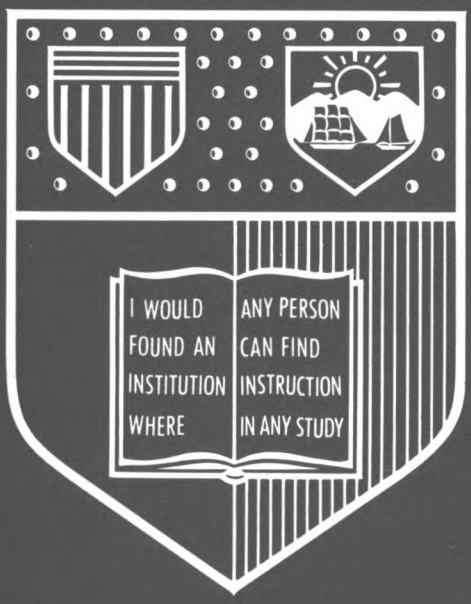
Cornell University Announcements



Graduate School of Medical Sciences

Cornell University

Graduate School of Medical Sciences

1300 York Avenue
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1978–79

Cornell University Announcements

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1978–79

Calendar*

Fall Semester

Labor Day holiday	Monday, September 4
Registration	Tuesday, September 5–Wednesday, September 6
Orientation, 9:00 a.m.	Wednesday, September 6
Opening Exercises, 3:00 p.m.	Wednesday, September 6
Instruction begins for first trimester and fall semester	Thursday, September 7
End of first trimester	Wednesday, November 15
Examinations for first trimester	Thursday, November 16–Wednesday, November 22
Thanksgiving recess	Thursday, November 23 Friday, November 24
Instruction begins for second trimester	Monday, November 27
Winter recess:	
Instruction suspended, 5:00 p.m.	Friday, December 15
Instruction resumed, 9:00 a.m.	Tuesday, January 2, 1979
Last day for completing all requirements for January degrees	Friday, January 12
Examination for first semester	Monday, January 22–Friday, January 26
Fall semester ends	Friday, January 26

Spring Semester

Registration	Monday, January 29
Instruction begins for spring semester	Monday, January 29
End of second trimester	Friday, February 23
Examinations for second trimester	Monday, February 26–Friday, March 9
Instruction begins for third trimester	Monday, March 12
Spring recess:	
Instruction suspended, 5:00 p.m.	Friday, March 30
Instruction resumed, 9:00 a.m.	Monday, April 9
Last day for completing all requirements for May degree	Friday, May 11
Commencement, 3:00 p.m.	Wednesday, May 23
Memorial Day holiday	Monday, May 28
End of third trimester and spring semester	Friday, June 1
Examinations for third trimester and spring semester	Monday, June 4–Friday, June 8

Summer

Registration for summer research	Monday, June 11
Summer research period begins	Monday, June 11
Last day for completing all requirements for August degrees	Friday, August 17
Summer research period ends	Friday, August 24

* Courses in the Graduate School of Medical Sciences are either semestral or trimestral. The calendar for this school is based primarily on the academic semester but is coordinated as well with the trimestral calendar of the Medical College. The dates shown in the calendar are subject to change at any time by official action of Cornell University.

In enacting this calendar, the Graduate School of Medical Sciences has scheduled classes on religious holidays. It is the intent of the School that students missing classes due to the observance of religious holidays be given ample opportunity to make up work.

Announcement

Contents

Cornell University

Graduate School of Medical Sciences

Purpose and History

The Graduate School of Medical Sciences, a semi-autonomous component of the Graduate School of Cornell University, provides an environment for advanced study and research in specific areas of the basic biomedical sciences. Graduate programs leading to the degree of Doctor of Philosophy are currently offered in the Fields of Biochemistry, Biological Structure and Cell Biology, Biology, Biomathematics, Biophysics, Genetics, Microbiology, Neurobiology and Behavior, Pathology, Pharmacology, and Physiology. Certain of these graduate fields also offer programs leading to the degree of Master of Science. The faculty recommends the award of advanced general degrees not only as the result of the fulfillment of certain formal academic requirements, but also as evidence of the development and possession of a critical and creative ability in science. Proof of this ability is embodied in a dissertation which the candidate presents to the faculty as an original research contribution in the area of study.

Freedom and independence are key qualities of scholarship, and graduate education at Cornell attempts to preserve them for teacher and student. Each graduate student is supervised by his or her own Special Committee, a small group of faculty members selected by the student. Within the broad framework of requirements for residence, examinations, and thesis, and additional regulations of individual fields, the Cornell graduate student and this Special Committee are completely free to plan a program of study. The Graduate School of Medical Sciences sets no overall course, credit-hour, or grade requirements. The Special Committee has extraordinary independence in guiding the student's program, and a student will be recommended for a degree whenever this committee judges the student qualified.

The opportunity for graduate study leading to advanced general degrees in the biomedical sciences was first offered at the Cornell University Medical College in 1912 in cooperation with the Graduate School of Cornell University. In June of 1950, Cornell University, in association with the Sloan-Kettering Institute for Cancer Research, established a new division of the Medical College, the Sloan-Kettering Division, for the purpose of providing additional opportunities for graduate study in the biomedical sciences. The resultant expansion of the graduate faculty and facilities on the New York City campus prompted the organization in January 1952 of the Graduate School of Medical Sciences, which has full responsibility for advanced general degrees granted for study in residence at the New York City campus.

Jacob S. Lasdon House, a student apartment residence.

Facilities

The Medical College Division. The buildings of the Medical College extend along York Avenue from Sixty-eighth to Seventieth streets. They contain the main library, lecture rooms, and study laboratories for the basic science departments, and extensive research facilities for faculty and students.

The Sloan-Kettering Division. The facilities of the Sloan-Kettering Institute for Cancer Research consist of the Howard Laboratory and the Kettering Laboratory on East Sixty-eighth Street in New York City and the Walker Laboratory in Rye, New York. These provide lecture and seminar rooms and well-equipped laboratories for biomedical research.

Organization

Faculty

The Graduate School of Medical Sciences is composed of two relatively separate divisions: the Medical College Division, consisting principally of the professorial staff of the basic science departments of the Cornell University Medical College; and the Sloan-Kettering Division, consisting of the professorial staff of the Sloan-Kettering Institute for Cancer Research. Within each of these divisions are fields or units of graduate instruction formed by faculty members with similar research and teaching interests. An individual faculty member may elect to affiliate with the one or two fields or units in which he or she agrees to sponsor graduate students.

General Committee

The General Committee of the Graduate School of Medical Sciences is an administrative board whose membership has responsibility for the academic affairs of the School. The committee considers matters referred to it by members of the faculty and offers recommendations to the faculty on questions involving the interests or policies of the Graduate School of Medical Sciences.

The General Committee is composed of the dean and the associate dean of the Graduate School of Medical

Sciences, the associate director of the Sloan-Kettering Division, one elected representative from each of the fields of the Medical College Division and from each of the units of the Sloan-Kettering Division, and two student representatives elected by the graduate student body. The General Committee approves new fields, reviews the admission of students, approves students' major and minor fields, reviews the curriculum of each field, reviews the requirements for degrees, and acts on faculty and student petitions.

The chairperson of the General Committee is the dean, who is the academic administrative officer of the Graduate School of Medical Sciences and is also an associate dean of the Graduate School of Cornell University. The secretary of the General Committee is the associate dean, who is also an assistant dean of the Graduate School of Cornell University.

Admission

Applications

For admission to the Graduate School of Medical Sciences an applicant must (1) have a baccalaureate degree or the equivalent from a college or university of recognized standing, (2) have adequate preparation in the chosen field of study, and (3) show promise of ability to pursue advanced study and research, as judged by his or her previous record.

Inquiries about graduate study should be addressed to the Dean of the Graduate School of Medical Sciences, 1300 York Avenue, New York, New York 10021 or to the Associate Director of the Sloan-Kettering Division, 410 East Sixty-eighth Street, New York, New York 10021.

Candidates may be admitted in September, February, or July although places in the graduate programs for February and July may not be available because of prior commitments to applicants for September admission. Applicants for February or July admission should correspond directly with the respective field representative in the Medical College Division or the unit chairperson of the Sloan-Kettering Division regarding the availability of places.

Application material must be completed and returned to the Office of the Dean together with (1) official transcripts of records from all colleges and universities attended, (2) a statement of purpose of graduate study, and (3) two letters of recommendation from individuals in academic positions who know the applicant professionally. In addition, scores from the Graduate Record Examinations are usually required by individual fields to aid in their evaluation.

Applications for September or July admission and all credentials, including official transcripts of records from all colleges and universities attended, must be received by the deadline date of February 1.

Applications and credentials for February admission must be received by November 1.

Application Fee. A nonrefundable charge of $10 is made for filing an application for admission.

The completed application and all supporting documents are reviewed by the Field (or Division) Credentials Committee. Applicants considered potentially acceptable are usually called for a personal interview. At the time of interview, after discussing his or her interests with the members of the field, the applicant may tentatively select a major sponsor. If accepted by the field, an application is returned to the dean who may refer it to the General Committee for final review and decision. A student is formally notified of acceptance for study in the Graduate School of Medical Sciences by a letter from the dean.

It is the policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age, or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

Admission policies are also in conformity with the policy of New York State in regard to the American ideal of equality of opportunity as embodied in the Education Practices Act.

Categories

An applicant is accepted by the Graduate School of Medical Sciences (1) as a degree candidate for the M.S. or Ph.D., or (2) as a provisional candidate.

Provisional candidacy provides opportunity for a prospective degree candidate, whose educational preparation is difficult to evaluate, to begin graduate studies. On the basis of the record of accomplishment in the first half of the academic year, the adviser or temporary Special Committee of a provisional candidate may recommend to the dean that (1) provisional candidacy be changed to degree candidacy, (2) provisional candidacy be continued for the remainder of the academic year, or (3) provisional candidacy be terminated. A maximum of one academic year in the status of provisional candidacy is permitted and credit of a maximum of one residence unit may be allowed on petition, provided there is convincing evidence that performance has been of the same quality as that required of degree candidates.

Degree Requirements

Major and Minor Fields

A candidate for the degree of Master of Science is required to register for study in one major and one minor field. Each field will determine whether two or three fields must be represented on the Special Committee of candidates for the Ph.D. degree. Accordingly, a candidate for the degree of Doctor of Philosophy is required to register for study in one major and one or two minor fields. At least one of the minors must be outside the area of the major field.

The Special Committee

The general degree requirements of the Graduate School of Medical Sciences are minimal in order to give maximum flexibility in choosing a desirable program of study. The student's program is determined with the aid and direction of a Special Committee, consisting of at least three faculty members chosen by the student from those fields that best fit his or her areas of interest. Satisfactory progress toward a degree is judged by the committee rather than by arbitrary standards imposed by the Graduate School of Medical Sciences. There are no regulations of the Faculty of the Graduate School of Medical Sciences governing the specific content of instruction, courses, or grades to which the Special Committee must subscribe, except those imposed by the fields. The committee is the agent primarily responsible for the candidate's development as an independent scholar and scientist.

No later than four weeks after enrollment, a candidate must file a statement of the major and minor fields selected for study, after which the student must choose one member of the faculty to represent each field and to serve on a Special Committee. The faculty member representing the major field usually advises the student in the other selections and serves as chairperson of his or her committee. At least one member of the committee must represent a field different from the candidate's major field. Members may agree to serve temporarily during the candidate's first year of residence until the candidate has had the opportunity to become acquainted with areas of research in the fields of his or her choice. On completion of this year of residence, a permanent Special Committee will be formed, the membership of which can be changed with agreement of all members of the old and newly formed committees and the approval of the dean. The members of the Special Committee decide upon the student's program of study and research and judge whether progress toward a degree is satisfactory. After consulting with the other members, the chairperson of the Special Committee prepares term reports on the candidate for submission to the dean. The members of the committee serve on all of the candidate's examining committees and they approve his or her thesis.

Registration and Course Grades

At the beginning of each term, students are required to register with the dean of the Graduate School of Medical Sciences and to file a Registration of Courses form indicating all courses they will take. A fee of $10 is charged for late registration. No student may double-register for an advanced general or professional degree with any other school or college except the Cornell University Medical College.

Registration is required of those graduate students who will be engaged in research during the summer.

All academic courses of the University are open to all students of all races, religions, ethnic origins, ages, sexes, and political persuasions. No requirement, prerequisite, device, rule or other means shall be used by any employee of the University to encourage, establish, or maintain segregation on the basis of race, religion, ethnic origin, age, sex, or political persuasion in any academic course of the University.

All courses for which the student registers for credit will be entered in the official record. Grades of graduate students are reported as: Excellent (E), Satisfactory (S), Unsatisfactory (U), Incomplete (I), Absent (Abs), or Unofficially Withdrawn (W). A grade of Incomplete or Absent cannot be changed later than one term following that in which the course was taken.

Residence

The Faculty of the Graduate School of Medical Sciences regards study in residence as essential. Each candidate for an advanced general degree is expected to complete the residence requirements with reasonable continuity. A student must register each term from the time of his or her first registration in the Graduate School of Medical Sciences until the student either withdraws or completes a degree unless granted a leave of absence. Full-time study for one-half academic year with satisfactory accomplishment constitutes one residence unit. Two units of residence are the minimal requirement for the master's degree and six units are the minimum for the Ph.D. degree. However, the time necessary to obtain the degree generally exceeds the minimal requirements. A candidate for the Ph.D. degree must spend two of the last four units of required residence in successive terms on the New York City or the Ithaca campus of Cornell University. No more than seven years may intervene between the time of first registration and the completion of all requirements for the doctoral degree. A student must complete all requirements for the master's degree in four years.

Part-time graduate study, if it is necessitated by off-campus employment noncontributory to the major field of study, is not encouraged. Requests for part-time study must be reviewed by the General Committee. If permission is granted for part-time study, the student must be in residence at least half-time.

The legislation with respect to eligibility of part-time students for residence units is as follows:

Employment	Residence Units Allowable Per Half Academic Year		
Total clock hours per week	Contributory in major field; on campus	Noncontributory; on campus	Off campus
0-10 hrs.	1 unit	1 unit	¾ unit
11-20 hrs.	1 unit	¾ unit	¾ unit
21-30 hrs.	¾ unit (teaching) ¾-1 unit (research)*	½ unit	———

* Time spent assisting in research, if it is contributory to the major field of study, shall be credited toward allowance of a full residence unit.

Transfer of Residence Credit

No residence credit will be granted for study outside the Graduate School of Medical Sciences to fulfill the requirements of the M.S. degree. No commitment can be made about granting residence credit toward the Ph.D. requirements for previous study in another graduate school until after the candidate has entered into residence at the Graduate School of Medical Sciences. At that time, the student's Special Committee may recommend acceptance of study outside the Graduate School of Medical Sciences to the General Committee, which will determine the number of residence units to be awarded. No credit can be transferred for study undertaken as an undergraduate or as a special student even in courses designed for graduate students.

A student who has satisfactorily completed two or more academic years of study toward the degree of M.D. at the Cornell University Medical College or another accredited medical school in the United States with a curriculum equivalent to that of the Cornell University Medical College, may transfer a maximum of two units of residence credit after passing an evaluation examination administered by a committee appointed by the General Committee of the Graduate School of Medical Sciences.

Summer Research

Registration is required for the summer research period whether or not this effort is to be credited toward residence unit accumulation. Students registered for summer research pay a prorated tuition only if they are obtaining residence credit. No degree candidate, however, is eligible for more than two residence units in any period of twelve consecutive months.

Study *in Absentia*

A candidate for the degree of Ph.D. may petition for permission to earn residence units for study away from Cornell University while regularly registered in the Graduate School of Medical Sciences. A candidate to whom this privilege has been granted may work temporarily under the immediate supervision of an individual designated by his or her Special Committee, but the candidate's program will continue to be directed by the committee. For study *in absentia*, not more than two residence units may be earned toward fulfillment of the minimal residence requirements for the degree of Ph.D. A student given leave for such study must register as a candidate *in absentia* and pay a fee of $75 per semester, and may continue his or her hospitalization insurance by payment of the annual premium directly to the Student Accounting Office of Cornell University Medical College. If students *in absentia* take advantage of local privileges, such as the use of the library, desk space, Student Health Service, hospitalization insurance, and Cornell housing, the fee is $400 per semester.

Leave of Absence

A candidate who finds it necessary to interrupt the continuity of his or her residence must petition the dean for an official leave of absence. This written petition must specify the term of absence, state the reason for the requested leave of absence, and be approved by the student's Special Committee.

A candidate who will *not* be in residence but will return to the Graduate School of Medical Sciences to present and defend a thesis at the final examination, having completed all requirements for a degree except for the final examination, must petition for a leave of absence.

On return to the Graduate School of Medical Sciences for the final examination, the candidate will register as a Candidate for Degree Only and will pay a fee of $35.

Examinations

Three examinations are required by the Faculty of the Graduate School of Medical Services: (1) final examination for the M.S. degree, (2) examination for admission to doctoral candidacy, and (3) final examination for the Ph.D. degree. Examinations are administered by an Examining Committee consisting of a chairperson appointed by the dean, the members of the candidate's Special Committee, and, in the case of the Admission to Candidacy Examination, three additional members selected from the faculty of the Graduate School of Medical Sciences and/or of other institutions. In addition to these examinations, the candidate's major field may require a qualifying examination as part of its evaluation of the candidate after two units of residence have been completed.

For the M.S. degree: the final examination may be oral or both oral and written.

For the Ph.D. degree: the Admission to Candidacy Examination is both oral and written and certifies that the student is eligible to present a thesis to the Faculty of the Graduate School of Medical Sciences. The examination should be taken after course work is largely finished but before significant thesis research has begun. Accordingly, the usual examination time will be at the end of the second year of residence. The examination may not be taken until two units of residence credit have been accumulated; a minimum of two units of residence credit is required after passing this examination before the final examination can be scheduled. The final examination for the Ph.D. degree is an oral defense of the candidate's thesis. It must be passed within four years after completion of the required residence units, or within seven years from the date of first registration, whichever is earlier.

Foreign Language Requirements

Each field of study has its own foreign language requirements. The student's Special Committee may require knowledge of foreign languages beyond the requirements of the fields listed in this *Announcement*.

Examinations in foreign languages will be administered by the Office of the Dean at the beginning of each term. As an alternative to this examination, the candidate may demonstrate proficiency by passing the reading part of the language qualification tests administered by the College Entrance Examination Board.

Theses

A principal requirement for both the M.S. and the Ph.D. degrees is the presentation of a thesis constituting an imaginative contribution to knowledge. Ordinarily, the thesis is written on a research topic in the candidate's major field of study, under the direction of the chairperson of his or her Special Committee. The faculty requires that the Ph.D. thesis be published in abstract and be recorded on microfilm.

Tuition and Fees

Tuition for a student regularly matriculated in the Graduate School of Medical Sciences is $5500 for the academic year and is payable in either two or three equal parts, the first of which is due at initial registration. Tuition includes fees for matriculation, hospitalization insurance, graduation, and miscellaneous thesis expenses.

For graduate students who (1) have been in continuous residence at Cornell in the same doctoral program and have passed their Admission to Candidacy Examination and (2) are not taking courses in the Medical College curriculum, a reduced charge of $800 per annum ($400 per semester) will be made for tuition and fees for the terms subsequent to the Admission to Candidacy Examination. For those students who will continue to take courses in the medical curriculum, the charge of $5500 per annum prorated on the basis of the percentage of total hours of the medical curriculum allotted to the specific courses taken, will be added to the reduced tuition of $800 per annum. Off-campus tuition will not be covered by the $800 fee.

A graduate student registered for study *in absentia* pays a fee of $75 per semester. If students *in absentia* take advantage of local privileges, such as the use of the library, desk space, Student Health Service, hospitalization insurance, and Cornell housing, the fee is $400 per semester.

A graduate student who has previously fulfilled all other degree requirements, who has been granted a leave of absence, and who returns to the Graduate School of Medical Sciences to present a thesis and to take the final examination must register as a Candidate for Degree Only and pay a fee of $35.

A student who is to receive partial residence credit because of employment should apply for proration of tuition on forms obtainable at the Office of the Dean. Proration of tuition does not apply to the special reduced tuition of $400 per semester.

Any individual who owes money to the University will not be allowed to register or reregister in the University, receive a transcript of his or her record, have his or her academic credits certified, be granted a leave of absence, or have a degree conferred.

The amount, time, and manner of payment of tuition, fees, or other charges may be changed at any time without notice.

Financial Assistance

Financial assistance is available to qualified applicants. Individual fields or units may offer predoctoral research fellowships, research assistantships, or teaching assistantships. These positions may provide a stipend in addition to tuition. Information about these positions may be obtained directly from the field or unit at the time of application.

The fields in the Medical College Division also have available a limited number of tuition scholarships.

Nationwide, competitive, predoctoral fellowships are available from the National Science Foundation and the National Research Council. Information about these fellowships should be requested directly from the appropriate governmental agency.

New York State residents are eligible for several predoctoral fellowships and for the Tuition Assistance Program which assists in tuition payments. Application forms may be obtained from the New York Higher Education Services Corporation, Student Financial Aid Section, Tower Building, Empire State Plaza, Albany, New York 12255.

Opportunity for part-time employment is often available in departmental research projects or other activities. Applications should be made directly to individual departments.

Several loan programs are available for the use of graduate students. Under these programs, repayment of the principal amount of the loan together with the interest on the loan can be deferred until after graduation.

Prizes

The Frank Lappin Horsfall Jr. Awards are endowed by funds provided in memory of Dr. Horsfall by his many friends and family. They are continued evidence of his concern for students manifest during his directorship of the Sloan-Kettering Division.

Two awards are available annually to students of the Sloan-Kettering Division; one to that student who, in the opinion of the Committee of the Faculty of the Sloan-Kettering Division, has been most distinguished, especially in the qualifying examination, and one to that student who, in the opinion of the Committee of the Faculty of the Sloan-Kettering Division, has similarly been most distinguished, especially in the Admission to Doctoral Candidacy Examination.

Student Health Service

Complete ambulatory medical care is provided at no charge for all students enrolled in the Graduate School of Medical Sciences through the Personnel Health Service of the Medical Center. Referrals will be made to the New York Hospital clinics and private physicians when appropriate. Students will be issued New York Hospital clinic cards and will receive courtesy privileges in the New York Hospital Pharmacy.

The student matriculating for the first time is required to have a physical examination by a member of the Health Service staff. In addition, the student must report for a chest X-ray examination, tuberculin test, and necessary immunizations. Office hours are held daily from 1-2 p.m. by the Health Service staff.

Each student is required to carry Associated Hospital Service (Blue Cross) hospitalization insurance unless some similar hospitalization insurance is currently in effect. The cost of the insurance for each student is included in the tuition. Tuition refunds cannot be made to students with outside coverage.

Spouses and families of students are not eligible for care through the Personnel Health Service but will be referred to appropriate members of the New York Hospital staff for medical treatment. It is strongly recommended that the students' dependents be covered by hospitalization and medical insurance. Students may purchase Blue Cross hospitalization insurance for their families through the school's group policy. However, Blue Shield medical insurance coverage can be obtained through the school only for those families previously holding Blue Shield coverage. If dependents wish to use the New York Hospital Clinics, they may be screened and evaluated for fees in relation to family income by the New York Hospital.

A student on leave for study *in absentia* may continue hospitalization insurance by payment of the annual fees directly to the Student Accounting Office, Room C-015, Medical College Building.

A student on a leave of absence for reasons other than study *in absentia* is not eligible to receive student health benefits.

Residence Halls

F. W. Olin Hall, a student residence completed in 1954, is at 445 East Sixty-ninth Street directly across from the Medical College entrance on York Avenue. Olin Hall contains a gymnasium, snack bar, lounge rooms, and 278 residence rooms. The Alumni Memorial Room houses the George T. Delacourt, Jr. Book Collection, as well as the War Memorial to Cornell graduates who gave their lives in the wars. Each residence room is furnished as a single bedroom-study, but since two rooms share a connecting bath, they may be used as a suite for two students. The rooms are completely furnished and linen service is provided.

Student rental for the academic year is $1200; for a full year (twelve months), $1440; and for periods of less than an academic year, $120 each month. Several cafeterias are available in the main college and hospital buildings.

Livingston Farrand Apartments, also located on East Sixty-ninth Street just beyond Olin Hall, have 1½, 2, 3, and 4 room furnished apartments. Cooking facilities are provided in these apartments and rents range from $150 to $270 each month, utilities not included.

Jacob S. Lasdon House, an apartment residence at 420 East Seventieth Street, is the newest student residence and was opened for occupancy in September 1974. This building, which was made possible by a gift from the estate of the late Mr. Lasdon, contains studio, one-bedroom, and two-bedroom apartments. Apartments are fully furnished and rents range from $250 to $420, including utilities.

The fees listed above may be changed at any time without previous notice.

Cornell University

Fields of Instruction

Instruction at the Medical College Division

Biochemistry

Faculty

E. Breslow, A. L. Boskey, J. Cornell, T. Duffy, G. F. Fairclough, J. D. Gass, H. Gilder, J. Goldstein, O. W. Griffith, R. H. Haschemeyer, B. Horecker, C.-Y. Lai, A. Meister, A. S. Posner, J. R. Rachele, R. R. Riggio, W. B. Rowe, A. L. Rubin, B. Saxena, E. T. Schubert, R. L. Soffer, K. H. Stenzel, S. S. Tate, P. P. Trotta, D. Wellner, K. Woods

Field Representative

S. S. Tate, Department of Biochemistry, Room E-106, Medical College

Graduate instruction is offered leading to the Ph.D. or M.S. degree. Within the framework of degree requirements and in consultation with the student, the course of study is planned to fit the needs of the individual. Although formal course work is required, emphasis is placed on research. Research opportunities exist in various areas of biochemistry including enzymology, structure and function of proteins and nucleic acids, molecular biology, physical biochemistry, and the intermediary metabolism of amino acids, carbohydrates, nucleic acids, and lipids. Entering graduate students usually work for short periods in several of the laboratories of the faculty members of the field before beginning thesis research. Students are encouraged to choose challenging and fundamental research problems that are on the frontiers of biochemistry.

The laboratories of the faculty members are equipped with virtually all of the instruments and facilities required for modern biochemical research; thus, graduate students are instructed in such methodology as chromatography, countercurrent distribution, radioactive and stable isotope techniques, spectrophotometry, electrophoresis, and analytical ultracentrifugation.

Students undertaking graduate study in biochemistry must have a sufficiently comprehensive background in chemistry to pursue the proposed course of study and must present evidence of knowledge of biology, general experimental physics, and mathematics (including differential and integral calculus). Opportunity is offered to remedy deficiencies in these areas during the first year of graduate study. The Graduate Record Examinations (the Aptitude Test and the Advanced Test in chemistry) are ordinarily required.

The language requirement for the Ph.D. and the M.S. degrees is proficiency in one modern foreign language acceptable to the student's Special Committee. Proficiency in a computer science language, as demonstrated by executing a meaningful program, may substitute for proficiency in a foreign language.

Students are encouraged to complete application for fall admission, before the preceding February 1.

Special Interests of the Faculty

E. Breslow: protein-protein and metal ion-protein interactions; chemistry of the neurophysins

A. L. Boskey: biochemistry of hard tissue; calcium-phospholipid complexes

J. Cornell: biochemistry of reproduction; protein chemistry of the placenta

T. Duffy: carbohydrate and energy metabolism in altered functional states of brain; ammonia detoxification and hepatic coma; effect of anoxia on the developing brain

G. Fairclough: protein chemistry; clinical biochemistry

J. Gass: mechanism of enzyme action; clinical biochemistry

H. Gilder: metabolic response to surgery; electrolyte studies of gastric juice; studies in experimental shock

J. Goldstein: role of RNA in protein synthesis; fractionation of nucleic acids; role of macromolecules and protein synthesis in the maturation of red blood cells

O. W. Griffith: enzyme mechanisms, particularly mechanisms of energy transduction; amino acid metabolism

R. Haschemeyer: structure of fibrinogen and subunit interactions in protein and nucleoproteins; electron microscopy of enzymes and viruses; lipoprotein structure and function

B. Horecker: mechanism of enzyme action; regulation of enzyme action; intermediary metabolism of carbohydrate

C.-Y. Lai: bacterial toxins and membrane-mediated cell functions
A. Meister: enzymology; proteins and amino acids
A. Posner: crystal chemistry; ultrastructural biochemistry; atomic structure of bone; hard tissue chemistry
R. R. Riggio: transplantation; dialysis and biomaterials research
W. B. Rowe: amino acid metabolism; action of methionine sulfoximine
A. L. Rubin: collagen structure and function; biomaterials research; dialysis; transplantation research
B. Saxena: chemistry, measurement, and mechanism of action of pituitary protein hormones
E. T. Schubert: enzyme studies of the developing kidney; investigation of renal dysfunction at enzyme level
R. L. Soffer: enzymatic posttranslational modification of proteins; membrane-enzyme interaction; enzyme-antibody interaction; angiotension converting enzyme and regulation of blood pressure
K. Stenzel: transplantation; dialysis and biomaterials research
S. Tate: amino acid, peptide transport; plasma membrane enzymes; metabolism and physiology of hypothalamic releasing hormones
P. P. Trotta: adenosine deaminase, growth and differentiation
D. Wellner: enzyme kinetics; mechanisms of enzyme action; protein structure
K. Woods: physicochemical understanding of human blood fractions; blood coagulation; structure of antibodies

Courses

1. Graduate Biochemistry Offered jointly by the faculties of the Medical College and Sloan-Kettering Divisions. Details are given on p. 27 under Interdivisional Courses.

2. Introduction to Research Experimental biochemistry dealing with the isolation, synthesis, and analysis of substances of biochemical importance (enzymes, coenzymes, various metabolites, and intermediates), and study of their properties by various chemical and physical techniques. The student obtains this varied research experience by spending approximately two months in the laboratory of each of four faculty members of his or her choice. For incoming graduate students majoring in biochemistry. The staff.

3. Selected Topics in Biochemistry Advanced study in selected topics will be offered in areas such as (1) nucleic acids and protein synthesis; (2) intermediary metabolism; (3) kinetics and enzyme mechanism; (4) protein chemistry; (5) structure of membranes and the biochemistry of transport; and (6) hormones. Generally, one or two of these courses will be offered yearly in the third trimester. The staff.

4. Advanced Biochemistry Offered jointly by the faculties of the Medical College and Sloan-Kettering Divisions. Details are given on p. 27 under Interdivisional Courses.

5. Physical Methods Offered jointly by the faculties of the Medical College and Sloan-Kettering Divisions. Details are given on p. 27 under Interdivisional Courses.

Biological Structure and Cell Biology

Faculty

R. Bachvarova, J. M. Bedford, C. G. Becker, D. Bennett, D. C. Brooks, G. Dooher, F. G. Girgis, J. Goldstein, R. L. Greif, W. D. Hagamen, M. D. Hamburg, B. B. Kaplan, T. H. Meikle, Jr., C. R. Minick, R. Nachman, T. C. Rodman, C. A. Santos-Buch, B. Saxena, E. T. Schubert, J. L. Sirlin, G. W. Siskind, D. Soifer, M. Spiegelman, K. H. Stenzel, D. H. Sussdorf, R. C. Swan, J. C. Weber, J. M. S. Winterkorn

Field Representative

J. L. Sirlin, Department of Anatomy, Room A-229, Medical College

Graduate study in the Field of Biological Structure and Cell Biology leads to a Ph.D. degree and emphasizes the basic relationships between structure and function of biological systems at all levels of organization. Thus the field is fundamentally concerned with the nature, development and functional modulation of biological systems, as well as significance of configuration, pattern, and other spatial relations in biological systems. The scope of interest extends from the molecular level to that of the whole organism and embraces normal as well as pathological structure.

Opportunities for research training include the investigation of cellular fine structure using such techniques as light and electron microscopy, isolation and analysis of cellular subfractions by differential ultracentrifugation, cytochemistry, molecular biochemistry, and enzymology.

For graduate study in the field, adequate undergraduate preparation in biology, chemistry (including organic chemistry), physics, and mathematics is recommended. Requirements for admission are flexible in proportion to the promise and accomplishments of the applicant. Applicants are requested to present the results of the Graduate Record Examinations.

Requirements for minor sponsorship in the field will be arranged with individual students, but research experience in the minor sponsor's laboratory is strongly encouraged.

In addition to the courses listed below, appropriate courses for graduate students in the field are Biochemistry, Physiology, and those courses given by the Field of Neurobiology and Behavior.

A reading knowledge of a foreign language is desirable.

The field requires a qualifying examination at the end of the first year of residence. At the discretion of the examining committee, the examination may be written, or oral, or both. The Admission to Candidacy Examination required by the Graduate School of Medical Sciences must be taken before six units of residence credit have been accumulated and before substantial progress has been made in the candidate's thesis research.

Special Interests of the Faculty

R. Bachvarova: molecular developmental biology
J. M. Bedford: physiology of mammalian gametes and reproductive tract
C. G. Becker: cardiovascular and renal disease; immunopathology
D. Bennett: mammalian genetics, with special reference to genetic regulation during early embryonic development
D. C. Brooks: spontaneous electrical activity of the central nervous system; brain stem influences upon the visual system during sleep and wakefulness in the cat
G. Dooher: genetics and fine structure of male reproduction
F. G. Girgis: the cranial and facial sutures, their development, structure, and the analysis of sutural position; of particular interest are factors inducing chondrogenesis in the cranial vault
J. Goldstein: role of RNA in protein synthesis, fractionation of nucleic acids; role of macromolecules and protein synthesis in the maturation of red blood cells
R. L. Greif: physiology of the thyroid gland and its secretion
W. D. Hagamen: self-stimulation, habituation, and changes in affective behavior in cats; artificial intelligence in computers
M. Hamburg: neurochemistry and regulatory mechanisms of the enzymes involved in monoamine biosynthesis
B. B. Kaplan: gene activity and its regulation in brain
T. H. Meikle, Jr.: animal studies of neural mechanisms basic to learned behaviors, particularly visual learning
C. R. Minick: pathogenesis of arteriosclerosis and hypertension; immunopathology; electron microscopy
R. L. Nachman: biology of platelets
T. C. Rodman: analytical cytology of cell nuclei; cytogenetics
C. A. Santos-Buch: cellular biology, immunopathology; cardiovascular disease; electron microscopy
B. Saxena: chemistry, measurement, and mechanism of action of pituitary protein hormones
E. T. Schubert: enzyme studies of the developing kidney; investigation of renal dysfunction at enzyme level
J. L. Sirlin: molecular biology and pharmacology of brain function
G. W. Siskind: immunology; ontogeny of immune response; antibody heterogeneity
D. Soifer: structure and function of microtubules
M. Spiegelman: early embryonic development, particularly with respect to cell movement and cellular interactions
K. Stenzel: transplantation; dialysis and biomaterials research
D. H. Sussdorf: cellular interactions during the immune response; function of the thymus and related lymphoid tissues in development of immunocompetence
R. C. Swan: fine structure of excitable cells
J. C. Weber: vitamin D and mineral metabolism in hard tissue
J. M. S. Winterkorn: visual behavior and learning after brain lesions

Courses

1. Microscopic Anatomy This course is offered by the Department of Anatomy in the Medical College to first-year medical students and is open to graduate students who have Biological Structure and Cell Biology as their major field. (Other graduate students should arrange to take the Introductory Microscopic Anatomy course described on p. 28.) The course follows a cellular and differentiative approach aimed at understanding the structure-function correlates which characterize the different tissues and organs. Selected topics are presented in the lectures and laboratory exercises to indicate a pattern of study and depth of analysis which the student can be expected to apply to the study of cells and tissues. First and second trimesters. The staff.

2. Gross Anatomy Regional anatomy is studied principally through dissection of the human body. Supplementing this technique are prosections by instructors, tutorial group discussions, and radiographic and endoscopic demonstrations. Enrollment is limited and students should consult the staff early in order to determine the availability of places. First and second trimesters. The staff.

Biomathematics

Faculty

B. J. Flehinger, S. I. Rubinow

Field Representative

S. I. Rubinow, Division of Biomathematics, Room KB 122, Kips Bay Building, Medical College

The Field of Biomathematics offers a wide range of opportunities for the development of quantitative methods in the biological and medical sciences, with special emphasis on the application of mathematics. Graduate study programs leading to advanced degrees in the Field of Biomathematics are available to students whose primary interests are mathematical, but who wish to concentrate on biological or medical applications.

Graduate students are admitted to study in this field from a variety of educational backgrounds, including the several branches of engineering and the physical and biological sciences, as well as mathematics. Their programs of study include a thorough grounding in mathematical methods and a particular biological area of interest.

Applicants are expected to support their applications with their scores on the Graduate Record Examinations in both the Aptitude Test and Advanced Test.

The thesis in biomathematics must be a mathematical contribution toward the solution of a problem arising in a biomedical area.

Graduate students in the Field of Biomathematics are required to obtain thorough training in linear algebra, complex variables, partial differential equations, and boundary value problems. In addition to other courses, an appropriate plan of study in the relevant aspects of biology, chemistry, physics, and medicine will be

made to suit the particular area of application of the individual student. A programming language such as Fortran is required in lieu of a foreign language.

Special Interests of the Faculty

B. J. Flehinger: biostatistics; medical diagnosis with computers; clinical trials
S. I. Rubinow: blood flow; cell proliferation; enzyme kinetics; physiological systems; reaction-diffusion phenomena

Courses

1. Introductory Biomathematics I, II, and III Introduction to the use of elementary mathematics in various areas of medicine and biology. The course is divided into three parts, offered separately in each trimester. Topics treated mathematically include the simplest rate processes in biology, cell growth, theory of enzyme kinetics, compartment equations, and transport processes, especially convection, diffusion, and sedimentation. Two hours each week; hours to be arranged. Prerequisite: elementary calculus. Unlimited enrollment. S. I. Rubinow

2. Biomathematics Seminar Presentation of research investigations by the staff and student reports on various topics chosen from current literature. Required of biomathematics majors. One hour each week; hours to be arranged. The staff.

Genetics

Faculty

F. H. Allen, V. G. Allfrey, K. Artzt (SKD), R. Bachvarova, A. G. Bearn, D. Bennett (SKD), J. L. Biedler (SKD), E. A. Boyse (SKD), L. J. Cavalieri (SKD), R. S. K. Chaganti (SKD), B. S. Danes, G. Darlington, G. A. Dooher (SKD), B. Dupont (SKD), J. L. German III, Z. Harsanyi, R. M. Krug (SKD), G. Litman (SKD), S. D. Litwin, L. J. Old (SKD), T. C. Rodman, P. Rubinstein, S. Silagi, M. Siniscalco (SKD), J. L. Sirlin, M. Spiegelman (SKD), G. Vidali, R. J. Winchester

Field Representative

Z. Harsanyi, Department of Microbiology, Room B-402, Medical College

Academic and research training is available chiefly in the following areas: cytogenetics, developmental genetics, genetics and cell differentiation, human biochemical genetics, human somatic cell genetics, immunogenetics, microbial genetics, and nucleic acid biochemistry. The faculty includes members of the preclinical and clinical departments of the Medical College and faculty members of the Sloan-Kettering Division. A unique opportunity for integrating the study of genetics with other biological and medical interests is thus provided. Within broad limits, students pursue their own programs according to particular interests.

The usual prerequisites for admission to graduate study for an advanced degree in genetics are undergraduate work in chemistry or biology, and courses in general genetics, general chemistry, organic chemistry, general biology, general physics, and mathematics through calculus. Applicants are required to present Graduate Record Examinations scores in the Aptitude Tests and in the Advanced Test in chemistry or biology.

Courses generally required of genetics majors are those numbered 1 through 7 below, and Graduate Biochemistry and Introductory Microscopic Anatomy, given by the Field of Biochemistry and by the Biology Unit of the Sloan-Kettering Division, respectively. Other courses for students in genetics include those numbered 8 through 10 and Advanced Virology offered by the Field of Microbiology.

Students minoring in genetics are required to take two semesters of the Genetics Seminar and one additional course from the following: Advanced Genetics, Advanced Microbial Genetics. A limited period of work in the laboratory of the minor sponsor is recommended.

Requirements for foreign language are at the discretion of the student's Special Committee, although the field recommends a reading knowledge of French or German.

An oral qualifying examination is required at the end of the first year of residence and the Admission to Candidacy Examination must be taken at the end of the second year of graduate work. The oral portion of the Admission to Candidacy Examination will include discussion of the specific research proposal and general biological topics.

Special Interests of the Faculty

F. H. Allen: immunogenetics of blood groups
V. G. Allfrey: cell nucleus chemistry; chromosomal proteins; genetic control
K. Artzt: genetics of embryonal tumors
R. Bachvarova: developmental molecular biology
A. G. Bearn: biochemical and somatic cell genetics of man
D. Bennett: mammalian developmental genetics; immunogenetics
J. L. Biedler: cytogenetics
E. A. Boyse: mammalian immunogenetics
L. Cavalieri: DNA replication in bacteria and bacteriophage
R. Chaganti: human genetics; cell genetics
B. S. Danes: somatic cell genetics (with particular emphasis on human genetic metabolic errors)
G. Darlington: human genetics; cell genetics
G. Dooher: genetics and fine structure of male reproduction
B. Dupont: human immunogenetics
J. L. German: mammalian cell genetics and cytogenetics
Z. Harsanyi: biochemical genetics of microorganisms
R. M. Krug: viral and molecular genetics
G. Litman: immunogenetics
S. D. Litwin: genetics of immunoglobulins and serum proteins
R. Norum: clinical and laboratory aspects of α-1-antitrypsin and its deficiency; clinical genetics
L. J. Old: tumor immunovirology
T. C. Rodman: cytogenetics with emphasis on mechanisms of genetic control
P. Rubenstein: immunogenetics; histocompatibility; genetics; immunology; immunohematology

S. Silagi: gene action and cellular differentiation in culture
M. Siniscalco: somatic cell genetics
J. Sirlin: molecular biology of brain function
M. Spiegelman: early embryonic development
G. Vidali: chromosomal proteins; molecular genetics
R. J. Winchester: human genetics

Courses

1. Genetics Seminar The topic for fall 1978 will be announced. T 3-5. Course sponsors: J. German and D. Bennett.

2. Medical Genetics Conference Consists of a series of conferences on topics in medical genetics. Offered every two weeks throughout the year. M 4. S. D. Litwin.

3. Genetics Journal Club An informal meeting of students and staff at which current literature or research is discussed. Held every two weeks throughout the year. F 12. R. Bachvarova.

4. Advanced Genetics Designed to give the student a sound background in genetic theory; an in-depth consideration of the gene as a unit of heredity. First semester: three hours each week to be arranged. Not offered 1978-79. D. Bennett.

5. Advanced Microbial Genetics Z. Harsanyi. (See Microbiology).

6. Introduction to Research in Genetics Students are expected during their first year to spend time and perform experiments in the laboratories of three faculty members of the Field of Genetics.

7. Medical Genetics Rounds Students participate in the activities of the Medical Genetics Clinic by assisting in the taking of family histories, construction of pedigrees, and in genetic counseling. Ward rounds are carried out weekly. The staff of the Division of Human Genetics.

8. Karyotyping Practical experience in chromosome analysis in the laboratory. Introduction to tissue culture techniques. Limited to two students. Third trimester: one day a week for seven weeks; hours to be arranged. J. L. German.

9. Somatic Cell Genetics The course will include lectures and discussions of a variety of topics including studies of mutagenesis, culture techniques, cell hybridization and gene mapping, gene expression, metabolic cooperation, and inborn errors. Drs. Danes, Darlington, German, Silagi, and Siniscalco.

10. Immunogenetics An advanced elective in immunogenetics will be offered in alternate years. The program will consist of 12 weekly meetings of 2-3 hours each in which a general description of an area of immunogenetics will be followed by reports on selected papers and by discussion. General concepts in immunogenetics will be covered, certain of the more widely used laboratory approaches will be critically discussed, and the biological problems associated with the histocompatibility gene complex and genetic control of immunoglobulins will be emphasized. Drs. S. Litwin and P. Rubenstein.

Microbiology

Faculty

R. W. Dickerman, Z. Harsanyi, L. Korngold, A. R. Neurath, W. M. O'Leary, R. B. Roberts, W. F. Scherer, L. B. Senterfit, G. W. Siskind, D. H. Sussdorf, M. E. Weksler, M. E. Wiebe, J. F. Woodruff

Field Representative

M. E. Wiebe, Department of Microbiology, Room S-500A, Medical College

The Field of Microbiology offers graduate training leading to the Ph.D. degree. Under special circumstances, candidacy towards the M.S. degree will be considered. Candidates may select an area of research from such microbiological topics as general and medical bacteriology, microbial chemistry and physiology, microbial genetics, immunology, and virology.

Prospective students should complete at the undergraduate level a minimum of one year (or its equivalent) in general chemistry, organic chemistry, general physics, mathematics (including college algebra), botany or zoology (preferably both), and one semester or its equivalent of analytical or quantitative chemistry. General microbiology or bacteriology and calculus are strongly recommended. Students who have not completed the above requirements may be admitted to graduate study on the condition that deficiencies be corrected soon after admission. Applicants are ordinarily required to present Graduate Record Examinations scores for the Aptitude Tests and for the Advanced Test in chemistry or biology.

Individual programs are determined by the student's Special Committee, composed of faculty members representing the major and minor fields. Students majoring in microbiology select their primary courses from those listed below. The nature and number of other courses, that may be taken at this institution or at nearby universities, will depend on the students' minor fields, their research activities, their individual interests, and the advice of the Special Committees.

Students majoring in other fields who elect to minor in microbiology are ordinarily required to take the course Microbiology and an Introduction to Infectious Disease. In addition, students are required to enroll in an advanced course in microbiology or participate in a research project in the laboratory of their minor sponsors. In general this research is expected to take one to three months to complete depending upon whether the project is pursued on a full-time or part-time basis.

Ph.D. candidates are required to be proficient in one modern foreign language acceptable to their Special Committees.

Although a qualifying examination is not ordinarily given, a student's Special Committee has the prerogative of requiring it. The Admission to Candidacy Examination is administered by a committee consist-

ing of a chairperson appointed by the dean, the student's Special Committee, and three additional faculty members in the Field of Microbiology. The written portion of this examination tests for basic facts and concepts in the candidate's area of study and for the candidate's problem-solving ability within and across disciplinary boundaries. The oral examination provides an opportunity for the student to correct deficiencies in the written examination, to be examined further on general knowledge, and to discuss and be questioned on his or her planned or current research.

Special Interests of the Faculty

R. W. Dickerman: involvement of birds and mammals in the ecology of viruses pathogenic to man
Z. Harsanyi: genetics of viruses; genetic control of enzyme structure; drug and chemically induced chromosomal aberrations; genetics of *Aspergillus nidulans*
L. Korngold: antigenic structure of immunoglobulins and of various human tissues
A. R. Neurath: characterization of hepatitis B-associated antigens
W. M. O'Leary: microbial cellular composition; mechanisms of pathogenesis; microbial lipids; antibiotic function; instrumental characterization of bacteria; anaerobiasis
R. B. Roberts: interactions between microorganisms and phagocytic cells
W. F. Scherer: cell-virus relationships; virus virulence; host defense mechanisms; ecology and epidemiology of arbo viruses, especially mosquito-borne encephalitis viruses of tropical North and South America
L. B. Senterfit: antigenic structure of mycoplasma; pathogenesis of respiratory viral and mycoplasmic disease; vaccine development; clinical microbiology
G. W. Siskind: factors involved in control of the immune response; changes in antibody affinity and heterogeneity with increasing time after immunization; ontogeny and genetics of heterogeneity of antibody affinity
D. H. Sussdorf: function of the thymus and related lymphoid tissues in development of immunocompetence; immunology of the athymic ('nude') mouse; immunological factors in carcinogenesis
M. E. Weksler: lymphocyte interactions with autologous cells in autoimmune and neoplastic diseases; immunology of aging
M. E. Wiebe: molecular virology; mechanism of virus replication, host cell response, viral interference, and viral virulence
J. F. Woodruff: interactions of viruses with lymphocytes; immunological mechanisms in viral myocarditis

Courses

Students who wish to attend any of the following courses either for credit or as auditors should contact the field representative or the faculty member responsible for each course well in advance of the beginning of each course. In general, as many students as possible are accommodated in lectures; however, participation in laboratory sections is restricted.

1. Microbiology for Graduate Students (Interdivisional) Offered by the staff of the Field of Microbiology of the Medical College Division and of the Biology Unit of the Sloan-Kettering Division. For details, refer to Interdivisional Courses, p. 27. Not offered 1978-79. D. J. Hutchison (SKD) and W. M. O'Leary.

2. Microbiology and an Introduction to Infectious Disease Presented in the first and second trimesters. Consists of laboratory experiments, lectures, and group discussions. The laboratory work includes an introduction to the procedures used in studying microorganisms, experiments on various physical and biological manifestations of antigen-antibody reactions, the actions of chemotherapeutic agents, a survey of the microbial flora of the upper respiratory and lower intestinal tracts of healthy humans, and an intensive study of the causal agents of specific infections, including fungi, spirochetes, rickettsiae, and viruses, as well as bacteria. The lectures are directed toward the development of basic concepts, particularly the principles involved in microbial growth, the principles underlying active immunization, and the factors that enter into host-parasite relationships. Emphasis is placed on aspects related to the etiology, pathogenesis, epidemiology, and prevention of infectious disease. Special attention is also given to the immunological principles underlying such noninfectious conditions as hypersensitivity, autoimmunity, and graft rejection. Offered every year. Microbiology staff and invited lecturers.

3. Advanced Diagnostic Microbiology The lecture and laboratory sessions acquaint the student with the procedures used in and techniques of management of a clinical microbiology laboratory. Emphasis is upon developing the student's capability in the isolation and rapid identification of organisms from various types of clinical specimens. Liberal use is made of clinical materials available through the diagnostic laboratories of The New York Hospital. Offered every year in the third trimester. Hours by arrangement. L. B. Senterfit.

4. Microbial Chemistry and Physiology Lectures cover literature and methodology pertinent to physicochemical properties of microorganisms and their environments, the growth and death of microorganisms, chemical composition of cells and subcellular structures, nutritional requirements, microbiological assay and auxotrophic mutants, energy metabolism, degradations and biosyntheses, the physiology of pathogenesis, and important microbial products. Laboratory sessions provide experience with large-scale culture and recovery of cells, synthetic media, microbiological assay, extraction of cellular constituents, respirometry, and studies of substrate utilization employing radioactive metabolites. Minimal prerequisites are general microbiology, qualitative and quantitative analysis, organic chemistry, and at least one semester (or its equivalent) of biochemistry. Offered every other year in the third trimester. Not offered 1978-79. W. M. O'Leary.

5. Advanced Microbial Genetics Selected concepts of molecular genetics are examined using both

prokaryotic and eukaryotic microorganisms as models. Topics include intra- and intercistronic complementation, mitotic and meiotic recombination, genetic control mechanisms, gene conversion, polyploidy and aneuploidy, genetic interference, mechanisms of suppression, and polarity. The course is designed to elucidate the genetic methods available for studying hereditary material. Offered every second year in the third trimester, one lecture weekly. Th 2-4. Offered 1978-79. Z. Harsanyi.

6. Advanced Immunology (Interdivisional) A comprehensive, two-trimester lecture course is offered by members of the staffs of the Medical College and Sloan-Kettering Divisions. Offered every other year during the second and third trimesters, two lectures weekly. Offered 1978-79. Y. B. Kim (second trimester) and D. H. Sussdorf (third trimester). A laboratory course is given every third year in the third trimester. Not offered 1978-79. D. H. Sussdorf. For details, refer to Interdivisional Courses, p. 27.

7. Advanced Virology Presents, in lectures and laboratory sessions, modern concepts and techniques of virology. Virus structure, chemical composition, physical and biologic properties, and relationships with host cells are considered in depth. Minimal prerequisites for credit are general microbiology and at least one semester (or its equivalent) of biochemistry. Every third year. Not offered 1978-79. M. E. Wiebe and W. F. Scherer.

8. Research on Special Problems For students who want significant experience in specialized procedures which they could not obtain otherwise, the field offers individualized research on special problems. The nature, complexity, and time required for such research vary according to the needs and desires of each student. Such experience is available in each specialty covered by the faculty of the field and can be arranged by consultation of the student with the appropriate faculty member. Available each year and throughout the year. The staff.

9. Thesis Research in Microbiology Required of all students taking a major in microbiology. Offered yearly and throughout the year. The staff.

10. Microbiology Seminar Reports on surveys of the literature in the field and on current research. Presented by graduate students, faculty, and visiting scientists. Attendance is required of all students majoring or minoring in microbiology throughout their programs of study. Offered yearly and throughout the year. One-hour sessions on alternate weeks; first and second trimesters, T 1-2; third trimester, Th 1-2. Z. Harsanyi.

11. Clinical Microbiology Program on Ithaca and New York Campuses During the senior year of a special undergraduate study program at Ithaca or during the year after receiving a bachelor's degree, the student may concentrate on developing skills in clinical microbiology at the Cornell Medical School-New York Hospital in New York City. Students will participate in courses concerned with microbiology, an introduction to infectious diseases, diagnostic microbiology, parasitology, immunology, and virology, in addition to working in the hospital diagnostic laboratory. This clinical microbiology specialization is designed to prepare students for employment in clinical microbiology laboratories. However, it could also be selected by students interested in further education or other careers.

Neurobiology and Behavior

Faculty

I. B. Black, D. C. Brooks, T. Duffy, D. Gardner, M. S. Gazzaniga, M. D. Gershon, J. G. Gibbs, Jr., S. Goldstone, B. Grafstein, W. D. Hagamen, M. Hamburg, T. H. Joh, B. B. Kaplan, K. W. Lieberman, T. H. Meikle, Jr., M. A. Nathan, M. Okamoto, V. M. Pickel, F. Plum, D. J. Reis, W. F. Riker, Jr., W. N. Schoenfeld, J. A. Sechzer, G. P. Smith, P. E. Stokes, J. M. S. Winterkorn

Field Representative

V. M. Pickel, Department of Neurology, Room KB 421, Kips Bay Building, Medical College

The Field of Neurobiology and Behavior provides training in the study of the nervous system. It includes the disciplines of neuroanatomy, neuroembryology, neurophysiology, neuropharmacology, neurochemistry, neuroendocrinology, and neuropsychology and perception. The program of the field emphasizes a multidisciplinary approach to the study of the nervous system, based on the belief that future advances in our understanding of the nervous system will be derived from a knowledge of the thinking and research techniques employed by more than one discipline. Towards this end, the program of the students entering the field is planned in consultation with several staff members, and the students are expected to spend some period of time working closely with members of the faculty whose interests are related to theirs. In addition, there are regularly scheduled seminars in the field during which various aspects of work in progress are presented and discussed. By this means, the students are afforded the broadest possible view of the field during their total training experience.

The student who chooses Neurobiology and Behavior as a major field will be required to satisfy the requirements of the courses in neuroscience, statistics, and biomathematics, and two of the following: microscopic anatomy, physiology, biochemistry, or pharmacology. The student whose major Field is Neurobiology and Behavior must have two minors, at least one of which is outside the Field. In addition, participation in the seminar program is expected. While there are no language requirements, it is suggested that the student achieve mastery of a modern foreign language or a computer language. When Neurobiology is chosen as a minor field of study, the student is required to participate in the neuroscience course and the seminar program as well as any additional experience which the minor sponsor may suggest.

Applicants to the Field of Neurobiology and Behavior are expected to have had adequate undergraduate

training in biology, organic chemistry, physics, and mathematics. Graduate Record Examination scores are to be submitted with the application. An interview with the applicant is considered highly desirable.

Special Interests of the Faculty

I. Black: developmental neurobiology in periphery and brain, including enzyme regulation, trans-synaptic controls; genetic influences
D. Brooks: brain stem influence upon the electrical activity of the visual system during both sleep and waking
T. Duffy: carbohydrate and energy metabolism in altered functional states of brain; ammonia detoxification and hepatic coma; effect of anoxia on the developing brain
D. Gardner: neurobiology and biophysics of invertebrate synaptic transmission
M. S. Gazzaniga: neuropsychological approaches to behavior
J. Gibbs: central and peripheral mechanisms of feeding behavior in animals and humans
S. Goldstone: human information and processing and cognitive functioning
B. Grafstein: growth of nerve and the transport of materials in axons
W. D. Hagamen: self-stimulation, habituation and changes in affective behavior in cats; artificial intelligence in computers
M. Hamburg: regulatory mechanisms for the biosynthesis of catecholamine neurotransmitters
T. H. Joh: neurochemistry and regulatory mechanisms of the enzymes involved in monoamine biosynthesis
B. B. Kaplan: gene activity and its regulation in brain
K. W. Lieberman: neurochemical aspects of mental illness and alcoholism
T. Meikle: animal studies of neural mechanisms basic to learned behavior, particularly visual learning
M. A. Nathan: control of cardiovascular system in basic reflex regulation, hypertension, and emotional behavior
M. Okamoto: neuropharmacology; sedative-hypnotic drug dependence
V. M. Pickel: immunocytochemistry of monoamine synthesizing enzymes in development and regeneration
F. Plum: cerebral metabolism in disease states; central regulation systems
D. J. Reis: central neural regulation of cardiovascular function; regeneration and degeneration in CNS; neurobiology of central monoamine neurons
W. F. Riker, Jr.: pharmacology and physiology of neuromuscular transmission
W. N. Schoenfeld: effects of long-term stress upon selected behavioral and physiological systems; reinforcement schedules; behavior theory
J. Sechzer: visual learning and memory in adult and neonatal split-brain animals; learning and memory in split-brain animals
G. Smith: feeding behavior, emotional behavior, and learning in rats and monkeys, utilizing concepts of neuroendocrinology
P. Stokes: endocrinology and psychobiology
J. M. S. Winterkorn: visual behavior and learning after brain lesions

Courses

1. Neuroscience This is the basic undergraduate medical course and is required of all major and minor candidates in the field. It is a broadly based course taught by members of the field and introduces the student to neuroanatomy, neurophysiology, and pertinent neurology. Third trimester. D. Brooks and B. Grafstein.

2. Neurobiology Elective Each year the field offers an elective course which considers various special aspects of neurobiology and behavior. In the past, the courses have examined in depth the synapse, developmental neurobiology, and the impact of the environment on the nervous system. Offered in the third trimester, two hours each week; hours to be arranged, four to twenty students. B. Grafstein and staff.

Pathology

Faculty

D. R. Alonso, H. C. Anderson, C. G. Becker, P. G. Bullough, F. Daniels, Jr., J. W. Dougherty, J. T. Ellis, A. Kellner, R. C. Mellors, C. R. Minick, G. E. Murphy, C. K. Petito, A. M. Prince, C. A. Santos-Buch, L. B. Senterfit, M. Susin, C. W. Watson, M. E. Weksler, J. Woodruff

Field Representative

C. G. Becker, Department of Pathology, Room C-444, Medical College

Pathology is the study of the causes and mechanisms of disease processes. The purpose of a graduate program in pathology is to provide individuals with a baccalaureate or medical degree with a basic knowledge of disease processes through study of the disciplines of anatomic and clinical pathology and by learning modern techniques of biologic investigation. It is hoped that a student completing this program will have both the information and technical skills to make significant inquiries into the nature of disease processes and to bridge the gap between classical, descriptive pathology, and such disciplines as biochemistry and molecular biology.

The graduate program in pathology includes the observation of diseases in their various forms at autopsy and in clinical laboratories and study and research in the areas of immunology and immunopathology, oncology, virology, cellular biology, and electron microscopy. It may also include study in advanced mathematics, physiology, biophysics, pharmacology, anatomy, cytochemistry and histochemistry, advanced biochemistry, genetics, and microbiology.

New students are expected to have completed mathematics through integral calculus, chemistry through organic chemistry (although physical chemistry is recommended), basic physics, and at least general biology. A reading knowledge of at least one foreign language is suggested but not required. For those students entering the program with baccalaureate degrees only, the Graduate Record Examinations,

including the Aptitude Tests and the Advanced Test in biology or chemistry, are required.

Graduate students in pathology are required, as a beginning part of their program, to take the course in general and systemic pathology offered to second-year medical students. They must minor in at least one and not more than two other biomedical fields. Courses in biomathematics, advanced biochemistry, genetics, and microbiology are also required. Additional courses not available at the Graduate School of Medical Sciences can be taken at neighboring institutions with approval of the Field of Pathology and the candidate's Special Committee.

Special Interests of the Faculty

D. R. Alonso: cardiovascular pathology
C. G. Becker: cardiovascular and renal diseases; immunopathology; host-parasite relationships
P. G. Bullough: diseases and metabolism of bone
F. Daniels, Jr.: diseases of the skin
J. W. Dougherty: diseases of the skin
J. T. Ellis: electron microscopy; kidney disease; and muscle diseases
A. Kellner: immunohematology; lipid metabolism; pathogenesis of arteriosclerosis
R. C. Mellors: studies in immunopathology relating to the role of viruses in autoimmune disease and leukemogenesis
C. R. Minick: pathogenesis of arteriosclerosis and hypertension; lipid metabolism; immunopathology; electron microscopy
G. E. Murphy: cardiovascular diseases; host-parasite relationships
C. K. Petito: neuropathology; ultrastructure and histochemistry of diseases of central nervous system
A. M. Prince: virology; pathogenesis of liver diseases
C. A. Santos-Buch: cellular biology; immunopathology; cardiovascular disease; electron microscopy
L. B. Senterfit: antigenic structure of mycoplasma; pathogenesis of respiratory viral and mycoplasmic disease; vaccine development; clinical microbiology
M. Susin: pathology of renal disease; electron microscopy
C. W. Watson: exfoliative cytopathology
M. E. Weksler: lymphocyte interactions with autologous cells in autoimmune and neoplastic diseases; immunology in aging
J. Woodruff: virology

Courses

1. General and Systemic Pathology Lectures, practical classes, and seminars. First trimester: M W F 9-1. Second trimester: M W 10-1, Th 9-1. The staff.

2. Correlative Pathology Gross and microscopic material is correlated and related to the disease processes. The staff.

3. Forensic Pathology Courses are offered in the above by special arrangement with the chief medical examiner of the City of New York.

4. Seminars in Pathology Discussions outlining the scope of modern pathology are given weekly. These include reports on original research by members of the staff and by visiting lecturers. Hours to be arranged. The staff.

5. Experimental Pathology Independent research projects in various areas of pathology are offered. The staff.

The following courses are offered by various members of the field in collaboration with faculty members of related fields. The terms and hours are by arrangement.

Immunopathology
Cardiovascular Pathology
Autopsy Pathology
Orthopedic Pathology
Renal Pathology
Gastrointestinal Pathology
Neuropathology
Surgical Pathology
Cytopathology
Tumor Pathology
Clinical Biochemistry
Hematology and Immunohematology
Clinical Microbiology

Pharmacology

Faculty

T. Baker, B. Berkowitz, J. J. Burns, W. W. Y. Chan, D. E. Drayer, R. W. Houde, C. E. Inturrisi, A. Kappas, H. Kutt, R. Levi, M. Okamoto, M. M. Reidenberg, A. Rifkind, W. F. Riker, Jr., A. Van Poznak

Field Representative

M. Okamoto, Department of Pharmacology, Room E-411, Medical College

Emphasis in the graduate program is upon sound basic training in general pharmacology. By means of individual instruction, the candidate then receives exposure to several specialized aspects of pharmacology. The latter part of the graduate curriculum is devoted to research in an area of the candidate's choice.

An adequate preliminary training in organic chemistry, physical chemistry, biochemistry, and physiology is prerequisite to graduate work in pharmacology. Training in statistics is strongly recommended.

Special Interests of the Faculty

T. Baker: neuropharmacology; neuromuscular transmission
B. A. Berkowitz: biochemical pharmacology; catecholamines; immunopharmacology of narcotics
J. J. Burns: biochemical pharmacology; drug metabolism
W. W. Y. Chan: renal pharmacology; endocrine pharmacology; polypeptide pharmacology
D. E. Drayer: drug metabolism
R. W. Houde: clinical pharmacology of the analgesic drugs; development of methods of evaluating the effects of drugs on subjective response

C. E. Inturrisi: biochemical pharmacology; metabolism of narcotic analgesics
A. Kappas: clinical pharmacology; drug metabolism, porphyrins, corticosteroids
H. Kutt: clinical pharmacology, neuropharmacology; drug metabolism
R. Levi: cardiovascular pharmacology and electrophysiology; immunopharmacology
M. Okamoto: neuropharmacology; neuromuscular transmission; sedative-hypnotic drug dependence
M. M. Reidenberg: clinical pharmacology; drug metabolism
A. Rifkind: clinical pharmacology; endocrine pharmacology
W. F. Riker, Jr.: general pharmacology; neuropharmacology; neuromuscular transmission
A. Van Poznak: clinical pharmacology; pharmacology of halogenated hydrocarbons; neuropharmacology

Courses

1. General Pharmacology The basic pharmacology course is offered to second-year medical students and to qualified graduate students. It consists of lectures, laboratory work, demonstrations, and seminars given during the first and second trimesters. The purpose of these exercises is to teach the principles of pharmacology. Detailed consideration is given to the parameters of drug action to provide the student with the fundamental concepts essential for the evaluation of any drug. Consequently, emphasis is placed on the scientific basis of pharmacology. Prototype drugs, considered essentially systemically, serve to illustrate several mechanisms and parameters of drug action. Therapeutic applications are considered only insofar as they illustrate principles of pharmacology or drug hazards. Prerequisites: biochemistry and physiology. The staff.

2. Molecular Pharmacology Fundamental principles governing the effects of chemicals on living systems are examined from the viewpoint of drug-receptor interactions. Several concepts are introduced including drug selectivity, specificity dose-response, and receptor theory. Examples of receptor isolation and receptor-drug interactions are discussed in detail. Prerequisites: an adequate background in biology, organic and physical chemistry, and biochemistry is required. The staff and invited lecturers.

3. Research in Pharmacology Research opportunities may be arranged throughout the year for graduate students who are not majoring in pharmacology but who wish some investigative experience in the discipline. Special opportunities are offered for work on the nervous and cardiovascular systems and in biochemical and clinical aspects of pharmacology. The staff.

4. Advanced Courses and Seminars The Field of Pharmacology offers several advanced courses and seminars in the areas that are of interest to the faculty of the field and the graduate students. The content, format, and schedule of these courses are determined each year on the basis of the number and the backgrounds of the interested students. The staff.

Physiology

O. S. Anderson, S. Balagura-Baruch, W. A. Briscoe, W. W. Y. Chan, L. S. Costanzo, C. Fell, G. Frindt, D. Gardner, B. Grafstein, R. L. Greif, N. B. Javitt, C. Lee, R. Levi, C. Liebow, M. Lipkin, T. M. Maack, T. G. Pickering, A. Taylor, E. E. Windhager

Field Representative

T. M. Maack, Department of Physiology and Biophysics, Room D-407, Medical College

Opportunities are offered toward the Ph.D. degree in several areas of physiology and biophysics. Ample space is available and laboratories are well equipped to provide predoctoral training in a medical environment. Interested individuals are urged to contact the field representative before preparing a formal application. Letters of inquiry should include a discussion of educational background and indicate possible areas of emphasis in graduate study. There has been a tendency to encourage applications from individuals who have a probable interest in one or more of the areas of physiology represented within the field.

Formal applications should include full college transcripts and at least two letters of recommendation. Graduate Record Examination scores are mandatory, since performance in these examinations is an important factor in the selection of applicants. Introductory courses in biology, inorganic and organic chemistry, physics, and mathematics through the level of differential and integral calculus are required. Additional course work in these disciplines at the undergraduate level is encouraged. Applicants with otherwise exemplary records who lack certain course requirements will be considered for acceptance provided that they remedy their deficiencies while in training.

The course of study emphasizes the importance of teaching and research in the preparation and development of individuals for careers in physiology. This goal is achieved by a combination of didactic courses, seminars, and closely supervised research leading toward the preparation of a satisfactory thesis.

A special program of study will be developed for each student in consultation with his or her Special Committee. In addition to the general requirements set by the Graduate School for all fields, all candidates for the doctoral degree in physiology will be expected to meet the following specific requirements:

1. Evidence of a satisfactory background in neurosciences. Ordinarily, the course in neuroscience described under the Field of Neurobiology and Behavior, or an equivalent course, will be taken concurrently with the course in physiology and biophysics.
2. Satisfactory completion of the course in physiology and biophysics, or an equivalent course.
3. For majors and minors in the field, a minimum of two elective courses in the field ordinarily will be required, in addition to the course in physiology and biophysics.
4. Proficiency in reading scientific literature in one modern foreign language.
5. Satisfactory completion of an individualized laboratory experience in an area of research different from that chosen for the doctoral dissertation.

Special Interests of the Faculty

O. S. Andersen: properties of cell membranes, artificial lipid membranes
S. Balagura-Baruch: renal metabolism and transport of Krebs cycle intermediates
W. A. Briscoe: blood gas transfer in health and disease
W. W. Y. Chan: pharmacology of neurohypophysial hormones and related polypeptides
L. S. Costanzo: renal electrolyte metabolism
C. Fell: cardiovascular function; in particular, blood flow distribution, blood volume, and blood volume distribution
G. Frindt: renal electrolyte metabolism; isolated perfused tubules
D. Gardner: neurophysiology
B. Grafstein: nerve regeneration and transport of materials in nerve axons
R. L. Greif: physiology of the thyroid gland and its secretions
N. B. Javitt: gastrointestinal and hepatic physiology and pathophysiology
C. Lee: cardiac electrolyte physiology
R. Levi: heart electrophysiology; heart hypersensitivity reactions; histamine in cardiac function
C. Liebow: pancreatic secretion
M. Lipkin: proliferation and differentiation of normal and diseased gastrointestinal cells
T. M. Maack: protein transport and metabolism by the kidney
T. G. Pickering: cardiovascular physiology and pathophysiology
A. Taylor: cellular mechanisms of action of antidiuretic hormone
E. Windhager: renal electrolyte metabolism

Courses

Students planning to register for the course in Physiology and Biophysics must consult the field representative before the start of the second trimester. Students who wish to take a third-trimester course (2-8) are advised to consult the field representative no later than the seventh week of the second trimester in order to assure a place in the course.

1. Physiology and Biophysics Lectures and conferences in body fluids, bioelectric phenomena, circulation, respiration, and gastrointestinal function. Second trimester: four hours each week. The staff.

Lectures and conferences on kidney function, acid-base regulation, endocrinology, and metabolism; and a weekly laboratory on selected aspects of physiology. Third trimester: eleven hours each week. The staff.

2. Respiratory and Renal Mechanisms of Regulation of Acid-Base Balance Each session consists of an informal lecture and a succeeding seminar discussion based on assigned reading in the area of the immediately preceding lecture. Third trimester: three hours each week. Five to fifteen students.

3. Selected Topics in Endocrinology Important scientific papers dealing with certain aspects of endocrinology are distributed to the participants one week in advance of discussion. Each paper is considered in detail in a seminar directed by an investigator in the area under discussion. One or two preliminary orientation sessions are given by Professor Greif before distribution of the first scientific paper, and, if feasible, one or two laboratory days are planned. Third trimester: three hours each week. Six to twelve students. R. L. Greif and staff.

4. Selected Topics in Gastrointestinal and Hepatic Physiology and Pathophysiology Topics include bilirubin metabolism and excretion, cholesterol metabolism, bile salt excretion, bile formation, esophageal motility, gastric function, intestinal cell turnover, absorption of fat, absorption of carbohydrate, the malabsorption syndrome. Third trimester: two hours each week. Six to twelve students. N. B. Javitt.

5. Selected Topics in Respiratory Physiology Topics covered include: (1) physiological anatomy of the lung; (2) logical formulation and solution of clinical problems; (3) ventilation, alveolar air diagram, nitrogen washout; (4) relevant lung function tests; (5) lung volumes, effect of posture and disease; (6) diffusion, Fick equation, Bohr integration; (7) acid-base considerations in blood; (8) mechanical properties of lung; (9) ventilation-perfusion ratio and Bohr integral isopleths; (10) ecology, sealed spaces, altitude, diving; (11) lung function in the first week of life. Students wishing to take this course must consult with Professor Briscoe no later than the seventh week of the second trimester. Third trimester: two hours each week. Maximum of twelve students. W. A. Briscoe

6. Selected Topics in Kidney and Electrolyte Physiology and Pathophysiology Lectures, seminars, and demonstrations. Topics include: (1) GFR, clearance concept, reabsorption and secretion of electrolytes; (2) concentrating mechanism; (3) electrophysiology of the nephron; (4) pathophysiology of potassium; (5) renal blood flow and its intrarenal distribution; (6) renal physiology in the newborn; (7) control of body fluid volume and tonicity; (8) pathology of renal failure; urinary sediment; pathophysiology of renal failure; (9) radiology of the kidneys; (10) dialysis; (11) transplantation. Third trimester: two hours each week. Maximum of twelve students. E. Windhager and staff.

7. Special Topics in Cardiovascular Physiology Original research papers will be made available in advance of each session, and these and the general problems associated with each topic will serve as the basis for the discussion. Insofar as possible, experimental approaches to each problem will be demonstrated. To some extent, choice of topics can be determined by the interests of the group. Probable topics include: (1) regulation of peripheral blood flow; (2) integrated cardiovascular responses to hypoxia; (3) pulsatile flow in arteries; (4) measures of myocardial performance; (5) blood volume, hemorrhage, and hemorrhagic shock; (6) cardiac catheterization in man, congenital heart disease, valvular heart disease. Third trimester: three hours each week. Six to twelve students. C. Fell.

8. Neurobiology Elective Described under courses offered by the Field of Neurobiology and Behavior.

Interdisciplinary Program in Molecular Medicine

This program offers studies leading to the Ph.D. in an established field of the Graduate School of Medical Sciences (biochemistry, microbiology, pathology, pharmacology, physiology). Although formal course work is required, emphasis is placed on basic research directed toward the understanding of human disease at the molecular level. A major goal of the program is to emphasize interdisciplinary interactions and collaboration, and thus to broaden the scope of the research capabilities of participating students. Research opportunities exist in many areas, including those listed below. Entering students may work for short periods in several laboratories before beginning thesis research.

The curriculum of each student is planned to meet individual interests and needs. In addition to research and regular course work, graduate students, postdoctoral research fellows, research associates, and the faculty participate in informal seminars and discussion groups, conducted in cooperation with various departments of the Medical Center.

The graduate student works directly with a faculty sponsor in the sponsor's laboratory and is expected to complete a research thesis of high quality in a subject relating to the major field.

Representative Thesis Research Areas

Altherosclerosis, aging, blood coagulation, renal diseases, endocrine disorders, drug dependence, cerebral function, hypertension, skin disorders, lung surfactants, liver disease, obesity, hemoglobin diseases, pancreatitis, hemolytic diseases, diseases of purine, amino acid, carbohydrate, and lipid metabolism.

Faculty

S. Balagura-Baruch (physiology); C. G. Becker (pathology); J. S. Cornell (biochemistry); J. T. Ellis (pathology); G. F. Fairclough (biochemistry); B. Grafstein (physiology); R. H. Haschemeyer (biochemistry); C. E. Inturrisi (pharmacology); R. Levi (pharmacology); A. Meister (biochemistry); C. R. Minick (pathology); A. Rifkind (pharmacology); W. F. Riker, Jr. (pharmacology); A. L. Rubin (biochemistry); C. A. Santos-Buch (pathology); L. B. Senterfit (microbiology); R. L. Soffer (biochemistry); K. H. Stenzel (biochemistry); S. S. Tate (biochemistry); E. H. Windhager (physiology)

Instruction at the Sloan-Kettering Division

1. Graduate Seminar This weekly graduate seminar is offered each year and is attended by all first- and second-year students of the division. Two or three topics are selected for discussion each year. Topics are usually chosen from the following: carcinogenesis; nucleic acid and protein chemistry and biochemistry; chromosome structure and function; special topics in bacterial genetics; regulation; radiobiology; immunology; membranes, cell surfaces; mammalian and bacterial viruses. The discussion is carried principally by graduate students under the guidance of faculty members whose area of specialization coincides with the topic. From time to time outstanding authorities are invited as guest speakers. In addition, students in the third and later years of graduate study address the seminar on the progress being made in their thesis work.

2. Research Colloquia Discussions of research conducted by the faculty and literature reports by students.

3. Special Laboratory Programs Throughout the year students may spend time in research laboratories. Arrangements for laboratory rotation should be made with major sponsor.

4. Introduction to Biohazards and Laboratory Safety All students are encouraged to take by their second year the course of six basic lectures sponsored by the Sloan-Kettering Institute Committee on Biohazards. The series covers general laboratory safety, radioisotopes, carcinogens, primary and secondary barrier systems, contamination control, and hazards associated with research animals, and is supplemented by lectures on special topics given throughout the year. M. S. Zedeck and staff.

5. Special Topics Seminars and discussions by the faculty. Second and third trimesters.

6. Minor Projects Two minor projects involving one month of full-time study or three months of part-time study are required of all students. These projects are to be completed before a student stands for the Admission to Candidacy Examination.

Biochemistry

Faculty

N. W. Alcock, L. H. Augenlicht, I. Balazs, M. E. Balis, F. C. Bancroft, A. Bendich, R. S. Bockman, E. Borenfreund, J. D. Braunstein, L. F. Cavalieri, C. Cunningham-Rundles, Z. Darzynkiewicz, D. B. Donner, J. D. Fissekis, M. Fleisher, J. J. Fox, A. Giner-Sorolla, S. Green, M. G. Hamilton, U. Hämmerling, P. J. Higgins, L. Kopelovich, W. Kreis, K. O. Lloyd, S. L. Marcus, P. W. Melera, M. J. Modak, J. S. Nisselbaum, B. A. Otter, J. C. Parham, J. Roberts, B. Rosenberg, J. S. Salser, A. S. Schneider, M. K. Schwartz, M. R. Sherman, V. P. Skipski, M. Sonenberg, G. Stöhrer, N. I. Swislocki, P. P. Trotta, K. A. Watanabe, S. S. Witkin, L. C. Yip

Unit Chairperson

M. Earl Balis, Sloan-Kettering Division, Kettering Laboratory, Room 921

Opportunities are available for advanced work and research in chemistry and metabolism, bio-organic chemistry, enzymology, hormone chemistry and action, and molecular biology.

Undergraduate requirements for a major in biochemistry include courses in inorganic chemistry, qualitative and quantitative chemistry, organic chemistry, physical chemistry, physics, general biology, and mathematics (through calculus). Any of these requirements not completed at the undergraduate level must be completed during graduate study.

Graduate Record Examinations scores in both the Aptitude Test (verbal and quantitative) and the Advanced Test in chemistry or biology are required.

Students electing biochemistry as a major or minor subject must complete the first term of the Graduate Biochemistry course and the Advanced Biochemistry course as minimal requirements. Two minor subjects are required.

Students may be required to take an oral qualifying examination. A written examination may be required at the discretion of the student's Special Committee. The Admission to Candidacy Examination is both written and oral.

The only language requirements are those imposed by the student's Special Committee.

Special Interests of the Faculty

N. W. Alcock: trace metals; parenteral nutrition
L. H. Augenlicht: transciptional control, eukaryotes
I. Balazs: RNA characterization; transcription and translation in man-mouse cell hybrids
M. E. Balis: enzyme regulation; purine metabolism
F. C. Bancroft: regulation of gene expression in eukaryotes
A. Bendich: macromolecules; biochemical genetics; mammalian cell transformation
R. S. Bockman: parathyroid action, hypercalcemia and carcinogenesis
E. Borenfreund: biochemical genetics; chemical carcinogenesis
J. D. Braunstein: immunobiology of carcinogenesis
L. F. Cavalieri: reverse transcriptase; macromolecules
C. Cunningham-Rundles: molecular aspects of immunity; HLA composition; B-cell receptors
Z. Darzynkiewicz: differentiation and carcinogenesis
D. B. Donner: hormone action; cell surface regulation
J. D. Fissekis: structural and functional relationships of biomolecules
M. Fleisher: tumor associated antigens; clinical chemical automation
J. J. Fox: development of antitumor and antiviral chemicals
A. Giner-Sorolla: synthesis of antitumor and antiviral chemical; carcinogenesis
S. Green: isolation of tumor necrotizing factor, macrophage enzymes
M. G. Hamilton: eukaryotic ribosomes; characterization of nucleic acid and proteins
U. Hämmerling: differentiation of lymphocytes; immunochemistry of T and B cells
P. J. Higgins: comparative biochemistry of embryonic and neoplastic development
L. Kopelovich: chromosomal proteins, nucleic acids, and neoplastic transformation
W. Kreis: biochemical pharmacology; biochemistry of macromolecules
K. O. Lloyd: immunochemistry; melanoma and ovarian antigens
S. L. Marcus: biochemistry of reverse transcriptase and DNA polymerase
P. W. Melera: growth and differentiation; biochemistry of RNA
M. J. Modak: DNA polymerase; reverse transcriptase; oncogenic viruses
J. S. Nisselbaum: mechanism of enzyme activity; isozymes
B. A. Otter: synthesis of antitumor compounds
J. C. Parham: chemical carcinogenesis; photochemistry; synthesis of antitumor drugs
J. Roberts: enzyme therapy and nutritional deprivation of neoplasms
B. H. Rosenberg: mechanism and control of DNA synthesis
J. S. Salser: biochemical and immunological characteristics of enzymes
A. S. Schneider: membrane structure and function; biopolymerspectroscopy
M. K. Schwartz: antigens, hormones, and enzymes in cancer detection; automated clinical biochemistry
M. R. Sherman: mechanism of steroid hormone action
V. P. Skipski: lipid metabolism and malignancy
M. Sonenberg: mechanism of peptide hormone action; liquid control of membrane structure and function
G. Stöhrer: carcinogenesis and cell differentiation
N. I. Swislocki: hormone action and plasma membranes
P. P. Trotta: adenosine deaminase, growth and differentiation
K. A. Watanabe: synthesis of nucleoside antibiotics and antimetabolites
S. S. Witkin: carcinogenesis and embryogenesis
L. C. Yip: enzymes in purine metabolism, aging, carcinogenesis

Courses

1. Graduate Biochemistry The course and hours are described on p. 27 under Interdivisional Courses.

2. Advanced Biochemistry The course and hours are described on p. 27 under Interdivisional Courses.

3. Physical Methods The course and hours are described on p. 27 under Interdivisional Courses.

Biology

Faculty

J. Abbott, A. M. Albrecht, R. S. Anderson, K. Artzt, D. Bennett, J. L. Biedler, E. A. Boyse, D. W. Braun, Jr., P. L. Chello, Y. S. Choi, T.-C. Chou, R. G. Coffey, N. K. Day, S. B. Day, E. deHarven, A. Demsey, E. E. Deschner, M. A. B. deSousa, G. B. Dooher, B. Dupont, M. G. Eisinger, D. P. Evenson, R. B. Faanes, A. M. Feinberg, E. Fleissner, J. E. Fogh, P. J. Gomatos, R. A. Good, S. Gupta, J. W. Hadden, W. D. Hardy, Jr., Y. Hirshaut, J. A. Hirst, M. Hoffman, D. J. Hutchison, G. Incefy, A. J. Kenyon, Y. B. Kim, P. W. Kincade, G. C. Koo, R. M. Krug, G. W. Litman, C. Lopez, H. Marquardt, B. M. Mehta, M. R. Melamed, V. Miké, M. A. S. Moore, M. J. Murphy, Jr., H. F. Oettgen, L. J.

Old, R. J. O'Reilly, R. H. F. Peterson, F. S. Philips, W. Prensky, P. Ralph, F. K. Sanders, N. H. Sarkar, M. Scheid, T. M. Setcavage, J. Sethi, F.-W. Shen, F. P. Siegal, M. Siniscalco, F. M. Sirotnak, E. M. Smithwick, M. Spiegelman, C. W. Stackpole, E. Stavnezer, J. Stavnezer, S. S. Sternberg, O. Stutman, M. N. Teller, H. Thaler, L. Thomas, J.-S. Tung, S. S. Wachtel, Y. Y. Wang, M. S. Zedeck

Unit Chairperson

G. W. Litman, Sloan-Kettering Division, Walker Laboratory, Room 3083

The program in biology is oriented toward an understanding of factors that initiate control and modify growth and biological development. Opportunity is offered for advanced work and research in cell biology, cytology, genetics, immunology, microbiology, pharmacology, pathology, biostatistics, and virology.

Undergraduate prerequisites for a major in biology include courses in inorganic chemistry, organic chemistry, qualitative and quantitative chemistry, physics (mechanics, electricity, and magnetism; sound, heat, and light), mathematics (through calculus), and general biology or zoology or botany or microbiology. Physical chemistry is recommended. Any of these requirements not completed at the undergraduate level must be completed during the first year of graduate study.

Graduate Record Examinations in both the Aptitude Test (verbal and quantitative) and the Advanced Test in biology or chemistry are required.

Programs are determined individually on the basis of interest, training, and prior experience. Elective courses in basic medical sciences include those described for the Medical College. Formal graduate courses, seminars, and tutorials are arranged with the faculties of the Sloan-Kettering Division and the Medical College Division.

Students may be required to take a qualifying examination. All students are required to pass the Admission to Candidacy Examination and defend a thesis. A major and two minor subjects are also required. The foreign language requirement will be determined by the student's Special Committee.

Special Interests of the Faculty

J. Abbott: differentiation and cell surface antigens
A. M. Albrecht: folate metabolism and transformation and control mechanisms
R. S. Anderson: phylogeny; immunity and cancer
K. Artzt: cell surfaces and tumorigenesis in early mouse embryogenesis
D. Bennett: developmental genetics and differentiation
J. L. Biedler: somatic cell genetics and oncogenic potential
E. A. Boyse: immunogenetics of the cell surface
D. W. Braun, Jr.: biostatistics; computer graphics; nonparametric methods
P. L. Chello: molecular therapeutics and pharmacology
Y. S. Choi: immunobiology—tumor and lymphoid cell interactions
T.-C. Chou: molecular pharmacology and enzymology
R. G. Coffey: regulatory and effector hormones
N. K. Day: comparative and developmental studies of the complement system
S. B. Day: biomedical communication
E. deHarven: ultrastructure of cells, viruses, and cell surfaces
A. Demsey: morphogenesis and ultrastructure of leukemia; mammary tumor and SV40 viruses
E. E. Deschner: proliferation and differentiation of gastrointestinal epithelium
M. A. B. de Sousa: lymphocytic environment; normal and malignant lymphoid organs
G. B. Dooher: surface and fine structure analysis of mouse spermatozoa
B. Dupont: human immunogenetics
M. G. Eisinger: human wart virus studies
D. P. Evenson: ultrastructure of RNA and DNA and RNA tumor virus
R. B. Faanes: immunobiology; target cell-lymphocyte-antibody interaction
A. M. Feinberg: mechanisms of chemical carcinogenesis
E. Fleissner: molecular, biological, and immunological studies of murine leukemia viruses
J. E. Fogh: cancer cell biology and virology
P. J. Gomatos: biochemistry and genetics of animal viruses and transformed cells
R. A. Good: immunobiology and cellular engineering
S. Gupta: primary and secondary immunodeficiencies; T-cell characterization
J. W. Hadden: immunopharmacology
W. D. Hardy, Jr.: feline lymphosarcoma (leukemia)
Y. Hirshaut: human tumor antigens
J. A. Hirst: cellular immunity; T cell function and development
M. Hoffman: regulation of humoral immunity
D. J. Hutchison: microbiology; drug resistance and cytoregulation
G. Incefy: lymphocyte (T and B cells) differentiation
A. J. Kenyon: pathogenesis of lymphoproliferative diseases
Y. B. Kim: ontogeny of immune systems and microbial toxins
P. W. Kincade: hematopoietic differentiation; immunoglobulins
G. C. Koo: immunogenetics of sperm
R. M. Krug: biochemistry of transcription, translation, and viral replication
G. W. Litman: immunoglobulins; malignant transformation and carcinogenesis
C. Lopez: immunopathology; herpes and slow viruses
H. Marquardt: chemical carcinogenesis; pharmacology of antitumor agents
B. M. Mehta: quantitative microbiology; genetics
M. R. Melamed: cytophysics and cytochemistry
V. Miké: biostatistics; robust estimation
M. A. S. Moore: multipotential stem cells; granulopoiesis
M. J. Murphy: erythropoietin; cell differentiation
H. F. Oettgen: cellular immune reactions
L. J. Old: cancer immunology and immunotherapy
R. J. O'Reilly: microbial immunology
R. H. F. Peterson: malignancy; plasma membrane composition
F. S. Philips: pharmacology of antitumor and carcinogenic agents

W. Prensky: molecular cytogenetics
P. M. Ralph: immunobiology, hematopoiesis, oncogenesis
F. K. Sanders: molecular events in viral infections
N. H. Sarkar: morphology of RNA oncogenic viruses
M. Scheid: regulation of T and B cell differentiation
T. M. Setcavage: ontogeny and regulation of immunity
J. Sethi: immunobiology; human sarcoma associated antigens
F. W. Shen: immunogenetics of the mouse
F. P. Siegal: pathophysiology of immune deficiencies
M. Siniscalco: somatic cell genetics
F. M. Sirotnak: regulation; mutagenesis; transport and drug action
E. M. Smithwick: neutrophil function and metabolism
M. Spiegelman: cell-cell interactions and embryonic development in mice
C. W. Stackpole: immunological and ultrastructural changes during differentiation and malignant transformation
E. Stavnezer: organization of eukaryotic genomes; regulation of RNA synthesis
J. Stavnezer: isolation and differentiation of immunoglobulin genes
S. S. Sternberg: pathology and drug toxicity
O. Stutman: cellular immunobiology; oncogenesis
M. N. Teller: aging; immunology; oncogenesis
H. Thaler: biostatistics; clinical trials
L. Thomas: microbial toxins and mycoplasma
J. S. Tung: biochemistry and immunogenetics of mouse cell surface antigens
S. S. Wachtel: immunogenetics
Y. Y. Wang: biostatistics; methodology and analysis
M. S. Zedeck: mechanisms of chemical carcinogenesis; biochemistry of antitumor drugs

Courses

1. Introductory Microscopic Anatomy The course is described on p. 28 under Interdivisional Courses.

2. Microscopy for Cancer Research A laboratory course. An introduction to the morphology of cancer cells with a double emphasis: 1) *advanced methods in microscopy* and 2) *human cancer pathology.* Sessions consist of lectures and/or demonstrations, followed by a laboratory in which students will examine microscopic slides (microscopes will be provided). Methods of light microscopy (autoradiography, enzyme-cytochemistry, immunofluorescence, etc.), as well as electron microscopy (transmission, scanning, high resolution, etc.) will be emphasized. Approximately half of the sessions will deal with the pathology of human neoplastic tissue (leukemia, breast cancer, hepatoma, etc.). Third trimester. E. deHarven, S. S. Sternberg, and staff.

3. Molecular Virology A formal course in which major emphasis is placed on the basic mechanisms in the biology of all animal viruses, including RNA and DNA tumor viruses. The topics considered include virus structure and composition; assay of viruses and viral-specific products; transcription and replication of viral nucleic acids; translation of virus-specific proteins; assembly of viral particles; structural and functional alterations in viral-infected cells including transformation; pathogenesis of viral diseases; and viral genetics. Second trimester. Not offered 1978-79. P. J. Gomatos, R. M. Krug, E. Fleissner, M. Modak, and staff.

4. Tumor Virology and Immunology A lecture and discussion course designed to give the student an in-depth understanding of tumor-virus host interactions in tissue culture and in animal systems. Both RNA and DNA tumor viruses will be considered, especially leukemia-sarcoma viruses of mice, cats and other mammals, mouse mammary tumor virus, and polyoma and SV40 viruses. Topics to be covered include inheritance of viral genes and genetic loci affecting virus expression, defective and recombinant viral genomes as oncogenic agents, transformed cell phenotypes and virus-coded transforming functions, tumor antigens and host immune responses, and viral proteins as tissue-specific differentiation antigens. The overall aims will be to show (1) how viral and host genetic elements interact in the formation of specific gene products leading to cellular transformation and to tumor growth or rejection and (2) how such an analysis of neoplastic cells can clarify certain aspects of normal growth control and differentiation. (It is recommended that this course be taken after the course in Molecular Virology, which is offered in the preceding trimester.) Third trimester. Not offered 1978-79. E. Fleissner and staff.

5. Fundamentals of Cell Biology An interdisciplinary course designed to explore at a fundamental level those aspects of cellularity with regard to the interaction between cells and their environment. The main purpose will be to compare the way in which prokaryotic cells, unicellular organisms such as protozoa, constitutive eukaryotic cells of multicellular organisms, and cells in tissue culture react to and upon their environment. Comparisons will be made at the morphological, biochemical, biological and molecular levels. There will be discussions of cell replication, modes of expression of the cellular genome, and their regulation. Intercellular as well as intracellular controls of biochemical activities (e.g., DNA, RNA, and protein synthesis) and aspects of embryogenesis and histodifferentiation will be emphasized. Two-hour classes will be given by members of the faculty and by invited guest speakers and will include one half hour of discussion. Second trimester. E. deHarven, F. K. Sanders, and staff.

6. Cell Culture Techniques Short-term course in tissue culture techniques for a limited number of students at the Walker Laboratory in Rye. Each course, with two students in attendance, will run for a two week period.

The course work will include the theoretical and practical aspects of tissue culture with demonstrations and practice. It will cover general and special techniques as they apply to various fields of cancer research. Methods of prevention and detection of tissue culture contaminants will be demonstrated. J. Fogh.

7. Genetics Seminar Described on p. 15 under the Field of Genetics.

8. Microbiology for Graduate Students Described on p. 27 under Interdivisional Courses.

9. Advanced Immunology Described on p. 28 under Interdivisional Courses.

10. Biostatistics I: Introduction to Statistical Reasoning It is the aim of this course to help participants gain some insight into the theory underlying a probabilistic approach to the treatment of observational or experimental data, and to acquaint them with the most basic techniques of statistical analysis. Prerequisite: elementary algebra. First trimester. D. Braun, Jr.

11. Biostatistics II: Experimental Design and Curve Fitting Application of concepts introduced in Biostatistics I to the analysis of scientific data. Topics include statistical design of experiments, analysis of variance, correlation and linear regression. Prerequisite: Biostatistics I or equivalent. Second trimester. V. Miké and staff.

12. Biostatistics III: Analysis of Frequency Data Methods for analyzing frequency data are presented. Topics include contingency tables, trends in proportions, binary regression, and relative risk. Prerequisite: Biostatistics I and II or equivalent. Third trimester. V. Miké and staff.

13. Biostatistics Workshop Participants gain experience in the use of modern computing equipment and statistical software for the analysis of scientific data. The workshop is designed to complement Biostatistics I, II, and III, and is held at the Biostatistics Laboratory. First, second, and third trimesters. V. Miké and staff.

Biophysics

Faculty

L. L. Anderson, R. E. Bigler, B. Djordjevic, J. Fried, A. Gelbard, E. W. Hahn, J. H. Kim, J. S. Laughlin, J. C. McDonald, J. M. McDonald, D. W. Miller, G. A. Russ, R. S. Tilbury, H. Weiss, L. Zeitz

Unit Chairperson

Roy S. Tilbury, Sloan-Kettering Division, Kettering Laboratory, Room 219

Graduate work is offered leading to the Ph.D. degree in biophysics and the M.S. degree in radiation physics. A candidate for the Ph.D. must have a B.A. or B.S. degree with a major in physics, or with a major in biology, chemistry, or mathematics and a minor in physics. A candidate for the M.S. must have a B.A. or B.S. in physics from a recognized university.

Graduate Record Examination scores in both the Aptitude Test (verbal and quantitative) and the Advanced Test in physics, mathematics, chemistry, or biology are required.

Undergraduate prerequisites for the Ph.D. candidate include courses in general physics, electricity and magnetism, mechanics, mathematics (through calculus), and thermodynamics, and acceptable laboratory experience in these subjects. Any of those requirements not completed at the undergraduate level must be completed during graduate study. Graduate course work required for the Ph.D. is flexible, depending upon the student's background and basic interests, but ordinarily would include advanced quantum mechanics, electrodynamics, and nuclear physics and courses in the student's minor subjects. In addition, a month spent full time on a laboratory project is required in each of the two minor disciplines.

Students may be required to pass a qualifying examination covering various basic aspects of their major and minor subjects and must pass the Admission to Candidacy Examination. The thesis required for the Ph.D. in biophysics should demonstrate the ability of the student to make a thorough and original investigation in an important area of biophysics. There is no mandatory foreign language requirement.

Some of the research projects in biophysics that are pertinent to the Ph.D. program include: methods of production of radionuclides using a biomedical cyclotron, synthesis of labeled compounds, and their use for *in vivo* metabolic studies; the mechanism of radiation action on bacteria and small animals, including metabolism studies with human and other tumors influenced by radiation under different environmental conditions; fundamental radiobiological studies of mammalian cells in tissue culture and study of the early radiation-induced processes in cells using high-intensity pulsed irradiation techniques; effects of chemotherapeutic agents on cell survival and progression through the cell cycle; application to the treatment of human leukemia; the measurement of radiation by calorimetric, chemical, and solid-state techniques; the measurement of bone mineral content in the human.

A candidate for the M.S. must have a B.A. or B.S. in physics from a recognized university and have completed undergraduate courses in general physics, mechanics, electronics, electricity and magnetism, modern physics, and mathematics through differential equations. The candidate is expected to satisfactorily pass courses selected from some of the following subjects: physics, biophysics, biology, radiobiology, biochemistry, and biomathematics and must minor in one of those subjects other than physics. The thesis subject must be in the field of radiation physics and must represent a comprehensive study demonstrating a thorough knowledge of the chosen subject. A final oral examination will be given, primarily on the subject of the thesis and may be preceded by a written examination covering the fundamental principles of the course work. There is no mandatory foreign language requirement.

The course of study leading to the M.S. degree in radiation physics trains physicists in the various aspects of production, measurement, and application of radiation to various medical and biological problems. These problems particularly involve the use of radiation in the diagnosis and treatment of cancer. A variety of radiation sources is available, capable of generating photons and electrons with energies ranging from 5 Kev to 25 Mev and with electron dose-rates up to 10^{14} rads per second. Experience also is provided in the handling and use of many

different radioisotopes. The magnitude and variety of facilities and unique radiation projects at the Sloan-Kettering Institute and the Memorial Hospital are particularly pertinent for training in this area. An important feature is the coexistence of fundamental research and practical and clinical applications in the same center.

Special Interests of the Faculty

L. L. Anderson: radiation dosimetry
R. E. Bigler: *in vivo* neutron activation analysis
B. Djordjevic: radiobiological mechanisms in synchronous cells
J. Fried: cytotoxic agents and the cell cycle; flow cytofluorometry
A. S. Gelbard: enzymatic synthesis of compounds labeled with short-lived isotopes
E. W. Hahn: cytotoxicity of hyperthermia on normal and neoplastic cells
J. H. Kim: hyperthermia, radiation and drug actions on cell systems
J. S. Laughlin: metabolic studies with radionuclide labeled compounds
J. C. McDonald: radiation therapy; mechanisms of action
J. M. McDonald: computerized data taking and analysis concerned with short half-life; cyclotron produced isotopes
D. W. Miller: radiation dosimetry for diagnostic x-ray
G. A. Russ: chemistry and metabolism of short-lived labeled compounds
R. S. Tilbury: radiopharmaceuticals for use in nuclear medicine
H. Weiss: fast time processes in biophysics and radiobiology
L. Zeitz: mechanisms of damage and repair in mammalian cells

Courses

1. Radiological Physics Lectures and problems. A series of hourly lectures and assigned problems in applied mathematics, fundamentals of radiation physics, X-ray and radium treatment planning, diagnostic X-ray principles, radiation protection, and uses of radioactive isotopes. Hours by arrangement.

2. Radiobiology A semester course in fundamental radiobiology dealing with the effects of radiation on cells, viruses, and macromolecules, as well as on whole animals. The course also covers areas of radiation physics and radiation chemistry pertinent to radiobiology.

3. Advanced Biophysics Laboratory courses in each of the topics of radiation biophysics. Hours by arrangement.

4. Radiopharmaceutical Chemistry A tutorial course in radiopharmaceutical chemistry will be offered to those students majoring or minoring in this subject. Hours by arrangement.

5. Biophysics Colloquia Reports on research in progress by faculty and outside lecturers. Required for majors in biophysics. Hours by arrangement.

Interdivisional Courses

1. Graduate Biochemistry Offered by the staff of the Field of Biochemistry, Medical College Division, and of the Biochemistry Unit, Sloan-Kettering Division. This is a course designed to provide the student with a knowledge of the fundamentals of biochemistry and an appreciation of the molecular basis of biological phenomena. Graduate students in biochemistry are required to pass this course (or its equivalent) prior to pursuing advanced courses. Fall and winter trimesters. M T Th F 11-12. S. S. Tate, P. P. Trotta, and staff.

2. Advanced Biochemistry A course offered jointly by the faculties of the Medical College and Sloan-Kettering Divisions. The course will consist of a series of lecture units (minicourses) covering topics such as: size and shape methods for the study of macromolecules, molecular biology, information transfer, membrane structure and function, hormones, enzyme structure and function, antimetabolites in chemotherapy, and other subjects of current research interests. These subjects will be taught at an advanced level with particular attention to contributions of recent research. It is not essential that students take the lecture units in any particular sequence. Minimal prerequisite is the Graduate Biochemistry course (described above) or its equivalent. Winter and spring trimesters. L. H. Augenlicht, J. Parham, S. S. Tate, and staff.

3. Physical Methods This course will consist of a series of workshops including laboratory demonstrations and lectures and/or tutorials in physical techniques for the study of macromolecular and cellular structure. Examples of techniques available for study are: hydrodynamic and equilibrium methods, electron microscopy and other optical methods, resonance methods, separation techniques such as chromatography, electrophoreses, isoelectric focussing, affinity methods, etc. Time and place should be arranged with the faculty in charge. Prerequisites; Graduate Biochemistry or its equivalent and Physical Chemistry. First trimester. R. H. Haschemeyer and P. P. Trotta.

4. Microbiology for Graduate Students This course is intended to give a much wider coverage of the subject than that dealt with in the course Microbiology and an Introduction to Infectious Diseases (see page 16), which is primarily intended for medical students. Accordingly, this course is given weekly throughout the academic year and covers the history of the science; basic concepts and procedures; microbial growth and physiology; genetics; immunology; mycology; virology; human, animal, and plant pathogens; microbial ecology; and applied microbiology, including food, dairy, and alcoholic products as well as antibiotics. This course is designed to be of use not only to majors and minors in this subject, but also to those desiring a general and yet functional knowledge of the field. It consists of lectures, demonstrations, and laboratory work, in varied combinations for a total involvement of two hours a week. Attendance in this course is by formal registration for

credit; auditors by special permission only. Given by selected faculty members from both the Field of Microbiology of the Medical College Division and from the Sloan-Kettering Division. Not offered 1978-79. D. J. Hutchison and W. M. O'Leary.

5. Advanced Immunology Lectures, discussions, and assigned readings will cover: properties of antigens and antibodies; mechanism of antibody formation; phylogeny and ontogeny of the immune system; structural and functional aspects of the immune system; effector mechanisms of antibody- and cell-mediated immunity; complement and other amplification systems; mechanisms of immune injuries; regulation and control of the immune response; genetics and immunology of transplants and tumors. Laboratory work will include the isolation, purification, quantitation, and characterization of antibodies; the critical measurement of antigen-antibodies reactions, and the dynamics of the *in vivo* antibody response. The laboratory course is given every third year. Not offered 1978-79. D. H. Sussdorf.
Minimal prerequisites: introductory immunology (as given in courses in general microbiology) and at least one semester (or its equivalent) of biochemistry. The lecture course is offered every second year during the second and third trimesters. Offered 1978-79 as follows: second trimester, two lectures weekly, Y. B. Kim and staff; third trimester, two lectures weekly, D. H. Sussdorf and staff.

6. Introductory Microscopic Anatomy Offered by the staff of the Field of Biological Structure and Cell Biology, Medical College Division, and of the Biology Unit, Sloan-Kettering Division. This course is designed for graduate students and consists of lectures and laboratory exercises on cell structure and the organization and development of tissues and organs. Selected concepts of fine structure, processes of differentiation, and genetic regulation are presented. A microscope slide collection, presenting tissues and organs in a variety of physiological and developmental states, as well as correlative electron micrographs are provided for individual study in the laboratory. Students must provide their own compound microscopes through their departments or sponsors. First trimester. Lectures, three hours each week, and laboratory, six hours each week; hours to be arranged. M. Spiegelman, G. Dooher, D. Bennett, and E. P. deHarven.

Special Programs

Ph.D.-M.D. Program

Students enrolled in the Graduate School of Medical Sciences are eligible for admission into the Ph.D.-M.D. Program, jointly sponsored by the Medical College and the Graduate School of Medical Sciences. This program is designed for those few graduate students whose teaching and research goals require the acquisition of the M.D. degree in addition to the Ph.D. degree. The program is *not* designed as an alternate path for students who have the M.D. degree as their primary goal, but who have not been accepted by a medical school. Those who know, at the time of application to Cornell, that they wish to pursue a course of study leading to both degrees should apply to one of the M.D.-Ph.D. programs of the Medical College described below. Only students enrolled in the Graduate School of Medical Sciences, or accepted for enrollment, are eligible for admission to the Ph.D.-M.D. Program at Cornell University Medical College.

Requirements for Admission

Applications to this program are ordinarily made after completion of the first year of study in the Graduate School of Medical Sciences, although more advanced students may be considered. The deadline for application is July 1.

To apply, the student must submit to the Ph.D.-M.D. Committee of the Graduate School of Medical Sciences:
1. A completed application for admission with advanced standing to Cornell University Medical College (obtainable from the Medical College Admissions Office);
2. A plan of graduate study incorporating all required course work of the first two years of the Medical College curriculum and endorsed by the student's Special Committee;
3. Evidence of successful completion of at least two major medical school basic science courses (anatomical sciences, biochemistry, microbiology, pathology, pharmacology, physiology);
4. Two letters of evaluation from faculty of the Graduate School of Medical Sciences.

The Ph.D.-M.D. Committee of the Graduate School of Medical Sciences will review the students' credentials and will select from among the applicants those students to be considered by the Committee on Admissions of Cornell University Medical College. Only applicants who are found to be acceptable for admission to Cornell University Medical College by its Committee on Admissions, after review of the application and a personal interview, will be accepted into the Ph.D.-M.D. Program. Final decisions will be made before August 15.

Degree Requirements

Students accepted in this program must fulfill the following requirements before admission to the third year clinical curriculum of the Medical College:
1. Complete all required graduate courses and the remainder of the first two years of the medical curriculum. The students must satisfy the academic requirements of the medical curriculum as these are determined by each of the departments of the first two years.
2. Pass the Admission to Candidacy Examination required by the Graduate School of Medical Sciences.
3. Complete the dissertation research; present and successfully defend an original thesis at the final examination for the Ph.D. degree. After satisfactory fulfillment of the required clinical rotations of the Cornell third-year medical curriculum, these students may receive credit for their graduate studies to satisfy the elective requirements of the fourth-year medical

curriculum and will then be recommended for award of the M.D. degree by Cornell University.

While registered as a graduate student in the Ph.D.-M.D. program the student is subject to the tuition schedule of the Graduate School of Medical Sciences. Upon completion of the requirements for the Ph.D. degree, the student is registered in the Medical College and is subject to the tuition schedule of the Cornell University Medical College.

M.D.-Ph.D. Program

Programs of study leading to the Ph.D. degree are available to (1) students entering Cornell University Medical College, (2) medical students already matriculated at the Medical College, and (3) resident physicians in hospitals affiliated with the Medical College.

Entering Medical Students

The applicant to this program for entering medical students must apply to both the Cornell University Medical College and the Graduate School of Medical Sciences and be accepted through the admissions procedures of both schools.

The purpose of this program is to expose the student to both medical and graduate disciplines from the outset. The student spends the first two years as a medical student studying the basic medical sciences and attending regular graduate seminars. The summer months are spent in the laboratory learning experimental techniques and doing research. The third, fourth, and fifth years of the student's program are spent as a full-time graduate student and are devoted exclusively to laboratory research and writing the thesis. The sixth year of the program is spent as a medical student in clinical study. This six-year program represents the minimum time required to satisfy residence requirements of both the M.D. and Ph.D. degrees at Cornell University.

Ordinarily an entering medical student accepted into the M.D.-Ph.D. program will initially register in both the Cornell University Medical College and the Graduate School of Medical Sciences. For the first and second years of the program, the student ordinarily will maintain registration as a full-time medical student and be granted an administrative leave of absence from the Graduate School of Medical Sciences. The student may accumulate residence credit in the Graduate School of Medical Sciences for full-time graduate study during the summer.

During the third and fourth years of the M.D.-Ph.D. program, a student ordinarily will be registered as a full-time graduate student and will be granted an administrative leave of absence from the Medical College. While registered in the Graduate School of Medical Sciences, the student will be subject to the tuition schedule of the Graduate School of Medical Sciences. In general, a student will be registered in both the Cornell University Medical College and the Graduate School of Medical Sciences during the last year of study for the Ph.D., which in most cases will be the fifth year of the program. During the final year of the program, usually the sixth year, a student will be registered only in the Cornell University Medical College.

A student in the M.D.-Ph.D. program is liable for tuition to the school in which registered. During the year in which the student is registered in both the Cornell University Medical College and the Graduate School of Medical Sciences, the student will be liable for half the tuition to each school.

Matriculated Medical Students

A medical student enrolled in the Cornell University Medical College may interrupt medical studies at any time to pursue full-time graduate study leading to the Ph.D. degree. The student must fulfill all regular requirements of the Graduate School of Medical Sciences. A maximum of two residence credits for basic science course work taken in the medical curriculum can be granted toward the Ph.D. degree after the student passes an evaluation examination.

A medical student who elects to begin graduate work leading to the Ph.D. degree in the senior year of medical school may register in both the Cornell University Medical College and the Graduate School of Medical Sciences. The student begins his or her graduate didactic work during that year, and, ordinarily, the M.D. degree is granted at the end of that year. Research in the area of the Ph.D. thesis topic is begun during the fifth year. A two-year period of full-time research is a realistic minimum estimate for the time required to execute the experimental and theoretical work necessary to fulfill the requirements for the Ph.D. degree.

Resident Physicians

The resident physician may enroll in the Graduate School of Medical Sciences as a full-time graduate student working toward the Ph.D. Part-time graduate study is not permitted. A maximum of two residence credits for medical school course work in the basic sciences can be granted toward the residence requirements of the Ph.D. degree after the student passes an evaluation examination.

Prospective applicants to these programs should communicate with the associate dean of the Graduate School of Medical Sciences.

Register

University Administration

Frank H. T. Rhodes, President of the University
Dale R. Corson, Chancellor of the University
W. Keith Kennedy, University Provost
Theodore Cooper, Dean of the Medical College and Provost for Medical Affairs
William G. Herbster, Senior Vice President
Mark Barlow, Jr., Vice Provost
Constance E. Cook, Vice President for Land-Grant Affairs
W. Donald Cooke, Vice President for Research
June M. Fessenden-Raden, Vice Provost
William D. Gurowitz, Vice President for Campus Affairs
Robert T. Horn, Vice President and Treasurer
Samuel A. Lawrence, Vice President for Financial and Planning Services
Robert M. Matyas, Vice President for Facilities and Business Operations
Richard M. Ramin, Vice President for Public Affairs
Kenneth Greisen, Dean of the University Faculty
Neal R. Stamp, University Counsel and Secretary of the Corporation

Graduate School of Medical Sciences

Administration

Frank H. T. Rhodes, President of the University
William W. Lambert, Dean of the Graduate School
Julian R. Rachele, Dean of the Graduate School of Medical Sciences and Associate Dean of the Graduate School
Robert A. Good, Director, Sloan-Kettering Division
Dorris J. Hutchison, Associate Director, Sloan-Kettering Division; Associate Dean of the Graduate School of Medical Sciences; Assistant Dean of the Graduate School

Faculty

Joan Abbott, Assistant Professor of Biology. B.A. 1954, Connecticut College; M.A. 1957, Washington University; Ph.D. 1965, University of Pennsylvania

Alberta M. Albrecht, Associate Professor of Microbiology. B.S. 1951, Seton Hall College; Ph.D. 1961, Rutgers University

Nancy W. Alcock, Assistant Professor of Biochemistry. B.S. 1949, University of Tasmania; Ph.D. 1960, University of London (England)

Fred H. Allen, Jr., Clinical Associate Professor of Pediatrics. A.B. 1934, Amherst College; M.D. 1938, Harvard University

Vincent G. Allfrey, Visiting Professor of Genetics. B.S. 1943, City College of New York; M.S. 1948, Ph.D. 1949, Columbia University

Daniel R. Alonso, Associate Professor of Pathology. M.D. 1962, University of Cuyo (Argentina)

Olaf S. Andersen, Associate Professor of Physiology. Candidatus Medicinae, 1971, University of Copenhagen (Denmark)

H. Clarke Anderson, Visiting Professor of Pathology. B.A. 1954, University of Louisville; M.D. 1958, University of Louisville School of Medicine

Lowell L. Anderson, Visiting Assistant Professor of Biophysics. B.S. 1953, Whitworth College; Ph.D. 1958, University of Rochester

Robert S. Anderson, Assistant Professor of Biology. B.S. 1961, Drexel University; M.S. 1968, Hahnemann Medical College; Ph.D. 1971, University of Delaware

Karen Artzt, Assistant Professor of Biology. A.B. 1964, Ph.D. 1972, Cornell University

Leonard H. Augenlicht, Assistant Professor of Biochemistry. B.A. 1967, SUNY Binghamton; Ph.D. 1971, Syracuse University

Rosemary F. Bachvarova, Assistant Professor of Genetics. B.A. 1961, Radcliffe College; Ph.D. 1966, Rockefeller University

Thomas Baker, Assistant Professor of Pharmacology. A.B. 1968, Hunter College; M.S. 1971, Cornell University

Sulamita Balagura-Baruch, Associate Professor of Physiology. M.D. 1959, University del Valle (Colombia); Ph.D. 1963, Cornell University

Ivan Balazs, Assistant Professor of Biochemistry. Ph.D. 1972, Albert Einstein College of Medicine

M. Earl Balis, Professor of Biochemistry. B.A. 1943, Temple University; Ph.D. 1949, University of Pennsylvania

F. Carter Bancroft, Associate Professor of Biochemistry. B.S. 1959, Antioch College; M.A. 1961, Johns Hopkins University; Ph.D. 1966, University of California, Berkeley

Alexander G. Bearn, Professor of Medicine. M.B., B.S. 1946, M.D. 1951, University of London (England)

Carl G. Becker, Professor of Pathology. B.S. 1957, Yale University; M.D. 1961, Cornell University

J. Michael Bedford, Professor of Anatomy. B.A. 1955, M.A., Vet. M.B. 1958, Cambridge University (England); Ph.D. 1965, University of London (England)

Aaron Bendich, Professor of Biochemistry. B.S. 1939, City College of New York; Ph.D. 1946, Columbia University

Dorothea Bennett, Professor of Biology. A.B. 1951, Barnard College; Ph.D. 1956, Columbia University

Barry A. Berkowitz, Adjunct Associate Professor of Pharmacology. B.S. 1964, Northeastern University; Ph.D. 1968, University of California

June L. Biedler, Associate Professor of Biology. A.B. 1947, Vassar College; Ph.D. 1959, Cornell University

Rodney E. Bigler, Assistant Professor of Biophysics. B.S. 1966, Portland State University; Ph.D. 1971, University of Texas

Ira B. Black, Associate Professor of Neurology. A.B. 1961, Columbia College; M.D. 1965, Harvard University

Richard S. Bockman, Assistant Professor of Biochemistry. B.A. 1962, Johns Hopkins University; M.D. 1967, Yale University; Ph.D. 1971, Rockefeller University

Ellen Borenfreund, Associate Professor of Biochemistry. B.S. 1946, Hunter College; Ph.D. 1957, New York University

Adele L. Boskey, Assistant Professor of Biochemistry. B.A. 1964, Barnard College; Ph.D. 1970, Columbia University

Edward A. Boyse, Professor of Biology. B.S. 1952, M.D. 1957, University of London (England)

Esther M. Breslow, Professor of Biochemistry. B.S. 1953, Cornell University; M.S. 1955, Ph.D. 1959, New York University

William A. Briscoe, Professor of Medicine. B.A. 1939, M.A. 1941, B.M., B.Ch. 1942, D.M. 1951, Oxford University (England)

Dana C. Brooks, Professor of Anatomy. B.E.E. 1949, M.D. 1957, Cornell University

Peter Bullough, Associate Professor of Pathology. M.D. 1956, Liverpool University (England)

John J. Burns, Adjunct Professor of Pharmacology. B.S. 1942, Queens College; M.A. 1948; Ph.D. 1950, Columbia University

Liebe F. Cavalieri, Professor of Biochemistry. B.S. 1943, Ph.D. 1945, University of Pennsylvania

R. S. K. Chaganti, Visiting Assistant Professor of Genetics. B.S. 1954, M.S. 1955, Andhra University (India); Ph.D. 1964, Harvard University

Walter W. Y. Chan, Professor of Pharmacology. B.A. 1956, University of Wisconsin; Ph.D. 1961, Columbia University

Paul L. Chello, Assistant Professor of Biology. B.A. 1964, Johns Hopkins University; Ph.D. 1970, University of Vermont

Yong S. Choi, Professor of Biology. M.D. 1961, Seoul National University (Korea); M.S., Ph.D. 1965, University of Minnesota

Ting-Chao Chou, Assistant Professor of Pharmacology. B.S. 1961, Kaohsiung Medical College (Taiwan); M.S. 1965, National Taiwan University; Ph.D. 1970, Yale University

Ronald G. Coffey, Assistant Professor of Biology. B.S. 1958, Colorado State University; Ph.D. 1963, Oregon State University

James S. Cornell, Assistant Professor of Biochemistry. B.S. 1969, Michigan State University; Ph.D. 1973, University of California at Los Angeles

Linda S. Costanzo, Assistant Professor of Physiology. B.A. 1969, Duke University; Ph.D. 1973, State University of New York

Charlotte Cunningham-Rundles, Assistant Professor of Biochemistry. B.S. 1965, Duke University; M.D. 1969, Columbia College of Physicians and Surgeons; Ph.D. 1974, New York University

B. Shannon Danes, Assistant Professor of Medicine. B.A. 1948, Mount Holyoke College; M.A. 1949, University of Texas; Ph.D. 1952, State University of Iowa; M.D. 1962, Columbia University

Farrington Daniels, Jr., Professor of Medicine and Public Health. B.A. 1940, University of Wisconsin; M.D. 1943, Harvard Medical School

Gretchen Darlington, Assistant Professor of Genetics. B.A. 1964, University of Colorado; M.A. 1966, Ph.D. 1970, University of Michigan

Zbigniew Darzynkiewicz, Assistant Professor of Biochemistry. M.D. 1960, Academy of Medicine, Warsaw (Poland); Ph.D. 1965, Academy of Medicine and Polish Academy of Sciences (Poland)

Noorbibi K. Day, Associate Professor of Biology. B.A. 1956, M.A. 1960, Trinity College (Ireland); Ph.D. 1967, McGill University (Canada)

Stacey B. Day, Professor of Biology. M.D. 1955, Royal College of Surgeons (Ireland); Ph.D. 1964, McGill University (Canada); D.Sc. 1971, University of Cincinnati

Eleanor E. Deschner, Assistant Professor of Biology. B.A. 1949, Notre Dame of Staten Island; M.S. 1951, Ph.D. 1954, Fordham University

Etienne P. de Harven, Professor of Biology. M.D. 1953, Universite Libre de Bruxelles (Belgium)

Maria A. B. de Sousa, Associate Professor of Biology. M.D. 1963, Lisbon Medical Faculty (Portugal); Ph.D. 1971, University of Glasgow; M.R.C. 1973, Royal College of Pathologists (England)

Robert W. Dickerman, Associate Professor of Microbiology. B.S. 1951, Cornell University; M.A. 1953, University of Arizona; Ph.D. 1961, University of Minnesota

Bozidar Djordjevic, Assistant Professor of Biophysics. M.S. 1952, University of Belgrade (Yugoslavia); Ph.D. 1960, Rutgers University

David B. Donner, Assistant Professor of Biochemistry. B.A. 1966, Queens College; Ph.D. 1972, Rensselaer Polytechnic Institute

Gerald B. Dooher, Assistant Professor of Biology. B.A. 1965, Rutgers University; M.A. 1967, Ph.D. 1971, Columbia University

John W. Dougherty, Clinical Associate Professor of Medicine. B.S. 1941, M.D. 1943, University of Minnesota

Dennis E. Drayer, Assistant Professor of Pharmacology. B.S. 1966, Brooklyn College; Ph.D. 1971, University of Delaware

Thomas E. Duffy, Associate Professor of Biochemistry in Neurology; Assistant Professor of Biochemistry

(Neurology). B.S. 1962, Loyola University; Ph.D. 1967, University of Maryland

Bo Dupont, Professor of Biology. M.D. 1966, University of Arhus (Denmark)

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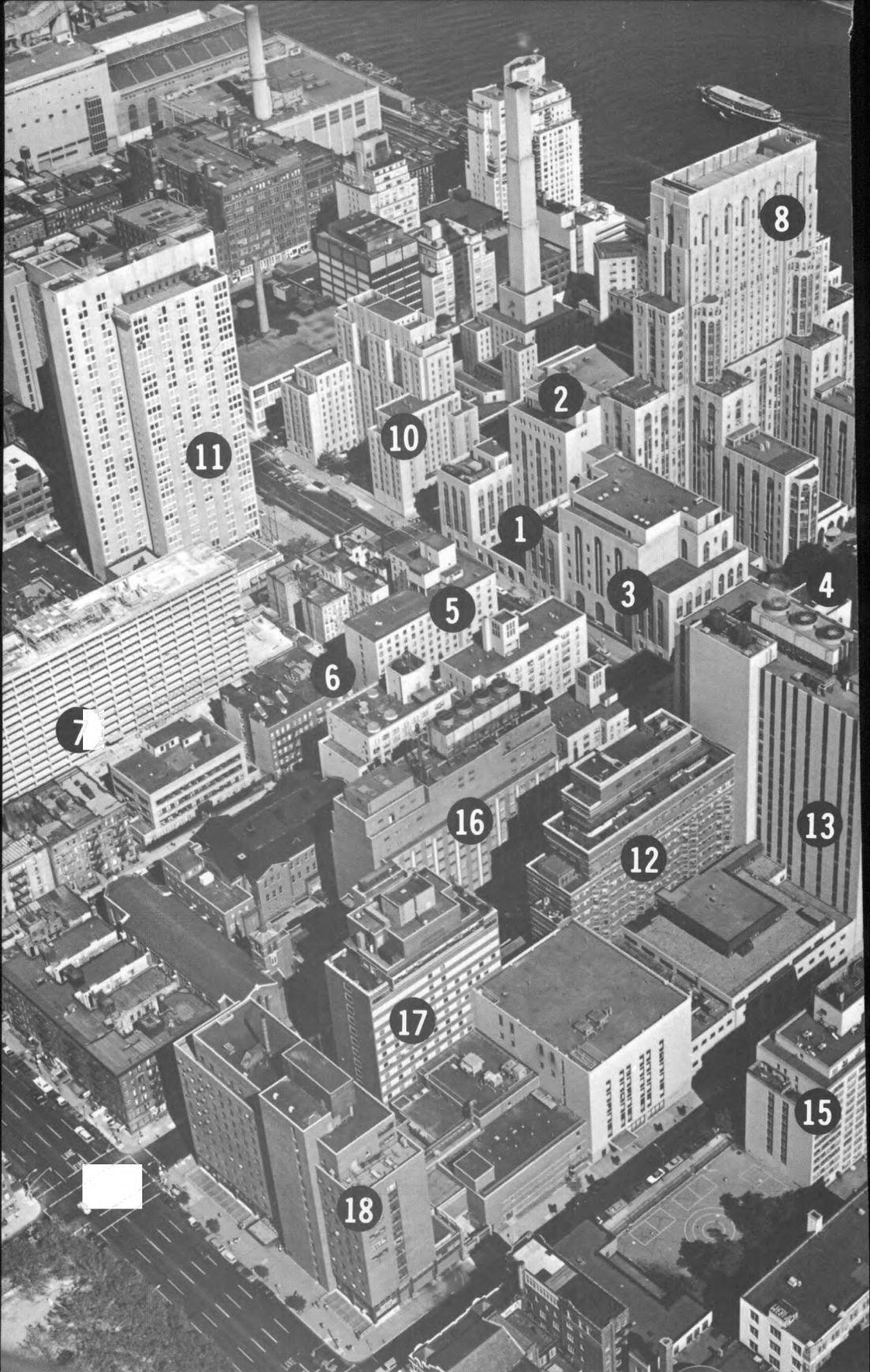
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Cornell University Medical College

1 Anatomy Building
2 William Hale Harkness Medical Research Building
3 Samuel J. Wood Library and Research Building
4 Biochemistry-Pharmacology Building
5 Olin Hall
6 Livingston Farrand Apartments
7 Lasdon House

The New York Hospital

8 The New York Hospital
9 Payne Whitney Psychiatry Clinic
10 Nurses' Residence
11 Payson House

Memorial Sloan-Kettering Cancer Center

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