TV is more expensive in capital outlay and in programing. It seems likely that developments in the techniques and use of TV will be rapid and varied in the years to come. Therefore, conduits should be installed in new construction to make possible various uses and combinations. It has been suggested that 4- by 4-inch wireways be used with inspection panels at 50-foot intervals. Spaces should be provided for control rooms, studios, and equipment rooms on the basis of the best current information.

Table 48 gives areas for hospital supporting services for hospitals of 500 and 700 beds.

Television has proved valuable in the demonstration of patients when the audience is too large for close student-patient contact. It is also helpful in increasing the effectiveness of interviewing, demonstrations, laboratory experiments, and technical procedures (*42*).

Air-conditioning requirements must be considered in control areas.

The following are examples of programs that may utilize television for teaching purposes:

1. The department of psychiatry may have interviewing studios for inpatients and outpatients in clinical or research areas. Video and audio may be received in the auditorium and departmental conference and lecture rooms.

2. The department of surgery may originate programs in the operating suite which could be received in the auditorium and departmental conference and lecture rooms.

3. The department of medicine may originate programs in a studio or heart catheterization laboratory to the auditorium and departmental conference and lecture rooms.

4. The department of radiology may originate programs in a fluoroscopic room equipped with an image intensifier, radioisotope laboratory, or total-body counting room to selected departmental offices, conference rooms, auditorium, or student areas.

The auditorium should be arranged for both originating and receiving programs. A large-screen projector for black and white or color is more effective than monitors in the auditorium.

Such areas as physical therapy, occupational therapy, and clinical psychology should be equipped for mobile TV. Video and audio from these areas could be directed through central control for distribution to various receiving areas.

MEDICAL ILLUSTRATION

If medical illustration is in the basic science building remote from the hospital, some duplication of facilities will be necessary in the hospital. For example, darkroom, storage room for cameras and other equipment, and possibly a studio for photographing patients may have to be provided.

DATA PROCESSING

Rapid progress is being made in the development of data-processing equipment and in its application to hospital functions, and some hospitals are finding it feasible to institute systems for accounting and medical statistical functions. The sharing by several hospitals or facilities of equipment and programing services is being done in some cases.

In the university teaching hospital, the increased activity over the community hospital of comparable size will make it more feasible for the teaching hospital to utilize data-processing systems.

Facilities should be designed to permit either initial or ultimate installation of data-processing systems.

TECHNICAL SHOPS

Unless the following shops are available in a contiguous building, they must be provided in the hospital. They will serve not only for main-

tenance and repair but will assist in research and development programs.

Medical instrument shop.—In addition to the maintenance and repair of surgical and other instruments, this shop will serve as support for various types of research.

Electronics shop.—This shop will serve for the maintenance of electronic systems and equipment used in diagnosis, treatment, and research.

Technical X-ray shop.—See Radiology.

LIBRARY

If the medical school library is not in a building adjacent to the teaching hospital, a branch library with some duplication of books and journals should be provided in the hospital, since standard medical texts and journals should be available around the clock in the hospital. Department libraries may be private collections or be related to the central library system.

TABLE 48.—*Net area for hospital supporting services for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		7, 800		7, 800
Television [1]				
Central control				
Studio				
Medical illustration [2]				
Data processing [1]				
Technical shops [3]				
Medical instrument shop				
Electronics shop				
Library				
Hospital library [1]				
Auditorium and lecture rooms [3]				
Auditorium	(300 persons)	4, 000	(300 persons)	4, 000
Lecture rooms	(2 @ 1900)	3, 800	(2 @ 1900)	3, 800

[1] Optional.
[2] In medical school.
[3] See Ch. 4 for a discussion of these areas.

TABLE 49.—*Net areas for other hospital facilities for hypothetical hospitals of 500 and 700 beds*

Type of facility	500 beds		700 beds	
	Square feet			
Total		74, 650		96, 820
Undergraduate medical students:				
Study cubicles with lockers	(128 persons)	6, 150	(192 persons)	9, 220
Recreation center		1, 000		1, 200
Mechanical plant areas:				
Maintenance shops [1]		9, 500		12, 000
Transformer room		1, 200		1, 500
Mechanical space [2]		5, 300		6, 400
Security guardroom and check-in		600		700
General services:				
Central sterile supply		5, 000		6. 000
Laundry		12, 000		13, 500

See footnotes at end of table.

TABLE 49.—*Net areas for other hospital facilities for hypothetical hospitals of 500 and 700 beds*—Continued

Type of facility	500 beds	700 beds
	Square feet	
Storage and receiving:		
Bulk stores (@ 30 sq. ft. per bed)	15, 000	21, 000
Receiving area	500	700
Furniture and mattresses	1, 700	2, 000
General storage	5, 000	7, 000
Disaster equipment storage	1, 000	1, 200
Personnel lockers and toilets:		
Nursing personnel lockers [3]	2, 200	3, 100
Nursing personnel toilets and lounges	1, 300	1, 700
Employees lockers [4]	4, 400	6, 200
Employees toilets and restrooms	1, 600	1, 900
Employees main lounge	1, 200	1, 500

[1] Including plant engineers' offices.
[2] Assumes remote boiler and air-conditioning plant.
[3] See patient-care units for additional facilities.
[4] For all nonprofessional personnel.

NOTE.—Central animal quarters, morgue and autopsy, and medical illustration are located in basic science area and *not* included in hospital areas.

TABLE 50.—*Summary of areas for hypothetical teaching hospitals of 500 and 700 beds*

Type of facility	500 beds	700 beds
	Square feet	
Total gross square feet (rounded)	602, 000	809, 000
Total net square feet (65 percent (rounded))	391, 000	526, 000
Gross-net difference square feet (35 percent (rounded))	211, 000	283, 000
Gross square feet per bed	1, 204	1, 156
Administration	21, 240	26, 260
Patient care	114, 010	174, 400
Outpatient department	27, 040	34, 580
Emergency service	6, 930	8, 370
Radiology department	25, 140	32, 780
Clinical diagnostic laboratories	19, 820	25, 380
Surgical suite	22, 210	28, 420
Anesthesiology department	860	1, 050
Inhalation therapy service	800	900
Labor-delivery unit	5, 575	7, 030
Rehabilitation services	19, 190	22, 240
Other patient services	45, 530	60, 160
Hospital supporting services	7, 800	7, 800
Other hospital facilities	74, 650	96, 820

Chapter 8

ENGINEERING AND SAFETY REQUIREMENTS

Mechanical Facilities

Mechanical facilities should be designed to accommodate changes in teaching content and methods and the rapid and continuing developments of new types of equipment that serve both teaching and research. These changing conditions will require ingenuity in design to provide flexibility and capacity in service systems that will permit frequent changes in the services with a minimum of disturbance and expense and a potential for future expansion of the facilities.

Design standards for such areas as hospital, amphitheater, lecture rooms, and offices are well established and available to designers and are not repeated here. However, not so widely understood are the designs for utility services, environmental and safety requirements for such areas as teaching laboratories, research laboratories, and animal quarters with their auxiliaries and facilities for highly specialized subjects.

PLUMBING

The use of the various utility services will vary according to the department served in teaching laboratories and to a greater degree in research laboratories. To provide greater flexibility, all laboratories should have air, vacuum, water, gas, and electrical services at all work areas.

Laboratories cannot be designed primarily to accommodate the various piping systems. However, required piping systems, which are often subject to change, should not be crowded into improvised spaces. During the planning stage the space requirements for these services should receive a priority equal to that of any other element of the laboratory.

Plumbing fixtures.—Plumbing fixtures and their trim must be selected with care to suit the particular function they serve. The types are fairly well standardized so will not be covered here. However, care must be exercised in selection to assure materials that will withstand the rigorous usage to which they will be subjected.

A deluge shower, with continuous-acting supply valve, and an eye bath must be installed in each teaching laboratory equipped with a fume hood. In research areas these showers may be placed in the corridor to serve several laboratories. Floor drains should not be installed at these showers because of the possibility of the drain traps drying out from infrequent use and admitting sewer gases to the area.

Control valves for the operation of utility services within *fume hoods* should be mounted on the exterior of the hoods. Each laboratory hood should be equipped with a sink in addition to a general-purpose sink located adjacent to the hood.

Radioisotope hoods, toxic fume hoods, and hoods used for strong oxidizing agents should have stainless-steel interiors and stainless steel exhaust ducts equipped with washdown facilities that will serve the hood and the first 10 feet of the duct interior. The drain for the hood and duct system may be located under the plenum space of the hood.

Piping systems.—Four basic considerations are important in the piping systems design for the laboratory area: (1) Location of the systems to provide easy accessibility; (2) provision of sufficient space to accommodate the systems without crowding; (3) sizing and arrangement to facilitate expansion and modification as required; and (4) quality of materials used in fabrication of the systems.

Normally the main piping systems from which branch lines are taken to serve individual workbenches will be concealed in wall chases. The chases serving vertical piping systems should be

shafts of sufficient size to permit the entrance to the shaft of service personnel and the use of tools within the area. The entrance to such shafts should be from a point outside the laboratory proper. Sufficient space should be provided between the individual piping systems to permit the use of tools for opening or removing pipe sections, valves, and fittings. The loss of use of bench space and service personnel labor time involved in simple repairs or replacements is too often aggravated by crowded piping systems. These shafts should also be designed to accommodate ventilation or airconditioning duct systems and electrical raceways. Although shafts require space which is usually at a premium and expensive, they permit changes in laboratories with a minimum of cost and interruption of service and will reduce normal maintenance costs.

Pipelines connecting the main vertical systems to the workbenches may be installed in several ways, among them: (1) in horizontal wall chases which are covered by removable panels; and (2) overhead on or above the laboratory ceiling.

Horizontal wall chases are located behind the workbenches which are removable to permit access to the piping as required. These chases have the advantage of being adjacent to the area served; since they are concealed they present no problem of dirt accumulation.

Overhead systems may be exposed or concealed above a suspended ceiling. Exposed overhead ceiling-mounted piping requires housekeeping to remove accumulations of dust and condensed vapors from the tops of the pipes. Concealed overhead systems eliminate the housekeeping chore, but have the disadvantages of requiring removal of sections of the ceilings to service the systems.

Good laboratory design assumes that a number of physical changes in layout and equipment will occur periodically to accommodate advances in techniques and research, and that facilities will be expanded. For this reason individual piping systems should be sized to serve not less than twice the demand initially estimated.

Materials used in fabricating piping systems should be the best quality available. Selection of water supply and drainage piping materials should take into account the characteristics of the local water supply, the various corrosive liquids disposed of through the drainage systems, the carelessness of users of the systems, and the ever-present possibility of new types of waste materials. Piping systems of inferior quality or types unsuited to the function required cause costly repairs and replacements far in excess of the additional cost involved in securing proper materials at the time of the original installation.

The various piping systems should be carefully zoned and valved to permit isolation of individual segments of the system and individual branch lines to laboratory workbenches. Attention to this detail will amply repay the additional cost of installation in reduction of lost bench time and labor costs during the life of the structure.

To facilitate the removal of increments in the piping system for replacement or repair and to facilitate the installation of additional services as the need develops, unions for quickly disconnecting the piping system and plugged tees for new connections should be strategically located in each system. In addition, the use of tees with one outlet plugged at 90° changes of direction in the piping system instead of elbows will provide a ready means of extending the system. Because of the cost of installation, the use of additional fittings should be made only after a realistic appraisal of the probability of future use.

Drainage systems.—In general, drainage systems and the materials used in their fabrication will conform to standard construction practice for most areas of the medical school and hospital. The exceptions to this rule will be systems serving laboratories and animal quarters. In these areas waste lines are subjected to harsh usage because of the types of waste materials, carelessness, or accidents. For this reason a determination of the type of liquid waste to be disposed of from each laboratory should be the basis for the selection of piping materials and the design of the systems.

Because the drainage systems in the vicinity of the workbenches are often subject to blockage resulting from careless or accidental insertion of foreign objects, it is important that ample and easily accessible cleanouts be provided in the system.

The acid wastes discharged from such laboratories as biochemistry, pathology, and pharmacology would very quickly destroy ordinary galvanized iron or steel waste lines normally used in other areas. This situation is aggravated by the volume of discharged material and the carelessness of the users who neglect to dilute solutions properly before pouring them into the drainage system. To insure a permanent trouble-free drainage

system, acid-resisting piping materials should be used for all drainage systems serving laboratories in which acids will be used. The traps of acid drainage systems, usually located under the workbenches, should be provided with guards to reduce maintenance costs resulting from breakage. Where the volume or acid waste produced is great, it may be advisable to install a separate acid-waste system. This system should empty into a dilution sump prior to discharge to the sewer.

Because lead amalgamates with mercury, lead pipe and fittings should not be used in any area where there is the possibility of mercury getting into the drainage system.

High silicon cast-iron pipe and fittings marketed under several trade names have been a standard for this purpose for many years. In recent years glass pipe has been gaining recognition and has been successfully used in a number of installations.

Normally the concentration of radioactivity in wastes resulting from the use of radioisotopes in medical schools and hospitals is sufficiently low to present no problem in the municipal sewer system because of the high dilution effected. However, with the increased use of radioisotopes, particularly in research, care must be exercised to eliminate the possibility of contamination of waste lines within the buildings. Where extensive use of high-level radioisotopes is indicated, a separate drainage system should be installed. This may discharge to a stainless-steel detention tank or a separate house trap where it can be properly monitored before discharge to the house lines or sewer.

Stainless steel is recommended for drainage systems of laboratories where radioactive waste materials will be handled. Stainless steel is preferred because it can be made leak-tight, which is imperative with such wastes, and because of its relatively smooth interior including welded joints, which facilitates cleaning by flushing. Periodic monitoring of the system at traps and at points where the system changes direction is recommended as a safety measure.

Water.—If experience data are not available, an analysis showing the characteristics of the local water supply should be the basis for the selection of the piping materials for the hot and cold water systems. This analysis will also indicate whether water treatment is required and the type needed.

Copper piping is recommended for water distribution systems with galvanized wrought iron for mains over 5 inches in size. This piping will be satisfactory for most areas of the country although the water analysis may indicate other materials as equal to or better in some areas.

Flanged test nipples, which are easily removed from the piping system for visual observation of the interior condition of the pipe, are recommended for installation in several locations in the main water distribution system. A bypass should be installed around each nipple to permit continuity of service when the nipple is removed.

The water distribution systems serving work areas of laboratories are in constant danger of contamination from the toxic elements used in experimentation and research. This hazard is aggravated by the necessary use of hoses and equipment which are attached to the water outlet. Such contamination can endanger the entire potable water supply of the building and is frequently difficult to recognize. It can occur from cross-connection of systems which emphasizes the necessity for color coding and lettering of piping systems, but more often it results from back-siphonage of materials into the system during repairs (*43*). To eliminate this hazard, an industrial water system is recommended to serve all laboratory work areas. The distribution system must be independent of the potable domestic system and must be so installed as to make impossible any contamination of the domestic system from it. One system serving the entire building can be installed. However, in multistory buildings housing many laboratories, consideration should be given to zoning the industrial system by floors. The industrial water system poses the administrative problem of preventing the use of this water for drinking.

The use of an industrial water system will eliminate the need for the many vacuum breakers, which will be required for protection where a single distribution system serves all functions. Vacuum breakers are expensive to install and costly to maintain in operating condition. To insure safety through proper operation, the vacuum breakers must be inspected at regular intervals.

Distilled and demineralized water.—Generally, demineralized water will suffice for many laboratory procedures although distilled water may be required for microbiology, biochemistry, physiology, and for certain research studies in the medical school and in the clinical laboratory and other areas of the hospital. Where demineralized

water serves most needs and only small amounts of distilled water are required, consideration should be given to piping demineralized water to stills within the laboratories. The quality of water required for specific areas should be determined prior to design of the distribution systems. The analysis of local water characteristics, previously referred to, should be reviewed to determine the feasibility of obtaining the quality of water desired from the local water supply by the demineralization process. This is important because the products not removed by the ion-exchange process may vary from one source of water to another, or in the same source from one time to another. In localities where demineralization does not suffice, distillation is required.

Because of the possibility of wasteful use of these waters, which are expensive, they should not be piped to the workbenches of general teaching laboratories. One source of supply may be provided in each teaching laboratory. For a number of small research laboratories, one source of supply may be provided in the general corridor or in a preparation room convenient to them. With this system, individual carboys of water are mounted high enough on each workbench to provide gravity flow to the work area. Containers can be refilled from the one source as required.

Stills and demineralization equipment should be located at an elevation within the building sufficient to provide gravity flow to the centrally located supply points. Space should be provided around this equipment for easy servicing and cleaning. This area should have a conveniently located water supply and a floor drain.

Pure block tin lining is recommended for the treated-water storage tank. Aluminum and stainless-steel piping are most commonly used for the distribution system although glass and unplasticized geon resin polyvinyl chloride have been used successfully. Centrally located dispensing units are usually fabricated of stainless steel sized to accommodate a standard 5-gallon bottle. A block tin lined self-closing swing spout faucet is recommended at the dispensing unit. Periodic checks should be made of the quality of the water delivered by the system.

Animal quarters.—The location of the animal quarters and the number of animals housed will influence the design of the drainage systems for these areas. Cleaning of the areas and of cages results in a considerable quantity of bedding, animal hair, and other materials being washed down the drains.

A lower floor location is recommended, but if animal quarters are located on upper floors of the building, a drainage system independent of the normal building system is recommended to reduce the possibility of blocking the entire building system. Such blocking would result in flooding of lower floors in addition to the inconveniences of interrupted service. Oversizing will provide protection for the drainage systems serving small animal rooms on individual floors.

Floor drains of animal quarters should be protected with deep seal traps. Drains for rooms housing larger animals such as dogs and monkeys should be of a flushing-ring type with special hair traps.

Sprinkler system.—Although the buildings will be of fireproof construction, a sprinkler system in addition to the standard standpipe system is recommended for storage rooms housing volatile materials and laboratories in which such materials are used.

Gaslines.—These lines should be generously sized to provide for expansion of the service and to maintain constant pressure at workbenches. A main emergency shutoff valve controlling the gas supply to each laboratory should be installed in an accessible location, preferably outside the laboratory. Black steel pipe is recommended for gas piping systems.

Compressed air and vacuum air systems.—Copper tubing is usually used for these systems although galvanized steel and threaded malleable iron fittings may be used. Generous demand factors should be used in sizing the systems to provide for expansion and increased usage. Air filters and driers should be included in the design of compressed-air systems.

Discharge from vacuum pumps should be exhausted to the outside because laboratory workers inadvertently and sometimes deliberately use these systems to discharge highly toxic or flammable solvents.

Air compressors and vacuum pumps should be located on lower floors and isolated from the building structure because of vibration occurring during their operation. This vibration is often transmitted through the building structure and can seriously affect microbalances, electron microscopes, and other precision equipment if not controlled.

Oxygen system.—Copper piping is recommended for oxygen systems. An emergency shut-off valve controlling the oxygen supply to each laboratory shall be installed in an accessible location, preferably outside of the laboratory. Because of the fire hazard, care must be exercised in locating the outdoor bulk supply system with reference to other facilities in the area.

HEATING, VENTILATING, AND AIR CONDITIONING

The boiler plant serving the university will, in most instances, serve the medical center. In this case, present and future loads contemplated for the existing boilers and equipment should be analyzed to insure that sufficient capacity is available to serve the additional loads to be imposed. A separate boiler plant remotely located with reference to the medical center is recommended for new facilities not physically associated with a university. Because of the ventilation problems arising from the incineration of waste materials in individual buildings, consideration should be given to housing a main incinerator plant in or as a part of the boiler plant.

With the exception of the northernmost areas of the United States, heating, ventilation, and humidity control can be provided with an air system. In colder sections of the country, air systems may be supplemented by conventional heating units. Combining the functions of ventilation, heating, and cooling into one air system is not only economical in cost, but also provides more workspace within the buildings by eliminating floor-mounted units and allows greater flexibility in use.

Careful attention during the preliminary design stages to items such as orientation of the buildings, the sizing of glazed areas, shielding of glazed areas from direct solar load, and proper insulation of walls and roofs will reduce the size and initial and operating costs of the air-conditioning and heating equipment.

Considerable mechanical equipment will be housed in the buildings of the medical center. Because of its size and characteristics, most of this equipment produces vibration which can be transmitted through the building structural members to occupied areas as noise or vibration. This is a nuisance and is also particularly objectionable because of its detrimental effects upon delicate scientific equipment and its operation. For this reason, mechanical equipment rooms within or adjacent to the school buildings should be located to minimize this problem. Heavy equipment with moving parts such as refrigeration machines, air compressors, and pumps should be located in basement areas where possible without complicating good design. Equipment with heavy vibration characteristics should be mounted on foundations which are independent of the building structure, and those producing less vibration should be isolated by standard methods. Small fans, pumps, and other equipment may be located throughout the building as required or in attic machine rooms if properly isolated. No equipment should be installed above ceilings or in similar inaccessible spaces.

The term "air conditioning" as used in this text refers to air treatment to control simultaneously its temperature, humidity, cleanliness, and distribution to meet the requirements of the area served in both summer and winter. Air conditioning is particularly important for the medical center because the success of any of its programs is dependent upon the quantity, quality, and distribution of air. Ventilation rates expressed in the text refer to room volumes of fresh outdoor air which are to be provided for the area to maintain desirable conditions. These ventilation rates do not refer to air turnover required to maintain the specified temperatures and humidities of the various areas. Amphitheaters, lecture rooms, and conference rooms require ventilation and temperature control for comfort and to maintain alertness of the occupants. Such rooms as operating and delivery rooms and nurseries have special problems (*29*, *35*). Toxic and explosive byproducts result from many procedures carried out in the laboratories and must be removed by ventilation. The removal of normal contaminants of the air is required to insure the accuracy of some procedures. Humidity control is essential to preserve the accuracy and dependability of much equipment, particularly that involving electronic components. Large investments in collected data and research equipment can be lost by unsatisfactory or incomplete control of the air of the environment. An air-treatment plant is required to provide these and many other essential conditions. Reliance cannot be placed upon open-window or gravity ventilation systems.

LABORATORIES

Engineering requirements of teaching and research laboratories are similar. Reference is made to research facilities wherever their requirements differ from those of the teaching facilities.

Particular attention should be given to the types and sizes of equipment used in various laboratories. Heat gain from ovens, drying cabinets, kettles, sterilizers, electronic equipment, and heating elements can negate the usefulness of an otherwise well-designed ventilating or air-conditioning system if this factor is neglected in the initial design.

The quantities of outdoor air required to ventilate some areas of laboratories represent a considerable load on the air-conditioning system. To reduce this load, consideration should be given to the use of air-to-air heat exchangers which have shown exceptional efficiencies in some applications. If applicable, this equipment should reduce initial cost of installation and annual operating costs.

Duct systems used for the distribution of air for laboratories require considerable space. As previously noted under the plumbing section, shaft spaces should be designed to accommodate the air-conditioning duct systems as well as the plumbing and heating systems and the electrical raceways.

Spaces for duct systems should be large enough to permit the installation of duplicate systems often paralleling the original system. This provides for expansion of the systems to serve new areas that require different quality and quantity of air or the addition to an existing area of such equipment as fume hoods. The lack of space for ducts for hoods not initially contemplated has been a serious error in design of most science laboratories.

General air distribution and return systems should be constructed of conventional materials following standard designs for the type of system employed. Exhaust duct systems serving safety hoods and fume hoods require special materials to handle the exhaust products originating in the hoods. These fumes may be toxic, radioactive, infective, explosive, or corrosive; therefore, the type of hoods and the materials for duct systems serving them should be selected for specific application. Exhaust ducts serving hoods in which radioactive materials, volatile solvents, and strong oxidizing agents are used should be stainless steel for a minimum distance of 10 feet from the hood outlet and should be equipped with washdown facilities.

Because of the necessity for preventing any backflow of air from the hoods to the laboratory, a face velocity of 100 feet per minute inflow of air to the hood should be provided. This velocity is required to overcome external drafts at the face of the hood which may be created by many activities in the room, and to overcome thermal air currents created by heating elements used in the hood. A supplementary air supply over and above normal ventilation requirements should be provided to the laboratory to compensate for the quantities exhausted through the hoods. This supplementary air supply, which need not be completely conditioned, may be provided by a system independent of the normal ventilating system. With such a system the supplementary air is discharged downward near the face of the hood. Usually, exhaust systems serving hoods are manually activated at the hood at the time of use. Where such a system is used, the individual hood exhaust systems should be electrically interconnected with the supplementary air supply system to provide an ample air supply to any hoods placed in operation. However, failure of the supplementary air supply should not shut off the hood exhaust system. Under normal operation this system will prevent any imbalance in the pressure maintained in the laboratory proper by the normal ventilation system. As a safety measure some authorities recommend only one centrally located switch to activate the exhaust systems of all hoods in a single laboratory and thus insure that all hoods are in operation when the laboratory is in use. Such a system has some merit for teaching laboratories which are not subject to much change, but is not recommended for research laboratories or areas where expansion or the addition of hoods can be expected to occur.

Each laboratory hood should have an individual exhaust system with the fan located as near as possible to the outdoor exhaust port to insure a negative pressure in the duct. Attic machine

rooms or the building roof are preferred locations for these fans. They should be located and spaced to provide easy access for servicing. Radioactive isotope hoods for high levels and hoods used for highly infectious materials should be equipped at the point of exhaust from the hood with high efficiency submicron filters. Depending upon the types of organisms used, the filters serving bacteriological hoods and similar bacterially contaminated exhaust systems may require means of sterilizing the filter media prior to changing the filter. Several means of accomplishing this sterilization are available. A steam-formaldehyde spray system may be installed or filters with integral electrical resistance wiring for producing 400° F. heat for dry sterilization may be used.

The location of fresh-air inlets and exhaust-air outlets for buildings are of vital importance and should be decided upon in the preliminary design stages. The importance of these locations in the overall operation of the facilities cannot be overemphasized, and architectural design features should not be permitted to influence the locations unduly. Supply inlets should be as remote as possible from any exhaust system discharge. In determining the separation distance, consideration should be given to prevailing winds, other buildings, and obstructions in the vicinity. Air inlets should be located as high as possible on the structure. Exhausts should be carried above the roof and located remote from windows or openings to the building or adjoining buildings. The quality of air maintained in the various departments will depend upon the filtering systems selected and the ventilation rates decided upon for each department or area within a department. Filters should be selected with due regard for the functions served. Manometers should be installed across each filter bed to determine the resistance of the bed to the airstream and to indicate the necessity for cleaning or replacing filters.

For particularly sensitive areas, such as operating rooms and microbiology laboratories, in addition to the regular filtering system, a final or polishing filter of high efficiency should be installed in the duct systems at the entrance to the area.

A central chilled-water system utilizing at least 2 units of equal capacity is recommended. Because of the nature of the loading imposed by laboratory equipment, the refrigeration units should have a wide capacity range and be automatic in operation.

To provide the varying environmental requirements of different areas, separate fan coil units may be installed in each to maintain constant specific conditions. Such systems simplify controls and reduce the possibility of mixing air of one area with that of another.

To prevent the inflow or outflow of air from a particular area with consequent spread of odors or contamination, air systems should be balanced to provide a positive or negative air pressure relative to the air pressure of adjoining areas. This is accomplished by providing more air to an area than is exhausted from it, or vice versa. These air pressures should be monitored periodically to insure safety and comfort.

Ventilation requirements for teaching laboratories will vary according to the particular discipline served. Requirements for the individual department laboratories will be found under the various department headings which follow. Ventilation rates recommended are based upon the assumption that all experiments involving above-normal quantities of odorous or hazardous materials will be performed in safety cabinets or fume hoods. It also assumes a supplementary air supply to the laboratory equivalent in amount to that exhausted through the hoods during the time they are in use. All laboratories should be kept under negative air pressure relative to the air pressure of adjoining areas unless otherwise noted.

The nature of the work performed in research laboratories will vary from time to time, and its character cannot be predicted with any degree of accuracy. To accommodate these changes, the ventilation system should be designed with sufficient flexibility to permit varying ventilation rates.

DEPARTMENTAL AREAS

Some areas within each department will require special temperature, humidity, and ventilation. All areas not specifically mentioned in the following departments may be air conditioned for comfort only.

The following rooms occur in many departments. To avoid repetition under each department heading, their requirements follow.

729-445—64——13

Animal quarters and animal rooms.—A ventilation rate of 15 room volumes of air per hour of outside air with no recirculation of air is recommended for all animal rooms to reduce the odor level common to such areas. A negative air pressure relative to the air pressures of adjoining areas should be maintained.

Where exhaust air from animal quarters would create a nuisance for nearby buildings, consideration should be given to the use of activated charcoal filters in the exhaust system. These filters, while not effective against all odors originating in the quarters, will materially reduce the problem.

To prevent the spread of odors or other contaminants from the animal quarters to other areas, a negative air pressure of not less than 0.06 inch of water relative to the air pressure of adjoining areas must be maintained. Within the animal quarters—clean animal rooms should be maintained at a positive pressure while contaminated animal rooms should be at a negative pressure.

Throwaway dust-stop filters should be installed on animal-room exhaust grilles to prevent animal hair from entering the exhaust system.

Air distribution to the rooms must be carefully designed to prevent drafts because of their adverse effect on most animals.

In some quarters, animals may be infected with pathogenic organisms or viruses, or they may be treated with radioactive isotopes. The organisms used may be dangerous and the excreted and exhaled CO_2 from the isotope-treated animals may reach undesirable levels. To isolate individual animals and provide protection for attendants, animals are placed in individually ventilated cages especially constructed for the containment of excreta.

Such contaminated animal rooms require an auxiliary exhaust-air manifold with flexible connections to the cage rack or cages in conjunction with the room exhaust system. A ventilation rate of 2 cfm per cage will suffice for most animals, and bacterial filters are required on the exhaust manifold. A static pressure regulator should be installed in this cage system to insure a constant negative pressure, regardless of the number of cages connected to the system.

Rooms in which small animals are held in open cages and large contaminated animals are held in open stalls may require bacterial-type filters on both the supply inlet and the exhaust outlets from the room. A minimum ventilation rate of 15 room volumes of air per hour is recommended.

A temperature range of 70° to 80° F. with a relative humidity of 50 percent should be available for all animal rooms. Individual temperature control must be provided in each room to insure the proper temperature for the species of animal housed.

The animal surgery should conform in most respects to a human surgery. A ventilation rate of 12 room volumes of air per hour should be provided with no recirculation. For economy of operation, the air-supply system should be designed to permit recirculation of air when the rooms are not in use. Temperatures within the comfort range should be maintained. To reduce the explosion hazard when explosive anesthetics are used, the relative humidity should be maintained at a minimum of 50 percent. A positive air pressure relative to the air pressure of adjoining areas should be provided.

Technical development and storage rooms.—Particular study should be given to the humidity requirements of rooms in which electronic and highly specialized equipment is developed and stored. This equipment is very delicate, and in most instances represents a considerable investment in time and money. It is highly susceptible to, and adversely affected by, moisture. For this reason, the relative humidity of these areas should not exceed 35 percent, and constant temperatures should be maintained.

Darkrooms.—A ventilation rate of 10 room volumes of air per hour with no recirculation is recommended to eliminate high humidities and odors common to such areas. To insure a dust-free atmosphere in these rooms, high-efficiency filters should be installed in the supply-air duct system at the point of entry to the room and a positive air pressure relative to the air pressure of surrounding areas should be maintained.

Glassware washing room.—A ventilation rate of 10 room volumes of air per hour with no recirculation is recommended to eliminate odors and high humidities common to these areas. Canopies over sinks and washing machines are recommended to facilitate capture and removal of the contaminated air. A negative air pressure relative to the air pressures of adjoining areas should be maintained to prevent the spread of contaminated air from this area.

Solvent storage room.—If flammable materials

are purchased and stored in large quantities, the storage areas should be located in a detached building. This building should be constructed according to applicable codes and located so as not to endanger any other structures in case of an accident.

Small storage rooms within buildings should be constructed according to applicable codes. Special reference is made to the National Board of Fire Underwriters requirements for type B inside storage or mixing rooms. The rooms should be protected with a fixed CO_2 extinguisher system installed in accordance with NBFU or NFPA requirements.

Steel storage cabinets located under the fume hoods in laboratories for active storage of solvents will eliminate the hazard created by containers which might otherwise be placed around the laboratory. These cabinets may be vented through the systems serving the exhaust hoods.

Cold rooms.—These are refrigerated rooms and are usualy stacked one above the other. This arrangement permits the use of a central refrigeration plant. Since volatile liquids will be used in these rooms, a ventilation rate of 5 to 6 cfm is recommended. Air, vacuum, cold water, and electrical outlets should be provided at the work benches.

Department of anatomy.—*Animal quarters* and *cold rooms* are discussed above.

Dissecting rooms require a minimum of 10 room volumes of air per hour with no recirculation. A negative air pressure relative to adjoining areas must be maintained in this room to prevent the spread of formalin which is odorous and bactericidal and may adversely affect the work in other adjoining areas.

Gross neuroanatomy rooms should be treated the same as the dissecting room. A canopy hood over the dissecting table is sometimes used for exhaust, but a more desirable arrangement is to provide a table with perforated top through which air may be drawn downward away from the observers into a plenum within the table and then to the exhaust system. However, this fixes the table and reduces flexibility.

Cadaver storage rooms are usually maintained at a temperature of 40° F. and a relative humidity of 40 percent. A ventilation rate of 1 room volume of air per hour is recommended. Investigation should be made of reports of embalming methods reputed to preserve cadavers at normal room temperatures. These methods would materially reduce the refrigeration load and cost of storage.

Embalming rooms require 10 room volumes of air per hour with no recirculation and temperatures and humidities within the comfort range.

Crematories must have a supply of combustion air, based upon the capacity and the reduction rate of the equipment.

Electronmicroscope rooms should be vibration free, dust free, and maintained at constant temperature and a relative humidity not to exceed 40 percent. These requirements are necessary for the protection of the equipment and to insure its accuracy. This equipment produces considerable heat, which requires cooling the room. High-efficiency filters should be installed on the air-supply inlet to the room, and a positive air pressure relative to the air pressure of adjoining areas should be maintained to eliminate any infiltration of dust.

Tissue-staining and embedding rooms should have a ventilation rate of 2 room volumes of air per hour. The temperature of this room should not exceed 80° F. to preserve the consistency of the paraffin used in the embedding process.

Department of biochemistry.—*Animal rooms*, *cold room*, and *glass-washing room* are discussed at the beginning of this section.

Teaching laboratories should have a ventilation rate of 3 room volumes of air per hour to compensate for odor and toxic fumes generated by procedures carried out in this area.

Where special rooms are provided for the use of Van Slyke, Van Slyke & Neill, and Warburg apparatus, special ventilation rates will be required to protect operators from high concentrations of mercury vapors which are a hazard in such areas.

Chromotography room ventilation rate is influenced by the size and number of fume hoods used in this area. Depending upon the use of the room, the hoods may serve for all or a great part of the exhaust ventilation. Solvents used are extremely dangerous and high-face velocities are required at all hoods. Large hoods are sometimes equipped with movable exhaust ports within the hood. Temperatures and humidities within the comfort ranger are recommended. A negative air pressure relative to the air pressures of adjoining areas is recommended for this room.

The *isotope counting room* should have a ventilation rate of 2 room volumes of air per hour with a temperature of 75° F. and a relative humidity of 40 percent. Accurate humidity control is required for this room.

Department of microbiology.—*Animal rooms*, *cold rooms*, and *glass-washing room* are discussed at the beginning of this section.

Teaching laboratories should have a ventilation rate of 3 room volumes of air per hour, temperatures and humidities within the comfort range, and a negative pressure relative to adjoining areas.

Media preparation areas should have a ventilation rate equivalent to 6 room volumes of air per hour to remove steam and odor. Temperatures should be maintained within the comfort range. As this area may also serve as a sterile transfer room, the air of the area should be maintained as near sterile as possible. Filters with an efficiency of 90–99 percent in the removal of particulates in the 1- to 5-micron size range should be installed in the air-supply duct as the point of entry to the room. To prevent infiltration of air to the room, a positive pressure of 0.06 inch of water relative to the pressure in adjoining areas should be maintained.

Sterilizing rooms should have a ventilation rate of 3 room volumes of air per hour and temperatures and humidities should be maintained within the comfort range. A negative air pressure relative to the air pressures of adjoining areas is recommended. Air-exhaust hoods or louvers located immediately above the sterilizer doors will assist in voiding excess heat and steam and will protect wall and ceiling finishes.

Mycology laboratories require an atmosphere free of normal air contaminants. To accomplish this condition, filters with an efficiency of 90 to 99 percent in the removal of particulates in the 1- to 5-micron range should be installed in the air-supply duct at the point of entry to the room. A ventilation rate of 3 room volumes of air per hour is recommended. A positive air pressure relative to the air pressures of adjoining areas should be maintained to reduce the possibility of infiltration of contaminants. Temperatures and humidities within the comfort range are recommended.

In *virus and rickettsia laboratories* a ventilation rate of 10 room volumes of air per hour with no recirculation is recommended. High-efficiency bacterial filters preceded by lower efficiency filters must be provided at the exhaust outlets from hoods installed in this laboratory. Temperatures and humidities within the comfort range are recommended for this room.

Department of pharmacology.—*Animal rooms* *cold room*, *glass-washing room*, and *darkroom* are discussed at the beginning of this section.

Teaching laboratories should have a ventilation rate of 3 room volumes of air per hour with temperatures and humidities within the comfort range, and a negative air pressure relative to the air pressures of adjoining areas.

To insure safety from explosion, *anesthesia storage rooms* should be individually and continuously ventilated. Fresh air should be supplied by gravity and air should be mechanically exhausted at a rate of 8 air changes per hour. Construction and ventilation must conform to applicable codes.

Department of physiology.—*Animal rooms*, *cold rooms*, *darkroom*, and *instrument storage room* are discussed at the beginning of this section.

Teaching laboratories should have a ventilation rate of 3 room volumes of air per hour with temperatures and humidities within the comfort range and a negative air pressure relative to the air pressures of adjoining areas.

Treadmill and gas-analysis rooms should have a ventilation rate of 2 room volumes of air per hour with temperatures of 70° F. and 50 percent relative humidity.

Audio rooms should have a ventilation rate of 2 room volumes of air per hour with temperatures and humidities within the comfort range. Because of the necessity for absolute quiet in this room, careful design of the ventilation system is required to eliminate any noise from this source.

Constant-temperature rooms require a ventilation rate of 3 room air volumes per hour. As a quiet environment may be required, care should be exercised in installing the ventilation system.

Systems serving these rooms are usually provided with means of obtaining any temperature within the range of 50° to 110° F. and any humidity within the range of 15 to 40 percent. Temperature control should be accurate to within ½° F. Individual refrigeration systems located in the vicinity of the rooms are desirable.

Shielded rooms should have a ventilation rate of 2 room volumes of air per hour with temperatures within the comfort range. Cooling may be required to compensate for the heat produced

by equipment used in this room. To protect the equipment, the relative humidity should not exceed 40 percent.

Department of pathology.—*Animal rooms*, *cold room*, *darkroom* are discussed at the beginning of this section. *Electronmicroscope* rooms are discussed under the department of anatomy.

Teaching laboratories should have a ventilation rate of 3 room volumes of air per hour with temperatures and humidities within the comfort range and a negative air pressure relative to the air pressures of adjoining areas.

Autopsy rooms should have a minimum ventilation rate of 10 room volumes of air per hour with no recirculation. Exhaust air should be carried to a discharge point above the roof. To prevent the spread of odor and the possibility of contaminating adjoining areas, a negative air pressure of 0.06 inch of water relative to the air pressure of the adjoining areas should be maintained. Temperatures and humidities within the comfort range should be maintained.

Utility rooms serving autopsy rooms are contaminated rooms and should be maintained at a negative air pressure relative to the air pressure of adjoining rooms outside the autopsy suite. However, the air pressure should not be negative relative to the air pressure of the autopsy room where they adjoin each other.

Surgical pathology preparation rooms are subject to infectious contamination and should, therefore, be maintained at a negative air pressure relative to the air pressure of adjoining areas. Temperatures and humidities should be maintained within the comfort range.

Photo rooms are subject to some contamination from specimens and should be maintained at a negative air pressure relative to the air pressure of adjoining areas. Temperatures and humidities should be maintained within the comfort range.

Department of medicine.—*Animal rooms* and *cold rooms* are discussed at the beginning of this section.

The air of *cardiac catheter rooms* should be maintained as sterile as possible to prevent contamination of catheters at the time of use. The ventilation system should be designed to provide 12 room volumes of air with no recirculation during periods when the room is in use and for recirculation of air when the room is not in use. A positive air pressure relative to the air pressure of adjoining areas should be maintained. Filters with a 90- to 99-percent efficiency in the removal of particulates in the 1- to 5-micron size should be installed in the air-supply duct at the point of entry to the room.

Patient cold rooms used in this department are similar to the constant temperature room in the Physiology Department except that high temperatures are not required.

Department of surgery.—*Animal rooms* and *cold rooms* are discussed at the beginning of this section.

Department of pediatrics.—*Animal rooms* and *cold rooms* are discussed at the beginning of this section.

Department of psychiatry.—None.

Department of obstetrics and gynecology.—*Animal rooms* and *cold rooms* are discussed at the beginning of this section.

Refuse Disposal

The problem of refuse disposal in the medical school is aggravated by the character of the waste material and by storage requirements prior to final disposal. Incineration which assures complete destruction and maximum safety is the accepted method of disposal.

Even with the best operation and management, exhaust fumes from incinerators installed in individual buildings find their way into the fresh-air inlets of the ventilation systems. Ventilation systems distribute these fumes to all areas of the buildings where they are not only a nuisance, but may be hazardous to occupants of the buildings or may affect or destroy work in progress. Too much emphasis cannot be placed on the necessity for keeping incinerators out of individual buildings. The most satisfactory and trouble-free installation is a central incineration plant located remote from all buildings in the boilerhouse or adjacent to it where it can be operated by trained full-time employees.

Among the most troublesome wastes from the standpoint of quantity and type is the refuse from

animal cages and animal carcasses. Well-ventilated storage areas for holding refuse in suitable containers should be provided convenient to the areas in which such refuse originates. From these substorage areas refuse should be transported periodically to a central refrigerated storage room located at the loading dock for holding prior to transporting it to the incinerator plant.

Isotope dosages normally used create no problem. For holding highly radioactive animal carcasses until the radiation dosage subsides, a freezing compartment should be provided in the central refrigerated storage room.

Incinerators used for the disposal of radioactive wastes must be approved by the Atomic Energy Commission.

Electrical System

Electrical energy is used for the operation and control of practically all mechanical equipment used for heating, air conditioning, elevators, sanitation, and fire protection, as well as for lighting, communications, clocks, timers, office machines, and various appliances. In some laboratories where constant low temperature is required, an alternate, or emergency, source of power is needed to minimize the possibility of failure of experiments or loss of critical specimens or materials because of an interruption of the electric service.

The use of electrical equipment throughout the medical school and hospital, particularly in the teaching and research laboratories, has increased considerably during the past few years, and is expected to continue to increase in the future. In many instances, electricity has replaced gas (bunsen burner) as a source of heat at laboratory workbenches. Demands on the electrical system in many of the medical schools have increased to the extent that installation of additional incoming feed capacity was necessary to supply the system load demands. Inadequate distribution within the buildings and absence of convenience outlets where needed is a common source of complaint.

Remodeling an existing electrical service installation is costly, interferes with scheduled activities, and usually creates a noise, dust, and litter nuisance; hence, the probable need for electrical services in the future should be anticipated and provided for.

Receptacles.—Receptacles should be of the type and current rating required, and installed for convenient use at all locations where plug-in service is required. Receptacles for use at workbenches and similar areas should be located above the work plane. To permit free access above flasks, bottles, or other apparatus on the work area, the receptacles should be high enough to clear the ordinary, frequently used apparatus. At least 1 outlet per foot, or 1 duplex for each 2 feet, along workbenches is suggested. They may be installed in groups to minimize objectionable location of extension cords. All receptacles are required to be of the grounding type.

Where direct-current, high-frequency current, or other service outlets are required, they should be provided with polarized receptacles to prevent error in attachment of the apparatus.

Lighting.—Lighting systems should be designed to provide a comfortable visual environment, the amount of light, and the lighting color rendition needed. Luminaires should be of simple design, easily cleaned, and relamped, and located so as to minimize direct and reflected glare and shadows on the work areas (*44*).

In auditoriums and large lecture halls where slides or movies are to be projected onto a large screen, remote switching controls of the lighting system should be located conveniently for the projector operator.

Lighting levels in various areas should conform to recommendations of the Illuminating Engineering Society as published in IES Lighting Handbook, third edition. Following are examples of recommended lighting levels:

	Footcandles on task
Laboratories:	
Assay rooms	30
Work tables	50
Close work	100
Auditoriums:	
Assembly only	15
Exhibitions	30
Social activities	5
Lobby or lounge rooms	30
Stairs	20
Locker rooms	20
Corridors	20

	Footcandles on task
Library:	
Study and notes	70
Book repair and binding	50
Cataloging	70
Card files	70
Check-in and check-out desk	70
Offices:	
Regular office work, reading good repreductions, reading or transcribing handwriting in hard pencil or on poor paper, active filing, index references, mail sorting	100
Reading or transcribing handwriting in ink or medium pencil on good-quality paper, intermittent filing	70
Reading high-contrast or well-printed material, task and areas not involving critical or prolonged seeing such as conferring, interviewing, inactive files and washrooms	30
Lecture rooms:	
Lighting on chalkboard	150
Reading printed material and taking notes from chalkboards	30

Color and reflectances of interior finishes and equipment affects the lighting, and should be specified prior to, or in conjunction with, designing the lighting system.

Television.—Where television is to be used for teaching, authoritative advice on the system and type of equipment best suited for the intended use should be obtained early in the planning stage so that proper space can be provided for equipment, conduit, wiring, spare parts, records, tapes, general storage, office, and work spaces.

Fire alarm system.—A fire alarm system is required.

Clock system.—A clock system is recommended.

Communication.—Telephones should be provided in all office and service areas as required. Pay stations should be provided convenient for student and visitor use. Intercommunication systems, other than telephones, may be desirable. Paging and loudspeaker systems should be provided as needed for announcements and instructions, and in large assembly halls.

Emergency power.—An emergency power system is required for lighting exit ways and auditoriums, as well as for fire alarms, constant-temperature rooms, cold rooms, deep-freeze units, incubators in research laboratories, cadaver storage rooms, and for certain fume hood exhaust fans where interruption of the ventilation might permit a dangerous concentration of toxic fumes. For emergency electric power requirements in the medical school and the teaching hospital, see NFPA 76, National Electric Code, article 700, and NFPA Building Exits Code 101.

Radiology.—Radiation protection should be provided as recommended in the applicable handbooks of the National Bureau of Standards. This applies to X and gamma radiations.

Radioisotopes.—Shielded counting rooms may be required to minimize stray radiation where a high degree of accuracy is required.

Radiation protection in radioisotope laboratory and treatment areas is usually provided by shielded hoods, a temporary shield of lead bricks, lead-lined safe, and lead-lined shipping containers. These may produce heavy concentrated floorloadings.

The installation and use of teletherapy devices incorporating sealed gamma sources are described in handbook 73 prepared by the National Bureau of Standards.

Electronic equipment.—The use of electronic equipment is increasing so rapidly that definite recommendations are not possible. However, some measuring devices of this general type such as electroencephalographic require such a high degree of sensitivity to pick up the low impulses being measured that a completely metallically shielded room may be required to minimize static and cosmic-ray interference. Shielding of this type with copper screen in walls, floor, and ceiling will not exclude magnetic interference. To minimize magnetic interference it is recommended that these rooms be located a minimum distance of about 50 feet from large electric conductors carrying heavy current (*45*). Equipment that is voltage sensitive should be powered through a voltage regulator.

Structure

Fire safety and the need for fire-resistive construction are discussed under the heading, "Fire Safety." However, it is important to consider the selection of a structural frame and floor system which will allow flexibility of space arrangement and adequate live load to support the heavy and movable equipment associated with medical schools. It is not always possible to determine the

location where future expansion will be required; therefore, the structural elements and their enclosing walls should permit building expansion in all directions. Load-bearing wall construction methods are generally not suitable for such expansion. Floor construction should be of a type that will accept economically the many and varied openings and surface depressions required initially and in the future.

Materials and Finishes

Laboratories, preparation rooms, utility rooms, and the like should have floor finishes which are smooth and acid resistant. The use of quarry tile with cove base is recommended. However, good results can be obtained with resilient flooring such as vinyl-asbestos tile and rubber base. Wall finishes in these areas may be plaster, glazed tile (wall or wainscot), or the more economical masonry block. For partitions between research laboratories, cement asbestos, drywall, and prefabricated movable partitions of steel have been used. Masonry block has also proven satisfactory. To avoid cracks and joints, ceilings of these areas should be of monolithic material, such as plaster. With the changes in plumbing and mechanical facilities that often occur in these areas, many schools have left the structural ceilings and piping exposed.

In sterilizing and glasswashing areas, quarry tile or terrazzo floor is desirable. Walls and ceilings should be moisture resistant. Portland cement plaster and water-resistant, high-gloss paint is satisfactory, but glazed tile with sanitary cove base is better.

Cold rooms should have ceramic or quarry tile floors, cove base, and cement mortar walls and ceilings. Where prefabricated cold rooms are installed, prefinished surfaces are usually stainless steel or porcelain enamel.

In dissection rooms, vinyl-tile floors, glazed structural tile wainscot, and masonry block walls are recommended. If ceilings are installed, the finish should be plaster.

Corridors in research and teaching areas should have resilient flooring such as asphalt or vinyl-asbestos tile with a top-set base. Walls may be of masonry block, glazed tile, or other durable finish. In many installations, corridor ceilings must be removable for access to piping and ductwork. Removable mineral composition acoustic tile is recommended for these ceilings.

Such areas as autopsy rooms, scrubup areas, cadaver storage, embalming room, and embalming storage should have finishes such as quarry-tile floor and base with glazed-tile walls. Ceilings, if not exposed, should be plaster.

Materials and finishes for lecture rooms, medical school library, auditorium, lobbies, offices, and other similar areas should be selected for durability and minimum maintenance.

High-quality materials and finishes for cabinet work should be used throughout because it is subject to hard usage.

Solid-core doors with hardwood or similar veneer and with the best institutional grade hardware are recommended.

Fire Safety

It is important to provide a fire-safe facility not only to protect the life of the occupants in case of fire, but also to minimize damage to equipment and supplies and to safeguard complicated laboratory experiments, particularly those of a long-range nature which cannot readily be repeated.

To achieve adequate fire safety, the architects and engineers should incorporate the following planning measures in the design:

(1) *Plan to minimize the outbreak of fire*

All material used in the construction of the building should be incombustible and all structural members should be made fire resistive.

Space should be allotted around and above all mechanical equipment and electrical services to permit safe operation and encourage good maintenance. It is good design practice to increase

ceiling height in boilerrooms and mechanical equipment areas.

(2) *Plan for discovery of fire*

Automatic fire-detection of fire-alarm systems should be installed in areas that may be fire hazardous because of their content or use. Rooms containing intricate machinery or expensive supplies should be protected by a system which will not damage the contents of the rooms. For conditions that may lead to a rapid spread of fire, an automatic sprinkler or chemical extinguishing system is desirable, since it discovers the fire, applies an extinguishing medium, and spreads an alarm.

In addition, each building should be equipped with a manually operated local fire-alarm system. If possible, it should be interconnected to transmit an alarm to the municipal fire department.

(3) *Plan to restrict the spread of fire*

In spite of the most comprehensive precautions that can be taken to prevent fires, they still occur. It is important, therefore, to assure that accidental fires are controlled in time to avert a major catastrophe.

If a fire starts in a room, it should be possible to keep it within that room until it burns itself out or until it is discovered and extinguished. All walls, floors, and ceilings should be of noncombustible materials with no cracks or openings to concealed spaces that can transmit smoke or gases of combustion to other rooms. Openings through walls and floors should receive particular attention. The use of louvered panels and ventilating transcoms should not be permitted since they allow the passage of smoke and flames. If fire extends beyond the confines of a room, it is important that its effects should not be transmitted throughout the building. Stairways, elevator shafts, dumbwaiter shafts, and other vertical shafts should be totally enclosed in fire-resistive construction to retard the passage of smoke and gas from floor to floor. Smoke-barrier doors should be installed at strategic locations in corridors to subdivide the floor area into compartments. This is particularly important in the hospital.

Rooms of hazardous occupancy such as boilerrooms and combustible storage rooms should be equipped with suitable fire doors. Fire doors should also be installed in stair towers and other vertical shafts, and in all firewalls and partitions.

(4) *Plan for extinguishing fires*

Fire extinguishers should be provided to cope with fire at an incipient stage. Consideration should be given to the kinds of fires which may occur in various areas and to the type of extinguishers required.

The size, type, and location of fire extinguishers should be established after consultation with local firefighting authorities having jurisdiction.

(5) *Plan for evacuation*

Proper exit facilities should be available to expedite rapid evacuation. The recommendations of Building Exits Code of the National Fire Protection Association for the number, location, arrangement, and construction of exits should be followed.

Chapter 9

COSTS OF CONSTRUCTION AND OPERATION

Costs of constructing a medical school will vary greatly in relation to the functions for which the medical school is responsible, including (1) the extent to which it provides instruction and facilities for dentistry, pharmacy, nursing, technical, and graduate students; (2) the size of research programs; (3) the need for the teaching hospital; and (4) the need for student housing.

The diverse programs and responsibilities of medical schools make it impossible to set a narrow range of estimates for construction costs. At one extreme are schools built around a community hospital and remodeled college science building; at the other extreme are schools that required a capital investment of $35 to $50 million.

However, to indicate orders of magnitude, estimates have been developed for the cost of constructing two hypothetical schools, school A with an entering class of 64 students and a hospital of 500 beds and school B with an entering class of 96 students and a hospital of 700 beds. The central facilities of the smaller school, including classrooms and library and various other core services, were planned to permit future expansion of enrollment. In neither school A nor school B was space allowed for teaching students in other health professions such as dentistry or nursing. The numbers of medical students, graduate students, faculty, and fellows for which the 2 schools were designed were as follows:

	School A	*School B*
Medical students:		
Entering class	64	96
Total	250	370
Basic science departments:		
Faculty, full time	35	50
Graduate students and postdoctoral fellows	40	55
Clinical science departments:		
Faculty, full time	60	85
Postdoctoral fellows	30	40

Construction Costs

Illustrative cost figures should be considered only as a rough estimating guide. Regional location, differences in programing, the state of the construction industry, and type of construction are some of the factors contributing to substantial variations. In recent years there has been an average increase of 4 percent in construction cost per year.

With the area of the plant established, the experienced architect can adjust average costs for conditions existing in the area and derive a realistic cost estimate for budget purposes. Between the original planning and estimating and the time the project goes to bid (which may be several years) costs may change. The architect should revise his estimate during the planning period to keep abreast of price fluctuations which would require budget adjustments.

In estimating costs, it may be difficult to locate comparable types of construction in the local area. The Engineering News-Record cost indexes can be helpful in adjusting other regional costs to local conditions.

At the time of the present writing the average cost of construction of medical education facilities is about $33 per square foot, with a range of from $30 to $45. This figure covers only construction costs. It does not include the cost of the site or site improvements, architectural, engineering, and consultant fees, or costs of site surveying and soil testing. Fixed equipment (built in, such as sterilizers, counters, cabinets) is included in the $33

cost, but movable equipment and expendable items and supplies are not included. The cost of movable equipment for medical schools is estimated to be approximately 15 percent of the construction cost. The estimated average cost of movable (groups II and III) equipment for a university teaching hospital is approximately $4,500 per bed not including research equipment or consumable supplies. Both hospital practice and research activities are characterized by an increasing diversity and complexity of instrumentation which is a major factor in increasing equipment costs. Using the $33 average, it is possible to arrive at an order-of-magnitude cost estimate for the hypothetical schools and staffing levels (table 51).

TABLE 51.—*Summary of space estimates and costs for conventional basic science facilities, for clinical science facilities, for university teaching hospitals, and for auxiliary areas for hypothetical medical centers with entering classes of 64 and 96 students*

Type of facility	School A (entering class of 64 students)	School B (entering class of 96 students)
	Square feet	
Summary of space estimates:		
Total gross area (rounded) [1]	908, 000	1, 169, 000
Total net square feet (65 percent)	590, 000	760, 000
Gross—net difference square feet (35 percent)	318, 000	409, 000
Basic science facilities:		
Total gross area (rounded) [1]	152, 000	183, 000
Total net area (rounded)	99, 000	119, 000
Clinical science facilities:		
Total gross area (rounded) [1]	69, 000	80, 000
Total net area (rounded)	45, 000	52, 000
University teaching hospital:		
Total gross area (rounded) [1]	602, 000	809, 000
Total net area (rounded)	391, 000	526, 000
General administration and supporting facilities:		
Total gross area (rounded) [1]	85, 000	97, 000
Total net area (rounded)	55, 000	63, 000
General administration	3, 900	4, 700
General administration and supporting facilities—Continued		
Medical school library	29, 560	29, 560
Animal quarters	11, 980	14, 860
Auditorium [2]	----------	----------
Lecture rooms [3]	----------	----------
Study cubicles [4]	----------	----------
Student activities	1, 850	2, 400
Medical illustration	2, 020	3, 170
Technical shops	----------	----------
Service facilities	6, 000	8, 350
Departmental central storage [3]	----------	----------
	Dollars	
Summary of cost at $33 a square foot: 1963: [5]		
Basic science facility [6]	5, 016, 000	6, 039, 000
Clinical science facility	2, 277, 000	2, 640, 000
General administration and supporting facilities	2, 805, 000	3, 201, 000
Hospital	19, 866, 000	26, 697, 000

[1] To compute the gross area, it is estimated that 65 percent of the total gross area is available as usable space, while the remaining 35 percent will provide space for exterior walls, partitions, corridors, stairs, elevators, and duct ways and chases for mechanical and electrical requirements.

[2] Areas for the auditorium are in the teaching hospital.

[3] Areas for lecture rooms and departmental central storage are prorated between basic science and clinical science facilities and are shown on the summary tables for those facilities.

[4] Areas for study cubicles for students in the first 2 years and technical shops are in the basic science facilities; areas for study cubicles for 3- and 4-year students are in the teaching hospital.

[5] This cost covers *construction only* including fixed equipment and does not include costs for the site, site improvements, movable equipment, or fees. It is an *average* figure based on national construction costs and will vary considerably according to regional location, program differences, and type of construction. Recent medical school construction costs in different parts of the country have ranged from $30 to $45 a square foot. Therefore, costs should be carefully checked against local experience for comparable construction before application to a specific project.

[6] With conventional laboratories.

All construction funds need not be appropriated at one time. The first appropriation of funds will be needed for planning. Some schools have been successful in obtaining foundation support for planning. It is more economical to build the basic and clinical science facilities at the same time, but it is possible to space them 1 year apart, with separate appropriations. At present, Federal matching funds are available for space devoted to research and education. For the teaching hospital, Hill-Burton funds can often be obtained. The amount is dependent on the situation in the particular State. Occasionally, foundations will contribute toward the establishment of a medical school. These foundations are usually national, but sometimes local foundations have available funds and can be interested. Much research equipment can be obtained on grants, after the building is completed, the faculty is in residence, and research has begun. However, enough money for teaching and research equipment for the faculty to begin investigative work must be available.

Operating Costs

Sound planning of medical school facilities should give consideration to plans for operation and use of these facilities. Even if a university has adequate construction funds, it is unwise to establish a new medical school until it has been determined how much it will cost to operate the school and how these operating costs are to be met.

Each medical school should prepare its own operating budget with painstaking care by—

(1) Defining its teaching, research, and service goals.
(2) Identifying the role it will play in relation to the parent university and in relation to local, State, and national education and health programs.
(3) Identifying the nature and scope of each of the various programs and activities that must be undertaken to achieve its goals.
(4) Identifying in as much detail as possible each operating cost factor such as:
   (*a*) The effect of location and climatic conditions on costs.
   (*b*) Staffing pattern plans.
   (*c*) Competitive salary levels for the geographic area.
   (*d*) Medical service plans and their effect on salary costs and income.
   (*e*) The potential impact of voluntary faculty service on teaching costs.
   (*f*) The effect of nonuniversity hospital affiliations on costs.
   (*g*) The effect of university-owned clinics and hospitals on costs.
   (*h*) Maintenance and operation costs.
   (*i*) The extent of grounds, roads, and walks to be maintained.
   (*j*) Potential impact of government-sponsored teaching, training, and research programs on the school's performance and on its costs.
   (*k*) Potential impact of non-government-sponsored programs on the school's performance and on its costs.
(5) Identifying potential support from all sources.
(6) Utilizing all of the information and advice available from authoritative organizations and persons when making budget forecasts.

University teaching hospitals are obviously more expensive to operate than hospitals with limited or no teaching programs, and operating costs have risen about 5 percent per year in recent years. Therefore, design for low maintenance and operating costs is essential.

Deficits which may occur are generally met by (1) appropriations of State or local funds, (2) endowments, or (3) fundraising campaigns. Annual operating costs in the average hospital will equal the construction cost in about 2½ years.

Illustrative Operating Budget

The operating budget summaries for medical schools in tables 52 and 53 were prepared on the basis of staffing patterns contained in this report. They are presented only for general information. Detailed schedules, comments, and explanations, which can be obtained from the Association of American Medical Colleges, will help a university engaged in planning a new medical school to formulate a detailed budget.

The operating budget of a new medical school should be developed gradually over a period of at least 4 years. The illustrative budgets reflect the operating costs of medical schools in full operation with 4 classes of undergraduate medical students. The budgets do not reflect either the costs of operating teaching clinics and hospitals or the net costs to the medical school after deductions for grants or income from other sources.

TABLE 52.—*Illustrative budgets for a 4-year medical school*

Size of school and purpose of expense	Type of expense			
	Total	Personal service	Supplies and expenses	Traveling expenses
Entering class of 64 students: Total	$3,354,400	$2,500,280	$831,820	$22,300
Departmental instruction and research	1,984,050	1,873,900	95,900	14,250
Postgraduate medical education	24,900	20,000	2,500	2,400
Library	99,200	56,600	42,000	600
Animal care	48,550	48,400	----------	150
Central supportive services	102,200	76,300	25,000	900
Miscellaneous instruction and research expenses	62,700	53,000	9,700	----------
Equipment (all departments)	60,000	----------	60,000	----------
Student health service	7,400	5,000	2,400	----------
Admissions and student services	31,400	30,600	----------	800
General administrative services	448,060	174,500	270,360	3,200
Operation and maintenance of physical plant	485,940	161,980	323,960	----------
Entering class of 96 students: Total	4,112,100	3,070,550	1,012,050	29,500
Departmental instruction and research	2,450,900	2,302,400	128,400	20,100
Postgraduate medical education	24,900	20,000	2,500	2,400
Library	116,150	73,400	42,000	750
Animal care	59,950	59,800	----------	150
Central supportive services	102,200	76,300	25,000	900
Miscellaneous instruction and research expenses	62,700	53,000	9,700	----------
Equipment (all departments)	90,000	----------	90,000	----------
Student health service	12,400	8,800	3,600	----------
Admissions and student services	44,500	43,400	----------	1,100
General administrative services	567,160	239,700	323,360	4,100
Operation and maintenance of physical plant	581,240	193,750	387,490	----------

NOTE.—Since annual operating budgets for teaching hospitals vary widely depending on programs, none is included here. However, such a budget will usually equal the construction in about 2½ years. Deficits which may occur are generally met by (1) appropriation on State or local funds, (2) endowments, or (3) fundraising campaigns.

TABLE 53.—*Instructional department totals for illustrative medical school budgets*

Department	School A (entering class of 64 students)	School B (entering class of 96 students)
Total	$1,984,050	$2,450,900
Anatomy	137,750	168,700
Biochemistry	123,300	154,250
Microbiology	106,150	137,100
Pharmacology	102,150	132,800
Physiology	112,800	143,250
Pathology	158,700	194,450
Preventive medicine	79,600	117,550
Medicine	335,700	372,450
Obstetrics-gynecology	91,550	135,000
Pediatrics	113,450	147,400
Psychiatry	207,400	250,450
Radiology	113,250	156,800
Surgery	302,250	340,700

ASSUMPTIONS UNDERLYING ILLUSTRATIVE BUDGETS

Instruction and research departments.—This budget provides for only those departments that are common to most 4-year medical schools. It is expected that anesthesiology, otorlaryngology, ophthalmology, and other surgical specialties will be included in the department of surgery; neurology and dermatology in the department of medicine; and other specialties in other departments. The budget does not provide for major activities in the newer disciplines such as genetics and industrial medicine.

All estimates cover full-time faculty on a 12-month year. The number for each department conforms with the hypothetical staffing in table 11.

The number employed in each academic rank will vary in different departments and in different schools. Thus the budget for the various departments may change, but the overall totals for the school should approximate the estimated total.

Few medical schools operate exclusively with a full-time faculty in the clinical departments. The supply of practicing physicians who are competent and willing to teach either on a salaried part-time basis or on a voluntary basis varies in each community. Even when the supply is ample, a core of full-time faculty members is necessary for each department. The size of the full-time faculty is steadily increasing in most schools.

A strong voluntary clinical faculty is an important asset. These doctors are, in effect, part-time faculty members who usually serve without salary. A good voluntary faculty may make it possible to reduce the number of full-time faculty members and thereby reduce the budget. Part-time salaried faculty members may be employed in place of full-time personnel, but in most cases this will be done not because of its desirability but because of necessity. When costs are measured in relation to overall achievements (in teaching, research, and service), the employment of part-time faculty members seldom produces financial savings.

This does not mean that medical schools and teaching hospitals cannot or should not share the payment of certain full-time faculty salaries, especially in pathology, radiology, and anesthesiology.

The estimated salaries are based on data compiled in the Association of American Medical Colleges 1962 survey of faculty salaries. Salaries in this estimate range from $8,500 for instructors to $28,300 for some "geographic full-time" department heads.

Salary levels vary in different instruction and research departments and in different parts of the country. They have been increasing steadily during recent years and further increases may be expected, especially in the low and middle salary brackets.

Clinical department salaries provide for 12 months' employment under a geographic full-time salary plan. Geographic full-time faculty members are those who spend full time in the teaching center with major responsibility for medical college activities and the privilege of devoting part time to private medical practice. Earnings from private practice are usually limited and form a small part of their professional income (*46*). Private patients should be used for teaching.

Some clinical faculty members are employed under a "strict full-time" salary plan. They receive their entire professional income in salaries paid by the medical school with an understanding that fees earned will be turned over to the school. When this type of medical service salary plan is used, clinical department salaries are usually 20–25 percent higher than the geographic full-time salaries reflected in these illustrative budgets.

The extra cost, however, is frequently offset by the additional income the school receives from a portion of patient fees.

Table 11, p. 31, shows the minimum number of full-time faculty, graduate assistants, and postdoctoral fellows required for a program of teaching, research, and service. The operating budgets provide salaries for all faculty positions and one-half the graduate assistants and postdoctoral fellows. The budgeted positions should be established on a permanent basis and could appropriately be financed by university funds.

After the medical school gets underway, the remainder of the graduate assistants and postdoctoral fellows can be employed from teaching and training grant funds. It is usually necessary to employ the permanent faculty before extensive teaching, training, and research grants can be obtained. However, more and more funds for sponsoring such programs are becoming available each year. A competent faculty will attract grants that will enable a school to strengthen and improve its teaching and to expand its research by the employment of additional faculty and supporting staff personnel. Most granting agencies now permit paying from their grants the portion of the salary of a permanent faculty member for the time he is working on a sponsored research project. This may reduce the faculty salary budget of a medical school by a significant amount.

The scope and character of sponsored programs in medical schools will vary according to the size of the school, administrative policies, space available for faculty research, reputations and research interests of faculty members, and faculty teaching and service workloads. As research support continues to increase, many medical schools will employ more faculty and supporting staff with grant funds than with university funds. However, most teaching, training, and research grants are accepted by a medical school with an understanding that they will be used to expand and strengthen the school's basic programs and that its investments in teaching, research, and service will not be decreased.

Library.—This budget is for a medical school library that is independent from the university library.

If the medical school library is operated as a part or branch of the university library, or if some services such as ordering and cataloging are provided by the university library, the medical school budget may be smaller and the university library budget will be increased by an amount that should be charged to the medical school. A division of work or responsibility between the university and medical school libraries probably will not result in significantly lower total costs, unless standards are also lowered.

Budgeted expenses for books, subscriptions, and other supplies are as high for 64 students per class as for 96. A smaller class and a smaller faculty do not reduce the need for library reference materials. However, the increase in class size will call for more services or larger library staff and the library facilities will be more fully utilized.

Animal care.—This budget covers personal services only. It does not include the cost of acquiring animals, animal food, bedding, and other supplies. These expenses are chargeable to departmental teaching and to research grant budgets.

The number and kind of animals required and the average period during which they are housed, fed, and cared for depends upon the constantly changing research interests of faculty members and, to a less extent, upon the availability of a supply of animals. This makes budget forecasting difficult.

Some animal-care programs are supervised by a veterinarian who conducts his own research programs. This budget does not provide for such a program, although professional full-time supervision is highly desirable.

Miscellaneous instruction and research expenses.—If the teaching hospital is owned by the university, all resident salaries will probably be paid by the hospital and the $50,000 budgeted for this purpose will not be necessary. If the teaching hospital or hospitals are privately owned and operated, they may be unable to afford the number of interns and residents desirable for teaching purposes and the medical school may find it necessary to pay some resident salaries. The budgeted amount is a nominal figure which may be too high or too low.

Honoraria and travel expenses for consultants and special lecturers, costs of radioactive waste disposal, and laundry are also included in this item.

Admissions and student services.—This division will direct all phases of the student admissions program; keep student records; prepare class schedules; provide staff services for the admissions, curriculum, and grades committees of the

faculty; assist student organizations and student activities; and serve as advisers and counselors to students and groups of students.

General administrative services.—The size and character of the medical school budget for administrative services will depend upon these factors:

(1) The administrative and business services provided by the university and financed by university budget funds. Many accounting, purchasing, payroll, public relations, storage, mail, messenger, telephone, duplicating, and printing services may be provided by the university.
(2) The extent and the kind of mechanization provided for accounting, payroll, and other business services.
(3) The administrative policies, laws, and regulations under which the school must operate.
(4) The quality of administrative services provided.

Operation and maintenance of physical plant.—The size of this budget will be affected by many things, such as:

(1) The size, quality of construction, design, and age of the building.
(2) The extensiveness of roads, grounds, and walks.
(3) Climatic conditions.
(4) The intensity of building use.
(5) The standards of maintenance.

Because of these factors and the unusual plant characteristics of medical schools, this part of the budget is difficult to prepare in accurate detail. Expenditures for the operation and maintenance of physical plant range from 12 percent to 20 percent of educational and general expenditures. For this illustrative budget the average of 17 percent is used.

Source of Funds for Medical School Operations

Table 54 shows average expenditures of 45 private and 42 public medical schools, by source of funds in the accademic year 1961–62.

TABLE 54.—*Average expenditures from funds available for basic operations and from funds designated for sponsored programs in 1961–62*

Source of funds	Private schools (45)	Public schools (42)
Grand total of average expenditure per school	$6,374,524	$5,429,516
Funds available for basic operations:		
Total	2,590,909	2,930,663
Tuition and fees	477,734	207,700
Unrestricted endowment income	412,443	21,948
Unrestricted gifts and grants (non-Federal)	206,915	60,853
Non-Federal government subsidies	103,745	18,485
State appropriations	----------	1,885,800
Funds available for basic operations—Continued		
Support from general university funds	308,433	----------
Overhead on grants on sponsored programs	367,714	249,183
Teaching expenses paid by hospitals and clinics	306,511	192,450
Teaching expenses paid from medical service funds	181,076	175,033
Other	226,338	119,211
Funds designated for sponsored programs:		
Total	3,78,6135	2,498,853

NOTE.—The above data were taken from the 1962 annual medical school joint questionnaire of the American Medical Association and the Association of American Medical Colleges.

The average expenditures for basic operations are not entirely comparable to the illustrative budgets because no adjustments have been made for such variables as the size of the school and the scope of programs. The difference between average expenditures for basic operations and the illustrative budgets will reflect to some extent the financial impact of fully developed programs of sponsored research and training. Expenditures by the various schools for regular operating programs ranged from $379,220 to $8,037,827 in 1961–62. This table provides a good picture of sources of funds for basic operations and sponsored research.

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