



Cornell University

Announcements

Graduate School
Biological Sciences

1971-72

CORNELL UNIVERSITY ANNOUNCEMENTS

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The business office of the Graduate School and the Office of the Dean are in Sage Graduate Center. Office hours are 8:30 a.m. to 4:15 p.m., Monday through Friday. The office is closed on Saturday.

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Professors-at-Large are distinguished nonresident members of the University faculty. During short visits to the campus, of up to a month's duration, made at irregular intervals, they hold seminars, give public lectures, and consult informally with students and faculty.

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The courses and curricula described in this *Announcement*, the teaching personnel listed herein, and the dates shown in the Graduate School Calendar are subject to change at any time by official action of Cornell University.

Cornell University

Graduate Education at Cornell

Graduate education at Cornell is based on the principle that no objective of a university lies deeper in its tradition or springs higher in its aspiration than does the nurture of scholarship. The advancement of learning, the methods of learning, and the criticism of learning occupy the highest reaches of university life and work. Graduate education brings into fruitful contact the most distinguished scholars and the most advanced students, that learning may be shared and that wisdom may be at least glimpsed.

The Graduate School provides an environment within which scholarly capability is encouraged to emerge, thrive, and transmit itself. The School arranges a set of conditions congenial to the student who is prepared to profit from the availability of advanced courses of study; the opportunity for sustained reflection; the companionship of active, full-time fellow students; the most highly developed libraries, laboratories, and other facilities for research; the prospect of independent discovery or recovery, of evaluation or reevaluation; the daily presence of distinguished teachers; and the hope of attaining a firmly based structure of knowledge and a free and independent habit of judgment.

Freedom and independence are key qualities of scholarship, and graduate studies at Cornell are ordered so as to preserve them for both teacher and student. The Cornell principle is that scholars are begotten by other scholars, that judgments are formed by associating with the best judges, that learning lives in the unbroken succession of the learners and the learned, that genuine scholarship is always humane and rests ultimately on personal teaching and personal learning, that success in graduate studies must consist of satisfying the professor rather than a mute schedule of requirements. Graduate School standards are high, but they are maintained there not by the pronouncements of an office but rather by the men after whom such standards are themselves fashioned.

The Cornell graduate student selects not only the study he wishes to pursue, but also the scholar under whose tutelage he wishes to pursue it.

6 Admission

The candidate himself, no one else, makes the choice. Some candidates when they apply for admission have in mind the man or men with whom they wish to study. Those who do not are granted, under a temporary adviser, a semester in which to form an acquaintance and to come to a decision. The supervising professor is called the student's chairman. The chairman and his associate or associates, also chosen by the student, form the student's Special Committee. All such matters as the outlines of study, the observation of progress, the setting of general examinations, the conduct of the thesis, and other exercises leading to a graduate degree are determined within this small circle—the student and the professors he has selected to direct him. So successful is this arrangement and so strongly does Cornell believe in it, that the Special Committee enjoys extraordinary freedom and independence in conducting the student to his degree. The Graduate School sets no course requirement, no credit-hours requirement, no grade requirement. Within the broad agreements of the Graduate Faculty concerning residence, oral examinations, and thesis, the student will be recommended for his degree whenever his Special Committee judges him ready to receive it. When the Committee is satisfied, the requirements are.

The Cornell Graduate School has an enrollment of 3,500 students, and the Graduate Faculty consists of about 1,100 members. In contrast to many other graduate schools, approximately 98 percent of the students are full-time degree candidates, with the majority in programs leading to the Ph.D. degree.

The responsibility for administration of policies and procedures, including the general requirements, the establishment of Fields and subjects for study, admissions, and maintenance of records is placed in the hands of the dean and his staff under the guidance of the General Committee of the Graduate School. These matters are described in detail in *The Code of Legislation*, copies of which may be obtained by enrolled students from the Graduate School Office and which are also available for consultation in other academic and administrative offices of the University.

The University expects that all graduate students at Cornell University shall, at all times, act with a mature and morally responsible attitude, recognizing the basic rules of society and the common rights of others.

Admission

It is the policy of Cornell University actively to support the American ideal of equality of opportunity for all, and no student shall be denied admission or be otherwise discriminated against because of race, color, creed, religion, or national origin.

Since instruction in the Graduate School is primarily individual, those interested in becoming students are encouraged to communicate with individual members of the faculty with whom they may want to study. Personal

interviews in advance of formal application for admission are especially encouraged. For the benefit of those who are not acquainted with appropriate members in the Field or Fields of their interest, each Field has selected a representative, as director of graduate studies, to whom inquiries may be addressed.

An applicant for admission to the Graduate School must (1) hold a baccalaureate degree granted by a faculty or university of recognized standing or have completed studies equivalent to those required for a baccalaureate degree at Cornell, (2) have adequate preparation for graduate study in his chosen field of instruction, (3) have fluent command of the English language, and (4) present evidence of promise in advanced study and research. Students from United States colleges and universities should be in the top third of their graduating class.

Applications for admission should be requested from the Graduate School, Sage Graduate Center, Cornell University, Ithaca, New York 14850. Two letters of recommendation should be sent from the applicant's major instructors. Official transcripts from all the institutions of higher learning attended and, where required, the Graduate Record Examinations or the Miller Analogies Test scores complete the application.

All applications from residents or citizens of the United States or Canada must be accompanied by a \$15 nonrefundable fee. Applicants from other countries who are accepted for admission must pay this fee before registration.

Fellowship and admission applicants are urged to take the Graduate Record Examinations (GRE) Aptitude (Verbal and Quantitative) Tests of the Educational Testing Service no later than December, and to have the scores sent to the Cornell Graduate School as part of their application materials. Information about the times and places of test administrations may be obtained directly from the Educational Testing Service, Princeton, New Jersey 08540. The Field listings, pp. 50 ff., should be consulted for Fields requiring the scores of both the Aptitude Test and the pertinent Advanced Test.

Foreign applicants whose native language is not English and who have received their secondary or advanced education in the English language should submit to the Graduate School a statement to this effect signed by a responsible officer of a United States Embassy or Consulate or by an appropriate official of the educational institution involved. If English has not been the medium of instruction, applicants must take the Test of English as a Foreign Language by arrangement with Educational Testing Service, Princeton, New Jersey 08540. This testing program is available throughout the world. The test is given four times a year; information on times and places may be obtained directly from the address given above. The test score must be reported directly by the testing organization to the Graduate School; since this test is diagnostic, no final action on applications will be taken until the scores have been received. Admission to those applicants whose scores indicate unsatisfactory command of English may be denied, or it may be made contingent upon evidence of improvement.

8 Degree Requirements

Many Fields will not accept new students for the spring term; applicants should check with the Field Representative about the Field's policy on spring admissions.

Categories of Admission

DEGREE PROGRAMS. It is expected that most applicants for admission intend to pursue a program for an advanced degree. Applicants may specify candidacy for the Master of Arts or Master of Science or one of the professional Master's degrees listed on pp. 24–28. However, since Cornell has a strong commitment to doctoral work, most students are encouraged to enroll in a doctoral program. In some Fields, students registered in a doctoral program may be required to seek a Master's degree as an initial step in the program.

Only under unusual circumstances will anyone who already holds an advanced degree be permitted to apply for the same degree.

PROVISIONAL CANDIDACY. Under circumstances in which it is difficult to evaluate the academic background of qualified applicants, they may be admitted to *provisional* candidacy. Ordinarily only one semester of study in provisional candidacy is permitted, and the student who fails to qualify for candidacy at the end of that time may be requested to withdraw from the University.

NONCANDIDACY. When staff and facilities are available, the Graduate School will admit some applicants who do not intend to work toward an advanced degree at Cornell but who have special objectives for formal study or scholarly work at the graduate level, provided they satisfy all the entrance requirements expected of degree candidates. Registration in noncandidacy is restricted to two semesters.

CHANGE OF STATUS. A student who wishes to change his status from non-degree candidacy to regular candidacy or from one degree or Field to another, or who, after receiving the Master's degree, wishes to undertake candidacy for the doctorate, must submit to the Dean of the Graduate School a written request giving reasons for the proposed change. Provisional candidacy is automatically reviewed at the end of each semester; therefore, no letter is necessary.

Degree Requirements

THE SPECIAL COMMITTEE. The general degree requirements of the Graduate School are kept at a minimum in order to give the student maximum flexibility in choosing a desirable program of studies. Since progress in graduate study depends so much on the individual student's situation, there are no course or grade requirements imposed by the Graduate School. The

student's program is developed with the aid and direction of a Special Committee chosen by the student and is designed to fit his specific needs and desires. Satisfactory progress toward the degree is judged solely by the Special Committee rather than by any arbitrary standards imposed by the Graduate School.

The Special Committee under which a Master of Arts or a Master of Science candidate carries on his work is composed of a chairman who represents the major subject, and one representative of an appropriate minor subject. The Special Committee of a doctoral student is composed of a chairman, representing the major subject, and two other members representing other areas of interest. The chairman of the Special Committee directs the student's thesis research. Some Fields require two minor subjects for doctoral programs while others require only one, but all Ph.D. Special Committees have three members.

The Field and the major subject, as well as the chairman of the Special Committee, are selected by the incoming student. It is his privilege to ask any member of the Graduate School Faculty in the Field of his major subject to serve as his chairman. The chairman in turn advises the student about minor subjects and faculty members who might represent them on his Special Committee. The choice of major and minor subjects and the formation of the Special Committee must be recorded in the Graduate School Office within two weeks of the beginning of residency. Since the student may be uncertain of his aspirations at that time, he is encouraged to change the membership of his Special Committee as his aims become more definite.

In some of the larger graduate Fields the difficulty in making a wise selection of a Committee is so great that the Field Representative or other faculty member may serve temporarily as the chairman while the student seeks a permanent chairman and Committee.

The members of the Special Committee direct the student's program and decide whether he is making satisfactory progress toward the degree. They conduct and report on oral examinations, and they approve the thesis. The Committee and the student constitute an independent working unit. All members of the Graduate School Faculty, however, are free to participate in the scheduled examinations and review the theses of candidates for degrees.

The organization of the Graduate School at Cornell is based on a concept of fields of study independent of colleges and departments. It is thus possible for a graduate student to take courses in any division of the University and to choose major and minor subjects without regard to organizational lines.

RESIDENCE. The Graduate faculty regards study in residence as essential. Although a person working off campus may attain proficiency in a technique or even in a field of knowledge, he may fail in other ways to attain the breadth of knowledge necessary for scholarly work. In addition to contact with the libraries and physical facilities of the University, he needs the daily acquaintance, company, aid, and stimulus of others engaged in similar pursuits. He should form the habit of attending lectures, seminars, and meetings of groups in whose activities he takes interest.

10 Degree Requirements

Full-time study for one semester with satisfactory accomplishment constitutes one residence unit. The Graduate School Faculty requires that each candidate for a Master's degree earn two units of residence, and for the Ph.D. degree, six units of residence. However, a longer time is generally required to obtain the degree.

A student must complete all the requirements for the Master's degree in four years and for a doctoral degree in seven years from date of first registration in the Graduate School.

A student in a doctoral program may earn no more than two units, and a student in a Master's program no more than one, for work done in Summer Research, Summer Session, and the Division of Extramural Courses. At least four of the six units required for the Ph.D. degree must be earned as a full-time student, earning three-quarters of a residence unit or more each term, and two of the last four units must be earned in successive terms of full-time study on the Cornell campus.

Transfer of Residence. Candidates for the Master's degree may not count study in other graduate schools as part of their residence. Candidates for the doctorate may be permitted to count study for the Master's degree as equivalent to two residence units if it is relevant to their doctoral program; those who have received training of an exceptional quality and amount may petition for more. No commitment regarding this may be made until after the student has entered into residence and his Special Committee has had opportunity to judge his accomplishments. The residence transferred must not exceed that which would have been earned under similar circumstances at Cornell. Credits for study as an undergraduate or as a special student, even in courses designed primarily or wholly for graduate students, will not be allowed.

Summer Session. To receive residence credit for the Summer Session, the candidate must register in both the Summer Session and the Graduate School and must file a statement of courses satisfactory to his Special Committee. A student may, with his Special Committee's prior approval, earn one-half of a residence unit by completing eight hours or more of credit in the eight-week session, or two-fifths of a unit for six hours or more in the six-week session, but no more than two units in a twelve-month period.

Requirements for Master's degrees may, upon advanced approval of the General Committee, be completed solely during the summer period if instruction in the chosen major and minor subjects is offered. Residence may be transferred for study during one Summer Session preceding matriculation in the Graduate School if this study is an integral part of the graduate program subsequently undertaken, and if the transfer is recommended by the student's Special Committee and approved by the dean of the Graduate School.

Summer Research. To encourage students to continue their studies during the summer period, no tuition or fees are charged for Summer Research if the student has been registered during the previous academic year. Substantial funds are also available for Summer Research assistantship support.

The student has access to the regular services of the University Clinic and Infirmary during the summer with charge if he has been registered as a full-time student during the previous academic term and is registered for Summer Research on a non credit basis. Under certain conditions, students may also accumulate residence credit in Summer Research.

Part-Time Studies. Essentially, all graduate students at Cornell are full-time students. If employment is necessary, students may hold positions requiring up to ten hours of work per week without reduction of residence credit. Teaching fellows and research assistants whose duties require up to twenty hours a week can obtain full residence credit.

Part-time employees are eligible for residence units as follows.

Employment	Residence Units Allowable per Semester		
	<i>Contributory in the major field of study and on campus</i>	<i>Noncontributory but on campus</i>	<i>Off campus</i>
<i>Total clock hours per week</i>			
0-10 hours	1 unit	1 unit	1 unit
11-20 hours	1 unit	$\frac{3}{4}$ unit	$\frac{3}{4}$ unit
21-30 hours	$\frac{3}{4}$ unit	$\frac{1}{2}$ unit	(See below)

Those employed for more than twenty clock hours per week off campus, or more than thirty clock hours per week under any circumstances, may earn a maximum of two-fifths of a residence unit per semester through registration in the Division of Extramural Courses, but this will be permitted only on the basis of petition approved prior to the time that the work is undertaken.

Students enrolled in the Division of Extramural Courses are not legally graduate students.

To accumulate residence units for course work completed through the Division of Extramural Courses, fifteen credit hours are the equivalent of one residence unit, and six credit hours the equivalent of two-fifths of a unit—the smallest fraction that will be recorded by the Graduate School toward fulfillment of residence requirements. Detailed information concerning extramural courses and registration procedures may be obtained from the Division of Extramural Courses, B-20 Ives Hall.

EXAMINATIONS. The Special Committee conducts the examinations required for the degree. At the discretion of the Special Committee these examinations may be entirely oral or both oral and written.

For the Master's degree a final examination is required, which under certain conditions may be combined with the admission to (Ph.D.) candidacy examination.

For the doctoral degree: (1) A comprehensive admission to candidacy examination for formal admission to doctoral candidacy is required. This examination may not be taken until two units of residence credit have been

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accumulated; it must be attempted before the beginning of the student's seventh unit of residence. Two units of residence must be credited after this examination; (2) A final examination, given after completion of the doctoral dissertation and covering subject matter related to the dissertation topic, is also required.

In some Fields a qualifying examination is given at an early date to determine the student's fitness for advanced study and to help the Special Committee plan his program.

In Fields that so desire, the Special Committee may, after the admission to candidacy examination has been taken, nominate the student for a Master's degree without the requirement of a thesis whether or not admission to candidacy for the Ph.D. has been approved. The degree would be awarded after the completion of four units of residence.

FOREIGN LANGUAGE REQUIREMENTS. Each Field has its own foreign language requirements which it considers most useful to the particular area of study. Any Special Committee may, at its discretion, require knowledge of foreign languages beyond the announced requirements.

Candidates required by the Field or their Special Committee to demonstrate reading ability in a foreign language should find out from their Special Committee chairman how the requirement is to be satisfied. The method required is up to the Field or the Special Committee but typically could be a Field-administered examination, a passing grade in a specified language course, a passing score on either the Educational Testing Service Graduate School Foreign Language Tests or the College Entrance Examination Board language tests, or in case of the more unusual languages, an examination given by a faculty member of the Division of Modern Languages.

A student may petition the dean to transfer a language examination taken elsewhere to his record at Cornell.

Courses designed to aid graduate students in learning how to read French, German, Russian, and Spanish are given by the Division of Modern Languages in cooperation with the Graduate School Faculty.

THESIS. Candidates for the degree of Master of Arts or Master of Science are required to submit a thesis in fulfillment of the requirements for the degree (except as stated on p. 12). Some Fields also require a thesis for professional Master's degrees. Candidates for the doctoral degree must complete a thesis which constitutes an imaginative contribution to knowledge. The faculty requires publication of Ph.D. theses by abstract or microfilm.

Financial Support

Extensive financial resources are available to Cornell graduate students to help them defray the cost of their education. Currently, approximately 3,100 of the 3,500 graduate students receive financial aid in the form of fellowships, teaching assistantships, and research assistantships. But the amount of support available from outside the University is contracting sharply, so that the number of students with fellowships or assistantships is expected to decrease.

In most cases the stipends awarded to graduate students are not high enough to cover living expenses completely. A great deal depends on the level of subsistence to which the individual has become accustomed and the sacrifices that he is willing to make for his education. Experience has shown that married students with dependent children have particular financial difficulties. The minimum subsistence income which such students need is about \$4,000 plus tuition and the General Fee per academic year. Since stipends are frequently lower than this figure, it may be necessary for the student to find other sources of supplementary income, such as loans, in order to complete his studies.

Since the demands of graduate study are so great, students are discouraged from trying to support themselves by unrelated employment.

No special forms are available for financial aid. The applicant should check the type or types of appointment for which he wishes to be considered on the application for admission form.

TEACHING FELLOWSHIPS. The duties of a teaching fellow normally involve classroom and laboratory instruction of undergraduates and, as such, play a major role in the educational process and the academic atmosphere of the University. Since a large majority of Cornell's graduate students eventually seeks a career in teaching, the experience gained from these appointments is an invaluable part of the student's development. In most Fields students are encouraged to spend some time in teaching, and in some Fields the faculty believe the experience so important that they require it of all students in doctoral programs. An appointment as a teaching fellow is usually in the student's major Field or in one that is closely related. The duties require from ten to twenty total clock hours of the student's time a week, depending on the Field. A teaching fellow whose duties are in his major Field of interest and do not exceed twenty hours is eligible for full residence credit. Salary for a fifteen-hour week will be \$2,700 with a slightly higher amount for longer hours, supplemented by a fellowship which covers tuition and the General Fee. Because of possible problems in communication with undergraduates, applicants from non-English-speaking countries are not normally appointed as teaching fellows in their first year at Cornell. Teaching appointments are made by department chairmen. Applications for these positions should be made to the Field Representative of the Field offering the major subject of interest to the student.

RESEARCH ASSISTANTSHIPS. The duties of a research assistant involve work on a research project. The work performed is frequently applicable to

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the student's thesis research and is under the direction of the chairman of his Special Committee. The student is required to spend twenty hours a week, but if the research is in the Field of his major interest he can earn full-time residence credit. In many Fields of study such appointments are normally made after completion of at least one year of graduate study.

FELLOWSHIPS. A fellowship ordinarily is awarded in open competition to a full-time student who is a candidate for a higher degree (usually a Ph.D.), primarily on the basis of scholastic ability and promise of achievement as a graduate student. The award is made as a tax-exempt gift, and it usually not only covers tuition and the General Fee but also may provide a substantial stipend for living expenses during tenure. Because of the competition for a decreasing amount of funds, the inclusion of financial need criteria is currently under consideration. A student who holds a fellowship is free to select his own research project, subject to the approval of his Special Committee, and his primary responsibility is to pursue his studies for his degree. The award of the fellowship does not obligate the holder to render services to the University, except that in certain fields some teaching is required of all graduate students for the sake of experience and training, nor is the holder of a fellowship committed in any way with respect to future employment. The holder of a fellowship may accept no other appointment or employment without permission of the Cornell Graduate Fellowship Board; however, teaching responsibilities will usually be approved as a routine matter if they contribute to the student's graduate program and do not exceed ten clock hours of work per week.

More than 450 fellowships are under the direct supervision of the Fellowship Board or of academic units of Cornell. The range of stipend (in addition to tuition and the General Fee and, in some cases, dependency allowances) for different categories of fellowships available to first-year students is indicated below.

Cornell Andrew D. White Fellowships—\$2,500–\$3,000

Cornell Graduate Fellowships—\$2,000

Cornell Fellowships from Special Endowments—\$1,000–\$2,000

Industrial Fellowships—\$1,500–\$2,500

Many other fellowships are offered to students majoring in certain Fields of study, and some of these are noted in the descriptions of the Fields.

Many private and federally supported fellowships are also administered by the Graduate School. National Science Foundation Traineeships, as well as National Defense Education Act (NDEA) Title IV Fellowships, are available to United States citizens. The application deadline for these is February 1 for the following academic year; candidates for these fellowships are nominated by the Field, having been chosen from among those students applying. NDEA Title IV Fellowships offer three years of support to doctoral students who intend to enter a teaching career. (Since completion of a Ph.D. program at Cornell normally requires four years, and because the program is aimed at prospective teachers, NDEA Fellows are normally expected to gain teaching experience and have support during one of the years as teaching fellows.)

The purpose of the NDEA Title VI (NDFL) Fellowship program is to encourage individuals taking advanced training in languages and in associated area studies designated as being of critical importance to the United States. (For area studies, see pp. 31-40.) Applicants who are interested in NDFL Fellowship support must so indicate when requesting their application materials for admission. National Institutes of Health Traineeships are available and are offered by Fields which have been awarded such grants.

A space is provided on the admission application form in which the student may indicate the type of support for which he wishes to be considered. There is no special fellowship application form.

Prospective graduate students should also consider applying for fellowships awarded on a national basis by the National Science Foundation, the Atomic Energy Commission, the Woodrow Wilson National Fellowship Foundation, and the Ford Foundation. These programs have deadlines for applications, some as early as December 1. Applicants should check on the date pertinent to the fellowship. In some cases it is possible for winners of NSF and AEC awards to hold half-time appointments as teaching fellows for an additional stipend.

New York State provides several forms of financial support. The Herbert H. Lehman Fellowship program is open to applicants from all states whose interests are in social sciences or public or international affairs. These Fellowships are awarded on a competitive basis and may be used only in New York State institutions; they provide each recipient with \$4,000 for the first year of graduate study and \$5,000 for each subsequent year. New York State residents are eligible for Regents College Teaching Fellowships or Regents Fellowships for Doctoral Study in Arts, Science, and Engineering. Applications for these must be made by December 1 on forms obtained from the Regents Examination and Scholarship Center, New York State Education Department, Albany, New York 12224.

As agreed upon by some of the members of the Council of Graduate Schools in the United States, the regular time for notification of award from Cornell of fellowships and scholarships for the succeeding academic year is April 1. *All fellowship and scholarship applications received by February 1 will be considered for April awards*, and every effort will be made to notify each applicant approved for award no later than April 6 as to whether he has a fellowship or is named as an alternate. It is hoped that the awardees will notify the Graduate School no later than April 15 of their acceptance or rejection of the award; failure to do so will be considered a declination. Applications received after February 1 will be considered only if vacancies occur.

MINORITY GROUP FELLOWSHIPS. Recently the Fellowship Board has awarded a number of fellowships to applicants from minority groups who were not awarded support through the regular channels (regular fellowships, traineeships, teaching and research assistantships, etc.). The student does not apply for these fellowships directly, but is nominated by the Field to which he was admitted if the Field finds that the student cannot be offered support from the other sources mentioned above.

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RESIDENCE HALL ASSISTANTSHIPS are available for single or married men and women graduate students in any academic field. These positions are most appropriate for students who desire experience in working with undergraduate students and University staff while contributing financially to their own study.

There are approximately twenty-five resident positions available. Remuneration includes payment of one-half tuition and full fees plus a board supplement and stipend which varies according to responsibilities. Details about the assistantships and application forms may be obtained from the Office of the Dean of Students, 133 Day Hall. A personal interview is required of all applicants. Applications must be completed by February 1, 1971.

PRIZES. Several University prizes are open for competition to all students, including graduate students. The Committee on Prizes of the University faculty publishes an *Announcement of Prize Competitions*, which may be obtained from the Visitor Information Center, Day Hall.

Two prizes are open exclusively to graduate students:

The Guilford Essay Prize. Until at least 1971 a special prize of \$120 will be assigned annually to that graduate student who, in the judgment of the Graduate Faculty, writes the best English prose. Each competitor must submit, at or before 4:30 p.m. of the last Monday in November, specimens of his English prose, preferably prepared as a normal part of his training in candidacy for an advanced degree.

The Philosophy Prize. A prize of \$50 is awarded to the graduate student who submits the best paper embodying the results of research in the Field of Philosophy. The subject of the paper may be historical or critical or constructive. It may be concerned either with problems of pure philosophy or with the philosophical bearing of the concepts and methods of the sciences. Papers must be submitted on or before the first day of May.

Papers submitted in competition for either prize must be typewritten on bond paper (a clean *ribbon* copy), double-spaced, at least 1,500 and not more than 5,000 words in length, and signed with an assumed name, the real name and address of the competitor being enclosed in a sealed envelope, superscribed with the assumed name. They are to be deposited in the Office of the Graduate School. A student may not submit more than one paper.

LOANS. Applications for National Defense and University loans are available at the Office of Scholarships and Financial Aid, 105 Day Hall.

Increasingly the University is referring both undergraduate and graduate students to their state loan program sponsored under a federal program. Applications for this program can generally be obtained from the student's home bank.

Only graduate students duly registered in a degree-granting program are eligible for loans. Provisional or noncandidate students are not eligible.

The application date for National Defense and University loans is the mid-April prior to the student's September matriculation.

PART-TIME EMPLOYMENT. Opportunities for part-time work are often available in connection with departmental research projects or other activities. Applications for this type of work should be made directly to the department concerned. A candidate may find employment in research or other work closely allied to his academic interest valuable. On the other hand, progress in candidacy is difficult when a student attempts to support himself wholly or partially by work unrelated to his studies. It usually is sounder economy to borrow from the Office of Scholarships and Financial Aid and keep employment to a minimum. However, the University maintains a part-time employment service in that office.

EMPLOYMENT FOR WIVES OF STUDENTS. Cornell University offers many nonacademic positions for working wives through the Personnel Department, B-12 Ives Hall. Types of work include secretarial and clerical work, work for technicians in the various laboratories, library work, limited nursing positions, and some administrative positions. Applications may be made through the Personnel Department upon arrival on campus. Applications for academic positions should apply to the specific departments in which they are interested.

In addition to the University positions, the Ithaca area offers opportunities for similar positions in small industrial plants, at Ithaca College, the local hospital, and various businesses, as well as for teaching positions in the public school system and some professional positions in service agencies. Applicants should go to the New York State Employment Office for further information regarding these opportunities.

General Information

COURSES AND GRADES. The Graduate School is not a course-offering agency. Therefore, students wishing information about courses or grades should inquire at the Office of the Registrar. However, the Graduate Faculty has ruled that a course may not be dropped or changed from credit to audit after the tenth week of classes.

ACTIVITIES FOR GRADUATE STUDENTS. Cornell students enjoy the advantages of a small academic community while having access to many cultural events that rival those of any large city. Lectures, movies, dramatic productions, special art exhibitions, and concerts fill the University's weekly calendar. The Bailey Hall Concert Series brings internationally famous artists and orchestras to Ithaca.

Many graduate students participate with undergraduates in extracurricular activities such as intramural sports, Glee Club, Sage Chapel Choir, publications, music, and folk dancing. A Graduate Student Activities Committee is active in scheduling weekly social events. A Graduate Wives' Club has had a long tradition of activity for the wives of graduate students. Willard Straight Hall and the Sage Graduate Center provide facilities for graduate groups and aid in planning special functions for them.

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Cornell United Religious Work (CURW) includes a range of activities for graduate students. Its offices are in Anabel Taylor Hall, which serves as headquarters for chaplains who represent several denominations and who may be consulted by students.

Cornell's location in the Finger Lakes Region of New York State encourages outdoor activity. Many swimming and boating facilities are available. In addition, Cornell operates a private eighteen-hole golf course; indoor and outdoor swimming facilities; an indoor skating rink; tennis, handball, and squash courts; a gymnasium; and riding stables. Several ski resorts also operate nearby.

Many Fields sponsor weekly seminars for their faculty and graduate students.

COUNSELING. The University maintains a variety of counseling services available to graduate students. A student's primary academic counselors are the members of his Special Committee. Other counselors who are able to help in matters of various kinds will be found in the Office of the Dean of Students, the Office of Scholarships and Financial Aid, the International Student Office, the Gannett Medical Clinic, and the Sage Graduate Center.

INTERNATIONAL STUDENTS. Cornell has, since its founding, welcomed students from abroad. Currently about 1,100 foreign students representing ninety countries are pursuing study in a variety of fields.

In addition, each year more than one hundred faculty members spend some time abroad in study and research, often in close association with foreign universities. This creates within the University community opportunities for students from other countries to meet and exchange ideas with members of the Cornell faculty who have firsthand knowledge of several countries and understand and appreciate a variety of cultures.

Special programs within the Graduate School permit study in depth of particular areas such as Africa, Asia, Southeast Asia, Latin America, and the Near East (see p. 31 ff.) Students from these areas have an opportunity to contribute to such programs.

A group of Cornell faculty and Ithaca families maintain a Host Family Program, in which foreign students are invited to share in some aspects of American family life in the Ithaca community. Because the University population is a varied one, the community itself, although not large, tends to have a more cosmopolitan atmosphere than most other small cities, and the student can usually find an outlet for a wide variety of interests. Tours of the community are conducted at the beginning of the fall semester.

The University maintains an International Student Office at 142 Day Hall. Students from abroad are asked to report to this Office upon arriving in Ithaca and are invited to consult the staff on any questions they may have. The Office works in close association with academic advisers and sponsors, and also with persons involved in a number of student and community programs in efforts to enrich the international and cultural life of Cornell.

HEALTH REQUIREMENTS ON ENTRANCE. The following health requirements for entering graduate students have been adopted by the Board of Trustees of Cornell University. The responsibility for fulfilling these require-

ments rests upon the student; failure to do so may result in loss of the privilege of registering the following term.

Immunization. A satisfactory certificate of immunization against smallpox, on the form supplied by the University, must be submitted before registration. It will be accepted as satisfactory only if it certifies that within the last three years a successful vaccination has been performed. If this requirement cannot be fulfilled by the student's home physician, opportunity for immunization will be offered by the Cornell medical staff during the student's first semester, with the cost to be borne by the student. If a student has been absent from the University for more than three years, immunity will be considered to have lapsed and a certificate of revaccination must be submitted.

The University Health Services strongly recommend that all graduate students be immunized against tetanus before entering the University. Students may, however, obtain initial and all booster tetanus toxoid immunizations at the Gannett Clinic for a nominal charge.

Health History. Graduate students, when accepted, must submit *health histories* on forms supplied by the University. These should be returned promptly to the Gannett Medical Clinic. A University physician will review the material before it becomes part of the student's permanent health record. All information given is confidential. After arrival at Cornell, if the medical history indicates a need, a student will be given an appointment to consult a physician at the Clinic. When a student has been away from the University for more than a year, he must, upon reentrance, submit an interim health history on a University form.

X Ray. Every student is required to have a chest x ray. Opportunity to satisfy this requirement is given during the student's first week on campus. The cost of the x-ray examination is included in the General Fee. When a student who has been away from the University for more than a year wishes to re-enter, he must, at his own expense, once more fulfill the chest x-ray requirement.

HEALTH SERVICES AND MEDICAL CARE. Health services and medical care for students are centered in two Cornell facilities: the Gannett Medical Clinic (outpatient department) and the Sage Infirmary.

Students are entitled to unlimited visits at the Clinic. Appointments with individual doctors at the Clinic may be made by calling or going there in person. (An acutely ill student will be seen promptly whether he has an appointment or not.) Students are also entitled to laboratory and x-ray examinations indicated for diagnosis and treatment, hospitalization in the Sage Infirmary with medical care for a maximum of fourteen days each term, and emergency surgical care.

On a voluntary basis, insurance is available to supplement the services provided by the General Fee. For further details see the *Announcement of General Information*. If, in the opinion of the University authorities, the student's health makes it unwise for him to remain in the University, he may be required to withdraw.

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If a student prefers to consult a private physician rather than go to the Clinic, or to have the services of a private doctor while a patient in Sage Infirmary, he must bear the cost of these services.

LIVING ARRANGEMENTS. For information about and applications for the University housing described below, write to the Department of Housing and Dining Services, 223 Day Hall.

Dormitory Accommodations. The University has established Sage Graduate Center as a graduate residential center. Its dormitory facilities accommodate approximately 75 men in the north side of the building and 115 women in the south side. The Graduate Center, which is available for use by graduate students and faculty, also contains a cafeteria seating 200, study rooms, and lounges. In addition, Cascadilla Hall has accommodations for approximately 160 men and women.

Family Accommodations. The University has three apartment developments for married students and their families. They are Cornell Quarters, Pleasant Grove Apartments, and Hasbrouck Apartments, with housing for a total of 420 families. All apartments are unfurnished.

Off-Campus Housing. The Department of Housing and Dining also maintains files of voluntarily listed accommodations for use of students and staff members who call at the office. Because the list of available accommodations is constantly changing, it is not practical to mail listings, nor is it feasible to maintain a waiting list of persons seeking accommodations.

MOTOR VEHICLES. The University does not encourage student use of motor vehicles but recognizes that in certain cases there may be important reasons why a student needs a motor vehicle. University regulations apply to all types of motor vehicles, including automobiles, motorcycles, motor bikes, and motor scooters.

Every Cornell University student who owns, maintains, or for his or her own benefit operates a motor vehicle in Tompkins County while the University is in session must register that vehicle with the Board on Traffic Control, unless such vehicle is currently registered with the Board on Traffic Control.

All students required to register motor vehicles must do so within the time designated for academic registration at the beginning of the fall term or the beginning of the Summer Session. Students who enter the University at the beginning of the spring term must register upon entering. Students who re-enter the University after a period of absence must register upon reentering. Students who do not own, maintain, or operate motor vehicles which must be registered at one of these times but who later acquire a vehicle or otherwise become subject to registration requirements must complete their vehicle registration within five days after becoming so subject.

The following requirements must be met for vehicle registration:

- (1) The applicant must be legally qualified to operate a motor vehicle in New York State.

(2) The vehicle must be registered in New York State or in some other state or jurisdiction that qualifies it for legal operation in the state of New York.

(3) The owner of the vehicle must be covered by effective public liability insurance in the minimum amounts of \$10,000-\$20,000 for personal injury and \$5,000 for property damage. Such insurance must cover any liability incurred while the vehicle is driven either by the registrant or by someone with the registrant's explicit or implicit permission. If at any time such insurance lapses or ceases to be fully effective, the registration of the vehicle shall be automatically cancelled.

(4) There must be no unpaid University-imposed parking fines outstanding against the applicant or the vehicle to be registered.

No vehicle may be parked on the grounds of the University without valid registration and without displaying an appropriate registration and parking permit, as explained in *Regulations Governing Motor Vehicles*, unless the vehicle is not subject to such registration and is parked at a parking meter, parked in a parking area designated for visitors, or has the prior approval of the Board on Traffic Control or its authorized representative.

The student vehicle registration sticker is not a parking permit. Except for those holding parking permits, no student shall park his motor vehicle on the grounds of the University during the hours from 8:00 a.m. to 5:00 p.m. Monday through Friday or from 8:00 a.m. to 1:00 p.m. on Saturdays (except in posted unrestricted time zones and/or unrestricted metered parking spaces).

The student's registration in the University is held to constitute an agreement on his part that he will abide by all its rules and regulations with regard to traffic and parking or suffer the penalty prescribed for any violation of them.

For more detailed information regarding motor vehicle regulations, see the brochure *Regulations Governing Motor Vehicles*, available from the Division of Safety and Security in Barton Hall. Correspondence regarding motor vehicles should be addressed to the Board on Traffic Control, G-2 Barton Hall.

CAREER, SUMMER PLANS, AND PLACEMENT CENTER. The Career, Summer Plans, and Placement Center at 14 East Avenue is a clearing house for jobs in business, industry, government, and teaching, as well as for study programs leading to the professions. It serves as an information center for careers, teacher placement, fellowships, techniques of job hunting, and summer experiences (work, study, travel, service projects). More than a thousand recruiters visit the campus each year representing employers and graduate schools. Students and faculty may keep up to date on the activities of the Center by registering to receive its *Newsletter*. Alumni may be served by either the *Job Bulletin* or the *Registrants Available Bulletin*. Through the support and cooperation of the Cornell Club of New York and the Cornell Society of Engineers, a placement office is maintained in New York City primarily for alumni living in that area.

Tuition and Fees

Tuition and fees* become due when the student registers. Any student who fails to pay his tuition, fees, and other indebtedness to the University at the Treasurer's Office within the prescribed period of grace will be dropped from the University unless the treasurer has granted him an extension of time to complete payment. The treasurer is permitted to grant such an extension when, in his judgment, the circumstances of a particular case warrant his doing so. For any such extension the student is charged a fee of \$5. A reinstatement fee of \$10 is assessed against any student who is permitted to continue or return to classes after being dropped from the University for default in payments. The assessment may be waived in any instance for reasons satisfactory to the treasurer and the registrar when such reasons are set forth in a written statement.

Students registering at any time during the last ten weeks of any term are required to pay tuition at the rate of 10 percent of the regular tuition of the term for each week or fraction of a week between the day of registration and the last examination day of the term.

Tuition or fees may be changed by the trustees at any time without previous notice.

REGISTRATION DEPOSIT. Every applicant for admission must make a deposit of \$35 after receiving notice of acceptance, unless he has previously matriculated as a student at Cornell University. This deposit is used at the time of first registration to pay the matriculation fee, chest x ray, and examination-book charge, and covers certain expenses incidental to graduation if the student receives a degree. The deposit will not be refunded to any candidate who withdraws his application after May 10 or more than fifteen days after his admission approval. This fee is *not* covered by University fellowships, scholarships, or assistantships.

TUITION. Tuition is \$200 a term for all students registered in the Graduate School (1) whose major chairman is on the faculty of the statutory division† of the University or (2) who are enrolled in a Master of Arts in Teaching program. Those with major work in the School of Nutrition, the Field of Education, and the Division of Biological Sciences also pay \$200 a term. All students in other divisions must pay tuition of \$1,010 a term. Tuition is payable at the beginning of each term.

Upon recommendation by the appropriate college dean and by action of the controller, a student who is a teaching or research assistant in one of the statutory schools or colleges may obtain waiver of tuition in the Graduate School if his major field of study is in a statutory school or college.

Assistants in statutory schools or colleges who are on twelve-month appointments and who are registered for Summer Research for credit in the

* All statements in this section are prepared by the University treasurer, who alone is authorized to interpret them.

† The statutory divisions are the Veterinary College, the Colleges of Agriculture and Human Ecology, and the School of Industrial and Labor Relations.

Graduate School may be recommended for waiver of tuition during the summer period under the above limitations. This waiver of tuition does not apply if the student registers in the Summer Session or is not doing productive work for the department.

Any student who is to receive less than full residence credit because of his employment should apply for proration of tuition on forms procurable at the Graduate School Office. *Tuition is based on residence eligibility.* See p. 11.

GENERAL FEE. A fee of \$312.50, payable at the beginning of each term, is required of each student registered in the Graduate School whose major chairman is on the faculty of one of the statutory divisions, the School of Nutrition, the Field of Education, or the Division of Biological Sciences. All others pay a fee of \$290. This General Fee contributes toward the services supplied by the libraries, Clinic and Infirmary, and the student union in Willard Straight Hall, and pays a portion of the extra cost of laboratory courses and general administration.

A student who is regularly registered in the Graduate School for either one or both terms of the academic year and has paid the above fee is entitled to these services while in residence during the summer immediately following the academic year without payment of an additional General Fee. If such a student registers with the University during the summer, he is liable for payment of any tuition and other fees, and must present his ID card at the time of payment of these charges in order to claim exemption from payment of the General Fee.

A graduate student who returns to the University to present his thesis and to take the final examination for an advanced degree, all other work for that degree having been previously completed, must register as a "Candidate for Degree Only" and pay a fee of \$35.

THESIS FEE. Each doctoral candidate must pay \$30 when he deposits the approved thesis and abstract in final form. This fee covers the cost of preparing a master microfilm of the entire thesis; of publishing the abstract in the bimonthly periodical *Dissertation Abstracts*; of mailing the microfilm and abstract to the microfilm publisher; and of binding both copies of the thesis for deposit in the University Library.

LIMITED REFUNDS. Part of the tuition and General Fee will be refunded to students who officially withdraw or take a leave of absence during the first nine weeks of a term. A student arranges for a leave of absence or withdrawal at the Graduate School Office. Students who withdraw are charged tuition and the General Fee at the rate of 10 percent for each week or fraction of a week from registration to the effective date of withdrawal. No charge is made if the student begins his leave of absence or withdraws within six days of registration. No part of the registration or matriculation fee is refundable.

SUMMER SESSION. Graduate students who attend classes in the Summer Session must register both in the Graduate School and in the Summer Ses-

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sion; they must pay the tuition and fees listed in the *Announcement of the Summer Session*.

SUMMER RESEARCH. Students registered for Summer Research pay one-half of the General Fee for a registration period of not more than eight weeks and the full fee for a longer registration period unless they were regularly registered in the Graduate School during the previous academic year. For those students eligible for and desiring residence, a prorated tuition is charged in accordance with the fraction of a residence unit to be earned, based on the tuition in effect for the subsequent academic term.

IN ABSENTIA. A graduate student registered *in absentia* will pay a fee of \$35 each term.

Advanced Professional Degrees

Advanced professional degrees are designed as preparations and training for a special profession.* The admissions, requirements, and curricula for such degrees, as approved by the Graduate Faculty, are announced by the faculty of a professional school or college, which, for this purpose, acts as a Division of the Graduate Faculty. Degrees are awarded upon recommendation of the Division to the Graduate Faculty. Detailed information regarding admission or academic requirements for any professional degree is included in the *Announcement* of the separate school or college in which the degree is offered. Inquiries addressed to the Graduate School will be forwarded to the proper official. The professional degrees listed below are approved by the Graduate Faculty.

Agriculture

MASTER OF AGRICULTURE (M.Agr.). This degree is intended for professional agriculturists seeking opportunity to study in depth some subject or problem which is pertinent to their profession. Detailed information may be obtained from Director Herbert L. Everett, 192 Roberts Hall.

Architecture, Fine Arts, City and Regional Planning

The following three degrees are administered by the Division of Architecture, Art, and Planning of the Graduate School. Inquiries should be addressed to the listed professor.

* The following are advanced degrees which are also first degrees of a school or college and therefore are not subject to the jurisdiction of the Graduate Faculty. For information regarding them, address the school or college indicated.

Master of Engineering (Aerospace)	Graduate School of Aerospace Engineering
Master of Business Administration	Graduate School of Business and Public Administration
Master of Public Administration	
Doctor of Law	Law School
Doctor of Medicine	Medical College, New York City
Doctor of Veterinary Medicine	Veterinary College

For more detailed information on these degrees, as well as those in architectural structures, architectural history, and art, see also the *Announcement of the Graduate School: Humanities*.

MASTER OF ARCHITECTURE (M.Arch.). Training in urban design. Only graduates of a five-year professional program in architecture or graduates of a program in city planning or landscape architecture are admitted as candidates. (Professor Colin Rowe.)

MASTER OF FINE ARTS (M.F.A.). Advanced training in the practice of painting, sculpture, or graphic arts. (Professor Jason Seley.)

MASTER OF REGIONAL PLANNING (M.R.P.). Training for a professional career in the field of city planning or regional planning. (Professor Kermit C. Parsons.)

Communication Arts

MASTER OF COMMUNICATION ARTS (M.C.A.). The focus of this program is more on the *strategic application* of communication knowledge and technology than on technical competence in media operation. The curriculum is designed for those students who wish to work with agencies in which organized public communication is a key concern. Emphasis is placed on three key elements: (1) analysis of what is known about the communication process, (2) exploration of the potential of current and new communication techniques and technology, and (3) application of the first two elements to specific communication problems.

Education

Two professional degrees are administered by the Field of Education of the Graduate School. The programs leading to each of the degrees include courses, seminars, projects, and investigations that will develop the student's ability to perform acceptably the professional duties required of the several types of educational specialization.

MASTER OF ARTS IN TEACHING (M.A.T.). This program is designed for and limited to those preparing for teaching the following subjects only in secondary schools: agriculture, biology, chemistry, earth science, English, French, home economics, physics, and social studies. The student and his Special Committee will select those courses and seminars in his teaching specialty and in education which are deemed most appropriate for developing competence as a teacher. The student will be required to demonstrate his teaching skill in a supervised field experience. Completion of two regular semesters and one summer of full-time study, or two and two-fifths residence units is required. Graduates of a teacher-training program are not eligible for this degree.

DOCTOR OF EDUCATION (Ed.D.). The program for this degree is designed to prepare the candidate within a broad cultural context for positions of

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professional leadership in education. The program of studies must include advanced work in each of the following: educational psychology, history or philosophy of education, educational measurement and statistics, and research in education. At least fifteen hours of credit must be earned in courses other than those in professional education. A minimum of sixty-five credit hours beyond the Bachelor's degree is required, of which thirty-five hours should be completed beyond the Master's degree or its equivalent. A candidate is required to complete a minimum of five residence units beyond the Bachelor's degree and a year of directed field experience.

Professional Teaching

MASTER OF SCIENCE FOR TEACHERS (M.S.T.). This is a coordinated program of training in the biological and physical sciences for practicing teachers. Each degree candidate must satisfy a broad core program in mathematics and science and complete advanced work in his selected field of study. This degree is administered by the Division of Professional Teaching of the Graduate School. Detailed information may be obtained from the Graduate School Office, Sage Graduate Center.

Engineering

MASTER OF ENGINEERING. The Master of Engineering degree is administered by the Engineering Division of the Graduate School. Specially oriented graduate programs of study are in the areas of agricultural, chemical, civil, electrical, industrial, materials, mechanical, and nuclear engineering, and in engineering physics. The following titles designate the professional Master's degrees offered in engineering: Master of Engineering (Agricultural), Master of Engineering (Chemical), Master of Engineering (Civil), Master of Engineering (Electrical), Master of Engineering (Engineering Physics), Master of Engineering (Industrial), Master of Engineering (Materials), Master of Engineering (Mechanical), Master of Engineering (Nuclear). The Graduate School of Aerospace Engineering administers the Master of Engineering (Aerospace) degree program.

The general requirements for the degrees listed above are:

1. A minimum of thirty credit hours of advanced technical course work in the specific field or in related subjects.
2. A minimum of three credit hours (included in the above) of engineering design experience involving individual effort and formal report.
3. A minimum grade point average of 2.5 and a minimum final grade of C minus for all courses counting toward the degree.

There are no residence requirements, although all course work must, in general, be completed under Cornell University staff instruction. The degree requirements must normally be completed within a period of four calendar years.

Graduates of Cornell University who hold Bachelor of Engineering degrees may be granted up to fifteen hours credit for advanced courses taken during

their fifth undergraduate year, provided they enter the Master of Engineering program not later than the fall term following the sixth anniversary of their receiving the Bachelor of Engineering degree.

The *Announcement of the College of Engineering* should be consulted for further details on the various professional Master's programs.

English

MASTER OF FINE ARTS (M.F.A.). The degree of Master of Fine Arts in creative writing is designed to prepare candidates for careers in professional writing or in the teaching of creative writing. The program is administered by a specially appointed committee of the Department of English, acting as a Division of the Graduate School.

Industrial and Labor Relations

MASTER OF INDUSTRIAL AND LABOR RELATIONS (M.I.L.R.). The four-semester program leading to this degree provides a basic course of graduate study for those with professional interests in industrial and labor relations and further provides limited opportunities for specialized professional study where broad competence has been established. This degree is administered by the Division of Industrial and Labor Relations of the Graduate School. Students possessing a law degree may be eligible for a two-semester M.I.L.R. program. More information may be obtained by writing to: Graduate Field Representative, School of Industrial and Labor Relations, Ives Hall.

Law

The following two degrees are administered by the Division of Law of the Graduate School. The *Announcement of the Law School* should be consulted for a complete description of the program and requirements.

MASTER OF LAWS (LL.M.). This degree is intended primarily for the student who desires to increase his knowledge of the law by working in a specialized field.

DOCTOR OF THE SCIENCE OF LAWS (J.S.D.). This degree is intended primarily for the student who desires to become a proficient scholar by original investigation into the functions, administration, history, and progress of law.

Music

The following two degrees are appropriate for mature composers who seek further professional training as well as knowledge of the other arts and humanities, both to enrich their creative perspectives and to prepare them for the teaching of composition and theory at the university level.

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MASTER OF FINE ARTS (M.F.A.)

DOCTOR OF MUSICAL ARTS (D.M.A.)

These degrees are administered by the Department of Music, acting as a Division of the Graduate School for this purpose. More information may be obtained from Professor Robert M. Palmer, 218 Lincoln Hall.

Nutritional and Food Science

The following two degrees are administered by the faculty of the Graduate School of Nutrition acting as a Division of the Graduate School. More information may be obtained by writing to: Secretary, Graduate School of Nutrition, Savage Hall.

MASTER OF NUTRITIONAL SCIENCE (M.N.S.). This program emphasizes fundamental study in the basic biological sciences that can lead to specialization in such areas as nutritional biochemistry, human and clinical nutrition, experimental or animal nutrition, and public health and international nutrition. The program is open to students who have had no previous course work in nutrition. For candidates interested in the biological sciences, the program serves as a valuable preliminary for graduate study for the Ph.D. degree in such areas as biochemistry and physiology, as well as human or animal nutrition.

MASTER OF FOOD SCIENCE (M.F.S.). The fundamental sciences, chemistry, biochemistry, and bacteriology, that are involved in food processing and utilization, are emphasized. Electives are available to meet individual needs in engineering, economics, marketing, business administration, and international programs. The specialized training serves as a preparation for technical work in the food industry or for more advanced graduate study.

The *Announcement of the Graduate School of Nutrition* should be consulted for further details on the professional Master's degree programs.

Theatre Arts

MASTER OF FINE ARTS (M.F.A.). The degree of Master of Fine Arts in theatre arts is intended for students who wish to increase their professional competence as actors or directors through a studio-oriented program. It is administered by the Department of Theatre Arts, acting as a Division of the Graduate School for this purpose.

Veterinary Medicine

DOCTOR OF SCIENCE IN VETERINARY MEDICINE (D.Sc. in V.M.). This degree is characterized by a professional rather than a general research objective, and it is designed especially for experienced persons in the basic and clinical sciences who need more specific, advanced, scientific, and professional knowledge in order to equip themselves for careers in teaching and research. This degree is administered by the Division of Veterinary Medicine of the Graduate School.

Graduate School of Medical Sciences

The opportunity for graduate work leading to advanced general degrees was first offered in the Medical College in 1912 in cooperation with the Graduate School of Cornell University. In June 1950, the trustees of Cornell University entered into an agreement with the Sloan-Kettering Institute for Cancer Research whereby a new division of the Medical College, namely, the Sloan-Kettering Division, was created for the purpose of offering additional opportunities for graduate study toward advanced degrees, thus extending the areas of the basic sciences.

That expansion of the New York City component of the Graduate School resulted in the establishment, in January 1952, of the Graduate School of Medical Sciences which, with the approval of the Faculty of the Graduate School of Cornell University, was given the full responsibility for administrative matters related to the advanced general degrees granted for study in residence at the New York City campus of Cornell University.

DEGREES. The general degrees of Ph.D. and M.S. are awarded for advanced study and scholarly, independent research in the fields of anatomy, biochemistry, biomathematics, biophysics, biostatistics, cell biology, genetics, microbiology, neurobiology and behavior, pharmacology, and physiology.

FACILITIES. The facilities for graduate work at the Graduate School of Medical Sciences include those of the Medical College and of the Sloan-Kettering Division. The five buildings of the Medical College, extending along York Avenue from Sixty-eighth to Seventieth Street in New York City, contain the lecture rooms, student laboratories, library, and research facilities for graduate and undergraduate work. The Sloan-Kettering Division is located in the Sloan-Kettering Institute and the Kettering Laboratory on East Sixty-eighth Street in New York City, and in the Walker Laboratory in Rye, New York. The special facilities and experienced investigators of the Sloan-Kettering Division offer ample opportunity for advanced graduate work in the basic science aspects of research related to cancer and allied diseases.

FINANCIAL ASSISTANCE. Predoctoral fellowships are available to qualified applicants. The fellowships may be renewed yearly providing the academic performance of the fellowship holders is satisfactory. Teaching fellowships and research assistantships are available to qualified graduate students in some departments of the Medical College. In addition to a stipend, the costs of tuition and fees are defrayed for those students receiving financial assistance.

FURTHER INFORMATION. Information on financial assistance and the entire program of the Graduate School of Medical Sciences is provided in the *Announcement of the Graduate School of Medical Sciences*. Requests for that *Announcement* should be addressed to the Graduate School of Medical Sciences, Cornell University, Medical College, 1300 York Avenue, New York, New York 10021.

Special Resources for Research and Advanced Study

The descriptions below are limited to major general facilities available to graduate students. Other substantial collections and facilities, in many instances unique, have been assembled for the use of graduate students. Although the facilities cannot be described adequately in this *Announcement*, some of them are mentioned in the statements given under the Fields of Instruction on p. 50 ff.

Cornell University Libraries

The libraries are among the principal facilities in the University's program of graduate studies. The total number of volumes at Cornell is now over 3,600,000 and that figure increases by about 200,000 each year. For the convenience of students and faculty, the holdings are organized into a controlled system of distinct libraries. Some of the libraries are large; some have limited holdings. Some are general; some selective. Each library, whether within one of the colleges or housed in a building of its own, is situated where its books and its facilities lie most easily available to those who use them most. The libraries, whatever their nature, have been developed over many years by scholarly librarians and professors with the view of achieving breadth and depth in the central libraries, utility and coherence in the specialized ones.

The University's libraries offer support for graduate studies at several levels. They provide basic readings in virtually all subjects, collateral studies for classroom and seminar instruction, and highly specialized materials for advanced students. An unusually rich collection of reference works, both modern and antiquarian, expedites both daily study and dissertational research. Of journals and periodicals, about 50,000 titles are available, most of them in complete runs, some of them in multiple copies, all of them immediately available. Special departments are maintained for maps, microtexts, documents, newspapers, and other such collections.

To most graduate students, Olin Library, designed primarily as a research library, becomes the most familiar. Olin Library, completed in 1961, offers every modern library facility for its readers. The building is completely air-conditioned, scientifically lighted, comfortably furnished, and organized for efficient operation. It provides easy access to the book stacks, convenient photocopying facilities, and a comfortable lounge area for graduate students. Congestion is eliminated not only because of architectural design but also because undergraduates have their own open-stack library in a separate building. A graduate student whose work has advanced to the writing stage may apply for use of a carrel adjoining the book stacks in order to facilitate completion of his dissertation. Olin Library is open during the term from 8:00 a.m. to 12:00 midnight weekdays, and from 1:00 p.m. to 12:00 midnight Sundays.

Within Olin are a number of special collections likely to be of particular interest to advanced students of the social sciences and the humanities. The Department of Rare Books houses several distinguished collections, among them books and manuscripts relating to Dante, Petrarch, Wordsworth, Joyce, Shaw, and other literary figures. The Noyes Collection is rich in American historical documents, especially those pertaining to Lincoln and the Civil War. Students in the social sciences will also find extraordinarily interesting manuscripts and books in the collections of slavery and abolition, of witchcraft, of the French Revolution, and of the life and times of Lafayette. Long familiar to professional scholars are the Wason Collection on China, Japan, and Southeast Asia, and the Old Icelandic Collection. The History of Science Collections include the Adelman Library of Embryology and Anatomy, and the library of the French scientist, Lavoisier. The Collection of Regional History and Cornell University Archives is a manuscript depository with total holdings of more than 20,000,000 items. These manuscripts relate to all aspects of the economic, political, and social history of this region and the areas historically connected with it. Here, too, are the documents and manuscripts relevant to the founding and development of Cornell University. In addition to the collections in Olin Library, many of the college and department libraries also contain materials unique in their respective fields. Curators and reference librarians in all the libraries are available for counsel concerning the availability and use of research materials.

The University libraries in aggregate consist of Olin Library, as mentioned, Uris Library for undergraduates, the Physical Sciences Library, the Mann Library of Agriculture and Human Ecology, and the libraries of the following colleges and schools: Fine Arts, Business and Public Administration, Engineering, Hotel Administration, Industrial and Labor Relations, Law, Medicine (in New York City), and Veterinary Medicine. Added to these are the libraries of academic divisions and departments, together with those of the Agricultural Experiment Station at Geneva, New York.

International Studies Programs

Center for International Studies

The primary function of the Center for International Studies is to foster, coordinate, and support the University's international activities. In addition to its role as a link between the activities of the specialized programs, the Center routinely crosses interdisciplinary lines in its endeavor to interest faculty and students in innovative international teaching and problem-centered research.

Students interested in foreign area studies or in international problems will find that the flexibility of both undergraduate and graduate requirements permits considerable latitude in selecting subjects. Appropriate courses of study can be selected from the regular offerings of various departments of the University. For example, in the College of Arts and Sciences the Department of Government offers instruction in comparative government, international relations, and international law and organization; in the Department

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of Economics there are offerings in international economics, economic development, international trade, and the economics of workers' management; the Department of Sociology offers courses in population problems and international urbanization. In the College of Agriculture courses are available in the economics of agricultural development, international agriculture, and rural sociology. The School of Business and Public Administration offers courses in international development and comparative administration. The School of Industrial and Labor Relations offers courses in international and comparative labor relations.

The graduate student seeking specialized foreign-area knowledge may arrange a minor in one of the interdisciplinary area programs: Asian Studies or Latin American Studies. It is also possible to pursue an area interest in European Studies, Soviet Studies, or African Studies.

In cooperation with the Program on Science, Technology, and Society (STS), the Center is developing a Peace Studies Program. The core of this Program is an interdisciplinary seminar, "The Impact of Technology on Foreign Defense and Disarmament Policies," complemented by several other courses on defense and arms control.

Another area being developed jointly by the Center and STS is international flows of scientific information and manpower. Two new courses have been designed to explore this phenomenon. One deals with flows between developed and developing countries; the other concentrates on scientific/technological flows among developed countries.

A new doctoral specialization in the economics of participation and labor managed systems is offered as part of an interdisciplinary teaching and research program on the problem of participative management.

The International Population Program is being expanded to include the policy, administration, and communications problems related to the development of family planning programs in an international and comparative perspective.

Other activities of the Center include lectures and seminars presented by distinguished visitors, overseas and domestic research projects, conferences, student training, and publication.

The continued growth of the international programs has been accompanied by the creation of an outstanding and comprehensive infrastructure of staff, library, language facilities, and other necessary resources.

The work of the Center and of associated programs and activities is more fully described in the Center's *Annual Report of International Studies at Cornell University*. Further information may be obtained from the Center's office in 217 Rand Hall.

China Program

FACULTY: Knight Biggerstaff, Nicholas C. Bodman, Nai-Ruenn Chen, Chuen-tang Chow, John C. H. Fei, Ta-Chung Liu, John McCoy, David Mozingo, Charles A. Peterson, Harold Shadick, Judith M. Treistman, Martie W. Young.

The China Program provides comprehensive graduate-level training and sponsors a wide range of research. The faculty represent the following fields:

anthropology, economics, government, history, history of art, linguistics, and literature.

Graduate students in the program take a major in one of the fields listed above. They are expected at an early stage to attain sufficient mastery of the Chinese language to permit use of Chinese sources in their courses and seminars and in their research.

The focus of much of the research and teaching in the Program is the society, polity, economy, culture, and arts of modern and contemporary China. Students with this concentration are also expected to develop a general knowledge of traditional institutions and culture. Students majoring in history concentrate on medieval or modern China; no chronological limits apply to those in the history of art, linguistics, or literature.

The China Program supports three projects: political organization, social change, and personality development; economic development within a Chinese cultural setting; and linguistic studies in Southeast China and in the southwest border regions. Research Assistantships are available to advanced graduate students working in these areas, and occasionally in other fields as well. London-Cornell Studentships are open to advanced Ph.D. candidates in the social sciences and humanities who are in the China Program. They are tenable for study during an academic year at the London School of Economics and Political Science or at the School of Oriental and African Studies of the University of London. Stipends include air fares and tuition and fees.

London-Cornell Field Research Grants are open to Ph.D. candidates whose interests directly concern problems of social change in East Asia. Grantees may conduct dissertation research in any part of East Asia, and stipends for this purpose include travel and research expenses.

National Defense Foreign Language Fellowships and Foreign Area Training Fellowships are tenable in the Program. Graduate students may also apply for other assistantships, fellowships, and scholarships offered by the University and its departments.

Additional information on the Program and the various fellowships and awards may be obtained by writing to the Director, China Program, 100-A Franklin Hall.

Program on Comparative Economic Development

The Program on Comparative Economic Development at Cornell University was founded in 1966 by a group of economists in the Department of Economics, the Department of Agricultural Economics, and the School of Industrial and Labor Relations. Its primary purpose is theoretical and empirical research into the causes and forces of economic development, emphasis being placed on the multiplicity and diversity of forms of the development phenomenon.

Several secondary benefits derive, or are expected to derive, from the activities of the Program. One is the educational feedback in the form of seminars, guest lecturers, and the availability of research scholarships to graduate students in the Department of Economics. Further arrangements

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are being made for the establishment of regional research and educational centers in selected focal development countries.

The Program is not restricted to economists. On the contrary, it is hoped that as time goes on cooperation will be obtained from other fields. In fact, the philosophy of a wider basis of development science, not restricted to economics, is intended to become the central strength of the Program.

Additional information may be obtained by writing to Jaroslav Vanek, Director of the Program, Goldwin Smith Hall.

International Agricultural Development Program

Cornell University provides unusual scope and facilities for graduate-level study and research concerning development of the critical agricultural sector of newly developing nations. An integrated program of research and graduate training is available in the various biological, physical, and social sciences fields which are relevant to agricultural development.

A student preparing for work in international agricultural development majors in a specific Field. In addition to basic preparation in that Field, he may minor in the Field of International Agricultural Development. The student may take courses which help him in applying his knowledge to the special conditions of newly developing nations, consult with experienced faculty members in regard to such application, and pursue a research project for his dissertation which is relevant to the special problems of newly developing countries. In much of this work the program in agriculture draws upon the strong international programs in other colleges of the University, including the area study programs and the varied offerings in modern languages.

Faculty experience in overseas work is continuously developed through work in College of Agriculture overseas programs and individual consulting assignments. Several faculty members, who devote themselves full time to research and teaching in international agricultural development, have built special programs of research and continuing contact with particular geographic areas. The environment for the International Agricultural Development Program is further enhanced by more than 250 foreign graduate students majoring in the various fields of studies represented by the College of Agriculture.

Substantial expansion has recently taken place in the international program of several departments. Most departments have a number of assistantships and teaching fellowships designed to finance graduate students while they work closely with the teaching and research program in international agricultural development. Doctoral candidates in these departments who are interested in international agricultural development generally do field research in newly developing countries for their doctoral dissertations.

Additional information may be obtained by writing to Professor K. L. Turk, Director, International Agricultural Development Program, 102 Roberts Hall.

International Legal Studies Program

The Cornell Law School offers a program of concentrated study in international legal subjects. The full program is ordinarily pursued by J.D. candi-

dates in their second and third years of regular law study, but all the courses in the Field are open to graduate students in law. Some of the courses are offered by visiting faculty members who come to the Law School under its program for distinguished foreign professors. A number of foreign scholars and students also come to Cornell for research and study in the comparative and international law fields. Other activities of the International Legal Studies Program have included faculty seminars in comparative law, summer conferences in public international law, and a program of speakers and seminars open to students. In addition, the Law School sponsors a small number of fellowships for foreign students to pursue graduate work in law.

For more detailed information, see the current *Announcement of the Law School*, and the current *Annual Report of the Center for International Studies*. Further information may be obtained by writing to Professor Robert A. Anthony, Chairman, Graduate Study Committee, Cornell Law School, or to the Director, Center for International Studies, 217 Rand Hall.

Latin American Studies Program

FACULTY: Donald K. Freebairn, director; Frederick B. Agard, Solon Baraclough, Jerome S. Bernstein, Dalai Brenes, Loy V. Crowder, David Davidson, Tom E. Davis, Martin Dominguez, Matthew Drosdoff, Charles L. Eastlack, Rose K. Goldsen, Thomas Gregor, Joseph A. Kahl, Eldon Kenworthy, Anthony G. Lozano, Thomas F. Lynch, Robert E. McDowell, James O. Morris, John V. Murra, Thomas Poleman, Glenn F. Read, Bernard Rosen, Donald F. Solá, J. Mayone Stycos, H. David Thurston, William F. Whyte, Lawrence K. Williams, Frank W. Young.

The Latin American Studies Program enables the graduate student to develop specialized competence in the history, culture, social organization, and languages of Latin American countries. The student majoring in a relevant discipline can minor in Latin American Studies.

Some forty courses directly pertaining to Latin America are offered by the Departments of Agricultural Economics, Agronomy, Animal Science, Anthropology, Consumer Economics and Public Policy, Development Sociology, Economics, Government, History, History of Art, Industrial and Labor Relations, Romance Studies, and Sociology. The courses constitute the basis for formulating programs leading to a graduate *minor* in Latin American Studies. Normally, five or six semester-long offerings satisfy the formal course requirements. In addition, the degree candidate minoring in Latin American Studies must exhibit proficiency in reading and speaking either Spanish or Portuguese.

Applications for scholarships, fellowships, or teaching fellowships should be made to the department in which the student is taking his major. Students minoring in Latin American Studies qualify for NDEA Title VI Modern Language Fellowships. Application forms may be obtained from the Graduate School.

Summer research travel grants and support for on-campus course work during the summer are available to selected graduate students through the Latin American Studies Program. Although thesis research may be supported

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by the Program, support should first be sought from the Foreign Area Training Fellowship Program, the Social Science Research Council, Fulbright-Hays, the Doherty Foundation, and the Organization of American States.

Because of the considerable volume of research on Latin America currently being carried out by Cornell faculty members, students will normally be afforded the opportunity of participating in ongoing projects while in residence and will generally be expected to do field work in Latin America at some stage of their graduate training. Major research projects are under way in the fields of Andean community development, comparative economic development, fertility and population, descriptive linguistics, and urbanization.

Additional information may be obtained by writing to Donald K. Freebairn, Director, Latin American Studies Program, Rand Hall.

South Asia Program

(Bhutan, Ceylon, India, Nepal, Pakistan, Sikkim)

STAFF: Gerald Kelley, director; Messrs. Douglas E. Ashford, Harold R. Capener, Arch T. Dotson, Harold Feldman, James Gair, Leighton W. Hazlehurst, Michael Hugo-Brunt, Kenneth A. R. Kennedy, John W. Mellor, Stanley J. O'Connor.

The increasing importance of the peoples of the Indian subcontinent and of the role they play in world affairs enhances the need for providing opportunities in America for training and research in the field of Indic studies. The South Asia Program at Cornell, dealing primarily with India, Pakistan, Ceylon, and Nepal, is organized and equipped to help meet this need. Since 1948 it has sponsored a series of research projects on India and Ceylon, and it has trained a distinguished group of younger American and South Asian scholars in South Asian area and language studies. The Program faculty includes members from agricultural economics, anthropology, government, history of art, human development and family studies, business and public administration, development sociology, city and regional planning, and languages and linguistics. Sanskrit, Pali, Hindi, Urdu, Telugu, and Sinhalese are languages regularly offered at Cornell. Cornell participates in the interuniversity summer program which provides instruction in other South Asian languages and selected social sciences and humanities disciplines each summer on the campus of a member eastern university.

Qualified graduate students interested in specializing in the study of South Asia minor in Asian Studies with concentration on South Asia, in South Asian art history, or in South Asian linguistics. The doctoral candidate must have a reading knowledge of Hindi or, depending upon the subarea of his specialization, some other important language of South Asia.

RESEARCH AND FIELD TRAINING. The doctoral dissertations of students in the South Asia Program are normally based on research done in India, Pakistan, Ceylon, or Nepal. Students' field research may benefit from advice and guidance in the field by a Program staff member. At least one member of the faculty of the South Asia Program has been in South Asia for each of the last several years. Cornell is a charter member of the American

Institute of Indian Studies, which was organized to facilitate study and research in India by American advanced students and by faculty specializing in various aspects of Indian civilization and contemporary affairs. The University also maintains close links with a number of research agencies, programs, and institutions of higher learning, such as the Deccan College Postgraduate Research Centre, Delhi University, Osmania University (Hyderabad), and universities in Ceylon. Staff members of these institutions have provided valuable assistance to Cornell students working in India. There are opportunities for graduate students to become associated with Cornell-sponsored research in South Asia or to carry on independent research abroad. Every effort is made by the Program staff to aid qualified students to obtain financial support for a field training or research project in one of the countries of the area.

Research interests under the South Asia Program are focused largely on recent or contemporary developmental problems of the countries of the area—on changes taking place in the economic, political, social, religious, artistic, and intellectual life of the region. A long-term research project in progress in India is primarily concerned with the ramifying problems of introducing technological changes and the influence of such changes when adopted. Since 1949 faculty and students in anthropology have carried on an extended and varied series of rural and urban community studies in several different regions of India from the Deccan into the Himalayan foothills. A major related project, the Cornell International Agricultural Development Program, which is supported by Ford Foundation funds, is concerned with the development of the entire agricultural sector of the Indian economy. With Ford Foundation support, Cornell is assisting Delhi University to become a major center in the field of linguistics. At the same time, other studies in urban renewal and regional planning, public administration, the role of government in cultural change, and recent movements in the arts and in religions and ideologies are in progress under faculty direction. Cornell is also making a special study of the Sinhalese language and of linguistic problems of Ceylon. Research is also under way on Oriya and Telugu, important regional languages of India. The new nations of South Asia present so many problems for study that the areas of inquiry open to students and staff members are limited only by availability of research means.

FELLOWSHIPS AND ASSISTANTSHIPS. Fellowship and assistantship awards are available to qualified graduate students minoring in Asian Studies with a concentration on South Asia. The South Asia Program fellowships are open to incoming graduate students with South Asia interests and should be applied for by writing to: Director, South Asia Program, 221 Morrill Hall. These fellowships are normally given to provide supplementary support for student research projects, at Cornell or in the field. Students in the South Asia Program are also eligible for assistantships in their major discipline departments, for fellowships and scholarships offered by the Cornell Graduate School, for National Defense Foreign Language Fellowships, and for Foreign Area Training Fellowships. Additional information on financial aid may be obtained by writing to the director, at the address given above.

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Southeast Asia Program

FACULTY: Benedict R. Anderson, Arch T. Dotson, John M. Echols, Frank H. Golay, Alexander B. Griswold, Robert B. Jones, Jr., George McT. Kahin, Stanley J. O'Connor, Robert A. Poison, Robert M. Quinn, Lauriston Sharp, James T. Siegel, John U. Wolff, O. W. Wolters.

The Southeast Asia Program possesses substantial facilities for study and research on the graduate level and provides exceptional opportunities for general or specialized work on all of Southeast Asia in various disciplines of the humanities, social sciences, and some natural sciences, as well as in interdisciplinary area seminars. Instruction in the major languages of the area is an integral part of the graduate training of the Southeast Asia Program. Much basic and pioneering research remains to be done in this area, and the Southeast Asia Program is organized and equipped to help meet such needs.

Special intensive instruction in Southeast Asian languages is available during summer sessions. Entering graduate students intending to study one of these languages are encouraged to begin such study during the summer preceding registration in the Graduate School. Inquiries should be made as early as possible to the director of the Southeast Asia Program.

Southeast Asia Program fellowships are available on a competitive basis to graduate students. They carry stipends of up to \$3,200 plus tuition and General Fee, and are available only to qualified candidates for advanced degrees at Cornell. Competition for these awards is open to citizens of the United States or Canada, nationals of Southeast Asian countries, and, in exceptional cases, nationals of other countries.

The fellowships are available to applicants who are able to demonstrate a serious scholarly interest in Southeast Asian studies; who show the greatest promise of becoming qualified regional experts with specialization in a relevant discipline of the humanities, social sciences, or certain natural sciences; and who are admitted to the Cornell Graduate School for advanced work in such a discipline. Previous experience in Southeast Asia or in the study of that area is not necessarily required. It is important that the applicant be able to show that advanced work in a major subject offered at Cornell, combined with work in the Southeast Asia Program, will make his future professional activities more effective; this requirement is particularly important for a student in the natural sciences.

Fellowships are normally awarded for one academic year. If the student's work during the first year has been of high caliber, reappointment is sometimes possible. In such cases, formal reapplication is expected from the student. The primary purpose of these awards is to encourage graduate students to acquire a substantial knowledge of Southeast Asia while majoring in one of the discipline Fields of the Graduate School. Accordingly, they are usually offered only to students who take a minor in Asian Studies and participate fully in the Southeast Asia Program. The recipient of a fellowship may be asked to devote up to six hours a week under faculty supervision to work connected with the Program.

London-Cornell Studentships are available for advanced Ph.D. candidates in the social sciences and the humanities who have already had at least one year of resident study in the Southeast Asia Program. These fellowships are tenable for study during an academic year at the School of Economics and Political Science or the School of Oriental and African Studies in the University of London. Stipends range up to \$3,000 plus air fares and tuition and fees. London-Cornell Field Research Grants are open to Southeast Asia Program Ph.D. candidates in the social sciences and humanities after they have had appropriate training at Cornell, or at Cornell and London. They are tenable for up to twenty-two months for the purpose of dissertation research in any part of Southeast Asia. Stipends range up to \$12,000 for twenty-two months including travel and research expenses.

Cornell-Philippines Field Research Fellowships are available, under a grant from the Rockefeller Foundation, for advanced graduate students who plan to write dissertations in the social sciences or the humanities, based upon field research in the Philippines. Fellowship support is for ten to fifteen months in the Philippines and includes living costs, local transport, and round-trip transportation from the United States for the graduate student and dependent wife or husband.

National Defense Foreign Language Fellowships, Title VI, are offered by the United States Office of Education for study during the academic year, the summer, or both. Application should be made to Sage Graduate Center, Cornell University. Information about Foreign Area Training Fellowships, administered by the Social Science Research Council, may be obtained by writing to the Foreign Area Fellowships Program, 444 Madison Avenue, New York, New York 10022. Graduate students may also apply for other fellowships, teaching fellowships, assistantships, and scholarships offered by the University and its departments.

Additional information on the Program and the various fellowships and awards may be obtained by writing to the Director, Southeast Asia Program, 108 Franklin Hall.

Soviet Studies

COMMITTEE ON SOVIET STUDIES: George Gibian, chairman; Urie Bronfenbrenner, M. Gardner Clark, Walter Galenson, Richard Leed, Walter Pintner, Myron Rush, George Staller.

OTHER FACULTY MEMBERS IN SOVIET STUDIES: Patricia Carden, Frederick Foos, Antonia Glasse, Boris Glasse, Augusta Jaryc, Alla Novosilzova, Hugh Olmstead, Marla Wykoff.

The University offers a number of courses and seminars on the Soviet Union as well as pre-1917 Russia. Instead of a separate area program, graduate students have a choice of majors and minors in the established Fields of the Graduate School. Some of the subjects focus on area specialization: Russian history, Russian literature, Slavic linguistics. Other subjects combine area specialization with a nonarea framework: comparative government, economic planning, regional planning, social psychology.

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Graduate students pursuing Soviet Studies in any of these subjects are expected to attain proficiency in the Russian language either before entering the Graduate School or soon thereafter.

The University's academic activities related to Russia are coordinated by the Committee on Soviet Studies. The Committee also sponsors a colloquium for faculty members and graduate students in Soviet Studies. In the Soviet Studies Graduate Study in the John M. Olin Library, major reference works and key current periodicals from and about the U.S.S.R. are brought together.

The Committee on Soviet Studies selects a limited number of graduate students each year as research assistants. The Russian section of the Division of Modern Languages and the Department of Russian Literature also appoint several graduate students annually as teaching fellows in the Russian language. For other teaching fellowships, fellowships and scholarships, students apply directly to the Graduate School or to the department concerned. NDEA Title IV and Title VI Fellowships are available in various subjects.

A list of faculty specialization follows: *Economics*: M. Gardner Clark, Walter Galenson, George J. Staller; *History*: Walter M. Pintner; *Languages and Linguistics*: Frederick Foos, Boris Glasse, Richard Leed, Augusta Jaryc, Alla Novosilzova, Hugh Olmstead, Marla Wykoff; *Literature*: Patricia Carden, George Gibian, Antonia Glasse, Hugh Olmsted; *Political Science*: Myron Rush; *Psychology*: Urie Bronfenbrenner.

Inquiries about fellowships and other aspects of Soviet Studies should be addressed to Professor George Gibian, Chairman, Committee on Soviet Studies, Goldwin Smith Hall.

Other Programs and Studies

American Studies

COMMITTEE ON AMERICAN STUDIES: S. Cushing Strout, chairman; Archie R. Ammons, LeGrace G. Benson, Jonathan P. Bishop, Douglas F. Dowd, Robert H. Elias, Robert T. Farrell, Heywood Fleisig, Paul W. Gates, Rose K. Goldsen, Andrew Hacker, Baxter L. Hathaway, Richard I. Hofferbert, Michael G. Kammen, Michael Kaufman, Walter LaFeber, Thomas W. Leavitt, John E. Martin, James H. Matlack, Dan E. McCall, James R. McConkey, Andrew J. Milnor, Arthur M. Mizener, Richard Polenberg, Albert S. Roe, Joel H. Silbey, Walter J. Slatoff, James M. Smith, Fred Somkin, Gordon F. Streib, Robin M. Williams, Jr.

Although there is no formal program leading to a degree in American Studies, candidates for the doctorate in English and history will find ample opportunity to do interdisciplinary work in conjunction with a major in American Studies within their field. There are members of the staff in both fields who are professionally trained and currently active in the study of the interrelationships of American intellectual, literary, and social history, so that a student concentrating in American literature or American history may take advantage of the freedom permitted by Graduate School regulations and, in collaboration with his Special Committee, readily build an individual doctoral program that systematically embraces more than a single discipline. Inquiries concerning

opportunities in this area should be addressed to: Professor S. Cushing Strout, Chairman, American Studies Committee, Goldwin Smith Hall.

Brookhaven National Laboratory

Cornell is one of nine eastern universities participating in Associated Universities, Inc. (AUI). Operating under contract with the Atomic Energy Commission, this corporation has the responsibility for the management of Brookhaven National Laboratory. The Laboratory provides unusual research facilities for studies in biology, chemistry, applied mathematics, medicine, physics, high energy particle physics, and reactor and nuclear engineering.

Graduate students may participate in research at Brookhaven by association with Cornell staff members who are engaged in research at the Laboratory. Members of a variety of science departments at Cornell are currently involved in programs at Brookhaven. The Laboratory also offers temporary summer appointments to a limited number of selected graduate and undergraduate students in science or engineering.

Center for Environmental Quality Management

The Center for Environmental Quality Management brings together the faculties of the Cornell Medical College in New York and the various colleges and schools in Ithaca to study the manifold questions of environmental health in both urban and rural settings.

Current approaches to the modification and control of the environment, in concentrating on limited objectives such as air quality control, disease control, water quality control, pest control, food sanitation, and occupational health have had limited success since they have been unable to take into account the interdependence of environmental health problems. The character and the urgency of the total environmental quality problem facing us appears insoluble short of an overall approach that will enable decision makers to consider simultaneously the significant variables and relationships relevant to the management of environmental quality.

Scientific management through systems analysis has begun to make it possible to consider these multiple relationships within the framework of common objectives and subject to predetermined constraints. It provides mechanisms by which various innovations can be examined in terms of their short- and long-term effects upon the environment. Such an approach provides rational bases for establishing environmental quality goals and for the allocation of scarce resources to achieve these goals.

The Center is frequently able to provide predoctoral and postdoctoral fellowships for students interested in pursuing research topics in environmental health. For information regarding specific programs, write to: Professor Walter R. Lynn, Director, Center for Environmental Quality Management, 302 Hollister Hall.

Center for Urban Development Research

The purpose of the Center for Urban Development Research is to enable the University to expand its research, training, and service in the field of urban

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problems. It is intended to provide a continuing forum for questions pertaining to urban development; encourage new combinations of interdisciplinary problem-centered research; encourage and cooperate with interdisciplinary educational developments; provide for participation by faculty, staff, and students on an interdisciplinary basis in urban studies; assure integration and dissemination of the results of research.

The Center supersedes the Center for Housing and Environmental Studies. The acting director of the Center is Professor Barclay G. Jones, 109 West Sibley Hall.

Center for Radiophysics and Space Research

The Center for Radiophysics and Space Research unites research and graduate education carried on by several academic departments in the space sciences. It furnishes administrative support and provides facilities for faculty members and graduate assistants who are engaged in space research activities, and it offers opportunity for graduate students to undertake thesis work leading to the degrees of Master of Science and Doctor of Philosophy. A student's major professor can be chosen from the following Fields in the Graduate School: Aerospace Engineering, Applied Physics, Astronomy and Space Sciences, Chemistry, Electrical Engineering, Physics.

Thesis research in the following areas is now possible:

(a) *Astronomy and astrophysics.* Astronomical aspects of cosmic rays, gamma-radiation, x rays, neutrinos; cosmology; experimental studies and theory relating to the surface of the moon and the planets; processes in the interstellar gas; solar-system magnetohydrodynamics; stellar statistics; theory of stellar structure, stellar evolution, nuclear processes in stars.

(b) *Atmospheric and ionospheric radio investigations.* Dynamics of the atmosphere; incoherent electron scattering; study of refraction, scattering, attenuation due to the inhomogeneous nature of the troposphere and ionosphere; theory and observation of propagation of radio waves in ionized media such as the ionosphere.

(c) *Radar and radio astronomy.* Distribution and classification of radio sources; radar investigations of the moon and planets; solar radio observations; studies of gaseous nebulae.

(d) *Space vehicle instrumentation.* Instrumentation relating to lunar exploration; magnetic field measurements; tenuous gas and particle flux measurements; infrared observations from rockets.

The facilities of the Center include the lunar surface and electronics laboratory on the Cornell campus, the radio astronomy and ionospheric laboratories close to Ithaca, and the Arecibo Observatory in Puerto Rico. At Arecibo an extremely sensitive radio telescope and an unusually powerful space radar are available for use by qualified graduate students. In addition, certain facilities of Sydney University, Australia, are available through the Cornell-Sydney University Astronomy Center (see p. 43).

Center for Research in Education

The Center for Research in Education provides an instructional focus within the University for the interests of faculty members from different disciplines in educational research and development. In addition, the Center attempts to stimulate investigation of socially significant educational problems and to train students in educational research. At present, research projects in adult-child interaction and cognitive socialization, in language development and literacy, in science education, and in early school learning are under way. Research programs in mathematics education and in undergraduate education are being planned.

The Center provides predoctoral and postdoctoral training through research assistantships, training grants, and postdoctoral fellowships. For information write to Professor Alfred L. Baldwin, Director, Center for Research in Education, Rand Hall.

Cornell-Sydney University Astronomy Center

The Center is an interuniversity organization designed to create a larger pool of facilities and skills for research in astronomy and related fields than would be separately available to either university. Graduate students can be interchanged between the two institutions whenever appropriate for the research work in which they are engaged. Both universities recognize research supervision extended by the sister university, and the time spent by a student on thesis work in the sister university can be accepted toward residence requirements with the proviso that the approval of the home research supervisor is given and also that the home university bylaws are not contravened.

The facilities available through the Center, in addition to those of Cornell's Center for Radiophysics and Space Research, are the one-mile by one-mile Mills Cross situated at Hoskintown, New South Wales; the stellar intensity interferometer situated at Narrabri, New South Wales; the Criss-Cross, the Shain Cross, and Mills Cross situated at Fleurs, New South Wales; the Wills Plasma Physics Department, the Basser Computing Department, the Falkner Nuclear Department, and the facilities of the cosmic ray group at the University of Sydney. The Center includes H. Messel, R. Hanbury Brown, W. N. Christiansen, C. B. A. McCusker, and B. Y. Mills from the University of Sydney faculty.

Further information can be obtained from Professor T. Gold, Joint Director, Cornell-Sydney University Astronomy Center, Space Sciences Building, Cornell University.

Developmental Studies

Specializations in this area normally involves participation in a program jointly sponsored by the Fields of Human Development and Family Studies, and Psychology. The program presently emphasizes cognitive development. Students interested in the program should apply to either the Field of Human Development and Family Studies or the Field of Psychology. Training in research skills in both Fields is recommended. Students admitted to the program fulfill the requirements of whichever Field they enter. Current research interests of the faculty include development of language, perception,

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thinking, intellectual development in natural settings, conceptual and affective behavior in infancy, cognitive socialization, and biological maturation. For further information see the description of the Field of Psychology and the Field of Human Development and Family Studies, or write to either Field Representative.

Division of Biological Sciences

The Division of Biological Sciences was established in 1964 to bring together into a single administrative unit a number of investigators and teachers representing a broad spectrum of interests in basic biology. Its members hold appointments in one or more of four schools and colleges but serve the University as a whole through the Division. The Division is responsible for all the undergraduate teaching of biology, including the establishment of requirements for the major in its various branches. It also has the primary responsibility for the promotion of research in basic biology, and its members, as part of the Graduate School Faculty, teach in appropriate Fields. At present the following subject areas are represented by separate sections of the Division: biochemistry and molecular biology; ecology and systematics; genetics, development, and physiology; microbiology; and neurobiology and behavior. A number of graduate fellowships, teaching fellowships, research assistantships, and traineeships are available through the Division. For further information, write to Professor Richard O'Brien, 201 Roberts Hall.

Materials Science Center

The Materials Science Center (MSC) at Cornell is an interdisciplinary laboratory created to promote research and graduate student training in all phases of the science of materials. The subjects of study represented in the MSC program are applied physics, chemistry, electrical engineering, materials engineering, materials science, mechanics, metallurgy, and physics.

The extent of the benefits a graduate student may derive from the MSC program depends on the actual research he pursues. If the student chooses to follow the more conventional course of becoming a specialist in one specific area, the MSC program could help him by providing new equipment, financial assistance through research assistantships, or, in some cases, the help of a technician to carry out routine measurements.

If the student wishes to follow a program of considerably more breadth than usual in his research training, the MSC program provides an additional advantage. Several central facilities have been set up where more specialized apparatus such as crystal-growing furnaces, high-pressure equipment, x-ray and metallography equipment, electron microscopes, etc., are available to all MSC members and their students. In addition to the equipment, expert advice on its use and the interpretation of the results will be available. In these central facilities, it is expected that the student will come in contact with students from other disciplines, resulting in a mutually profitable interaction.

The office of the Director of the Materials Science Center, Professor R. E. Hughes, is in Room 627, Clark Hall.

Plasma Physics

Established in 1966, the Laboratory for Plasma Studies at Cornell enables students and faculty members to deal with plasma, electron, and laser physics on a unique, interdisciplinary basis. In the future, plasmas will provide power for cities, will power spacecraft, will help to explain the composition of the universe, and may unlock the energy resources of the sea. Nothing less than an integrated scientific and technological approach to these and other vital areas of plasma research is feasible.

The unified, interdisciplinary approach to plasma studies has added a new dimension to education at Cornell, enabling the University to give the best counsel to graduate students who want to combine their knowledge of some field of science or engineering with work in plasma studies. A program now exists whereby graduate study in plasma physics is offered to students in aerospace engineering, applied physics, chemistry, electrical engineering, mechanical engineering, and physics.

Graduate research assistantships are available through the Cornell Laboratory for Plasma Studies as well as from several departments within the University. It is also possible to obtain positions as postdoctoral research associates with the Laboratory. Prospective graduate students should also consider applying for fellowships awarded on a national basis by the Atomic Energy Commission and the National Science Foundation. The deadlines for these programs are usually in the fall for the following academic year. For further information, write to Professor Peter L. Auer, Director, Laboratory for Plasma Studies, Upson Hall.

Program on Science, Technology, and Society

F. A. Long, director; R. Bowers, deputy director; R. A. Rettig, executive secretary. Steering Committee: P. Bereano, U. Bronfenbrenner, M. Drosdoff, G. Gordon, E. Heitowit, G. Likens, W. Lynn, R. Morison, M. Nelkin, C. Stern, G. Winter

The purpose of the interdisciplinary Program on Science, Technology, and Society is to stimulate teaching and research on the interaction of science and technology with contemporary society. The Program is initiating a number of new research and teaching efforts and also plays a role in providing coherence and support to activities in this area which are already proceeding at the University.

The topics of concern to the Program are illustrated by the following examples: science, technology, and national defense; world population and food resources; legal and moral implications of modern biology and medicine; national policy for the development of science; sociology of science; the ecological impact of developing technology.

The mechanisms for studying these problems will vary and will probably include courses, seminars, short workshops, and summer studies as well as individual research programs. The Program welcomes the participation of students and faculty from all colleges and schools. A list of relevant courses in all parts of the University may be obtained from the Program office, Clark Hall.

46 Research Facilities

Society for the Humanities

Henry Guerlac, director. Fellows (1970-71): Darrell Jackson (Queens College), Philosophy; Paul Schwaber (Wesleyan University), Literature; Hayden White (University of California, Los Angeles), History; Joseph Kerman (University of California, Berkeley), Music; Bojan Bujic (University of Reading, England), Music; Edward Morris and Thomas Hill (Cornell University), Romance Literature and English Literature.

The Society awards three categories of fellowships for research in the humanities: Senior Visiting Fellowships, Faculty Fellowships, and Junior Postdoctoral Fellowships. The Fellows offer, in line with their research, informal seminars intended to be off the beaten track. Details about these seminars are circulated to interested departments.

Membership in the Society's seminars is open, upon written application, to graduate students and suitably qualified undergraduates. All seminars are held in the Society's house at 308 Wait Avenue. Only those officially enrolled, or specifically invited to attend, are admitted as visitors.

A student wishing to attend any of these seminars should write to the Secretary of the Society, 308 Wait Avenue, Ithaca, New York 14850, giving his name, address, telephone number, and a brief summary of his qualifications.

Statistics Center

The methods of statistics find important applications in many diverse fields of research. It is therefore necessary that (1) subject matter specialists be able to obtain assistance in using or developing statistical theory, (2) students who intend to do research work in a particular field which makes extensive use of statistical methods receive adequate training in statistics, and (3) individuals be trained as statisticians.

The staff members of the various schools and colleges of Cornell University who are interested in the development and application of statistical methods are associated with the Cornell Statistics Center. A major responsibility of the Center is to provide a focal point to which individuals, projects, and departments may come to receive assistance and guidance with respect to the statistical aspects of research and training programs.

The acting director of the Center is Professor Philip J. McCarthy, Ives Hall.

Center for Water Resources and Marine Sciences

The Center is an interdisciplinary organization serving the entire University at the graduate study and research level. Its purpose is to promote and coordinate a comprehensive program in water resources planning, development, and management that includes the sciences, engineering, agriculture, law, economics, government, regional planning, and public health.

Its responsibilities are to undertake and support water resources research in engineering, in the physical, biological, and social sciences, and in the humanities; to encourage and contribute to graduate studies in water resources; to coordinate research and training activities in water resources; to encourage new combinations of disciplines in research and training which

can be brought to bear on water resource problems; to disseminate the results of research; and to develop and operate central facilities which may be needed to serve participants in research and training.

Correspondence concerning the Center should be directed to Professor L. B. Dworsky, Director, Center for Water Resources and Marine Sciences, Hollister Hall.

Correspondence related to graduate study in the Field of Water Resources should be directed to the Field Representative, Professor C. D. Gates, Hollister Hall.

Special Facilities and Service Organizations

Military Science, Naval Science, and Aerospace Studies (ROTC, NROTC, and AFROTC)

The advanced course in military science (Army ROTC), naval science (Naval ROTC), and aerospace studies (Air Force ROTC) is open to graduate students who have satisfactorily completed a basic course in ROTC or who enroll in a two-year ROTC program. Successful completion of a two-year advanced ROTC course will qualify a graduate student for appointment as a second lieutenant in the United States Army, Air Force, or Marine Corps Reserve; or ensign in the United States Naval Reserve; or as second lieutenant in the Regular Army or Air Force. Interested graduate students should consult the *Announcement of Officer Education* and apply to Professor of Military Science, Professor of Naval Science, or Professor of Aerospace Studies (ROTC), Barton Hall.

New York State Agricultural Experiment Station at Geneva

The New York State Agricultural Experiment Station was established in 1880 to promote agriculture through scientific investigations and experimentation. It is located at Geneva, fifty miles from Ithaca, and has been under the administration of Cornell University since 1923.

Professors on the Geneva staff are eligible to serve as members of the Special Committees of graduate students along with professors on the Ithaca campus of the University. Normally the graduate training provided at Geneva consists of research experience and supervision of the student's work on a thesis problem. The formal course work of the student's training program is given on the Ithaca campus. Student who plan to do part of their graduate work at Geneva should correspond with their major advisers or with the dean of the Graduate School concerning regulations as to residence, Special Committees, etc.

The Station is equipped to care for graduate students in certain specific lines of research, viz., chemistry, economic entomology, food technology, microbiology, plant pathology, pomology, seed investigations, and vegetable crops. Ample facilities are available for graduate research under laboratory, greenhouse, pilot plant, insectary, orchard, and other field conditions.

Certain phases of the investigations now being conducted at the Station

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and other problems for which the facilities of the Station are suitable may be used as thesis problems by graduate students.

The director is Professor D. W. Barton, who may be addressed at the New York State Agricultural Experiment Station, Geneva, New York 14456.

Office of Computer Services

The principal computing facility at Cornell is an IBM 360 Model 65 located at Langmuir Laboratory at the Cornell Research Park. The system is equipped for remote access of several kinds, and the operating system is designed so that very few users find it necessary to visit Langmuir. The primary terminals are high-speed reader-printers located in Upson, Clark, and Warren Halls. While these are remote job-entry and delivery devices rather than conversational terminals, they permit convenient access, job turnaround-time in terms of minutes, and the use of on-line files. Each of these terminals is the core of a small computing center, with auxiliary equipment, consulting assistance, reference material, and work space. In addition to these high-speed terminals, teletypewriter terminals are available to individual projects that require interactive capability. This computing system is busy but not saturated, and use by graduate students is encouraged.

The University has one IBM 1800 computer, which is located in the Wilson Synchrotron Laboratory.

The Office of Computer Services is responsible for the operation of this system and for the provision of consulting and programming assistance. The Office cooperates with the Department of Computer Science in providing courses in programming and computing techniques. The Department of Computer Science employs a limited number of graduate students on assistantships for this work.

For further information write to the Office of Computer Services, Langmuir Laboratory.

University Press

Cornell University Press, founded by Andrew D. White in 1869, was the first university press in America and is among the leaders in number of volumes published annually. The Press publishes scholarly books on nearly every academic subject, serious nonfiction of general interest, and advanced or experimental textbooks for universities. The imprint of Comstock Publishing Associates, a division of the Press, is placed on certain books in the biological sciences. The Press also publishes a paperbound series, Cornell Paperbacks. More than twenty percent of the books published by the Press in recent years were written by members of the Cornell University faculty. All printing for the Press is done under contract by various book manufacturing firms; the Press has no production facilities of its own.

Visual Aids

The University owns and operates the Photo Science Studios, which create, or cooperate in the creation of, photographic studies and visual aids of all kinds.

The extension services of the New York State Colleges, which form integral parts of the University, disseminate knowledge through an intensive program of publication, photography, and recording supervised by professional staffs. Materials produced by graduate students may find outlets through these channels.

Other Research Units

Some other research units allied with the University, either as wholly owned and operated divisions or as wholly or partially autonomous organizations with which the University has a working agreement, are the Sloan-Kettering Cancer Research Institute in New York City, through the Graduate School of Medical Sciences, and the Veterinary Virus Research Institute in Ithaca.

Cornell is also one of fourteen founding members of the University Corporation for Atmospheric Research which, under National Science Foundation support, operates the National Center for Atmospheric Research at Boulder, Colorado. In addition to Brookhaven National Laboratory, Cornell, as a member of Associated Universities, Inc., has access to the facilities of the National Radio Astronomy Observatory in Greenbank, West Virginia.

Further opportunities for formal study, field work, and independent research by Cornell graduate students are available in many institutions, laboratories, and libraries both in the United States and in other countries. For example, the Cornell-Harvard Archaeological Exploration at Sardis, Turkey, and the Museum of Northern Arizona at Flagstaff, Arizona, both provide opportunities for field research related to doctoral work of Cornell graduate students. Information on that kind of arrangement is available directly from the Field Representatives.

Fields of Instruction

Agronomy

Faculty

Martin Alexander, W. H. Allaway, Richard W. Arnold, David R. Bouldin, Nyle C. Brady, Marlin G. Cline, Bernard E. Dethier, Matthew Drosdoff, William B. Duke, John M. Duxbury, Reeshon Feuer, David L. Grunes, W. Keith Kennedy, Harry A. Kerr, Warren W. Knapp, Ralph E. Krenzin, Joe Kubota, Douglas J. Lathwell, Edgar R. Lemon, Dean L. Linscott, Robert F. Lucey, Harry A. MacDonald, Robert D. Miller, Robert B. Musgrave, Ralph L. Obendorf, Gerald W. Olson, Michael Peech, William S. Reid, Thomas W. Scott, Robert R. Seaney, Earl L. Stone, Jr., Fred N. Swader, Madison J. Wright, Paul J. Zwerman

At Geneva

Benjamin E. Clark, Anwar A. Khan, LeRoy W. Nittler, M. T. Vittum

At Puerto Rico

Richard H. Fox

Field Representative

Earl L. Stone, Jr., 907 Bradfield Hall

MAJOR AND MINOR SUBJECTS

Field Crop Science

Meteorology

Seed Technology (major only for M.S.)

Soil Science

ADMISSION REQUIREMENTS. Scholastic records of applicants are judged by the extent and quality of previous training in chemistry, biological sciences, physics, mathematics, and geology, with emphasis depending on the intended major subject. All English-speaking applicants, where possible, must submit the results of the Graduate Record Examinations. A passing grade in a test of English proficiency is required of applicants whose native language or previous medium of instruction was not English.

Plant Breeding, which at many institutions is included in Agronomy, is a separate but closely related field at Cornell. Students primarily interested in plant breeding can apply to that field, or can choose it as a minor subject.

Ordinarily, students complete a Master's program before being accepted for a doctoral program, but direct admission to a doctoral program is permitted when students are exceptionally well prepared.

LANGUAGE REQUIREMENTS. There is no general language requirement for either the M.S. or the Ph.D. in the field. A candidate's

Special Committee may require language to be included in the student's program.

EXAMINATION REQUIREMENTS. The Graduate School requires all Ph.D. candidates to take an admission to candidacy and a final thesis examination. These are described on p. 11 of this *Announcement*.

OPPORTUNITIES FOR GRADUATE STUDY AND RESEARCH. Since 1968, the Field has occupied one of the most modern and diversified agronomic research facilities in the world. An air-conditioned, eleven-story research tower and adjoining wings incorporate fully equipped laboratory, teaching, office, and supporting spaces for work in field crop science, soil science, meteorology, and seed technology. The Field of Plant Breeding and the Section of Genetics, Development, and Physiology of the Division of Biological Sciences occupy a part of the tower and wings.

Graduate students have access also to newly constructed growth chambers and greenhouse facilities on the campus. The Agronomy Department operates three main field stations near Ithaca, representative of major agricultural regions of the state, to provide sites and equipment for field experimentation.

Seed technology studies are conducted also in new quarters at Geneva; students may arrange to work there while enrolled at Ithaca. Some members of the Field are staff members at the U.S. Plant, Soil, and Nutrition Laboratory (USDA) on the campus.

Minors may be elected from a large number of fields. In addition to physical, biological, and social sciences, these include water resources, soil engineering, soil and water engineering, and international agricultural development.

A limited number of students can do most or all of their research overseas under special agreements between Cornell and certain other institutions.

Special Interests of the Faculty

Field Crop Science and Seed Technology

Crop chemistry: Professors Duke, MacDonald, Obendorf.

Crop ecology: Professor Musgrave.

Crop physiology: Professors Duke, MacDonald, Musgrave, Obendorf, and Wright.

Crop preservation: Professors Musgrave and Wright.

Crop production: Professors Krenzin, Lucey, and Seaney.

Seed technology: Professors Clark, Khan, MacDonald, and Nittler.

Weeds and herbicides: Professors Duke and Linscott.

Meteorology

General meteorology: Professors Dethier and Knapp.

Climatology and microclimatology: Professor Dethier.

Agricultural micrometeorology: Professor Lemon.

Physical meteorology: Professor Knapp.

Soil Science

Soil chemistry: Professors Duxbury, Grunes, and Peech.

Soil fertility: Professors Allaway, Bouldin, Lathwell, Reid, Scott, and Vittum.

Soil microbiology: Professor Alexander.

Soil morphology, genesis, and cartography: Professors Arnold, Cline, Feuer, Kubota, and Olson.

Soil physics: Professors Lemon and Miller.

Soil and water conservation: Professors Kerr, Swader, and Zwerman.

Soil and water studies in aquatic environments: Professors Bouldin and Lathwell.

Soils of the tropics: Professor Drosdoff.

Forest soils: Professor Stone.

Organic soils: Professor Duxbury.

Courses

401 Geography and Appraisal of Soils of the Tropics. Spring term. Credit three hours. Mr. Drosdoff.

402 Chemical Methods of Soil Analysis. Spring term. Credit three hours. Prerequisite: 200 and Chemistry 236 or equivalent. Mr. Peech.

403 Organic Soils. Fall term. Credit two hours. Given every other year alternating with 404. Prerequisite: 200. Mr. Duxbury.

[404 Forest Soils. Fall term. Credit two hours. Given in alternate years. Prerequisite: 200. Mr. Stone. Not offered in 1971-72.]

405 Soil Mineralogy. Fall term. Credit three hours. Given in alternate years. Prerequisite: 200 and one year each of college chemistry and physics, or consent of the instructor.

406 Use of Soil Information and Maps as Resource Inventories. Fall term. Credit two hours. Given in alternate years. Mr. Olson.

407 Soil Physics, Lectures. Spring term. Credit three hours. Prerequisite: 200. Mr. Miller.

408 Soil Physics, Laboratory. Fall term. Credit two hours. Prerequisite: 200. Mr. Miller.

[410 Microbial Ecology. Spring term. Credit two hours. Given in alternate years. Prerequisite: an elementary course in some facet of microbiology. Mr. Alexander. Not offered in 1971-72.]

422 Tropical Agriculture. Spring term. Credit two to four hours, depending upon student preparation, participation, and related courses taken. Prerequisite: a course covering elementary botany and permission of the instructor. Mr. MacDonald.

450 Special Topics in Soil Science. Fall and spring terms. Credit one to six hours a term. Staff.

451 Special Topics in Field Crop Science. Fall and spring terms. Credit one to six hours a term. Staff.

461 Regional Agronomy Studies. Fall term. Credit four hours. Prerequisite: 111 and 200 or permission of the instructor. Enrollment limited and must be approved by the instructor in charge during preregistration. A three weeks' field study trip will take place during the preceding August. Enrollment in consecutive years permitted. Crops and soils staff.

481 Special Studies in Soils of the Tropics. Spring term. Credit three hours. Prerequisite: 200 and 301 or equivalent and approval of the instructor. Enrollment limited. Mr. Drosdoff.

501 Soil Chemistry. Fall term. Credit three hours. Given every other year, alternating with 507. Prerequisite: 200 and a one-year course in introductory physical chemistry, or consent of the instructor. Mr. Peech.

[503 Morphology, Genesis, and Classification of Soils. Spring term. Credit three hours. Given every other year, alternating with 524. Prerequisite: permission of the instructor. Mr. Arnold. Not offered in 1971-72.]

506 Advanced Soil Microbiology. Fall term. Credit one hour. Prerequisite: 306 or permission to register. Mr. Alexander.

[507 Soil Physics, Lectures. Fall term. Credit three hours. Given every other year, alternating with 501. Prerequisite: 200 and one year of college physics, or permission of the instructor. Mr. Miller. Not offered in 1971-72.]

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[513 Crop Ecology. Spring term. Credit two hours. Given every other year. Prerequisite: 200, 111, and Biological Sciences 240. Class meetings twice weekly for the first eight weeks of the semester, two hours per meeting. Mr. Musgrave. Not offered in 1971-72.]

514 Grasslands and Grassland Research. Fall term. Credit three hours. Offered in alternate years. Prerequisite: 312, Plant Breeding 200, and Biological Sciences 240, or equivalent, and permission to register. Mr. MacDonald.

522 Special Studies in Tropical Agriculture. Spring term. Credit three hours. S-U grades optional. Prerequisite: 111 and 313 or equivalent, and permission of the instructor. Field laboratory trip to tropical area held during preceding January intersession, but, because of limitation on participation, the field trip is not a prerequisite or a requirement of the course. Consult professor in charge regarding laboratory prior to December 1. Mr. MacDonald.

524 Soil Fertility, Advanced Course. Spring term. Credit three hours. Given every other year, alternating with 503. Prerequisite: a major or minor in agronomy or permission of the instructor. Mr. Bouldin.

550 Research Orientation and Perspective. Fall term. Credit two hours. S-U grades optional. Lectures and discussion. Mr. MacDonald.

560 Research in Soil Science. Fall and spring terms. All members of the professional staff.

561 Research in Field-Crop Production. Fall, spring, and summer terms. All members of the professional staff.

690 Seminar. Fall and spring terms. Required of graduate students majoring or minoring in the Field.

691 Soil Science Seminar. Fall and spring terms, alternating weeks with 690. S-U grades

only. Required of students whose major or minor subject is soil science.

692 Crop Science Seminar. Fall and spring terms, alternating weeks with 690. S-U grades only. Required of students whose major or minor subject is crop science.

Meteorology

The following courses carry Meteorology numbers.

411 Basic Theoretical Meteorology I. Fall term. Credit three hours. Prerequisite: one year each of calculus and physics. Mr. Knapp.

412 Basic Theoretical Meteorology II. Spring term. Credit three hours. Prerequisite: 411 or consent of the instructor. Mr. Knapp.

[438 Atmospheric Pollution. Spring term. Credit three hours. Given in odd-numbered years. Prerequisite: one year each of calculus and physics. Mr. Dethier. Not offered in 1971-72.]

447 Physical Meteorology. Fall term. Credit three hours. Given every other year, alternating with 449. Prerequisite: one year each of calculus and physics. Mr. Knapp.

[449 Physics of Clouds, Rain, and Rainmaking. Fall term. Credit three hours. Given every other year, alternating with 447. Prerequisite: one year each of calculus and physics. Mr. Knapp. Not offered in 1971-72.]

550 Special Topics in Meteorology and Climatology. Fall or spring term. Credit one or more hours. Prerequisite: permission of the instructor. Staff.

562 Research in Meteorology. Fall and spring terms. Credit one or more hours. Thesis research. Staff.

691 Seminar in Meteorology. Not offered every semester. Prerequisite: permission of the professor in charge. Staff.

Animal Breeding

Faculty

Stephen E. Bloom, Robert W. Bratton, Randall K. Cole, Robert W. Everett, Robert H. Foote, Charles R. Henderson, Robert E. McDowell, Paul D. Miller, L. Dale Van Vleck

Field Representative

C. R. Henderson, Morrison Hall

MAJOR AND MINOR SUBJECTS

Animal Breeding

Animal Genetics

Students entering a program of study in the areas of animal breeding and genetics are expected to have had good basic undergraduate training in biology, chemistry, and mathematics. Previous experience with large animals or with poultry is desirable but not absolutely essential.

There is no specific foreign language requirement in the Field, but individual faculty members of the Field may require one or more languages, depending upon the student's area of specialization and previous

training in languages. Graduate students are required to do some teaching during their course of study.

The admission to candidacy and final thesis examinations required by the Graduate School are described on p. 11 of this *Announcement*.

Special Interests of the Faculty

Professors Everett, Henderson, Miller, and Van Vleck: statistical genetics, with particular emphasis on selection programs for improvement of large animals.

Professors Bratton and Foote: reproductive physiology and related areas, and the use of various techniques in the genetic improvement of populations.

Professor McDowell: livestock breeding in the tropics.

Professor Bloom: avian cytogenetics.

Professor Cole: poultry genetics.

Superior facilities are available for graduate student training in each of these areas. Students are expected to participate actively in these research programs and generally are provided assistantships.

Animal Science

Faculty

Harry R. Ainslie, Robert C. Baker, Andre Bensadoun, Warren F. Brannon, Robert W. Bratton, H. Wilmot Carter, Randall K. Cole, Carl E. Coppock, J. Murray Elliot, Robert W. Everett, Robert H. Foote, William Hansel, Charles R. Henderson, Harold F. Hintz, Douglas E. Hogue, John K. Loosli, Robert E. McDowell, Alexander M. Meek, William G. Merrill, John I. Miller, Paul D. Miller, Roger P. Natzke, Malden C. Nesheim, Ellis A. Pierce, Wilson G. Pond, J. Thomas Reid, Glen H. Schmidt, Milton L. Scott, Samuel T. Slack, Sedgwick E. Smith, James R. Stouffer, Hugh F. Travis, George W. Trimberger, Kenneth L. Turk, Peter J. Van Soest, Ari van Tienhoven, L. Dale Van Vleck, Willard J. Visek, Richard G. Warner, George H. Wellington, Robert J. Young

Field Representative

John K. Loosli, 149 Morrison Hall

MAJOR AND MINOR SUBJECTS

Animal Breeding
Animal Nutrition
Animal Science
Dairy Husbandry
Meat Science
Physiology of Reproduction
Poultry Science (major only for M.S.)

To be admitted into graduate study in the Field of Animal Science, a student should have demonstrated a high order of scholar-

Courses

Animal Science 420. Quantitative Animal Genetics.

Animal Science 421. Seminar in Animal Genetics.

Animal Science 422. Research Techniques in Quantitative Animal Genetics.

Animal Science 520. Experimental Methods in Quantitative Genetics and Animal Breeding.

Animal Science 620. Seminar in Animal Breeding.

Poultry Science 420. Poultry Genetics.

Poultry Science 430. Cytochemistry and Cytophotometry.

In addition, faculty members assist in two seminars: Animal Science 601 and Poultry Science 609.

ship at the undergraduate level and should have had a good selection of animal science courses and as many physical science and biology courses as possible. It is desirable but not essential that a student who selects a poultry science major have some training and experience in poultry subject matters. A major in poultry science is available only at the Master's level. A student who expects to continue his graduate program in poultry science beyond that level should consider selecting a major in the Field of Animal Breeding, Food Science, Nutrition, or Physiology where he will work under the direction of appropriate faculty members in the Department of Poultry Science. Further information regarding these Fields will be found elsewhere in this *Announcement*.

There is no Field requirement regarding foreign languages; the choice of a foreign language is left to the individual's Special Committee.

Ph.D. candidates are required to have teaching experience for a minimum of two terms.

No particular examinations are required by the Field of Animal Science. The admission to candidacy and final thesis examinations required by the Graduate School are described on p. 11 of this *Announcement*.

FINANCIAL AID. Available to students in the Field is the F. B. Morrison Fellowship in Livestock Feeding: \$2,000 plus tuition and General Fee.

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Research and Study Opportunities

The Field of Animal Science is well staffed and equipped to offer research and study opportunities in the following areas of specialization.

Animal breeding: Professors Bratton, Everett, Foote, Henderson, P. D. Miller, and Van Vleck.

Animal nutrition: Professors Elliot, Hintz, Hogue, Loosli, Merrill, Pond, Reid, Smith, Van Soest, Visek, and Warner.

Animal physiology: Professors Bratton, Foote, Hansel, McDowell, Schmidt, Travis, and Visek.

Beef husbandry: Professor J. I. Miller.

Dairy husbandry: Professors Ainslie, Carter, Coppock, Elliot, Meek, Merrill, Natzke, Schmidt, Slack, Trimberger, and Turk.

Meats: Professors Stouffer and Wellington.

Sheep husbandry: Professors Brannon and Hogue.

Swine husbandry: Professors Pierce and Pond.

Students who desire a poultry science major will work under the direction of a faculty member in the Department of Poultry Science. Inquiries can be directed to Professor R. J. Young. Faculty specializations follow.

Animal breeding: Professor Cole.

Food science: Professor Baker.

Nutrition: Professors Nesheim, Scott, and Young.

Physiology: Professors Bensadoun and van Tienhoven.

Courses

Animal Science

400 Livestock Production in the Tropics. Spring term. Credit three hours. Prerequisite: 100, 112, or 220, or permission of the instructor. Mr. McDowell.

A discussion of the present and potential roles of domesticated animals as a source of food, power, and fiber in tropical areas of the world. The effects of climate on animal performance; the physiology of heat regulation in animals; problems of providing feed supplies in the tropics; systems of breeding; management practices as they affect reproductive performance; animal health and performance traits; the relative efficiency of livestock in the tropics; and economic considerations in livestock production will be summarized.

401 Special Studies in Livestock of the Tropics. Spring term. Credit three hours. Prerequisite: 220, 400, 410 and Biological Sciences 413, or permission of the instructor. Enrollment limited. Mr. McDowell.

Initial briefings will be at end of examination week of the fall term followed by an

eight- or nine-day field study trip to a tropical area during January intersession. Preregistration required by Dec. 1. Consult professor in charge regarding financial arrangements for travel and other course requirements.

410 Principles of Animal Nutrition. Fall term. Credit three hours.

411 Principles of Animal Nutrition, Laboratory. Fall term. Credit one hour.

420 Quantitative Animal Genetics. Fall term. Credit one, three, or four hours. S-U grades optional. Prerequisite: 220, Biological Sciences 281 or permission of the instructor. Mr. Van Vleck.

A consideration of the problems involved in the improvement of animals, especially farm animals, through the application of the theory of quantitative genetics with emphasis on the selection index.

The purpose of the optional (arranged) hour is to give an introduction to methods of research in quantitative genetics and animal breeding.

424 Animal Genetics. Fall term. Credit two hours. For veterinary students only. Mr. Van Vleck.

Principles of genetics; sex determination and sex linkage; inheritance of characteristics in domestic animals, with special reference to lethal genes, genetic resistance to disease and quantitative characters; progeny testing, genetic relationships and inbreeding.

427 Fundamentals of Endocrinology. Fall term. Credit four hours. Prerequisite: a course in human or veterinary physiology or permission of the instructor. Mr. Hansel.

A general course in the physiology of the endocrine glands and the roles played by each hormone in the regulation of normal body processes.

440 Advanced Reproductive Physiology. To be taught one term each year by a visiting professor. Credit three hours. Consult Mr. Hansel for details.

Depending on the qualification of the visiting professor, subjects may include neuro-endocrinology, biochemistry related to reproductive physiology, or biochemistry of the gametes.

451 Physiology and Biochemistry of Lactation. Spring term. Credit three hours. Given if 10 or more students register. Prerequisite: a course in physiology or 427. Mr. Schmidt.

An advanced course in the anatomy of the mammary gland, the physiological mechanisms of milk secretion, and the biochemical synthesis of milk constituents in laboratory and farm animals.

490 Meat Technology. Spring term. Credit three hours. Prerequisite: 290 or permission of the instructor. Mr. Wellington.

The character of muscle as a food, muscle structure, meat product formulations and production, methods for meat product quality control, product testing and improved meat packaging. The basic principles of meat preservation, processing, and meat product development through laboratory demonstration and practice in the pilot meat plant in Morrison Hall.

500 Research. Fall and spring terms. Credit by arrangement. All members of departmental staff.

505 Biochemistry of Gastrointestinal Fermentation. Fall term. Credit two hours.

511 Laboratory Work in Animal Nutrition.

513 Forage Analysis. Spring term. Credit two hours.

520 Experimental Methods in Quantitative Genetics and Animal Breeding. Fall term. Credit three hours. Prerequisite: Plant Breeding 514 or a course in mathematical statistics. Mr. Henderson.

Estimation of genetic and environmental parameters required to design efficient selection programs. Particular emphasis is given to interpretation of experimental and survey data with unequal subclass numbers and to prediction of genetic progress resulting from alternative selection methods.

601 Seminar in Animal Science. Fall and spring terms. Credit one hour. Required of all graduate students taking either a major or a minor subject in animal science. Staff.

610 Seminar in Animal Reproduction and Endocrinology. Spring term. No credit. Open to graduate students with a major or minor in physiology.

619 Seminar in Animal Nutrition. Fall term. Credit one hour. M 4:30.

620 Seminar in Animal Breeding. Fall or spring term. Credit one hour. Open to graduate students with a major or minor in animal breeding.

Biological Sciences 414. Mammalian Physiology. (Consult the course listing in this *Announcement* for the Field of Physiology.)

Advanced Nutrition Series. (Consult the course listing in this *Announcement* for the Field of Nutrition.)

Poultry Science

The following courses carry Poultry Science numbers.

420 Poultry Genetics. Spring term. Credit three hours. Offered in alternate years. Prerequisite: a course in genetics and permission of the instructor. Mr. Cole.

A survey of inherited characters in domestic birds, cytology, linkage, inbreeding, hybrid vigor, resistance to disease, genetic principles in poultry breeding, physiology of avian reproduction, infertility, embryonic mortality, and avian endocrinology.

425 Comparative Physiology of Reproduction of Vertebrates. Spring term. Credit three hours. Prerequisite: Animal Science 427 and consent of the instructor. Mr. van Tienhoven.

Sex and its manifestations, endocrinology of reproduction, interactions between endocrine and nervous systems. The laboratory will provide an opportunity for students to design and execute experiments with limited objectives.

440 Anatomy of the Fowl. Fall term. Credit three hours. Offered in alternate years. Prerequisite: Biological Sciences 102 or 104 and permission of the instructor. Mr. Cole.

The lectures, supplemented by laboratory periods for study and dissection, are designed to acquaint the student with the anatomy of the fowl.

450 Poultry Meat and Egg Technology. Spring term. Credit three hours. Offered in alternate years. Prerequisite: Chemistry 303 or equivalent, and Biological Sciences 290. Mr. Baker.

Advanced Nutrition Series. (Consult the course listing in this *Announcement* for the Field of Nutrition.)

511 Research in Nutrition. Fall or spring term. Credit and hours to be arranged. Registration by permission of staff member concerned. Messrs. Scott, Young, and Nesheim.

For students desiring experience in planning, conducting, and reporting independent research projects in poultry nutrition.

609 Seminar in Poultry Biology. Fall and spring terms. Members of the Departmental staff.

A survey of recent literature and research in poultry biology.

619 Seminar in Animal Nutrition. Fall term. Credit one hour.

Biochemistry

(See also the listing under Medical Sciences, p. 82 of this *Announcement*.)

Faculty

William J. Arion, Joseph M. Calvo, Louise J. Daniel, Stuart J. Edelstein, June Fessenden-Raden, James L. Gaylor, Quentin H. Gibson, Richard J. Guillory, Gordon G. Hammes, Leon A. Heppel, George P. Hess, Peter C. Hinkle, Andre T. Jagendorf, Elizabeth B. Keller, Richard E. McCarty, Donald B. McCormick, John K. Moffat, A. Leslie Neal, Walter L. Nelson, Efraim Racker, Gottfried Schatz, Harold A. Scheraga, John F. Thompson, David C. Wharton, Harold H. Williams, David B. Wilson, John F. Wootton, Lemuel D. Wright, Ray Wu, Roger G. Young, Donald B. Zilversmit

Visiting Professor
Robert W. Holley

Field Representative
Ray Wu, G17, Wing Hall, New Wing

MAJOR AND MINOR SUBJECT Biochemistry

ADMISSION REQUIREMENTS. Prior training in the physical sciences should include calculus, physics, and chemistry sequences through introductory physical chemistry; some knowledge of the basic principles of biology is desirable, but this can, if necessary, be acquired as part of the course of study to be prescribed. The Graduate Record Examinations Aptitude Test and Advanced Test in Chemistry or Biology are required.

LANGUAGE REQUIREMENTS. There is no uniform language requirement for the Ph.D. degree, but the major adviser could require a language.

TEACHING. Ph.D. candidates are required to teach for two semesters during their graduate training to enrich their teaching experience.

MINOR SUBJECTS. Appropriate minor subjects may be chosen from among those offered in biological sciences, chemistry, physics, and mathematics.

EXAMINATIONS. Ph.D. candidates are expected to schedule an oral admission to candidacy examination upon completion of the subject matter recommended by the Special Committee, and an oral examination on the thesis and related material.

Research and Study Opportunities

A wide variety of research opportunities is provided in modern, well-equipped laboratories. Faculty research specializations are summarized in the list below.

William J. Arion: role of phospholipids in membrane function and structure; regulation of liver microsomal enzymes.

Joseph M. Calvo: control of metabolic pathways in bacteria; bacterial genetics.

Louise J. Daniel: biochemical functions of vitamins B₁₂ and folic acid, interrelationship of vitamins and trace elements.

Stuart J. Edelstein: structure and function of polypeptides and proteins.

June Fessenden-Raden: enzymes in oxidative phosphorylation, immunological approaches to oxidative phosphorylation and membrane structure.

James L. Gaylor: biosynthesis of sterols and steroid hormones, control mechanisms of sterol biosynthesis.

Quentin H. Gibson: haemoproteins, flavoproteins, rapid reaction spectrophotometry, and physical methods in enzyme kinetics.

Richard J. Guillory: bioenergetics of muscle contraction.

Gordon G. Hammes: biophysical chemistry, especially enzyme kinetics and mechanisms.

Leon A. Heppel: structure and metabolism of nucleic acids, cell permeability in microorganisms.

George P. Hess: protein-mediated reactions, biological specificity and control mechanisms.

Peter C. Hinkle: mitochondrial ion transport and oxidative phosphorylation.

Robert W. Holley: biochemistry of nucleic acids.

Andre T. Jagendorf: electron transport and phosphorylation mechanisms in chloroplasts, synthesis of chloroplast proteins and their physiological controls.

Elizabeth B. Keller: enzymes, cofactors, and ribosomes in protein biosynthesis.

Richard E. McCarty: photosynthetic phosphorylation and electron transport.

Donald B. McCormick: enzymes concerned with transformation of vitamins and co-enzymes.

John K. Moffat: x-ray determination of protein structure, the relationship between structure and function in hemoglobin.

A. Leslie Neal: metabolism of plant pathogenic organisms and malignant cells.

Walter L. Nelson: biochemical mechanisms associated with functional states of cells.

Efraim Racker: mechanism of enzyme action, control mechanism, structure and function in mitochondria and chloroplasts, mechanisms in bioenergetics.

Gottfried Schatz: yeast mitochondria synthesis.

Harold A. Scheraga: physical chemistry of proteins.

John F. Thompson: nitrogen and sulfur metabolism of plants.

David C. Wharton: cytochrome oxidase, metalloenzymes, electron transport.

Harold H. Williams: biochemistry of proteins and amino acids, selenium metabolism in microorganisms.

David B. Wilson: biochemical genetics, physical chemistry of enzymes.

John F. Wootton: enzyme chemistry, relationships between structure and function.

Lemuel D. Wright: biosynthesis of biologically active compounds, mevalonic acid metabolism, biotin metabolism.

Ray Wu: nucleotide sequence analysis of phage DNA, control of enzyme and DNA synthesis in mammalian cells.

Roger G. Young: mechanism of action of insecticides, fat and wax metabolism of insects.

Donald B. Zilversmit: mechanism of fat absorption, lipid transport, cell membranes.

Combined graduate programs may be arranged with the following members of the staff of the Geneva Experiment Station: L. M. Massey, Jr., L. R. Mattick, R. S. Shallenberger, J. P. VanBuren.

Courses

All courses carry Biological Science numbers.

531-532 Intermediate Biochemistry, Lectures. Fall and spring terms. Credit four hours a term. Prerequisite: Chemistry 358, Biological Sciences 431, or permission of the instructor. Fall term: Mr. Calvo and staff. Spring term: Mr. Guillory and staff.

The major areas of biochemistry will be covered in some detail. This course is appropriate for students who have previously had a one-semester introductory biochemistry course. Fall term: proteins, enzymes and the nature of enzymatic catalysis; carbohydrate metabolism; nitrogen metabolism. Spring term: energetics; lipid metabolism; biosynthesis of informational macromolecules.

533 General Biochemistry, Laboratory. Fall term. Credit three hours. Prerequisite: Chemistry 287-288 or 389-390. Must be taken with or following 531. Messrs. Nelson, McCarty, and Wharton.

Selected experiments on carbohydrates, proteins, amino acids, and metabolism (cellular particulates, kinetics, general enzymology) will be given to illustrate basic biochemical principles. The course will emphasize the quantitative aspects rather than qualitative identifications.

536 Advanced Biochemistry Methods, Laboratory. Spring term. Credit two hours. Prerequisite: 533. Graduate majors in biochemistry only. Miss Keller and Mr. Wu.

After the formal instruction on research techniques in biochemistry and molecular biology, the students will do research work in the laboratory of three different professors chosen by the students.

631-632 Research Seminar in Biochemistry Fall and spring terms. Credit one hour a term. May be repeated for credit. Mr. Racker.

Required of all graduate students except first-year students majoring in biochemistry.

633-638 Advanced Biochemistry. Throughout the year. Lectures and seminars on specialized topics, three topics per term. Credit one hour per topic. Prerequisite: Biological Sciences 532 or consent of the instructor. May be repeated for credit.

The following fields will be covered (each field is divided into three related topics): Enzyme Structure and Mechanism of Action (Fall 1970, 1972); Aspects of Protein and Nucleic Acid Synthesis (Spring 1971, 1973); Structure, Function, and Synthesis of Biological Membranes (Fall 1971, 1973); Aspects of Metabolic Pathways and Their Control (Spring 1972, 1974).

633 Structure of Biological Membranes. Fall term 1971. First 4½ weeks of term. Mr. Zilversmit.

635 Structure and Function of Mitochondrial and Chloroplast Membranes. Fall term. Middle 4½ weeks of term. Mr. Racker.

637 Biogenesis of Membranes. Fall term. Last 4½ weeks of term. Mr. Schatz.

634 Regulatory Aspects of Photosynthesis. Spring term 1972. First 4½ weeks of term. Mr. McCarty.

636 Regulatory Aspects of Respiration. Spring term. Middle 4½ weeks of term. Mr. Wharton.

638 Regulatory Aspects of Muscle Contraction. Spring term. Last 4½ weeks of term. Mr. Guillory.

639 Biochemistry Seminar. Fall and spring terms. No credit. Staff.

Lectures on current research in biochemistry presented by distinguished visitors and staff.

Biology (See page 117.)

Botany

Faculty

Harlan P. Banks, Durwood F. Bateman, David M. Bates, Robert T. Clausen, Roderick C. Clayton, Leroy L. Creasy, Peter J. Davies, William J. Dress, Elmer E. Ewing, John W. Ingram, Jr., Andre T. Jagendorf, John M. Kingsbury, Richard P. Korf, Peter L. Marks, Lee N. Miller, Harold E. Moore, Jr., Ralph L. Obendorf, Jim L. Ozbun, Dominick J. Paolillo, Jr., Mandayam V. Parthasarathy, Loyd E. Powell, Jr., Roger M. Spanswick, Peter L. Steponkus, Frederick C. Steward, Harry T. Stinson, Jr., John F. Thompson, Harold B. Tukey, Jr., Charles H. Uhl, Robert H. Whittaker

Field Representative

Loyd E. Powell, Jr., 121 Plant Science Building

MAJOR AND MINOR SUBJECTS

Biosystematics
Cytology
Evolutionary Botany
General Botany (major only for M.S.)
Paleobotany
Phycology
Plant Ecology
Plant Morphology and Anatomy
Plant Physiology
Plant Taxonomy

ADMISSION REQUIREMENTS. It is strongly recommended that applicants provide scores of the Graduate Record Examinations. Students wishing to major in plant physiology are advised to obtain a background in calculus, inorganic and organic chemistry, and physics before entry.

LANGUAGE REQUIREMENTS. Although there is no language requirement for the M.S. or Ph.D. degree, a student's Committee may require him to demonstrate proficiency in languages appropriate to his educational objectives.

EXAMINATIONS. Except under unusual circumstances, each candidate for the Master's degree or the Ph.D. degree will take an oral prescriptive examination, administered by his Special Committee, during the first semester of residence. This examination gives the student and his Special Committee an opportunity to meet as a body and to plan a complete program. Other examinations required by the Graduate School are listed on page 11.

REQUIREMENTS FOR MAJORS IN PLANT PHYSIOLOGY. Degree requirements include a minimum of one intermediate or higher-level

course in three other relevant biological subjects (i.e., genetics, cytology, plant morphology, animal physiology, cell biology, ecology, microbiology, plant pathology, etc.) and one course in each of two supporting fundamental sciences (usually biochemistry and either organic or physical chemistry, biophysics, or relevant parts of mathematics, including computer usage). These requirements may coincide in part with those of the minor subjects or may be satisfied by courses taken before entry. Specific course requirements in plant physiology will include 340 or the equivalent, 543, 548, three terms of the student seminar 645, and two of the following three: 441, 545, 549. In addition to one major and two minor professors, each Ph.D. candidate will have a fourth voting member appointed by the plant physiologists.

RESEARCH FACILITIES. The Field offers exceptional facilities for all research programs related to the special interests of its faculty. Modern instrumentation, ranging from spectrophotometers to electron microscopes, is routinely available, as are growth and culture chambers and greenhouse facilities. The library ranks among the top ten in the country in number of botanical volumes, and the herbaria collectively represent one of the nation's major systematics resources. In the vicinity of the campus, Cornell owns many areas available for student research. Most of them are undeveloped and representative of a variety of habitats; however, some, such as the experimental ponds, are developed for specific research needs. Beyond the immediate confines of the campus, the faculty and the University maintain formal and informal relationships with other institutions or their staffs which permit students to carry on study and research under conditions most favorable to their individual programs.

Students majoring in plant physiology will be able to obtain training leading to professional competence in the physiology, biochemistry, biophysics, or cellular biology of plants. Research interests may be directed either toward fundamental science or toward the frontier between theoretical science and agricultural or oceanographic applications. The direction of studies will depend on the program worked out by the student together with his major adviser. In addition to staff members specializing in plant physiology, a number of faculty in the more applied areas of specialization have interests overlapping plant physiology. Opportunities for supplementary advice and training in chemistry, biochemistry, physics, subcellular morphology, and other areas are numerous.

Areas of Specialization

- Biosystematics: D. M. Bates and H. E. Moore, Jr.
 Cytology: C. H. Uhl.
 Evolutionary botany: Staff.
 General botany: Staff.
 Paleobotany: H. P. Banks.
 Phycology: J. M. Kingsbury.
 Plant ecology: R. T. Clausen, P. L. Marks, L. N. Miller, and R. H. Whittaker.
 Plant morphology and anatomy: H. P. Banks, D. J. Paolillo, Jr., and M. V. Parthasarathy.
 Plant physiology: D. F. Bateman, R. C. Clayton, L. L. Creasy, P. J. Davies, E. E. Ewing, A. T. Jagendorf, L. N. Miller, R. L. Obendorf, J. L. Ozbun, L. E. Powell, Jr., R. M. Spanswick, P. L. Steponkus, F. C. Steward, J. F. Thompson, and H. B. Tukey, Jr.
 Plant taxonomy: D. M. Bates, R. T. Clausen, W. J. Dress, J. W. Ingram, Jr., R. P. Korf, and H. E. Moore, Jr.

Special Interests of the Faculty

- H. P. Banks: paleobotany, especially of the Devonian, anatomy and morphology.
 D. F. Bateman: physiology, plant diseases caused by fungi and bacteria, cell-wall metabolism.
 D. M. Bates: biosystematics and evolution of flowering plants.
 R. T. Clausen: taxonomy, evolution, and ecology of vascular plants.
 R. C. Clayton: physical and photochemical mechanisms in photosynthesis.
 L. L. Creasy: physiology and biochemistry of plant phenolics.
 P. J. Davies: mode of action of plant hormones; regulation of senescence in higher plants.
 W. J. Dress: systematics and nomenclature of flowering plants, especially the Compositae.
 E. E. Ewing: nucleic acid metabolism; enzymes of potato tubers.
 J. W. Ingram, Jr.: systematics of flowering plants with emphasis on anatomical approaches.
 A. T. Jagendorf: electron transport, phosphorylation, ion fluxes and gradients in chloroplasts; protein and RNA synthesis in plastid development.
 J. M. Kingsbury: phycology, aquatic and marine ecology, phytotoxicology.
 R. P. Korf: systematics and nomenclature of fungi, lichens, and mycetozoa.
 P. L. Marks: plant ecology.
 L. N. Miller: physiological ecology, plant-water relations.
 H. E. Moore, Jr.: systematics of flowering plants, especially the Palmae, Gesneriaceae, and the Monocotyledonae in general.
 R. L. Obendorf: physiology and biochemistry of cold sensitivity during germination and

seedling development, greening and photosynthetic development.

- J. L. Ozbun: photosynthesis, photorespiration, and nutrition of crop plants.
 D. J. Paolillo, Jr.: plant morphology and anatomy.
 M. V. Parthasarathy: plant morphology and anatomy.
 L. E. Powell, Jr.: plant hormones, dormancy, hormonal aspects of fruit development, analytical techniques for hormones.
 R. M. Spanswick: ion transport in the Characeae and higher plants, electrophysiology of plant cell membranes.
 P. L. Steponkus: stress physiology, biochemical mechanisms of cold acclimation, freezing injury, hormonal controls in high-temperature injury and senescence.
 F. C. Steward: cell physiology, growth, metabolism, and morphogenesis in plants, cell and tissue cultures.
 J. F. Thompson: reactions and control mechanisms in amino acid biosynthesis; protein synthesis.
 H. B. Tukey, Jr.: physiology and growth regulation of higher plants; nutrition, uptake, and loss of substances by plants.
 C. H. Uhl: chromosomes and cytobotany.
 R. H. Whittaker: plant communities.

Courses

All courses carry Biological Sciences numbers unless otherwise noted.

Courses Open Only to Graduate Students

543 Plant Physiology, Advanced Laboratory. Fall term. Credit four hours. Primarily for students doing work in plant physiology, but open to others if space permits. Prerequisite: organic chemistry, biochemistry, Biological Sciences 240, or equivalent. Preregistration recommended. Staff.

An introduction to some modern methods in experimental plant biology.

545 Physical Approaches to Problems of Photosynthesis. Fall term of even-numbered years. Credit three hours. Prerequisite: Chemistry 104 or 108, Mathematics 112, Physics 208, or permission of the instructor. Mr. Clayton.

Emphasis is on physical and photochemical mechanisms and physical experimental approaches. Photosynthetic organisms, their photochemical apparatus, metabolic pathways and mechanisms for energy conversion; descriptive introduction to the physics of excited states in molecules and molecular aggregates; optical and photochemical properties of chlorophyll and of the living photosynthetic tissue; contemporary investigations of the photosynthetic mechanisms. At the level of

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Molecular Physics in Photosynthesis by Clayton.

547 General Photobiology. Fall term of odd-numbered years. Credit three hours. Prerequisite: same as for 545. Mr. Clayton.

A survey of systems of current interest in photobiology, including photosynthesis, bioluminescence, vision, photoperiodism, and the action of ultraviolet on nucleic acids. Physical concepts and methodologies are emphasized.

548 Plant Physiology: Aspects of Metabolism. Spring term. Credit three hours. Given in alternate years. Prerequisite: 240 and 431, Chemistry 353, or equivalent. Messrs. Jagendorf, Thompson, McCarty, and staff.

Selected areas of plant biochemistry will be reviewed in the context of the plant life cycle and responses to the environment. Probable topics include: metabolism and storage function of lipids, carbohydrates, organic acids; proteins and pigments; nitrogen and sulfur assimilation; hormone metabolism; respiration, photosynthesis, development and replication of mitochondria and chloroplasts; cell wall composition and properties. Emphasis will be on operation of control mechanisms.

549 Plant Physiology: Transport Phenomena. Fall term. Credit three hours. Given in alternate years. Prerequisite: 240 or equivalent. Mr. Spanswick.

An advanced course dealing with the transport of ions, water, and organic materials in plants. Mechanisms of ion transport. Relationships between ion transport and metabolism. Ion uptake and transport in higher plants. Phloem transport. Water relations of single cells and whole plants. Water relations of crops and natural communities.

564 Advanced Plant Ecology. (See Ecology and Evolutionary Biology.)

587 Perspectives in Plant Physiology: Advanced Lecture Series. Fall term. Credit two hours, or may be taken without credit. Mr. Steward.

The course will review salient topics in plant physiology, their present status, historical development, and the problems they still present. Topics considered will change somewhat from year to year but will normally include some treatment of cell physiology, organic and inorganic nutrition, metabolism, growth, and development.

643 Seminar in Plant Physiology. Fall and spring terms. Credit one hour if requested. Required of graduate students taking work in plant physiology and open to all who are interested. Staff.

Reports on current research in plant physiology by visitors, staff, or advanced graduate students.

645 Current Topics in Plant Physiology. Fall and spring terms. Credit two hours per term. May be repeated for credit. Staff.

Seminar reports by graduate students on current literature in experimental plant physiology or related areas.

647 Special Topics in Plant Taxonomy. Fall and spring terms. Credit one hour per term. Prerequisite: permission to register. Lecture and discussion.

A series of four topics, one presented each term, designed to provide professional background in biosystematics, literature of taxonomic botany, nomenclature, and tropical families of phanerogams.

A. Families of Tropical Phanerogams. Fall term, 1972. The families of flowering plants encountered solely or chiefly in tropical regions will be considered in lectures, discussions, and demonstrations with the aim of providing basic points for recognition and understanding of the diversity and relationships in these families for the student venturing into the tropics. Mr. Moore.

B. Literature of Taxonomic Botany. Spring term, 1972. A survey of the basic reference works in taxonomy from the pre-Linnaean literature drawn on by Linnaeus to contemporary publications, with comments on the peculiarities of the books (when appropriate), and on publication dates, typographic devices, and intricacies of bibliographic citation. Lectures, demonstrations, discussions, and problems. Mr. Ingram.

C. Nomenclature. Fall term, 1971. An analysis of the International Code of Botanical Nomenclatures and its application to various plant groups. Lectures, problems, discussion. Mr. Dress.

D. Biosystematics. Spring term, 1971. A consideration of biosystematic approaches to taxonomy, including chemical, numerical, cytological and statistical methodologies as well as a review of classic studies. Mr. Bates.

663 Seminar in Evolution and Ecology of Vascular Plants. Fall term. Credit one hour. Prerequisite: 464 or permission to register. Mr. Clausen.

An examination of primary problems concerned with the classification, evolution, and environmental relationships of vascular plants.

665 Environmental Physiology. (Field of Ecology and Evolutionary Biology.)

666 Population Ecology. (Field of Ecology and Evolutionary Biology.)

667 Community Ecology. (Field of Ecology and Evolutionary Biology.)

668 Ecosystems. (Field of Ecology and Evolutionary Biology.)

Agronomy 513 Crop Ecology.

Plant Breeding 505 Physiological Genetics of Crop Plants.

Plant Pathology 508 Disease and Pathogen Physiology.

Plant Pathology 579 Advanced Mycology.

Plant Pathology 599 Taxonomy of Fungi.

Plant Pathology 649 Mycology.

Pomology 504 Growth and Development of Woody Plants.

Undergraduate and Graduate Courses

340 Plant Physiology. Spring term. Credit five hours. Messrs. Jagendorf and Spanswick.

344 Biology of the Algae. Spring term. Credit four hours. Mr. Kingsbury.

345 Plant Anatomy. Fall term. Credit four hours.

347 Cytology. Fall term. Credit four hours. Mr. Uhl.

349 Plants and Man. Fall term. Credit three hours. Mr. Bates.

371 Evolution and Taxonomy of Vascular Plants. Fall term. Credit four hours. Mr. Clausen.

440 Cytogenetics. Spring term. Credit three hours. Mr. Uhl.

441 Plant Growth and Development. Fall term. Credit three hours. Given in alternate years. Prerequisite: 242 or 340, and 345 or equivalent, or permission of the instructor. Messrs. Paolillo, Davies, and staff.

444 Morphology of Lower Vascular Plants. Spring term. Credit four hours.

446 Morphology of Higher Vascular Plants. Spring term. Credit four hours.

448 Paleobotany. Spring term. Mr. Banks.

463 Plant Ecology. Fall term. Credit four hours. Mr. Miller.

464 Evolution and Ecology of Vascular Plants. Spring term. Credit four hours. Mr. Clausen.

Plant Pathology 309 Comparative Morphology of Fungi. Fall term. Credit four hours. Messrs. Korf and Lorbeer.

Communication Arts

Faculty

Jack A. Barwind, Joseph B. Bugliari, Royal D. Colle, Robert H. Crawford, Chester H. Freeman, Holim Kim, Russell D. Martin, Keith A. Miller, Charles C. Russell, Victor R. Stephen, William B. Ward

Field Representative

Robert H. Crawford, 640 Stewart Avenue

MAJOR SUBJECT

Communication Arts

The Field offers graduate training leading to the degree of Master of Professional Studies (Communication Arts). The degree program places emphasis on three elements: (1) an analysis of the communication process, (2) exploration of the potential of current and new communication techniques and technology, and (3) application of these elements to specific communication problems. Focus of the program is more on the strategic ap-

plication of communication knowledge and technology, both mass media and interpersonal, than on technical competence in media operation.

ADMISSION REQUIREMENTS. Normally, each applicant must meet the minimum requirements for the Cornell Graduate School. In cases of applicants whose academic records are outdated or are not pertinent to the profession, evidence of superior performance in the professional field, normally for at least three years, will be considered in combination with evidence bearing on intellectual and personal development, undergraduate record, test scores, special course work taken after completion of the Bachelor's degree, and similar documentation.

An undergraduate major in communication arts is not required. It is expected, however, that an applicant for the program will have some competence in one or several areas of communication through course work or exper-

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ience, or will be willing to spend time beyond the normal degree requirements to gain this competence. The extent of this competence will be decided on a case-by-case basis, determined partly by the applicant's educational and career goals.

LANGUAGES. No foreign languages are required by the Field. However, some professional opportunities may be dependent on the knowledge of one or more foreign languages. Upon evaluation of goals, the candidate and the chairman of his Committee determine the desirability of including languages in the program.

EXAMINATIONS. The Field requires only the examinations listed by the Graduate School on p. 11 of this *Announcement*.

RESEARCH. The faculty in this Field holds research interests in the following areas: press, telecommunication, international communication, communication theory, interpersonal communication, visual communication, history of the mass media, advertising, and sociopolitical dimensions of the mass media.

Courses

Specific programs are designed to fit the needs of each candidate. Information on time, location, and content of these courses is provided in the *Announcement of the College of Agriculture*.

The following courses are open to graduate students.

200 Theory of Human Communication. Fall term. Credit three hours. Mr. Barwind.

214 History of Mass Media. Spring term. Credit three hours. Mr. Crawford.

215 Introduction to Mass Media. Fall term. Credit three hours. Mr. Russell.

301 Oral Communication. Fall or spring term. Credit three hours. Messrs. Barwind, Freeman, and Martin.

302 Advanced Oral Communication. Fall or spring term. Credit two hours. Messrs. Barwind, Freeman, and Martin.

303 Small Group Communication. Spring term. Credit three hours. Mr. Miller.

311 Radio and Television Communication. Fall term. Credit three hours. Mr. Colle.

312 Advertising and Promotion. Spring term. Credit three hours. Mr. Russell.

313 Magazine Writing. Spring term. Credit three hours. Mr. Ward.

315 News Writing. Fall term. Credit three hours. Mr. Kim.

316 Science Writing. Spring term. Credit three hours. Mr. Kim.

318 Radio Writing and Production. Spring term. Credit three hours. Mr. Colle.

319 Television Writing and Production. Fall term. Credit three hours. Mr. Colle.

401 Communication Law. Spring term. Credit three hours. Mr. Bugliari.

403 Communication and Society. Fall term. Credit three hours. Mr. Miller.

404 Psychology of Human Communication. Spring term. Credit three hours. Mr. Barwind.

430 Visual Communication. Fall term. Credit three hours. Mr. Stephen.

431 Art of Publication. Spring term. Credit three hours. Mr. Kim.

The following are graduate-level courses.

501 International Communication. Spring term. Credit three hours. Mr. Crawford.

Analysis of the purposes, techniques, and effects of organizations involved in cross-national communication, with particular emphasis on the mass media. Also considered are the international conventions and other agreements that pertain to international communication.

512 Seminar: International Communication. Spring term. Credit three hours. Mr. Barwind.

A study of recent advances and research in listening, conference, small-group interaction, and nonverbal communication. New developments will be examined as they relate to business, administration, and education.

521 Seminar: United States Communication. Fall term. Credit three hours. Mr. Colle.

An examination of the structure of communication in the United States focusing particularly on the organization, content, controls, and audience of the print, broadcast, and film media. Selected media of other nations are included in the analysis to provide a perspective on the U.S. system.

524 Communication in Developing Nations. Fall term. Credit three hours. Mr. Crawford.

An examination of existing communication patterns and systems and their contributions to the development process. Special attention is given to the interaction between communi-

cation development and national development in primarily agrarian societies.

526 Comparative Mass Media. Spring term. Credit three hours. Mr. Colle.

A study of the mass media in several national settings with particular attention to the structure, controls, audience, and content of press and telecommunications.

531 Studies in Communication. Fall term. Credit three hours. Mr. Crawford.

An analysis of classic and contemporary research in communication, emphasizing both the findings of the studies and the methods of investigation.

532 Methods of Communication Research. Fall term. Credit three hours. Mr. Barwind.

An analysis of the methods employed in communications research. Particular concern is given to the philosophical rationale behind experimental, descriptive, and historical-critical research methods.

543 Frontiers in Communications. Fall term. Credit three hours. Mr. Colle.

A study of current developments in communication, with an emphasis on the creative application of the newest methods, materials, and technology in visual, print, film, oral, and telecommunication media to contemporary and future problems in communication. Examples include the applications and implications of satellite communication, multimedia "self-teaching" systems, mobile printing technology, facsimile, computer retrieval systems, heat-power radio, electronic video recorder, laser beams, etc.

550 Advanced Communication Seminar. Fall and spring terms. Credit three hours. Mr. Russell and staff.

A course designed to give students the opportunity to study and work on special problems in communication.

595 Directed Graduate Study. Fall and spring terms. Credit three to six hours. Staff.

Conservation

Faculty

Harlan B. Brumsted, Clarence A. Carlson, Alfred W. Eipper, John L. Forney, Douglas L. Gilbert, Lawrence S. Hamilton, Oliver H. Hewitt, Richard J. McNeil, Aaron N. Moen, Robert R. Morrow, Ray T. Oglesby, Edward C. Raney, Milo E. Richmond, Daniel Q. Thompson, Dwight A. Webster, Bruce T. Wilkins

Field Representative

O. H. Hewitt, 209 Fernow Hall

MAJOR AND MINOR SUBJECTS

Aquatic Science
Fishery Science
Forest Conservation (minor subject only)
Natural Resources Conservation
Wildlife Science

ADMISSION. To undertake study in this Field the student should be well prepared in biological sciences. A strong background in the physical sciences is highly desirable, and a working knowledge of statistical methods is important. To major in natural resources conservation, the student should come with training in some scientific discipline which he proposes to use in an integrative way to focus on natural resource problems, and he should preferably have professional job experience.

Applicants to this Field are requested to submit the results of the Graduate Record Examinations Aptitude Test, and Advanced Test in Biology if appropriate.

LANGUAGE REQUIREMENT. For the Ph.D. degree, the language requirement will be determined by the student's Special Committee.

EXAMINATIONS. An oral qualifying examination is given to Ph.D. candidates early in residence to explore possible deficiencies in educational background. This is followed by the comprehensive admission to candidacy examination taken after most of the course work has been completed. There is a final examination on the thesis subject. For the Master's degree, there is a final examination on subject matter and thesis.

Special Interests of the Faculty

Anadromous and marine fisheries management: Professor Raney.

Aquatic science and limnology: Professor Oglesby.

Fishery science: Professors Carlson, Eipper, Forney, and Webster.

Forest conservation: Professors Hamilton and Morrow.

Natural resources conservation: Professors Hamilton, McNeil, and Wilkins.

Outdoor recreation: Professors Brumsted and Wilkins.

Wildlife science: Professors Gilbert, Hewitt, McNeil, Moen, Richmond, and Thompson.

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Courses

Aquatic Science

443 Ecological Aspects of Water Resources Management. Fall term. Credit three hours. Limited to 30 students. Mr. Oglesby.

Basic structural and dynamic aspects of freshwater and estuarine ecosystems are reviewed. The nature and modes of action of stresses imposed by man on these systems and their significance to management decisions are then studied. Students will become acquainted with some of the more important laboratory and field study tools.

Fishery Science

439 Fish Ecology. Fall term. Credit three hours. Prerequisite: Biological Sciences 270 or permission of the instructor. Mr. Carlson.

Interactions between fishes and their living and nonliving environment and applications of ecological principles to fish population research and management; competition, predation, parasitism, commensalism, and other biotic interactions involving fishes; adaptations, behavior, distribution, and life histories of major taxonomic groups. The ecology of young fishes is stressed, and the student is introduced to the literature of fishery biology.

440 Fishery Science. Fall term. Credit three hours. Students with majors outside the Field must have permission of the instructor to register. Mr. Youngs.

Principles and theories involved in dynamics of fish populations; methods of obtaining and evaluating statistics of growth, population size, mortality, yield, and production as well as investigational aspects of fishery biology.

441 Fishery Resource Management. Spring term. Credit three hours. Prerequisite: 439 and 440 or permission of the instructor. Mr. Eipper.

Principles and problems in the management of freshwater and marine fishery resources, considered in relation to problems of human population and management of other natural resources; multiple use, evaluation, and allocation of water resources, with particular reference to fisheries; characteristics of fishery resources and their exploitation; applications of fishery science to the management of fish stocks through maintenance and improvement of habitat, fish population manipulation, and regulation of fishing.

600 Seminar: Major Fishery Investigations. Spring term. Credit one hour. Given in alternate years. Prerequisite: permission of the instructor. Staff.

A comparative review of major fishery investigations of the world. A study of pertinent literature and special topics will be assigned.

601 Seminar on Selected Topics in Fishery Biology. Fall or spring term. Credit one hour. Staff.

Natural Resources Conservation

415 Public Relations in Natural Resources Management. Spring term. Credit three hours. Prerequisite: one conservation course. Mr. Gilbert.

Methods of attaining and maintaining good public relations in the natural resource management professions through the use of effective communications, the media, and biopolitics, and by understanding the publics involved.

420 Outdoor Recreation. Fall term. Credit two hours. Prerequisite: 201 or permission of the instructor. Mr. Wilkins.

Factors involved in allocating natural resources for outdoor recreation are considered. Characteristics of public and private administration of recreation areas are studied and trends in outdoor recreation explored.

510 Perspectives on Conservation. Fall term. Credit two hours. Mr. Wilkins.

A seminar based upon extensive reading of articles highlighting varying philosophical approaches to the conservation of natural resources. Views espoused by developmentalists, preservationists, naturalists, economists, welfare economists, and urban planners will be considered.

511 International Natural Resources. Fall term. Credit two hours. Mr. Hamilton.

A seminar devoted to exploring international programs of nature conservancy, extinct and endangered species, floral and faunal protection in various countries, natural park systems, protection vs. management, the relevance of United States experience, and the role of nature conservancy in resource development of emerging nations.

602 Seminar in Natural Resources Planning and Development. Spring term. Credit two hours. Mr. Hamilton.

An interdisciplinary graduate seminar. Theme varies from year to year to include such topics as small watershed planning, multiple use management, urban fringe problems, outdoor recreation, land-use planning methods, and river basin development. Field trips and invited resource specialists.

604 Seminar on Selected Topics in Natural Resources Conservation. Spring term. Credit one hour. Mr. Brumsted and staff.

Primarily for students majoring or minoring in natural resources conservation.

Wildlife Science

304 Wildlife Ecology. Fall term. Credit three hours. Prerequisite: Biological Sciences 270. Mr. Moen.

Consideration of the basic interspecific, intraspecific, and physical relationships between the organism and its environment. Laboratories and field trips provide opportunities for student participation in environmental analysis.

410 Principles of Wildlife Management. Fall term. Credit three hours. Prerequisite: one conservation course. Mr. Hewitt.

Fundamental characteristics and mechanisms of wildlife population and habitats. Includes ecological, social, and economic aspects of wildlife management.

411 Wildlife Management Methods. Spring term. Credit two hours. Prerequisite: 410. Several all-day field trips. Mr. Hewitt.

Introduction to methods of management of wildlife and practical application of these techniques in the field. Intended for wildlife science majors.

412 Wildlife Management Laboratory. Fall term. Credit one hour. Prerequisite: 410 (or concurrent registration). Several all-day field trips. Mr. Hewitt.

Laboratory problems in wildlife management. Involves data collecting and analysis. Intended for wildlife science majors.

414 Advanced Wildlife Science. Spring term. Credit three hours. Prerequisite 410 and 411. Mr. Moen.

Nutrition, behavior and management of free-ranging wildlife.

603 Seminar in Selected Topics in Wildlife Science. Fall or spring term. Credit one hour. Staff.

Research

Either term. Credit to be arranged. Problems are undertaken in any of the areas of study in the Department, but adequate preparation in the specialized area and permission of the instructor are prerequisite.

492 Mammalogy. Mr. Richmond.

493 Aquatic Science. Mr. Oglesby.

494 Fishery Science. Messrs. Carlson, Eipper, Forney, and Webster.

495 Wildlife Science. Messrs. Gilbert, Hewitt, McNeil, Moen, and Thompson.

496 Forestry. Messrs. Hamilton and Morrow.

498 Natural Resources. Messrs. Brumsted, Hamilton, McNeil, and Wilkins.

500 Thesis Research. Fall and spring terms. Credit and hours arranged. S-U only. Limited to graduate students working on thesis research. Staff.

Departmental Seminar

610 Conservation Seminar. Fall and spring terms. Without credit. Staff.

Discussions of literature and current research in the broad field of conservation.

Ecology and Evolutionary Biology

Faculty

M. Alexander, H. W. Ambrose, J. P. Barlow, C. O. Berg, A. L. Bloom, J. W. Bradbury, W. L. Brown, P. F. Brussard, T. J. Cade, C. A. Carlson, R. T. Clausen, L. C. Cole, W. C. Dilger, G. C. Eickwort, T. Eisner, S. T. Emlen, H. E. Evans, P. P. Feeny, J. G. Franclemont, G. G. Gyrisco, R. G. Helgesen, J. W. Hudson, W. T. Keeton, J. M. Kingsbury, R. P. Korf, J. P. Kramer, D. A. Lancaster, G. E. Likens, W. N. McFarland, L. N. Miller, A. N. Moen, H. E. Moore, R. T. Oglesby, L. L. Pechuman, D. Pimentel, F. H. Pough, E. M. Raffensperger, E. C. Raney, M. E. Richmond, R. B. Root, E. L. Stone, M. J. Tauber, D. Q. Thompson, B. V. Travis, C. H. Uhl, L. D. Uhler, D. A. Webster, J. W. Wells, J. H. Whitlock, R. H. Whittaker

Field Representative

Lowell D. Uhler, Langmuir Laboratory

MAJOR AND MINOR SUBJECTS

Aquatic Ecology (including limnology, marine ecology, and oceanography)
Community and Ecosystem Ecology
Environmental Physiology
Evolutionary Biology
General Ecology
Paleoecology
Parasitology
Population Ecology
Terrestrial Ecology
Vertebrate Zoology (including herpetology, ichthyology, mammalogy, and ornithology)

REQUIREMENTS. Applicants are strongly urged to present scores on the Graduate Record Examinations Aptitude and Advanced Biology Tests.

The language requirement for the Master's degree is college entrance proficiency (or the equivalent) in one language. The language

66 Ecology and Evolutionary Biology

requirement for the Ph.D. degree is proficiency in two languages or superior ability in one.

A written Field examination in ecology and evolutionary biology must be taken before the student can schedule an admission to candidacy examination. A final thesis examination is required by the Graduate School and is described on p. 11 of this Announcement.

Students obtain teaching experience as teaching assistants for two terms in one of several basic or advanced courses.

A petition may be submitted for a waiver of teaching and language requirements.

Special Interests of the Faculty

Members of the faculty will be especially interested in directing research in the areas mentioned below, although research will not be limited to these areas. Prospective students will find it to their advantage to correspond before they apply with staff members whose interests are most closely related to their own.

- M. Alexander: microbiological ecology.
- H. W. Ambrose: behavioral ecology of mammals.
- J. P. Barlow: plankton ecology and oceanography.
- C. O. Berg: bionomics of freshwater invertebrates.
- A. L. Bloom: coastal geomorphology.
- J. W. Bradbury: comparative studies of social organization and communication; echolocation.
- W. L. Brown: systematics of ants and evolutionary theory.
- P. F. Brussard: structure and genetics of natural populations, species diversity.
- T. J. Cade: environmental biology of vertebrates.
- C. A. Carlson: ecology of freshwater fish.
- R. T. Clausen: systematics and distribution of flowering plants and ferns.
- L. C. Cole: population ecology.
- W. C. Dilger: vertebrate ethology.
- G. C. Eickwort: systematic behavior and morphology of bees and mites.
- T. Eisner: chemical basis of behavior in invertebrates.
- S. T. Emlen: behavioral ecology of birds and amphibians.
- H. E. Evans: vertebrate development and gross anatomy.
- P. P. Feeny: chemical ecology of insect-plant relationships.
- J. G. Franclemont: systematics of Lepidoptera.
- G. G. Gyrisco: insect ecology.
- R. G. Helgesen: quantitative population ecology of insects.
- J. W. Hudson: physiological ecology of mammals.

- W. T. Keeton: bird behavior and arthropod systematics.
- J. M. Kingsbury: phycology.
- R. P. Korf: systematics and evolution of fungi, lichens, and mycetozoa.
- J. P. Kramer: ecology of insect pathogens.
- D. A. Lancaster: behavior of neotropical birds.
- G. E. Likens: limnology.
- W. N. McFarland: comparative and environmental physiology of vertebrates.
- L. N. Miller: physiological plant ecology.
- A. N. Moen: environmental physiology of mammals and birds.
- H. E. Moore: systematics of flowering plants.
- R. T. Oglesby: aquatic ecosystems and pollution problems.
- L. L. Pechuman: systematics and ecology of diptera.
- D. Pimentel: population ecology and genetics.
- F. H. Pough: herpetology.
- E. M. Raffensperger: biology of the diptera.
- E. C. Raney: systematics, ecology, and behavior of fishes.
- M. E. Richmond: vertebrate ecology and reproduction.
- R. B. Root: comparative population and community ecology.
- E. L. Stone: forest soils and nutrient cycles in natural vegetation.
- M. J. Tauber: insect ecology.
- D. Q. Thompson: wildlife ecology.
- B. V. Travis: parasitology and biology of biting diptera.
- C. H. Uhl: chromosomes and cytotaxonomy.
- L. D. Uhler: insect ecology.
- D. A. Webster: population dynamics of fishes.
- J. W. Wells: systematics and ecology of recent and fossil corals.
- J. H. Whitlock: experimental epidemiology and endemiology.
- R. H. Whittaker: plant communities.

Courses

All courses carry Biological Sciences numbers unless otherwise indicated. This listing is not final; students should consult with their advisers to determine what the actual offerings for 1971-72 will be.

273 The Vertebrates. Fall term. Credit five hours. Prerequisite: 101-102 or 103-104. Limited enrollment.

An introduction to the evolution, classification, comparative anatomy, life history, and behavior of vertebrate animals. Laboratory dissection, experimentation, and demonstration are concerned with structure, classification, systematics, biology of species, and studies of selected aspects of vertebrate life.

344 Biology of the Algae. Spring term. Credit four hours. Mr. Kingsbury.

An introduction to the freshwater and marine algae including consideration of their

Ecology and Evolutionary Biology 67

ecology as members of the plankton and benthos and their importance to man. The laboratory, utilizing field material and cultures from an extensive living collection, is designed to illustrate lecture topics, provide familiarity with algae in the field, and introduce the student to techniques used in isolating, culturing, and studying algae in the laboratory.

361 General Ecology. Fall or spring term. Credit three hours. Prerequisite: 101-102 or 103-104 or equivalent. Mr. Root.

Principles concerning the interactions between organisms and their environment. Influence of competition, social behavior, predation, and other factors on population size and dispersion. Role of energy flow and mineral cycling in determining the structure and productivity of ecosystems. Succession and classification of natural communities. Influence of climate and past events on the diversity and stability of communities in different regions of the world. Interspecific competition and the niche concept. Chemical interactions between organisms. Application of ecological principles to human problems. Modern evolutionary theory will be stressed throughout and attention given to conflicting ecological hypotheses.

362 Laboratory and Field Ecology. Fall term. Credit two hours. Prerequisite: permission of the instructor. Enrollment limited. Mr. Cole and others.

A laboratory and field course to accompany or follow 361 for students who intend to concentrate in the area of ecology. This course will give the students a first-hand contact with ecological techniques.

364 Field Marine Biology. Credit two hours. Prerequisite: a full year of college biology. A special course offered on Star Island, off Portsmouth, N. H., in June. Messrs. Anderson, Gilbert, Hewitt, Raney, Barlow, and Kingsbury (in charge).

Living material and habitats will be emphasized in introducing students to the major disciplines of marine biology and in rounding out the student's knowledge of these topics as presented at inland locations. For more details, see the *Announcement of the Summer Session* or consult Mr. Kingsbury.

371 Evolution and Taxonomy of Vascular Plants. Fall term. Credit four hours. Prerequisite: 281 or permission to register. Mr. Clausen.

An introduction to the evolution and classification of vascular plants, with attention to principles, methods of identification, and literature. In the first part of the term, trips are held in laboratory periods.

460 Marine Ecology. Spring term. Credit three hours. Prerequisite: 361, 461, organic chemistry, and permission of the instructor. Enrollment limited. Mr. Barlow.

A consideration of oceanographic aspects of the marine environment. Lectures and seminars, with demonstrations and field trips to be arranged.

461 Oceanography. Fall term. Credit three hours. Prerequisite: college physics and chemistry; college mathematics desirable. Mr. Barlow.

462 Limnology. Spring term. Credit four hours. Prerequisite: 361, organic chemistry, and one year of college physics or permission of the instructor. Mr. Likens.

A study of processes and mechanisms in the biology, chemistry, and physics of inland waters taught from a functional and analytic point of view. Laboratories devoted to both field studies and experiments on model systems.

462A Limnology Lectures. Spring term. Credit three hours. Prerequisite: 361, organic chemistry, and one year of college physics, or permission of instructor. Mr. Likens.

The lecture portion of course 462.

463 Plant Ecology. Fall term. Credit four hours. Prerequisite: 101-102 or 103-104 or equivalent. Messrs. Whittaker and Miller.

Principles of plant-environment interactions in relation to the distribution, structure, and functioning of plant communities. These principles will be illustrated by analyzing in the field representative plant communities and their environments.

464 Evolution and Ecology of Vascular Plants. Spring term. Credit four hours. Prerequisite: 371 or permission to register. Mr. Clausen.

A study of the variation, evolution, and ecological distribution of vascular plants. Laboratory periods in the later part of the term are devoted to study of natural populations in the field.

466 Chemical Ecology. Spring term. Credit two hours. Prerequisite: Chemistry 353 or 357-358, Biological Sciences 101-102 or 103-104, or permission of the instructor. Messrs. Alexander, Eisner, Meinwald, Whittaker, and Feeny (in charge).

Ecological and evolutionary significance of chemical interactions between organisms. Summary of key processes in regulation of natural populations. Survey of major classes of natural products with emphasis on appropriate analytical techniques. Chemical adaptations for reproduction, defense, habitat selection, dispersal, feeding efficiency and

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competition in animals, plants, and micro-organisms. Choice of adaptive strategy in relation to energy flow. Practical applications of chemical ecology.

469 Biology of Fishes. Spring term. Credit four hours. Prerequisite: 101-102 or 103-104, or 273, or equivalent. Mr. Raney.

An introduction to the study of fishes; their structure, classification, evolution, distribution, ecology, physiology, and behavior. Laboratory studies on structure, identification, classification, and nomenclature. Field studies of local species.

[470 Ichthyology. Spring term. Credit four hours. Prerequisite: 469 or permission of the instructor. Mr. Raney. Not given in 1971-72.]

471 Mammalogy Lectures. Spring term. Credit four hours. Prerequisite: 273 or equivalent work in vertebrate biology and permission of the instructor. Mr. Hudson.

471A Mammalogy Laboratory. Spring term. Credit one hour. Prerequisite: concurrent enrollment in 471. Mr. Hudson.

472 Ornithology. Spring term. Credit four hours. Prerequisite: 273 or equivalent work in vertebrate biology and permission of the instructor. Mr. Lancaster.

Lectures cover various aspects of the biology of birds including anatomy, physiology, classification, evolution, migration and orientation, behavior, ecology, and distribution. Laboratory will include studies of external and internal morphology, pterylosis, molts and plumages, skin identification of birds of New York and families of birds of the world. Several demonstration periods will emphasize hybridization, evolution, adaptive radiation, mimicry, and geographic variation. Field work includes identification of birds and familiarization with some techniques used in field research.

474 Herpetology Lectures. Spring term of even-numbered years. Credit two hours. Prerequisite: 273, or equivalent work in vertebrate biology and permission of the instructor. Mr. Pough.

Lectures on evolution, classification, distribution, and adaptations of reptiles and amphibians. Emphasis on ecology, behavior, and environmental physiology.

474A Herpetology Laboratory. Spring term. Credit two hours. Prerequisite: concurrent enrollment in 474. Limited to 12 students.

Laboratory and field work on systematics, ecology, behavior, and physiology of amphibians and reptiles. In the second half of the semester the class will be divided into several groups which will concentrate on different projects.

475 Evolutionary Theory. Fall term. Credit four hours. Prerequisite: 281; a course with some taxonomic content in botany or zoology is desirable, or else some experience with making and maintaining a personal collection of some plant or animal group. Mr. Brown.

Lectures and class discussions on organic evolution, with primary emphasis on the mechanisms of speciation and adaptation. The course begins with a few lectures on taxonomic methodology.

480 Population Genetics. Spring term. Credit three hours. Prerequisite: 281 or equivalent and permission of the instructor. Mr. Wallace.

A study of factors which influence the genetic structure of Mendelian populations and which are involved in race formation and speciation.

[512 Comparative Physiology Lectures. Spring term. Credit four hours. Prerequisite: 413 or 414 and biochemistry or the equivalent. Messrs. McFarland and Pough. Not given in 1971-72.]

[512A Comparative Physiology Laboratory. Spring term. Credit two hours. Prerequisite: concurrent enrollment in 512. Not offered in 1971-72.]

561 Quantitative Ecology. Fall term. Credit four hours. Offered in alternate years. Prerequisite: one year of biology and permission of the instructor. Organic chemistry and some college mathematics are desirable. Mr. Cole.

A quantitative course on selected ecological topics, including the origin and interpretation of habitat differences, toleration and response physiology, population dynamics, construction and uses of life tables, spatial distribution patterns, and approaches to the quantitative analysis of biotic communities.

564 Advanced Plant Ecology. Spring term. Credit two or four hours. Prerequisite: 463 and permission of the instructor; one course each in plant physiology and soils recommended. Messrs. Whittaker and Miller.

Seminars dealing with either (a) physiological mechanisms and the physical, chemical, and biological processes which underlie the distribution of plants and communities, or (b) structure, function, and theoretic interpretation of plant communities. The seminars may be offered concurrently; both may be taken for four credits.

565 Special Topics in Limnology. Fall term. Credit one hour. Prerequisite: consent of the instructor.

Primarily a seminar course. Advanced discussion and experimentation in specific topics

in limnology. Content variable from year to year.

571 Special Topics in Higher Vertebrates. Fall term. Credit two hours. Prerequisite: advanced courses in vertebrate biology and permission of the instructors. Enrollment limited. Messrs. Cade and Hudson.

Seminars on selected topics of vertebrate ecology, behavior, physiology, and systematics with an emphasis on review of current literature.

572 Special Topics in Lower Vertebrates. Fall term. Credit and hours to be arranged. Prerequisite: consent of the instructor. Enrollment limited. For advanced students in biological sciences. Messrs. McFarland and Pough.

Detailed consideration of selected topics in comparative physiology. Preparation of demonstration experiments stressing technique and individual research problems will be included. Topics vary from year to year.

661 Seminar in Population and Community Ecology. Fall term. Credit one hour. Prerequisite: permission of the instructor. Messrs. Brussard, Levin, and Root.

Topic to be announced.

663 Seminar in Evolution and Ecology of Vascular Plants. Fall term. Credit one hour. Prerequisite: 464 and Statistics 510 or 511 or equivalent, or permission of the instructor. Mr. Clausen.

A consideration of primary problems concerned with the classification, evolution, and environmental relationships of vascular plants.

665 Environmental Physiology. Fall term. Credit three hours. Prerequisite: one course each in ecology and physiology and consent of the instructor. Messrs. McFarland and Miller.

Consideration of the responses of organisms to environmental variables. Emphasis on similarities and differences in molecular and organismal mechanisms by which plants and animals cope with their environments.

666 Population Ecology. Spring term. Credit three hours. Prerequisite: some background in calculus, statistics, ecology, and evolutionary theory plus consent of the instructor. Messrs. Brussard and Cole.

Critical examination of the properties and dynamics of populations. Emphasis on theories of population structure, dynamics, and regulation. Discussion of experimental approaches to analyses of natural populations.

[667 Community Ecology. Fall term. Credit three hours. Prerequisite: 666 or permission of the instructor. Messrs. Barlow, Marks, and Whittaker. Not given in 1971-72.]

[668 Ecosystems. Spring term. Credit three hours. Prerequisite: 667 or permission of the instructor. Messrs. Likens and Whittaker. Not given in 1971-72.]

Agronomy 306 Soil Microbiology. Spring term. Credit three hours. Prerequisite: 200 or 290. Mr. Alexander.

A study of the major groups of soil microorganisms, their ecological interrelationships, and the biochemical functions of the soil population.

Agronomy 307 Soil Microbiology, Laboratory.

Agronomy 404 Forest Soils.

Agronomy 506 Advanced Soil Microbiology.

Biological Sciences 421 Comparative Vertebrate Ethology. (Field of Neurobiology and Behavior.)

Biological Sciences 492 Microbial Ecology.

Biological Sciences 523 Ecological Aspects of Animal Behavior. (Field of Neurobiology and Behavior.)

Biological Sciences 622 Seminar in Ecological Animal Behavior. (Field of Neurobiology and Behavior.)

Conservation 439 Fish Ecology.

Entomology 331 Introductory Insect Taxonomy.

Entomology 351 Introductory Parasitology.

Entomology 531 Taxonomy of the Smaller Orders of Insects.

Entomology 532 Taxonomy of the Immature Stages of Holometabola.

Entomology 533 Taxonomy of the Coleoptera and Lepidoptera.

Entomology 534 Taxonomy of the Diptera and Hymenoptera.

Entomology 551 Advanced Parasitology (Protozoa and Helminths).

Entomology 553 Advanced Parasitology (Insect Pathology).

Entomology 672 Entomology and Limnology Seminar.

Plant Pathology 309 Comparative Morphology of Fungi.

70 Entomology and Limnology

Entomology and Limnology

Faculty

Clifford O. Berg, James L. Brann, William L. Brown, Jr., Jeffrey M. Camhi, James E. Dewey, George C. Eickwort, Thomas Eisner, Paul P. Feeny, John G. Franclemont, George G. Gyrisco, Robert G. Helgesen, Warren T. Johnson, William T. Keeton, John P. Kramer, Donald J. Lisk, John G. Matthyse, Roger A. Morse, Arthur A. Muka, Richard D. O'Brien, Ray T. Oglesby, Charles E. Palm, Robert L. Patton, L. L. Pechuman, David Pimentel, Edgar M. Raffensperger, W. Arthur Rawlins, Richard B. Root, Edward H. Smith, Maurice J. Tauber, B. V. Travis, Lowell D. Uhler, Dwight A. Webster, Christopher F. Wilkinson, Roger G. Young

Off Campus

J. Alfred Adams, Heinrich Arn, Alexander C. Davis, Charles J. Eckenrode, Edward H. Glass, F. David Judge, Ronald J. Kuhr, Siegfried E. Lienk, Wendell L. Roelofs, George A. Schaefer, Maurie Semel, E. Frederick Taschenberg, Haruo Tashiro, Kenneth Trammel

Field Representative

Roger G. Young, 192 Insectary

MAJOR AND MINOR SUBJECTS

Apiculture

Economic Entomology

Entomology (minor only)

Insect Biochemistry

Insect Ecology

Insect Morphology

Insect Pathology

Insect Physiology

Insect Taxonomy

Insect Toxicology

Insecticide Chemistry

Limnology

Medical Entomology

Parasitology

Graduate study in the Field of Entomology and Limnology includes all phases of the biology of insects including biochemistry, ecology, morphology, physiology, and systematics as well as apiculture and economic entomology. In addition, the Field has strong graduate programs in limnology, toxicology, and parasitology (including insect pathology). General biological concepts are studied using insects and other invertebrates. Insects are ideally suited as experimental animals in a wide variety of biological investigations because of their numbers and ease of manipulation in the laboratory and in nature.

To undertake graduate study, the student should be well prepared in the fundamentals of biology, chemistry, physics, mathematics,

and humanities. In completing his graduate study, the student will have a sound foundation in fundamental knowledge and research methodology. Each student will be provided individual guidance by the Field faculty.

Special facilities for study and research include the outstanding Comstock Entomological Library, an extensive insect collection, an insectary, greenhouses, bioclimatic chambers, field stations, natural preserves, and numerous well-equipped laboratories. Brochures describing the facilities and activities are available from the Field Representative.

LANGUAGE REQUIREMENT. The minimum requirement for the Doctor of Philosophy degree is one appropriate language to be determined by the student's Special Committee. The Committee will also specify the level of proficiency (ETS or CEEB). A student in some specialized areas of study (e.g., systematic entomology) may expect to be required to demonstrate proficiency in two appropriate languages. No foreign language is required for the Master of Science degree.

EXAMINATION REQUIREMENT. The Field requires a prescriptive examination for both Master's and doctoral candidates, usually held during the first semester of work. It provides an opportunity for the student and his Committee to plan a complete course program. The Graduate School requires the admission to candidacy and final thesis examinations of all Ph.D. candidates. These examinations are described on p. 11 of this *Announcement*.

FINANCIAL AID. In addition to teaching and research assistantships and the Comstock Scholarship, traineeships are available in environmental biology and entomology, environmental toxicology, and the ecology of pest management.

Specializations of the Faculty

Ecology

Behavior: Professors Camhi, Eickwort, Eisner, Morse, Roelofs, and Tauber.

Ecology: Professors Berg, Feeny, Gyrisco, Helgesen, Palm, Pimentel, Root, Tauber, and Uhler.

Economic Entomology

Apiculture: Professor Morse.

Application equipment: Professor Brann.

Chemistry of plant resistance to insects: Professors Arn and Feeny.

Floricultural insects: Professor Helgesen.

Forage insects: Professors Gyrisco and Pimentel.

Fruit insects: Professors Glass, Lienk, Schaefers, Smith, Taschenberg, and Trammel.

Household insects and insects affecting man: Professor Raffensperger.

Insects of ornamentals: Professors Johnson and Tashiro.

Livestock insects: Professor Matthyse.

Medical entomology: Professor Travis.

Vegetable insects: Professors Adams, Davis, Eckenrode, Judge, Muka, Rawlins, and Semel.

Limnology

Aquatic entomology: Professors Berg, Pechuman, and Travis.

Limnology: Professors Berg, Oglesby, Pimentel, and Webster.

Morphology

Morphology: Professors Eickwort and Eisner.

Parasitology

General parasitology: Professors Kramer and Travis.

Insect pathology: Professor Kramer.

Physiology and Biochemistry

Biochemistry: Professors Camhi, Patton, Wilkinson, and Young.

Physiology: Professors Camhi, Patton, Smith, Wilkinson, and Young.

Systematics

Acarology: Professors Eickwort, Matthyse, and Travis.

General systematics: Professors Brown, Eickwort, Franclemont, Keeton, and Pechuman.

Systematics of ants: Professor Brown.

Systematics of bees: Professor Eickwort.

Systematics of Diptera: Professors Berg and Pechuman.

Systematics of Lepidoptera: Professor Franclemont.

Systematics of millipeds: Professor Keeton.

Toxicology

Analytical technology: Professor Lisk.

Bioassay: Professors Arn and Dewey.

Biochemical aspects: Professors Kuhr, Wilkinson, and Young.

General toxicology: Professors Kuhr, Lisk, Wilkinson, and Young.

Selective toxicants: Professor O'Brien.

Synergists: Professor Wilkinson.

Courses

General Entomology

210 Introductory Entomology. Spring term. Credit three hours. Prerequisite: Biological Sciences 101 and 102, or 103-104, or equivalent. Mr. Raffensperger and assistants.

A survey of the structure, biology, and classification of insects; an introduction to the study of insects as a major segment of the biological community, with attention to representative species of economic importance and the techniques and consequences of their control. Laboratory exercises in anatomy and biology and practice in the techniques of insect identification. A collection of insects is required.

212 Insect Biology. Fall term. Credit three hours. Prerequisite or parallel: Biological Sciences 101 and 102, or 103-104, or equivalent. Mr. Eickwort and assistants.

Designed to introduce the science of entomology by focusing on the basic principles of the systematics, morphology, physiology, behavior, and ecology of insects. The laboratory in early fall includes field trips to study and collect insects in their natural environment.

[518 Techniques of Biological Literature. Fall term. Credit two hours. Given in alternate years. Mr. Franclemont. Not offered in 1971-72.]

[521 Acarology. Fall term. Credit four hours. Prerequisite: 210 or 212, or equivalent, and permission to register. Mr. Eickwort. Not offered in 1971-72.]

Apiculture

262 Biology of the Honey Bee. Fall term. Credit one hour. Prerequisite: Biological Sciences 103-104 or equivalent. Limited to 10 students. Registration only by permission. Fifteen laboratories by arrangement in September and October only. Mr. Morse.

A laboratory and field course in which the classical experiments on the vision, chemical senses, and language of the honey bee, as described by von Frisch, are repeated. Laboratories include demonstration of the sex attractant, swarm orientation, the natural nest, and a study of wasp, bumble bee, and other social insect nests.

562-563 Special Topics in Beekeeping. Throughout the year. Credit three hours a term. Registration by permission. By appointment. Mr. Morse.

A technical course designed for advanced studies and covering scientific investigation in all phases of the subject. Special atten-

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tion is given to improved methods of apiary and honeyhouse management and the preparation of honey for market. Current literature on beekeeping is assigned, reviewed, and evaluated by students. Lectures and discussions are supplemented by field trips.

Biological Control

577 Biological Control and Insect Behavior. Fall term. Credit three hours. Prerequisite: consent of the instructor. Mr. Tauber.

Participants will critically review theory and method of biological control of pest species, with emphasis on the role of behavior.

Ecology and Limnology

471 Bionomics of Freshwater Invertebrates. Spring term. Credit three hours. Prerequisite: 210 or 212; Biological Sciences 361 recommended. Mr. Berg.

A field and laboratory study focused on the aquatic insects but also including the Crustacea, Mollusca, and other macroscopic invertebrates. It includes identification of these organisms, understanding where and how they live, and consideration of the physical and chemical conditions and the ecological relationships in different freshwater biotopes.

595 Environmental Biology. Fall and spring terms. Credit one or two hours a term. Permission to register required. Seminar and discussions by arrangement. Mr. Pimentel and guest lecturers.

Consideration will be given to current environmental problems, with particular emphasis on the "systems approach" to pest management.

672 Seminar in Aquatic Ecology. Fall term. Credit one hour. Offered in alternate years. Prerequisite: 471 or Biological Sciences 462, and permission of the instructor. Mr. Berg.

Discussions and analyses of current concepts and problems in limnology and aquatic entomology, including the critical study of selected reference works and research papers.

Biological Sciences 361 General Ecology. (Ecology and Evolutionary Biology.) Fall or spring term. Credit three hours. Prerequisite: Biological Sciences 101-102 or 103-104 or equivalent. Messrs. Feeny and Root.

Principles concerning the interactions between organisms and their environment. Influence of competition, social behavior, predation, and other factors on population size and dispersion. Role of energy flow and mineral cycling in determining the structure and productivity of ecosystems. Succession

and classification of natural communities. Influence of climate and past events on the diversity and stability of communities in different regions of the world. Interspecific competition and the niche concept. Chemical interactions between organisms. Application of ecological principles to human problems. Modern evolutionary theory will be stressed throughout and attention given to conflicting ecological hypotheses.

Biological Sciences 466 Chemical Ecology. (Also Chemistry 470.) Spring term of even-numbered years. Credit two hours. Primarily for seniors and graduate students. Prerequisite: Chemistry 353 or 357-358, and Biological Sciences 101-102 or 103-104, or permission of the instructor. Messrs. Alexander, Eisner, Meinwald, Whittaker, and Feeny (in charge).

Ecological and evolutionary significance of chemical interactions between organisms. Summary of key processes in regulation of natural populations. Survey of major classes of natural products with emphasis on appropriate analytical techniques. Chemical adaptations for reproduction, defense, habitat selection, dispersal, feeding efficiency and competition in animals, plants, and microorganisms. Choice of adaptive strategy in relation to energy flow. Practical applications of chemical ecology.

Biological Sciences 462 and 565 Limnology, and Special Topics in Limnology. (Consult the listing for the Field of Ecology and Evolutionary Biology.)

Biological Sciences 661 Seminar in Population and Community Ecology. (Ecology and Evolutionary Biology.) Fall term. Credit one hour. Prerequisite: permission of the instructor. Messrs. Brussard, Levin, and Root.

Discussion of recent advances in population and community ecology.

Economic Entomology

441 Principles of Economic Entomology. Fall term. Credit three hours. Prerequisite: 210 or 212 or equivalent. Enrollment limited. Lectures, laboratory, several all-afternoon field trips arranged. Mr. Gyrisco.

Principles in the management and control of insect populations. Collection of economic species of insects will be required.

541 Experimental Methods in Economic Entomology. Fall term. Credit three hours. Given in alternate years. Prerequisite: 210 or 212 or equivalent, and Plant Breeding 510. Enrollment limited; permission to register required. Lectures, laboratory, and field trips. Mr. Gyrisco.

An advanced course dealing with the principles and methods of insect control and

experimentation. Emphasis will be placed on the use of and instrumentation for work in modern methods of insect control, biology, and applied ecology. Field plot designs, field techniques, analysis of data, practical sampling methods, regulations concerning pesticide residues on field crops and in milk and meat, and effects of pesticides on pollinators will be stressed. Soil insects, small grain insects, and forage insects will be used largely as examples.

[545-546 Economic Entomology. Throughout the year. Credit three hours a term. Prerequisite: 210 or 212 and permission to register (see Mr. Gyrisco). Lecture and laboratory. Messrs. Brann, Dewey, Glass, Gyrisco, Lisk, Matthyse, Muka, O'Brien, Pimentel, Rawlins, Morse, Feeny, Johnson, Tauber, Wilkinson, and Pechuman. Not offered in 1971-72.]

Morphology

322 Insect Morphology. Fall term. Credit four hours. Prerequisite: 210 or 212 or permission of the instructor. Mr. Eickwort.

An introduction to the external and internal anatomy of insects, with emphasis on the comparative and functional aspects. The laboratory is devoted largely to dissection.

Parasitology

351 Introductory Parasitology. Every spring term. Credit four hours. Prerequisite: Biological Sciences 101-102, 103-104, or equivalent; Entomology 210 or 212 and Biological Sciences 371 recommended. Limited to 12 students per section. Mr. Travis.

An introduction to the symbiotic ways of life among animals, primarily the protozoan, helminth, and arthropod species of temperate and tropical areas. Special emphasis is given to the recognition of selected symbiotic species and how they live with their hosts.

[551 Advanced Parasitology (Protozoa and Helminths). Fall term. Credit three hours. Given in alternate years. Prerequisite: 351 or equivalent. Mr. Travis. Not offered in 1971-72.]

552 Advanced Parasitology (Medical Entomology). Fall term. Credit three hours. Offered in alternate years. Prerequisite: 351 and 212 or equivalent. Mr. Travis.

A continuation of 351 for graduate students interested in medical or veterinary entomology. Practical experience with methods of collection and preparation; detailed studies on recognition, life cycles, and control. Special emphasis is given to causative agents, vectors, and intermediate hosts of disease-producing organisms. The study examples

include species of world-wide distribution, especially those of the tropical areas.

553 Advanced Parasitology (Insect Pathology). Spring term. Credit three hours. Prerequisite: permission of the instructor. A course in entomology and a course in microbiological science recommended. Mr. Kramer.

A survey of the microbial and zooparasitic diseases of insects with emphasis on the natural history of the pathogens. Pathogens considered include viruses, rickettsiae, bacteria, spirochetes, fungi, protozoa, nematodes, and selected arthropods. The role of these pathogens in natural and applied insect control will also be considered.

Physiology

483 Insect Physiology. Fall term. Credit four hours. No prerequisite; biochemistry, physics, and a course in animal physiology recommended. Mr. Patton.

An introductory to intermediate course in the physiology of insects.

Taxonomy

331 Introductory Insect Taxonomy. Spring term. Credit three hours. Prerequisite: 210 or 212. Messrs. Franclemont and Brown.

An introduction to the systematics and distribution of insects. Laboratory practice in the identification of orders, families, and representative genera of insects; methods of collection and preparation of insect specimens. Field trips are taken in the late spring.

531 Taxonomy of the Smaller Orders of Insects. Fall term. Credit three hours. Offered in alternate years. Prerequisite: 331. Mr. Brown.

Lectures on the classification, evolution, and bionomics of the orders and families of insects, exclusive of the larger orders of Holometabola. Laboratory studies on the literature and on the characters and classification of representative genera and species. Continuation of taxonomy of Holometabola is in Entomology 532, 533, and 534.

[532 Taxonomy of the Immature Stages of Holometabola. Fall term. Credit three hours. Given in alternate years. Prerequisite: 531 or permission of the instructor. Mr. Franclemont. Not offered in 1971-72.]

[533 Taxonomy of the Coleoptera and Lepidoptera. Spring term. Credit three hours. Given in alternate years. Prerequisite: 331. Mr. Franclemont. Not offered in 1971-72.]

534 Taxonomy of the Diptera and Hymenoptera. Spring term. Credit three hours. Offered in alternate years. Prerequisite: 331. Mr. Brown.

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Biological Sciences 475 Evolutionary Theory. (Ecology and Evolutionary Biology.) Fall term. Credit four hours. Prerequisite: Biological Sciences 281; a course with some taxonomic content in botany or zoology is desirable, or else some experience with making and maintaining a personal collection of some plant or animal group. Mr. Brown.

Lectures and class discussions on organic evolution with primary emphasis on the mechanisms of speciation and adaptation. The course begins with a few lectures on taxonomic methodology.

Environmental Quality

Faculty

B. E. Dethier, N. C. Dondera, L. B. Dworsky, A. W. Eipper, C. D. Gates, L. S. Hamilton, A. W. Lawrence, R. C. Loehr, D. P. Loucks, D. C. Ludington, W. R. Lynn, R. T. Oglesby, G. W. Olson, D. Pimentel, H. W. Seeley, Jr., J. C. Thompson, Jr., P. J. Zwerman

Field Representative

R. C. Loehr, 207 Riley-Robb Hall

MINOR SUBJECT

Environmental Quality

This Field offers qualified engineers and scientists an opportunity to broaden their knowledge in physical, chemical, and biological areas related to environmental quality problems and their control at the same time as they increase their depth of knowledge in their own disciplines. This minor is intended to encourage interdisciplinary study, and

Toxicology and Insecticidal Chemistry

590 Insect Toxicology and Insecticidal Chemistry. Spring term. Credit four hours. Given in alternate years. Prerequisite: general chemistry and organic chemistry. Messrs. Lisk and Wilkinson.

The chemistry of insecticides and their metabolism and mode of action in insects and mammals. Analytical techniques in residue evaluation and laboratory techniques in evaluating effects on insects.

students selecting it will take courses in several disciplines with the objective of understanding the environment and its interaction with man.

The environmental quality minor will represent for each student that combination of courses, seminars, and projects which, in the judgment of his committee, is most likely to meet his needs and the comprehensive aspects of the minor.

M.S. CANDIDATES. It is suggested that a student seeking a Master's degree take a minimum of three courses for this minor, with the courses being given in at least two areas outside his major field.

PH.D. CANDIDATES. It is suggested that a student seeking a doctoral degree take a minimum of five courses for this minor, with the courses being given in at least two areas outside his major field.

Floriculture and Ornamental Horticulture

Faculty

James W. Boodley, Jot Carpenter, John F. Cornman, Raymond T. Fox, George L. Good, Robert W. Langhans, Robert G. Mower, Robert J. Scannell, John G. Seeley, Peter L. Steponkus, Harold B. Tukey, Jr.

Field Representative

Peter L. Steponkus, 15C Plant Science Building

MAJOR SUBJECT

Floriculture and Ornamental Horticulture

MINOR SUBJECTS

Floriculture and Ornamental Horticulture (when the major subject is in another Field)

Landscape Architecture

Entering graduate students are expected to have adequate preparation in elementary horticulture, botany, plant physiology, genetics, pathology, agronomy, entomology, mathematics, chemistry, and physics.

There is no language requirement for the Master's degree or for the Ph.D. degree.

The thesis for the Master's degree is to be based on results of a research project. Requirements for the Ph.D. degree include selection of two minor subjects, passing a qualifying examination usually given before the termination of the third residence unit, an admission to candidacy examination normally given upon conclusion of course work, and a final thesis examination on the dissertation and related material.

Special Interests of the Faculty

Greenhouse crops: Professors Boodley, Langhans, and Seeley.

Landscape Architecture: Professors Carpenter and Scannell.

Nursery crops: Professor Good.

Ornamental horticulture physiology: Professors Steponkus and Tukey.

Plant materials: Professor Mower.

Turfgrass: Professor Cornman.

Studies relating to physiology, propagation, nutrition, and culture may be undertaken as research for an advanced degree and should

be approached from the standpoint of the basic sciences. Consequently, it is appropriate to select minor subjects from such areas as plant physiology, anatomy, morphology, taxonomy, pathology, biochemistry, genetics, agronomy, entomology, agricultural economics, and agricultural engineering.

For graduate course listings, consult the pertinent Field listings in this *Announcement*. The Department of Floriculture and Ornamental Horticulture does not offer courses for graduate students only; however, graduate students may take selected undergraduate courses in the Department.

Food Science and Technology

Faculty

Robert C. Baker, Paul A. Buck, Norman C. Dondero, Robert K. Finn, John D. Hartman, Robert F. Holland, Lamartine F. Hood, F. M. Isenberg, William K. Jordan, J. E. Kinsella, Frank V. Kosikowski, Richard A. Ledford, Richard P. March, Nell Mondy, H. Brooks Naylor, Neil L. Norcross, Ellis A. Pierce, Norman Potter, John W. Sherbon, W. Frank Shipe, Laura L. Smith, James R. Stouffer, D. V. Vadehra, Jeremiah J. Wanderstock, George H. Wellington, James C. White

At Geneva

Terry Acree, Malcolm C. Bourne, Donald L. Downing, L. Ross Hackler, Geza Hrazdina, Robert L. LaBelle, Chang Y. Lee, Louis M. Massey, Jr., Leonard R. Mattick, James C. Moyer, Willard B. Robinson, George D. Saravacos, Robert S. Shallenberger, Donald F. Splittstoesser, John R. Stamer, Keith H. Steinkraus, Gilbert Stoewsand, Jerome P. VanBuren

Field Representative

Robert C. Baker, 100 Rice Hall

MAJOR AND MINOR SUBJECTS

Dairy Science

Food Chemistry

Food Microbiology

Food Science (general)

International Food Development

Water and Waste Water Microbiology

ADMISSION REQUIREMENTS. There are no specific requirements for admission. The student should have good training in biology, chemistry, microbiology, and biochemistry. Prior training in food science is desirable but not essential since the student can make up deficiencies with satisfactory programming. Applicants must submit scores of the Graduate Record Examinations Aptitude Test.

MAJOR AND MINOR REQUIREMENTS. Candidates for the M.S. degree are required to

register for one major and one minor subject. Candidates for the Ph.D. degree can register for a major and two minor subjects or substitute a demonstrated proficiency in one of the following languages for one of the minor subjects: Danish, Dutch, Finnish, French, German, Japanese, Norwegian, Russian, Spanish, or Swedish. The minor subjects are chosen outside of the Field of Food Science and Technology. The choice of minor subjects is enormous and includes such subjects as animal science, biochemistry, business, chemistry, marketing, physiology, organic chemistry, vegetable crops, etc.

EXAMINATIONS. For the M.S. degree there is a final examination on subject matter and thesis. A qualifying examination is required of Ph.D. candidates early in residence to explore deficiencies in educational background; this may be combined with the final examination for the Master's degree if approved by the student's Special Committee for the Ph.D. Candidates for the Ph.D. also take a comprehensive admission to candidacy examination when most of the course work has been completed and a final examination on the thesis.

RESEARCH OPPORTUNITIES. The Field of Food Science and Technology offers excellent opportunities for graduate study, including a wide variety of courses as well as excellent research facilities. The members of this Field are associated with many different departments of the University. Research on meat, for example, is carried on in the Departments of Animal Science and Poultry Science; research on potato processing, in the Department of Vegetable Crops. All course work is taken on the Ithaca campus, but graduate students may elect to conduct their research at the Experiment Station in Geneva, where a new pilot plant and laboratories are available. A smaller pilot plant located on the Ithaca campus supplements

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the very adequate research facilities of the departments specializing in the various raw materials.

Special Interests of the Faculty

Dairy Science

Dairy chemistry: Professors Hood, Kinsella, Kosikowski, Sherbon, and Shipe.

Dairy microbiology: Professors Kinsella, Kosikowski, Ledford, Naylor, Potter, and White.

Quality standards and control: Professors March, Sherbon, and White.

Dairy process engineering: Professors Holland, Jordan, March, and Potter.

Food Chemistry

Analytical methods: Professors Kinsella, Mattick, Mondy, Robinson, Sherbon, and Shipe.

Enzymology: Professors Kinsella, Massey, Sherbon, Shipe, Vadehra, and VanBuren.

Flavor chemistry: Professors Buck, Hrazdina, Kinsella, Mattick, Mondy, Shallenberger, and Shipe.

Rheological properties: Professors Bourne, Buck, Hood, Saravacos, Sherbon, and Shipe.

Food biochemistry: Professors Hackler, Hood, Hrazdina, Kinsella, Lee, Massey, Mattick, Robinson, Shallenberger, Sherbon, Smith, Vadehra, VanBuren, and Wellington.

Food safety and toxicology: Professors Kinsella, Stoewsand, and Vadehra.

Instrumentation: Professors Acree, Mattick, Saravacos, and Sherbon.

Fats and oils: Professors Kinsella, Mondy, and Smith.

Additives: Professors Hood, Robinson, Smith, and Stoewsand.

Food Microbiology

Fermentations: Professors Buck, Kosikowski, Ledford, Naylor, Splittstoesser, Stamer, and Steinkraus.

Sanitary bacteriology: Professors Dondero, Splittstoesser, Stamer, and White.

Public health problems: Professors Kosikowski, Naylor, Potter, Splittstoesser, Vadehra, and White.

Commercial applications: Professors Finn, Potter, Stamer, and Steinkraus.

Food Science (General)

Sensory evaluation: Professors Bourne, Kinsella, Mondy, Shipe, and Smith.

Food sanitation: Professors Buck, Holland, Naylor, and White.

Plant operation and management: Professors

Jordan, Moyer, Pierce, Stouffer, Wellington, and White.

Product development: Professors Baker, Buck, Holland, Hood, Kosikowski, Potter, Sherbon, and Wellington.

Engineering and processing: Professors Buck, Finn, Jordan, Moyer, Potter, and Saravacos.

Food wastes: Professors Dondero and Jordan.

Enology: Professors Buck, Kosikowski, Robinson, and Splittstoesser.

Red meat technology: Professors Pierce, Stouffer, Wanderstock, and Wellington.

Poultry meat and egg technology: Professors Baker and Vadehra.

Fruits and vegetables: Professors Downing, Hartman, Isenberg, LaBelle, Massey, and Mondy.

Nutrition: Professors Hackler, Mondy, Robinson, Steinkraus, and VanBuren.

International Food Development

Professors Bourne, Buck, Hackler, Hood, Jordan, Kinsella, Kosikowski, LaBelle, Lee, Shipe, Steinkraus, Wanderstock, and Wellington.

Water and Waste Water Microbiology

Professors Dondero, Finn, Splittstoesser, and White.

Courses

210 Food Analysis. Spring term. Credit two hours. Prerequisite: Chemistry 104 or 108. Lecture and laboratory. Mr. Ledford.

The course is designed to acquaint the student with a variety of chemical and bacteriological tests used by the food analyst.

[302 Dairy and Food Engineering. Fall term. Credit four hours. Offered in alternate years. Prerequisite: Physics 101 and 102 or equivalent and Food Science 100. Mr. Jordan. Not offered in 1971-72.]

303 Lipid Technology. Fall term. Credit three hours. Offered in alternate years. Mr. Kinsella.

[311 Concentrated, Dehydrated, and Frozen Foods. Spring term. Credit four hours. Offered in alternate years. Messrs. Jordan and Potter. Not offered in 1971-72.]

[313 Sterilization Processes. Spring term. Credit three hours. Offered in alternate years. Prerequisite: Chemistry 353 or equivalent, Biological Sciences 394, and Physics 102. A course in calculus and a course in biochemistry are recommended. Not offered in 1971-72.]

[314 Milk and Food Sanitation and Plant Operations. Fall term. Credit four hours. Given in alternate years. Prerequisite: 100 and Biological Sciences 394. Mr. White and assistants. Not offered in 1971-72.]

401 Food From Fermentations. Fall term. Credit five hours. Given in alternate years. Prerequisite: beginning courses in microbiology and organic chemistry or biochemistry are recommended. Messrs. Kosikowski and Ledford.

403 International Food Development. Fall term. Credit three hours. Given in alternate years. Mr. Kosikowski.

412 Aquatic Microbiology. Spring term. Credit three hours. Given in alternate years. Prerequisite: introductory bacteriology (Biological Sciences 290 or equivalent, or Soil Science 306). Mr. Dondero.

420 Sensory Qualities and Evaluations of Foods. Spring term. Credit three hours. Open to upperclassmen and graduate students. Prerequisite: a course in statistics and biochemistry or organic chemistry. Mr. Shipe and assistants.

Deals with the factors affecting the color, odor, flavor, and texture of foods and the evaluation of these qualities. The techniques and interpretations of both objective and subjective evaluations are discussed. The laboratory exercises involve the evaluation of a variety of foods.

501 Food Proteins. Fall term. Credit three hours. Given in alternate years. Prerequisite: Biological Sciences 431 or equivalent. Mr. Vadehra and Mr. Sherbon.

[502 Food Lipids. Fall term. Credit two hours. Given in alternate years. Prerequisite: Biological Sciences 431 or Food Sciences 303. Mr. Kinsella. Not offered in 1971-72.]

503 Food Carbohydrates. Spring term. Credit two hours. Given in alternate years. Prerequisite: Biological Sciences 431 or equivalent. Mr. Hood.

[504 Advances in Dairy Chemistry. Fall term. Credit two hours. Given in alternate years. Prerequisite: qualitative and quantitative analysis and organic chemistry. Mr. Ledford. Not offered in 1971-72.]

512 Instrumental Methods. Spring term. Credit five hours. Offered in alternate years. Prerequisite: permission of the instructor. Mr. Sherbon.

514 The Biocolloidal Chemistry of Foods. Spring term. Credit three hours. Offered in alternate years. Prerequisite: Biological Sciences 431 and 433 or equivalent.

600 Seminar. Fall and spring terms. Credit one hour a term. Required for all food science graduate students.

Biological Sciences 394 Dairy and Food Microbiology. Spring term. Credit four hours. Prerequisite: Biological Sciences 290. Mr. Naylor.

A systematic study of the major families of microorganisms of importance in dairy and food science, with emphasis on the role these organisms play in food preservation, food fermentations, and public health. The laboratory work includes practice in the use of general and special methods for microbiological testing and control of dairy and food products, as well as practice in the isolation and characterization of organisms found in foods.

Also available to students in Food Science and Technology are courses from other Fields described in this *Announcement* or the *Announcement of the Graduate School: Social Sciences*, such as Agricultural Economics, Animal Science, Biochemistry, Business and Public Administration, Industrial and Labor Relations, Microbiology, Pomology, and Vegetable Crops.

Genetics

(See also the listing under **Medical Sciences**, p. 83 of this *Announcement*.)

Faculty

Antonie Blackler, Peter J. Bruns, Joseph M. Calvo, Gerald R. Fink, Ross J. MacIntyre, Adrian M. Srb, Harry T. Stinson, Charles H. Uhl, Bruce Wallace, Stanley A. Zahler

Field Representative

Adrian M. Srb, 219 Bradfield

MAJOR AND MINOR SUBJECT

Genetics

Applicants are urged to submit scores of the Graduate Record Examinations Aptitude and Advanced Biology Tests.

DEGREE REQUIREMENTS. Predoctoral students who are majoring in genetics are expected to have had training at the college level in at least one foreign language. The completion as an undergraduate of eight or more semester hours in one language with an overall B average or better is accepted as evidence for proficiency in that language. The student who has had insufficient training be-

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fore entering Graduate School has these alternatives: (1) completion at Cornell of any full year (six semester hours per term) basic foreign language course approved by his Special Committee or (2) satisfying for one language the requirements set by his Special Committee. The language requirement for each foreign predoctoral student will be decided on an individual basis by his Special Committee.

Shortly after its formation, the student's Special Committee meets with the student in order to examine his past training and research interests and to recommend a course of study. The admission to candidacy examination, given at the end of his second year in residence, is a comprehensive examination in which the student's formal training, familiarity with the literature, and intuitive research ability are tested. This and the final thesis examination are required by the Graduate School (see p. 11 of this *Announcement*).

All graduate students in the Field will have some teaching experience during their course of study.

Faculty members in the Field of Genetics have widely different research interests ranging from molecular through cytological, physiological, and evolutionary genetics. The student should choose a professor whose interests coincide with his own.

Courses

All courses carry Biological Sciences numbers unless otherwise indicated. Starred courses are not generally regarded as graduate courses but may be so regarded in special cases.

280 Human Genetics. Spring term. Credit three hours. Prerequisite: 101-102 or 103-104. Students who have had 281 may register only with the permission of the instructor. Mr. Srb.

An introduction to biological heredity through consideration of the genetics of man. Advances in the science of genetics are having a profound effect on man's understanding of himself and on his potential for influencing his present and future well-being. The course is intended primarily to contribute to the student's general education in these matters, and, although certain aspects of genetics will be considered with some rigor, the course is not designed to serve as a prerequisite to advanced courses in genetics.

281 Genetics. Fall or spring term. Credit four hours. Prerequisite: 101-102 or 103-104. Students who have had 280 may register only with the permission of the instructor. Messrs. Bruns, Fink, MacIntyre, and assistants.

A general study of the fundamental principles of genetics. Discussion of gene trans-

mission, gene action and interaction, gene linkage and recombination, gene structure, gene and chromosome mutations, genetic aspects of differentiation, genes in populations, breeding systems, extrachromosomal inheritance. Animals, plants, and microorganisms are used in the laboratory, which also includes independent study in inheritance in *Drosophila*.

347 Cytology. Fall term. Credit four hours. Prerequisite: 101-102 or 103-104 or equivalent. Mr. Uhl.

The principal topics considered are protoplasm, cells and their components, nuclear and cell division, meiosis and fertilization, and the relation of these to the problems of development, reproduction, taxonomy, and heredity. Both plant and animal materials are used.

440 Cyto-genetics. Spring term. Credit three hours. Prerequisite: 347 and 281 or equivalent. Mr. Uhl.

An advanced course dealing mainly with the cellular mechanisms of heredity and including recent researches in cytology, cyto-genetics, and cytotaxonomy.

480 Population Genetics. Spring term. Credit three hours. Prerequisite: 281 or equivalent. Mr. Wallace.

A study of factors which influence the genetic structure of Mendelian populations and which are involved in race formation and speciation.

482 Physiological Genetics. Spring term. Credit three hours. Prerequisite: 281 and a course in organic chemistry. Mr. Srb.

The nature and activities of chromosomal and nonchromosomal genetic material are considered in relation to the functional attributes of organisms.

489 Research in Genetics and Development. Fall or spring term. Credit to be arranged. Prerequisite: permission of the professor under whom the work is to be taken. Staff.

Practice in planning, conducting, and reporting independent laboratory and/or library research programs.

495 Microbial Genetics. Fall term. Credit four hours. Prerequisite: 281 and 290 or permission of the instructor. Mr. Zahler.

Genetics of bacteria and their viruses with emphasis on the mechanisms of genetic phenomena.

495A Microbial Genetics Lectures. Fall term. Credit two hours. Prerequisite: 281 and 290 or 290A. Mr. Zahler.

The course is the same as the lecture portion of 495.

680 Current Topics in Genetics. Throughout the year. Credit two hours a term. Preference given to majors in the Field of Genetics. No auditors. Enrollment limited to 20 students. Staff.

A seminar course with critical presentation and discussion by students of original research papers in a particular area of current

interest. Content of the course and staff direction will vary from term to term and will be announced a semester in advance.

See also courses listed under Animal Breeding, Animal Science, Biochemistry, Physiology, and Plant Breeding and Biometry in this *Announcement*.

Human Nutrition and Food

Faculty

Gertrude Armbruster, Marjorie Devine, E. Elizabeth Hester, Bertha Lewis, Leo Lutwak, Nell Mondy, Mary A. Morrison, Katherine J. Newman, Jerry M. Rivers, Daphne Roe, Diva Sanjur, Ruth Schwartz, Jean T. Snook, Kathryn O. Visnyei, Charlotte M. Young

Field Representative

Gertrude Armbruster, Martha Van Rensselaer Hall

MAJOR AND MINOR SUBJECTS

Human Nutrition

Human Nutrition and Food

Food

Administrative Dietetics (Major only for M.S.)

ADMISSION REQUIREMENTS. A candidate who wishes to major in this Field and whose previous studies include basic food science and human nutrition, general and organic chemistry, biochemistry, microbiology, and physiology may begin studies toward an advanced degree upon admission. A student who is deficient in one or more areas will be required to make up deficiencies. For students interested in applications of the natural sciences, additional undergraduate courses in chemistry, physics, and mathematics are desirable; for those with interests in the application of the social sciences, additional courses in sociology, psychology, and anthropology; and for those with a major interest in administrative dietetics, undergraduate courses in institution management and experience in dietetics.

All applicants are asked to submit results of the Graduate Record Examinations.

LANGUAGE REQUIREMENT. The Field has no specific language requirement. The Special Committee will ask that a Ph.D. candidate attain proficiency either in a foreign language or in a collateral area important for scholarly work related to his research interest.

EXAMINATIONS. Each M.S. candidate must pass a final oral examination covering the major and minor subjects and the thesis. Two examinations are required of Ph.D. candidates and are administered by the Special Com-

mittee. The comprehensive admission to candidacy examination is given to judge competence in subject matter; it may be oral or oral and written. An oral final examination is required in defense of the thesis.

RESEARCH AND STUDY OPPORTUNITIES.

Graduate study in the Field of Human Nutrition and Food is designed to provide in-depth study of the fundamental knowledge and research methods of human nutrition, food science, or administrative dietetics. Emphasis is placed on the application of the physical, biological, behavioral, and social sciences to these subjects. In nutrition, the student may choose to obtain laboratory experience with nutritional problems using either animals or human beings, or field experience applying the social sciences to nutrition. In foods, he may obtain experience in applying principles and laboratory techniques learned in organic chemistry, biochemistry, and microbiology to problems with various foods and food components. In the area of administrative dietetics, he may obtain experience in applying knowledge in the basic sciences to problems in administrative or management aspects of dietetics. With the aid of the Special Committee, specific programs are planned to fit the student's objectives and to develop original thinking and independent research.

A student may select from a variety of courses, seminars, and experiences in independent study in many Fields. For a student admitted to the Ph.D. degree program, a conference with members of his Special Committee is arranged shortly after admission to assess his competence, discuss his interests and goals, and plan the direction of future work.

Minor subjects for a student majoring in this Field may be selected from a wide variety of other Fields, consistent with the student's objectives. Suggested minors, in addition to those within the Field, include anthropology, biochemistry, botany, education, industrial and labor relations, microbiology, physiology, sociology, statistics, and other areas of human ecology. At least one minor chosen by a candidate for the Ph.D. degree should be in a basic discipline related to the major.

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Special Interests of the Faculty

Human Nutrition

Professor Devine: nutrition education; ascorbic acid metabolism.

Professor Lutwak: mineral and energy metabolism.

Professor Morrison: utilization of proteins and amino acids.

Professor Newman: nutrition and growth, and social nutrition.

Professor Rivers: ascorbic acid metabolism; nutrition and disease; community nutrition.

Professor Roe: sulfur metabolism in humans.

Professor Sanjur: food habits and social correlates.

Professor Schwartz: magnesium requirements in reproduction.

Professor Snook: effects of diet on pancreatic enzymes.

Professor Young: body composition studies; obesity; frequency of feeding studies.

Food Science

Professor Armbruster: interrelationships in plant tissue properties and product quality.

Professor Hester: protein-polysaccharide complexes; cereal chemistry.

Professor Lewis: food carbohydrates, polysaccharide-protein interactions.

Professor Mondy: enzyme and lipid chemistry in plants.

Administrative Dietetics

Professor Visnyei: food service in health-care facilities.

Inquiries should be addressed to the Graduate Field Representative, Human Nutrition and Food, Martha Van Rensselaer Hall.

Courses

441 Nutrition and Disease.

Study of the physiological and biochemical anomalies in certain diseases and the principles underlying nutritional therapy. Independent survey of the technical literature in this field. Some laboratory work on nutrient composition of food, physiological response to different diets, and methods of determining dietary patterns of individuals.

445 Community Nutrition and Health.

Study of biological and environmental dimensions of human nutritional problems in contemporary society; application of basic concepts of food and nutrition to the improvement of man's health; evaluation of federal, state, and community programs focused on improving man's nutrition. Laboratory work includes (a) developing materials for field studies and evaluation and (b)

projects and field trips in nearby communities. Field experiences will be selected and developed to expose students to food and nutrition problems of man over his entire life span, from infancy to old age. Estimated cost \$5.

446A Science of Food.

The relation to food quality of (a) rheological properties of food systems, (b) oxidation and reduction reactions, (c) enzymatic and nonenzymatic browning. Physical and chemical factors accounting for the color, flavor, and texture of natural and processed foods.

446B Science of Food, Laboratory.

Laboratory experiments designed to illustrate the effect of varying ingredients and treatment on the quality characteristics of food products. Objective testing methods are used to determine food quality characteristics.

446C Science of Food, Laboratory.

Laboratory experiments designed to illustrate (a) the physiochemical behavior of colloidal systems; (b) chemical reactions of some food components; (c) effects of temperature, pH, moisture, inorganic salts and enzymes on physiochemical changes in natural foods, food components, and food mixtures.

456 Experimental Food Methods.

Application of the scientific method in the design and performance of experimental food problems and in the interpretation and evaluation of results. Evaluation of the use of instruments and chemical and sensory methods in the measurement of food properties. Independent laboratory problems.

478 Volume Food Production.

Menu planning and evaluation relative to production capacity, cost, and nutritive quality. Food contamination and principles of sanitary handling and holding of ingredients and menu items. Techniques of processing and production scheduling in volume food production.

488 Volume Food Production Practice.

Practice experiences will be arranged in one of the food service units on campus, in health-care facilities and other community facilities for students to become familiar with quantity production and food service in an operating situation.

500 Special Problems for Graduate Students.

501-504 Advanced Nutrition Series.

A series of nutrition courses offered jointly by the Department of Human Nutrition and Food, College of Human Ecology; the Depart-

ments of Animal Science and of Poultry Science, College of Agriculture; and the Graduate School of Nutrition. (See listing under Field of Nutrition.)

512 Nutrition and Growth.

Aspects of human physical and chemical growth of particular interest to nutritionists. Survey of methodology; comparison of individual growth patterns of selected body dimensions with group patterns; consideration of some of the variables, including diet, which influence growth.

514 Readings in Nutrition.

Critical review of literature on selected topics in the field of nutrition. Emphasis on human nutrition. Topics are changed each term so the course may be repeated for credit with permission of the instructor.

515 Seminar in Perspectives of Human Nutrition and Food.

An introduction to food and nutrition for graduate students who have had limited or no work in this area. The seminar utilizes the lecture and discussion of 115A as a basis for supplementary readings and critical review of research on selected nutritional problems.

516 Readings in Food.

Critical review of selected topics in the current literature. Emphasis on experimental data and basic scientific principles underlying modern theory and practice relative to food quality. Topics are changed each term so the course may be repeated for credit.

524 Research Methods in Human Metabolic Studies.

Principles of human metabolic research; experimental design of human studies; dietary considerations; methods of collecting and analyzing biological material; and evaluation. Laboratory will include planning and management of a metabolic study, collection and appropriate analyses of blood, urine, and feces.

526 Special Topics in Food.

An intensive study of the organic and physical behavior of starch, its granule structure, and the nature and behavior of the starch fractions; and the technology and use of starch and the types of modified starches employed for specific purposes.

568 Special Topics in Dietetics.

Consultation techniques for dietitians.

578 Data Processing Applied to Dietary Department Administration.

Includes an introduction to the fundamental elements and functions of data processing equipment; basic concepts of programming, development of programs for the procurement and issuing of food commodities, the processing of ingredients, and the scheduling of departmental resources as related to automatic data processing.

588 Advanced Layout and Equipment Selection for Dietary Departments.

Current trends in facilities and systems in dietary departments with projections for future development. Field trip, estimated cost \$5.

599 Master's Thesis and Research.

605 Seminar in Human Nutrition and Food.

In the fall semester, primary emphasis will be given to nutrition; in the spring, to food science.

608 Seminar in Administrative Dietetics.

699 Doctoral Thesis and Research.

Graduate School of Nutrition 580 International Nutrition Problems, Policy, and Programs.

A review of food and nutrition problems, policy, and programs especially as they relate to developing countries. Emphasis is placed on the need to coordinate the efforts of various government departments including those of agriculture, education, economics, health, and community development.

Graduate School of Nutrition 620 General Nutrition.

This course is offered to students whose principal academic training has been in a field other than nutrition. It is designed to meet their need for a basic but intensive introduction to the principles, history, and application of nutrition.

Graduate School of Nutrition 650 Clinical and Public Health Nutrition.

Designed to familiarize the student with some of the applications of nutrition to clinical and public health problems.

82 Medical Sciences

International Agricultural Development

Faculty

Douglas E. Ashford, Solon L. Barraclough, Frederick T. Bent, Carl W. Boothroyd, Paul A. Buck, Marlin G. Cline, Royal Colle, Howard E. Conklin, Robert H. Crawford, Loy V. Crowder, Tom E. Davis, Matthew Drosdoff, Eugene C. Erickson, Reeshon Feuer, Donald K. Freebairn, Frank H. Golay, Robert F. Holland, William K. Jordan, William C. Kelly, George C. Kent, Richard P. Korf, Frank V. Kosikowski, Douglas J. Lathwell, J. Paul Leagans, Gilbert Levine, John K. Loosli, Harry A. MacDonald, John G. Matthyse, Robert E. McDowell, John W. Mellor, Philip A. Minges, Henry M. Munger, Robert B. Musgrave, Thomas T. Poleman, Jr., Robert A. Polson, Kenneth L. Robinson, Milton L. Scott, Daniel G. Sisler, Robert M. Smock, Earl L. Stone, Jr., Robert D. Sweet, H. David Thurston, Frederick K. T. Tom, George W. Trimberger, Kenneth L. Turk, Donald H. Wallace, Frank W. Young

At Geneva

Keith H. Steinkraus

At Puerto Rico

R. H. Fox

Field Representative

Kenneth L. Turk, 102 Roberts Hall

MINOR SUBJECT

International Agricultural Development

This Field is intended primarily for students who are preparing for service in international agriculture. The student will seek depth of knowledge by majoring in a biological, physical, or social science. The minor subject draws from several disciplines with the objective of assisting the student in understanding the special conditions and problems of newly developing economies. While this minor is planned specifically for students majoring in one of the graduate fields of agriculture, other qualified students are welcome. It is intended for students from other countries as well as for those from the United States. Students will register for seminars, courses, and special problems offered by the several departments and colleges.

A student minoring in this Field is encouraged to gain speaking proficiency in a language likely to prove most useful in this area of service in addition to meeting the language requirements in his major Field.

A student may not minor in this Field if he is minoring in Asian Studies or Latin American Studies, and he may not select a professor for this minor who also serves on the Graduate Faculty in the student's major Field.

A complete listing of the courses offered by the Field of International Agricultural Development is found in the *Announcement of the Graduate School: Social Sciences*.

Medical Sciences (Graduate School of Medical Sciences)

(See p. 29 of this *Announcement*.)

Requests for information regarding the Fields in the Medical Sciences should be addressed to Professor Julian R. Rachele, Assistant Dean, Graduate School of Medical Sciences, Cornell University, Medical College, 1300 York Avenue, New York, N.Y. 10021.

Anatomy

Graduate students interested in pursuing analyses of biological systems in terms of spatial relations, form, their development, functional modulation, and chemical significance at levels of organization ranging from the macromolecular to the organismic may find major or minor sponsorship for study in the Field of Anatomy. Instruction by the graduate faculty is available in the disciplines of light and electron microscopy, microtomy and ultramicrotomy, histochemistry, cytochemistry, cytospectrophotometry, cell fractionation, autoradiography, x-ray and electron diffraction

analysis, electrical and histological methods in neuroanatomy, and gross and microscopical dissection.

Biochemistry

The Field of Biochemistry in the Graduate School of Medical Sciences provides the Ph.D. candidate with the opportunity and facilities for thesis research in various areas of biochemical investigation such as: enzymology; mechanism of enzyme action; intermediary metabolism; physical chemistry and structure of proteins, nucleic acids, and other macromolecules; neurochemistry; hormone chemistry and action; molecular biology; and synthesis and biochemical action of chemotherapeutic compounds. The Field also offers courses and seminars concerned with advanced topics in the chemistry and biochemistry of carbohydrates, lipids, nucleic acids, and proteins and in the methodology of physical biochemistry.

Biomathematics

A new program of applied mathematics in biology is offered by the Biomathematics Division to students whose primary interests are mathematical or theoretical, but who wish to concentrate on biological applications. Programs leading to the Ph.D. degree are flexible to suit the particular area of biological application of the individual student, and appropriate courses of study in the relevant aspects of biology, chemistry, physics, and medicine are planned accordingly.

Biophysics

Graduate work toward the Ph.D. degree in the Field of Biophysics and the M.S. degree in the Field of Radiation Physics is offered, as well as opportunities for postdoctoral research in biophysics. Active research programs are being conducted in fundamental radiation biophysics, including cellular radiobiology, and in the biophysics of membrane transport.

Biostatistics

The graduate program in the Field of Biostatistics offered by the Biomathematics Division applies the quantitative methods of the theory of probability and statistics to biological or medical problems. The use of modern computers is an integral part of the program which leads to the Ph.D. degree.

Cell Biology

The Field of Cell Biology deals with the structure and chemical composition of organelles, with the synthesis of their macromolecular components, and with the integration of their separate functions in the economy of the whole cell. The techniques employed include cell structure, electron microscopy, radioautography, isolation of organelles by differential centrifugation, enzymology, and biochemical analysis. The Field is concerned with the alterations of ultrastructure which are associated with differentiation, with disease, and with the initiation, control, and modification of growth in normal and neoplastic cells.

Genetics

Courses, seminars, and opportunities for research training in the Field of Genetics are available in several different areas including cytogenetics, human biochemical and cell

genetics, mammalian developmental genetics, microbial genetics, nucleic acid chemistry and biochemistry, and virology.

Microbiology

The Graduate School of Medical Sciences offers a widely diversified field of study in microbiology covering both medically oriented and more general aspects of the science. To provide this coverage, the Field of Microbiology draws on both faculty and facilities in various departments and divisions of the Medical School and the Sloan-Kettering Institute. Courses, seminars, and thesis research are available in the areas of general and medical bacteriology, microbial chemistry and physiology, virology, immunology, genetics, and mycology.

Neurobiology and Behavior

Seminars, courses, and research experience are designed to present an integrated, multidisciplinary approach to graduate training in the neurological and behavioral sciences with emphasis on neurochemistry, neurophysiology, and neuropsychology and perception. Special facilities are available for research with humans and with experimental primates.

Pharmacology

Pharmacology is concerned with the interaction of exogenous chemical substances in living structures. Training is offered in the concepts and techniques of this science. Opportunities for thesis research include the influence of drugs and chemicals on biochemical systems; the peripheral, autonomic, and voluntary nervous systems; the central nervous system; the cardiovascular system; and the kidney. Also there is opportunity for using modern concepts of organic chemistry to analyze the relationship between chemical structure and biological activity.

Physiology

Predocloral and postdoctoral facilities are available for studies of function in intact animals, whole organs, subunits of organs, isolated cells, and subcellular systems. Supervision is provided by a staff whose specific areas of interest may be obtained from the *Announcement of the Graduate School of Medical Sciences*. Advanced course work is also available.

84 Microbiology

Microbiology

(See also the section on p. 83.)

Faculty

Martin Alexander, Eugene A. Delwiche, Norman C. Dondero, Robert K. Finn, A. Jane Gibson, Russell E. MacDonald, H. Brooks Naylor, Harry W. Seeley, Jr., Lawrence I. Slobin, D. V. Vadehra, Paul J. VanDemark, Stanley A. Zahler

At Geneva

Donald F. Splittstoesser, John R. Stamer, Keith H. Steinkraus

Field Representative

R. E. MacDonald, 410 Stocking Hall

MAJOR AND MINOR SUBJECT

Microbiology (See also the Field of Veterinary Medicine, p. 110.)

Students planning graduate study in the Field of Microbiology should have preparation in general chemistry, qualitative and quantitative analysis, organic chemistry, physics, and introductory courses in the biological sciences. In addition, training in physical chemistry and calculus is desirable. Deficiency in any of the subjects listed does not necessarily preclude admission, but it may increase the time necessary to earn a degree.

Applicants for admission are required to submit scores for the Graduate Record Examinations Aptitude Test.

There is no general Field requirement for proficiency in a foreign language.

One semester or more of teaching is required of all graduate students.

Other Field requirements for candidates for the doctoral degree are those of the Graduate School as outlined on p. 11.

RESEARCH AND STUDY OPPORTUNITIES.

Well-equipped laboratories are available. Branches of microbiological research in which the staff is experienced and especially interested include bacteriophagy, genetics, morphology and cytology, physiology and biochemistry, and systematic and applied microbiology. Among specific interests are:

Bacterial photosynthesis: J. Gibson.

Bacteriophagy: H. B. Naylor.

Food microbiology: H. B. Naylor, D. F. Splittstoesser, J. R. Stamer, K. H. Steinkraus, D. V. Vadehra.

Immunology: L. I. Slobin.

Industrial fermentations and bioengineering: E. A. Delwiche, R. K. Finn.

Microbial ecology: M. Alexander, E. A. Delwiche, H. W. Seeley, Jr.

Microbial genetics and differentiation: S. A. Zahler.

Microbial nutrition: H. W. Seeley, Jr., P. J. VanDemark.

Microbial physiology: E. A. Delwiche, J. Gibson, R. E. MacDonald, H. W. Seeley, Jr., D. V. Vadehra, P. J. VanDemark.

Soil microbiology: M. Alexander.

Water and waste microbiology: N. C. Dondero.

Courses

All courses carry Biological Sciences numbers unless otherwise indicated.

391A Natural Selection in the Bacteria. Fall term. Credit three hours. Prerequisite: 290, 431, or permission of the instructor. 431 may be taken concurrently. Mr. MacDonald.

A study of the comparative physiological and ecological relationships among bacteria and some related organisms. A number of groups of bacteria will be discussed in detail as well as factors which influence their ability to survive in nature. In addition, a number of lectures will be devoted to the theory and development of bacterial classification.

391B Bacterial Ecology Laboratory. Fall term. Credit three hours. Prerequisite: registration in 391A and permission of the instructor. Mr. MacDonald.

Techniques for the isolation, cultivation, and detailed study of selected groups of organisms. Some of the more standard techniques of physiological study will be introduced.

490A Microbial Physiology Lecture. Spring term. Credit three hours. Prerequisite: 391A or permission of the instructor. Mrs. Gibson.

A study of the organization of physiological processes in microorganisms, including a study of structure, energy-yielding mechanisms, macromolecular biosynthesis, and growth and regulation.

490B Microbial Physiology Laboratory.

Spring term. Credit three hours. Enrollment limited. Preference given to students obtaining a grade of B- or better in 391B. Prerequisite: coregistration in 490A, and permission of the instructor. Mrs. Gibson.

Experiments on material covered in 490A will be used to introduce students to modern techniques used in physiological research, such as the use of radioisotopes, large-scale growth of microorganisms, and the isolation and characterization of specific cellular components.

[492 Microbial Ecology. Spring term. Credit two hours. Given in alternate years. Prerequisite: an elementary course in some facet of

microbiology. Mr. Alexander. Not given in 1971-72.

An introduction to the basic principles of microbial ecology. Attention is given to the behavior, activity, and interrelationships of bacteria, fungi, algae, and protozoa in natural ecosystems.}

495A Microbial Genetics Lecture. Fall term. Credit two hours. S-U grades optional. Prerequisite: 281 and 290, or permission of the instructor. Mr. Zahler.

Genetics of bacteria and their viruses, with emphasis on the mechanisms of genetic phenomena.

495B Microbial Genetics Laboratory. Fall term. Credit three hours. Prerequisite or parallel: 495A and permission of the instructor. Mr. Zahler.

Laboratory methods in the genetics of bacteria and their viruses.

496 Selected Topics in Microbial Metabolism. Spring term. Credit two hours. Prerequisite: beginning courses in general microbiology, biochemistry, and organic chemistry. Mr. Delwiche.

Selected topics pertaining to the energy metabolism, oxidative and fermentative abilities, and biosynthetic capacities of microorganisms. Where possible and appropriate the subject matter deals with the various microbial forms in a comparative sense.

498 Virology. Spring term. Credit three hours. Given in alternate years. Prerequisite: 290 and 281 or permission of the instructor. Mr. Naylor, assisted by Messrs. Ross and Carmichael.

A study of the basic physical, chemical, and biological properties of plant, animal, and bacterial viruses.

590 Methods in Advanced Bacteriology. Either term. Credit two hours. Primarily for graduate students in microbiology. Prerequisite: permission of the instructor. Limited enrollment. Staff.

596 Molecular Immunology Spring term. Credit two hours. Prerequisite: an introductory course in biochemistry and permission of the instructor. Mr. Slobin.

A study of the immune response with particular emphasis on the structure and evolution of immunoglobulins, the nature of antigen-antibody interactions and the molecular biology of antibody biosynthesis.

691 Graduate Seminar in Microbiology. Fall and spring terms. Credit one hour per term. Staff.

Required of all graduate students majoring in microbiology.

699 Microbiology Seminar. Fall and spring terms. Without credit. Staff.

Required of graduate students majoring in microbiology and open to all who are interested.

Agronomy 506 Advanced Soil Microbiology.

Veterinary Medicine 941 Serology.

Veterinary Medicine 944 Immunochemistry.

Veterinary Medicine 945 Animal Virology and Tissue Culture Methods.

Neurobiology and Behavior

(See also the listing under Medical Sciences, p. 83.)

Faculty

Harrison W. Ambrose, Jack Bradbury, Jeffrey Camhi, Robert Capranica, John F. Cummings, Alexander de Lahunta, William C. Dilger, Thomas Eisner, Stephen T. Emlen, Edgar L. Gasteiger, Perry W. Gilbert, Bruce Halpern, Howard C. Howland, William T. Keeton, Myunghwan Kim, Eric Lenneberg, Richard D. O'Brien, Thomas R. Podleski, Frank Rosenblatt, Miriam M. Salpeter, Fred Stollnitz, Daniel N. Tapper, Ari van Tienhoven

Field Representative

Frank Rosenblatt, 141 Langmuir Laboratory

MAJOR AND MINOR SUBJECTS

Neurobiology (including neurophysiology, neurochemistry, sensory physiology, neuroanatomy, theory of brain functions)

Behavioral Biology (including ethology)

Applicants must present scores of the Graduate Record Examinations Aptitude Test and one of the advanced sciences tests.

LANGUAGE REQUIREMENT. There is no language requirement for the M.S. degree. For the Ph.D. degree, the requirement is either high proficiency in one language or medium proficiency in two languages. If possible, the requirement should be fulfilled by the end of the third semester after admission to the Ph.D. program. Acceptable languages are

86 Neurobiology and Behavior

French, German, and Russian; students may petition to substitute another language. High proficiency is demonstrated either by completing twelve semester hours (or equivalent) of course work in a language with a grade of B- (or equivalent), or by completing twelve semester hours of course work and passing the College Board Entrance Examination for the language with a score of 630 or higher. Medium proficiency is shown by completing six semester hours with a grade of B- or better or by completing six semester hours and passing the College Board Entrance Examination with a grade of 560 or higher. Course work presented in fulfillment of this requirement may be taken as an undergraduate or a graduate student. Students who have acquired adequate language proficiency without formal course work may petition the Field, during the first semester after admission to the Ph.D. program, for waiver of this requirement. Students who have received all of their high school or college instruction in a foreign language need not be examined in that language.

Each Special Committee has the right to set additional language requirements.

One weekly seminar in Neurophysiology, Behavior, and Animal Physiology will be given in German each year, and another in French. Students are urged to take one of these seminars for one year after fulfilling the appropriate language requirement.

OTHER REQUIREMENTS. The Field of Neurobiology and Behavior requires each student to attend an orientation meeting with his Special Committee. This meeting is held during the first semester of study and gives the student and his Committee an opportunity to discuss and plan a course and research program. The admission to candidacy and the final thesis examinations required by the Graduate School are held at a later date.

The Field appoints a fourth member to each student's Special Committee. At least one of the minor Committee members must not be a member of this Field.

The Field requires each student to acquire teaching experience during his graduate training at Cornell.

Research Areas

Members of the faculty in the Field of Neurobiology and Behavior will be especially interested in directing research in the following areas, although research will not be limited to these areas.

H. W. Ambrose: ecological aspects of animal behavior; social and orientation behavior.
J. W. Bradbury: social behavior of animals.
J. Camhi: neurophysiological aspects of behavior; insect orientation.

R. R. Capranica: mechanisms of animal communication; sensory physiology.
J. F. Cummings: comparative neurology and histology.
A. de Lahunta: clinical neurology; neural pathology.
W. C. Dilger: comparative aspects of vertebrate behavior.
T. Eisner: biocommunication; insect behavior and physiology.
S. T. Emlen: ecological aspects of vertebrate behavior; mechanisms of orientation and navigation.
E. L. Gasteiger: electrical activity of the nervous system; systems analysis.
P. W. Gilbert: biology of the elasmobranch fishes; functional vertebrate anatomy.
B. Halpern: sensory psychobiology; taste mechanisms.
H. C. Howland: behavioral physiology; mathematical biology.
W. T. Keeton: orientation behavior; evolution of behavior.
M. Kim: intracellular electrophysiology; systems application.
E. H. Lenneberg: functional development of the nervous system; speech mechanisms.
R. D. O'Brien: neuropharmacology; neurochemistry.
T. R. Podleski: neurochemistry; membrane physiology.
F. Rosenblatt: neural networks; physiology of memory.
M. Salpeter: electron microscopy; functional ultrastructure of the nervous system.
F. Stollnitz: discrimination learning in primates.
D. N. Tapper: sensory physiology; receptor and central integration processes.
A. van Tienhoven: neuroendocrinology.

Courses

All courses carry Biological Sciences numbers unless otherwise indicated.

320 Neurobiology and Behavior. Spring term. Credit three hours. Prerequisite: 101-102 or 103-104. Mr. Eisner (in charge) and other faculty.

Evolution of behavior, cueing of behavior, social and nonsocial behavior, neuroanatomy, neurophysiology, neurochemistry, neural networks, memory.

323 Physiological Psychology (Psychology 323). Fall term. Credit three hours. Prerequisite: introductory biology and chemistry, Psychology 201 or a 300-level course in psychology. Mr. Halpern.

Selective examination of neural, endocrine, and biochemical functions related to emotion, memory, learning, perception, hunger, and thirst.

323A Physiological Psychology Laboratory.

Fall term. Credit three hours. Prerequisite: introductory biology and 320; the latter may be waived by permission of the instructor. Mrs. Salpeter.

421 Comparative Vertebrate Ethology. Fall term. Credit three hours. Prerequisite: 101-102 or 103-104 and permission of the instructor. Mr. Dilger.

A survey of the methods and principles of vertebrate ethology for students specializing in this field or for those in other branches of zoology wishing to broaden their knowledge of animal behavior. Emphasis is placed on the causation, function, biological significance, and evolution of species-typical behavior. The laboratories are designed to give firsthand knowledge of the material covered in lectures.

423 Animal Communication. Fall term. Credit four hours. Prerequisite: 320 and introductory physics. Enrollment limited. Messrs. Capranica and Bradbury.

The course will emphasize the functional aspects of biological signals, their physical properties, and the physiological mechanisms underlying their generation and reception. Lectures will examine in detail selected biological communication problems from each of the known sensory modalities. Discussion will cover signal analysis, transmission properties, and the limitation of each type of communication. Laboratories will include behavioral observations under both field and captive conditions and individual experience with the techniques of signal recording and analysis.

427 Sensory Function (Psychology 427). Fall term. Credit three hours. Prerequisite: 320 or equivalent. Messrs. Halpern and Tapper.

Sensory receptors and the central nervous system transformation of afferent activity will be considered in relation to human and animal psychophysical data and to the adaptive significance of behavior. The receptor will be examined in terms of anatomy, biochemistry, biophysics of transduction, and the central nervous system control of peripheral input. Information and signal detection theories will be applied.

427A Sensory Function, Laboratory. Fall term. Credit two hours. Prerequisite: 427. Enrollment limited to 15 students. Messrs. Halpern and Tapper.

Experiments on the principles of receptor function and afferent neural activity.

429 Research in Neurobiology and Behavior. Fall or spring term. Credit and hours to be arranged. S-U grades optional. Staff.

Practice in planning, conducting, and re-

porting independent laboratory and/or library research programs.

522 Brain Mechanisms and Models. Spring term. Credit four hours. S-U grades optional. Prerequisite: calculus, introductory biology or psychology, and consent of the instructor; acquaintance with modern algebra and probability theory is desirable. Mr. Rosenblatt.

Deals with mechanisms underlying the higher functions of the central nervous system, particularly perception, learning, and memory. Topics will include coding and representation of information in the brain; analysis of sensory data; mathematical and computer models for perceptual processes; adaptive mechanisms, memory and learning, including physiological and biochemical basis of memory, perceptions, and other models; and approaches to language and thinking.

523 Ecological Aspects of Animal Behavior. Fall term. Credit three hours. Prerequisite: 320 and 361 or equivalent, or permission of the instructor. Messrs. Emlen and Ambrose.

A discussion of the interrelationships of animal behavior and ecology, with emphasis placed upon the following topics: behavior adaptations to the environment; ecological significance of diverse social systems; spatial relationships (habitat selection, homing, orientation, and navigation); role of social behavior in population regulation; evolution of altruistic behavior.

524 Behavioral Neurophysiology. Spring term. Credit three hours. Prerequisite: 320 or equivalent. Mr. Camhi.

A study of the relationship between animal behavior and the activity of individual nerve cells, considered empirically. Review of electrical properties of excitable tissue. Predictions from the study of animal behavior. Sensory coding of environmental energies. Principles of integration. Integration of sensory inputs. Neural control of muscle contraction. Correlating nerve activity and behavior, problems and prospects. Examples will be chosen from throughout the animal kingdom, with slight preference for invertebrate phyla.

524A Behavioral Neurophysiology Laboratory. Spring term. Credit two hours. Concurrent registration in 524 required. Enrollment limited to 15 students. Mr. Camhi.

Experiments in neurophysiology, often related to specific behavior patterns.

525 Functional Organization of the Nervous System. Fall term. Credit five hours. Prerequisite: a course in college physics, organic chemistry, and physiology. Mr. Gasteiger.

Function of the nervous system will be considered primarily from an electrophysiologic viewpoint. Where appropriate, important

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studies of reflexology, chemical and feedback control, and comparative anatomy will be utilized. Laboratory studies will include electrical activity of cells, reflexes, decerebrate rigidity, acoustic microphonic response, subcortical stimulation, and evoked and spontaneous cortical activity.

526 Bioelectric Systems. Spring term. Credit three hours. Prerequisite: 423 or 427, or Mathematics 122, or Electrical Engineering 4401, or permission of the instructor. Messrs. Capranica and Kim.

Deals with the application of systems techniques to biological problems. Electrical activity of nerve cells; generation and propagation of nerve impulse; voltage clamp technique, Hodgkin-Huxley model; electrical excitability and transfer function of neuromuscular systems; synaptic transmission; models of nerve cells and oscillatory activity. Nerve nets: (a) evoked activity; (b) spontaneous activity; (c) simulation and computer analysis. Functional neuroanatomy of the brain; transfer characteristics of sensory receptors; sensory encoding and processing in the peripheral and central nervous systems; neural mechanisms for vision and hearing.

Nutrition

Faculty

Richard H. Barnes, Andre Bensadoun, Cyril L. Comar, Carl E. Coppock, Marjorie Devine, J. Murray Elliot, James L. Gaylor, L. Ross Hackler, John N. Hathcock, Harold F. Hintz, Douglas E. Hogue, Lennart Krook, Michael C. Latham, Frederick W. Lengemann, John K. Loosli, Leo Lutwak, Donald B. McCormick, William G. Merrill, Mary A. Morrison, Malden C. Nesheim, Katherine J. Newman, Wilson G. Pond, J. Thomas Reid, Jerry M. Rivers, Daphne Roe, Milton L. Scott, Ben E. Sheffy, Sedgwick E. Smith, Jean T. Snook, Hugh F. Travis, Darrell R. Van Campen, P. I. Van Soest, Willard J. Visek, Richard G. Warner, Robert H. Wasserman, Lemuel D. Wright, Charlotte M. Young, Robert J. Young

Field Representative

J. Thomas Reid, 325 Morrison Hall

MAJOR AND MINOR SUBJECT

Nutrition

ADMISSION REQUIREMENTS. Applicants must meet the general requirements for admission to the Graduate School and should be well prepared in the basic sciences. Preparation is highly desirable in analytical and organic chemistry, general biology or zoology, genetics, mathematics, physics, physiology, and a foreign language. Some deficiencies in background preparation can

622 Seminar in Ecological Animal Behavior. Spring term. Credit one hour. Prerequisite: courses in animal behavior and animal ecology, and permission of the instructor. Mr. Ambrose.

629 Advanced Topics in Neurobiology and Behavior. Fall or spring term. Credit one hour. Staff and students.

A seminar course for graduate students and selected undergraduates, designed to provide several study groups each semester on specialized topics. A group may meet for whatever period is judged adequate to permit coverage of the selected topics. Ordinarily, topics will be selected and circulated during the preceding semester. Suggestions for topics should be submitted to the chairman of the Department of Neurobiology and Behavior.

Psychology 323 Physiological Psychology.

Psychology 326 Comparative Psychology.

Psychology 465 Mathematical Behavior Theory.

be made up after admission, but this usually prolongs the time necessary to complete degree requirements.

LANGUAGE REQUIREMENTS. There is no language requirement specified for the Master's degree. There is no language requirement set by the Field for Ph.D. candidates; the requirements for the individual student for study in a foreign language are determined by his Special Committee, particularly if he does not offer adequate foreign language training on admission.

EXAMINATIONS. The Special Committee conducts all examinations. For the Master's degree, the student must present an acceptable thesis and be examined in one major and one minor subject at the end of his course of study. For the Ph.D. degree, two minor subjects are required. The Field requires a qualifying examination in addition to the two examinations required by the Graduate School (see p. 11).

AIMS AND OPERATIONS OF FIELD OF NUTRITION. The organization of the Field coordinates the programs in nutrition in the several separate colleges and units of the University, including the College of Agriculture, the College of Human Ecology, the Veterinary College, and the Graduate School of Nutrition. Strong programs in animal nutri-

tion, nutritional biochemistry, and human and clinical nutrition, including international nutrition, are maintained within this framework. A professional degree of Master of Nutritional Science is administered by the Graduate School of Nutrition. Students interested in this program should consult the *Announcement of the Graduate School of Nutrition* and should direct their correspondence to the Secretary of the Graduate School of Nutrition, Savage Hall.

RESEARCH AND STUDY OPPORTUNITIES.

According to their special interests, candidates may acquire training in biochemistry, economics, food technology, histology, nutrition, organic and inorganic chemistry, pathology, physiology, and other areas of science and technology. Students are generally advised to select either biochemistry or physiology as a minor for the Master's degree and both of these subjects as minors for the doctorate. However, other minor subject matter areas may be selected, depending upon the students' interests.

A wide latitude is allowed in the selection of the research problem for the degree. Studies can be of a fundamental or applied nature and with application to animal or human nutrition, including international nutrition.

Within the broad field of nutrition, faculty interests encompass a wide range of research specializations. These include the following specific categories: proteins and amino acids, fats, energy metabolism, vitamins, minerals, digestion, absorption, nutrient transport, nutritional pathology, endocrine-nutrition interrelationships, and nutrition education. Each of these special subjects can be studied with a variety of animal species.

Clinical and human nutrition studies: Professors Barnes, Devine, Latham, Lutwak, Morrison, Newman, Rivers, Roe, Snook, Visek, C. M. Young.

Nonruminant nutrition studies with dogs, horses, laboratory animals, mink, poultry, swine: Professors Barnes, Bensadoun, Comar, Devine, Elliot, Gaylor, Hackler, Hintz, Hogue, Krook, Lengemann, Loosli, McCormick, Nesheim, Pond, Reid, Rivers, Scott, Sheffy, Smith, Travis, Van Campen, Visek, Warner, Wasserman, Wright, R. J. Young.

Ruminant nutrition studies with beef cattle, dairy cattle, sheep: Professors Coppock, Elliot, Hogue, Krook, Lengemann, Loosli, Merrill, Reid, Smith, Van Soest, Warner.

Courses

Animal Science 410 Principles of Animal Nutrition. Fall term. Credit three hours. Prerequisite: a course in human or veterinary physiology, and a course in organic chemistry

or biochemistry, or permission of the instructor. Drs. Loosli, Nesheim, and Hintz.

The chemistry and physiology of nutrition and the comparative nutritive requirements for maintenance, growth, reproduction, egg production, and lactation.

Animal Science 411 Principles of Animal Nutrition, Laboratory. Fall term. Credit one hour. Prerequisite: concurrent registration in 410. (Nonnutrition majors from other graduate fields who want some research experience will be admitted to this course.) Drs. Hintz and Nesheim.

Laboratory problems with animals will be designed to introduce the student to techniques of experimentation in nutrition.

Animal Science 511 Laboratory Work in Animal Nutrition. Fall term. Credit three hours. S-U grades optional. Prerequisite: quantitative analysis and 410, or equivalent, and permission of the instructor. Dr. Warner.

Each student engages in a series of short research projects with experimental animals, such as rats, rabbits, and sheep. Both classical and modern techniques of animal experimentation are taught. The applications of biochemical methods to the solution of animal nutrition problems are stressed.

Poultry Science 415 Poultry Nutrition. Spring term. Credit one hour. Prerequisite: Animal Science 410 or permission of the instructor. Dr. Nesheim.

Intended to provide a discussion of applications of principles of nutrition to feeding poultry. Feed formulations will be stressed, with emphasis on linear programming and computer formulation.

Poultry Science 511 Research in Nutrition. Fall or spring term. Credit and hours to be arranged. Registration by permission of staff members concerned. Drs. Nesheim and Scott.

For students desiring experience in planning, conducting, and reporting independent research projects in poultry nutrition.

For descriptions of the next six courses, please see the listing for the Field of Human Nutrition and Food in this *Announcement*.

HNF 441 Nutrition and Disease.

HNF 445 Community Nutrition and Health.

HNF 512 Nutrition and Growth.

HNF 514 Readings in Nutrition.

HNF 515 Seminar in Perspectives of Human Nutrition and Food.

HNF 524 Research Methods in Human Metabolic Studies.

90 Nutrition

Graduate School of Nutrition 580 International Nutrition Problems, Policy, and Programs. Fall term. Credit three hours. Registration by permission. Dr. Latham.

A review of food and nutrition problems, policy, and programs especially as they relate to developing countries. Emphasis is placed on the need to coordinate the efforts of various government ministries or departments including those of agriculture, education, economics, health, and community development. Among topics discussed are planning and evaluation of applied nutrition programs; education and training in nutrition; the importance of social and cultural factors; methods of increasing the use of protein-rich foods; assessment of nutritional status; the role of FAO, WHO, UNICEF and other agencies; action in case of famine; the integration of nutrition with other projects of disease control in developing countries.

Graduate School of Nutrition 620 General Nutrition. Fall term. Credit three hours. Prerequisite: permission of the instructor. Dr. Lutwak and staff.

This course is offered to students whose principal academic training has been in a field other than nutrition. It is designed to meet their need for a basic but intensive introduction to the principles, history, and applications of nutrition.

Graduate School of Nutrition 650 Clinical and Public Health Nutrition. Spring term. Credit three hours. Prerequisite: a course in nutrition, in physiology, and in biochemistry, and permission of the instructor. Lectures to be arranged. Drs. C. Young and Roe.

Designed to familiarize the student with some of the applications of nutrition to clinical and public health problems.

Graduate School of Nutrition 660 Special Topics in Nutrition. Throughout the year. Maximum of three credit hours a term. Registration by permission. Graduate School of Nutrition faculty.

Designed for a student who wishes to become well informed in any specific topic he selects which is related directly or indirectly to nutrition. The course may include individual tutorial study, experience in research laboratories, a lecture series on a special topic selected by a professor or a group of students, and/or selected lectures of a course already offered. Topics can be changed so that the course may be repeated for credit.

Veterinary Pathology 931 Pathology of Nutritional Diseases. Spring term. Credit three hours. Prerequisite: Veterinary Pathology 630 and 631. Lecture and laboratory hours to be arranged. Designed primarily for graduate students of nutrition. Dr. Krook.

Advanced Nutrition Series

A series of nutrition courses offered jointly by the Department of Human Nutrition and Food, College of Human Ecology; Department of Animal Science and Department of Poultry Science, College of Agriculture; and the Graduate School of Nutrition. Prerequisite: courses in nutrition, physiology, and biochemistry to include intermediary metabolism.

The subjects covered include the biochemical and physiological bases of digestion, absorption, transport, and metabolism of nutrients; species differences where applicable; historical as well as current concepts of nutrition.

Human Nutrition and Food 501 Proteins and Amino Acids. Fall term. Credit two hours. Dr. Morrison.

Poultry Science 502 Lipids and Carbohydrates. Fall term. Credit two hours. Dr. Bensadoun.

Animal Science 503 Nutritional Energetics. Spring term. Credit two hours. Dr. Reid.

Poultry Science 504 Minerals and Vitamins. Spring term. Credit two hours. Dr. Scott.

Animal Science 505 Biochemistry of Gastrointestinal Fermentation. Fall term. Credit two hours. S-U grades optional. Prerequisite: quantitative analysis, Animal Science 410 and Biochemistry 431, or permission of the instructor. Dr. Van Soest.

Gastrointestinal fermentations in relation to utilization of cellulosic materials as food. Chemical composition of plants and factors affecting their nutritive value.

Animal Science 513 Forage Analysis. Fall or spring term. Credit two hours. Prerequisite: Animal Science 505 and permission of the instructor. Enrollment limited to 5 students a term. Laboratory only. Dr. Van Soest.

Nutritive evaluation of forages and related materials through various chemical and *in vitro* procedures. Course will include a term paper summarizing results of independent laboratory study of either materials or methods. The student may develop or provide his own forage materials.

Seminars

Graduate School of Nutrition 700 Nutrition Seminar. Fall and spring terms. Credit one hour. Dr. Barnes and faculty.

Intended primarily for Graduate School of Nutrition students; it is recommended that they attend throughout the year.

Animal Science 619, Poultry Science 619, Graduate School of Nutrition 619 Field of Nutrition Seminar. Fall and spring terms. No credit. Current research in nutrition presented by visitors and faculty.

Human Nutrition and Food 605 Seminar in Human Nutrition and Food. Fall and spring terms. Credit one hour. Dr. Rivers and staff.

Physiology

(See also the listing under Medical Sciences, p. 83 of this *Announcement*.)

Faculty

William J. Arion, Arthur L. Aronson, Andre Bensadoun, John Bentinck-Smith, Emmett N. Bergman, Robert W. Bratton, Alison P. Casarett, R. K. Clayton, Cyril L. Comar, Alan Dobson, Thomas Eisner, Robert H. Foote, Edgar L. Gasteiger, Perry W. Gilbert, Bruce Halpern, William Hansel, J. W. Hudson, Frederick W. Lengemann, Samuel L. Leonard, George Lust, Leo Lutwak, William N. McFarland, Robert S. Morison, Louis L. Nangeroni, Robert L. Patton, Frank Rosenblatt, Miriam M. Salpeter, Glen H. Schmidt, Herbert F. Schryver, Alvin F. Sellers, Charles E. Stevens, Daniel N. Tapper, Ari van Tienhoven, Willard J. Visek, Robert H. Wasserman, William A. Wimsatt, John F. Wootton, Donald B. Zilversmit

Field Representative

C. E. Stevens, D-132, Veterinary College

MAJOR AND MINOR SUBJECTS

Cellular Physiology
Comparative Physiology
Physical Biology
Vertebrate Physiology

See also listing under special interests of the faculty for major area subjects. Minors may be selected from such areas as biochemistry, biometry, chemistry, ecology, electrical engineering, genetics, histology, microbiology, nutrition, pathology, physics, and psychology.

All applicants, where possible, should submit the results of the Graduate Record Examinations Aptitude and Advanced Biology Tests. Students preparing for work in the Field of Physiology are urged to obtain a good knowledge of biology, chemistry, biochemistry, and physics. Calculus, statistics, and genetics are also advisable.

There is no foreign language requirement for the Master's degree. For the Ph.D. degree, the language requirements will be left to the candidate's Special Committee.

In addition to the examinations specified by the Graduate School, the Field requires that doctoral candidates pass a qualifying examination. This should be taken before two residence units have been earned. The Field requires of each major at least one semester

of teaching, except in instances where the Special Committee deems it inadvisable or inappropriate.

A doctoral candidate in Physiology must have two minor subjects with a representative from each on his Committee. At least one of the minor committeemen must not be a member of the Field of Physiology. An additional voting member will be appointed to the candidate's Committee by the Field of Physiology.

Special Interests of the Faculty

Behavioral physiology: Professors Eisner and Gilbert.

Biochemistry, membrane structure: Professors Arion and Lust.

Biophysics: Professor Clayton.

Cardiovascular physiology: Professors Bergman, Dobson, and Sellers.

Comparative neurology and neuropharmacology: Professor Salpeter.

Comparative physiology: Professor McFarland.

Electrophysiology: Professor Nangeroni.

Endocrinology: Professors Hansel, Leonard, Lutwak, and van Tienhoven.

Environmental physiology: Professor Hudson.

Enzymology: Professor Wootton.

Gastrointestinal physiology: Professors Bensadoun, Dobson, Sellers, Stevens, Visek, and Wasserman.

Histology, cytology, and electron microscopy: Professors Salpeter and Wimsatt.

Insect physiology: Professors Eisner and Patton.

Lipid transport and metabolism: Professors Bensadoun and Zilversmit.

Metabolism: Professors Bergman, Lengemann, Lutwak, and Visek.

Neurophysiology: Professors Gasteiger, Gilbert, Morison, Rosenblatt, and Tapper.

Pathological physiology: Professors Bentinck-Smith, Lust, and Schryver.

Pharmacology and toxicology: Professor Aronson.

Photobiology: Professor Clayton.

Physiology of lactation: Professor Schmidt.

Psychology: Professor Halpern.

Radiation biology and physical biology: Professors Casarett, Comar, Lengemann, and Wasserman.

Reproduction: Professors Bratton, Casarett, Foote, Gilbert, Hansel, Leonard, van Tienhoven, and Wimsatt.

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Ruminant physiology: Professors Bergman, Dobson, Sellers, and Stevens.
Vertebrate physiology: Professors Gilbert, Nangeroni, Sellers, and Wimsatt.

A prospective student is urged to correspond with the professor in the above list whose interests are nearest his own.

Courses

Biological Sciences 414 Mammalian Physiology. Spring term. Credit six hours. Registration by permission. Prerequisite: a year of biological science; courses in biochemistry, histology, and gross anatomy desirable. Messrs. Visek (in charge), Bensadoun, Gasteiger, and Hansel.

A general course in mammalian physiology including circulation, respiration, digestion, metabolism, renal function, endocrinology, and the nervous system.

Biological Sciences 427 Sensory Function. Fall term. Credit three hours. Prerequisite: Biological Science 320 or equivalent. Messrs. Halpern and Tapper.

Sensory receptors and the central nervous system transformation of afferent activity will be considered in relation to human and animal psychophysical data and to the adaptive significance of behavior. The receptors will be examined in terms of anatomy, biochemistry, biophysics of transduction, and the central nervous system control of peripheral input. Information and signal detection theories will be applied.

Biological Sciences 513 Experimental Endocrinology. (Consult the *Announcement of the College of Agriculture*.)

Biological Sciences 522 Brain Mechanisms and Models. (Consult the listing for the Field of Neurobiology and Behavior.)

Biological Sciences 547 General Photobiology. (Consult the listing for the Field of Botany.)

Animal Science 427 Fundamentals of Endocrinology.

Animal Science 451 Physiology and Biochemistry of Lactation.

Poultry Science 425 Comparative Physiology of Reproduction of Vertebrates.

Veterinary Medicine 915 Methods in Physiological Research.

Veterinary Medicine 916 Physiological Disposition of Drugs and Poisons.

Veterinary Medicine 917 Physiology.

Veterinary Medicine 918 Physiology.

Veterinary Medicine 920 Elements of Physiological Biology.

Veterinary Medicine 921 Radioisotopes in Biological Research—Principles and Practice.

Veterinary Medicine 922 Biological Effects of Radiation.

Veterinary Medicine 923 Biological Membranes and Nutrient Transfer.

Veterinary Medicine 924 Functional Organization of the Nervous System.

Veterinary Medicine 928 Experimental Physiology for Graduate Students.

Plant Breeding and Biometry

Faculty

Ronald E. Anderson, Loy V. Crowder, Herbert L. Everett, Walter T. Federer, Clarence O. Grogan, Neal F. Jensen, Carl C. Lowe, Henry M. Munger, Royse P. Murphy, William D. Pardee, Robert L. Plaisted, Douglas S. Roberson, Robert R. Seane, Shayle R. Searle, Daniel L. Solomon, Donald H. Wallace

At Geneva

Donald W. Barton, John Einset, Robert C. Lamb, Gerald A. Marx, Donald K. Ourecky, Richard W. Robinson, Roger D. Way

Field Representative

Neal F. Jensen, 420 Bradfield Hall

MAJOR AND MINOR SUBJECTS

Plant Breeding
Biometry
Plant Genetics

Plant breeding and plant genetics cannot be a major-minor combination within the Field; however, genetics (Field of Genetics) may be a minor.

ADMISSION REQUIREMENTS. Applicants to this Field should be well grounded in the fundamentals of the natural sciences and should have had courses in advanced chemistry, biology, calculus, and physics. Students intending to specialize in biological statistics

will find it to their advantage to have additional training in mathematics.

FIELD REQUIREMENTS. The language requirement for each student will be determined by the Field following a recommendation from the chairman of the student's Special Committee. This may range from no foreign language training to fluency in one or more languages. All students must pass an English proficiency examination as specified by the Field.

Examinations required by the Graduate School are described on p. 11 of this *Announcement*.

Research Areas

Students interested in crop improvement through breeding, the genetics of higher plants, population dynamics, or quantitative inheritance studies with higher plants may choose plant breeding or plant genetics as a major. Problems for research may involve studies of breeding methods, the application of genetic principles to breeding, and the correlation of knowledge from other areas such as biochemistry and statistics in attacks on problems affecting yield, quality, adaptability, and disease-insect resistance. The Department now has active research projects with most of the important field and vegetable crops of New York, and certain materials from these projects are available for graduate students' problems. Plant genetics as a major subject generally involves research problems more specifically aimed towards the analysis of hereditary and evolutionary phenomena; almost any suitable biological materials can be used.

Students with mathematical interests in the development and application of statistical models in biology may elect a biometry major. Research problems may be purely theoretical studies, computer simulation studies, novel statistical analyses of real data, or may involve a combination of these approaches to various topics, such as estimation and sampling, the design and analysis of experiments, statistical genetics, quantitative ecology, or epidemiology. The department now has active research projects in these and other areas of statistics and biomathematics.

Students majoring in plant breeding or plant genetics will find it necessary to remain in Ithaca during the summer or to make arrangements elsewhere for growing and studying the material used in connection with their research problems. Special provisions are available for students interested in international agriculture who would like to do their thesis research in Latin America.

Members of the staff will be especially interested in directing research in the areas listed, although research will not be limited to

those areas. Staff listed under plant breeding direct thesis research on the genetics of the crop plants with which they are primarily concerned. Staff listed under biometry direct theses on various aspects of statistical and mathematical genetics.

Biometry: W. T. Federer, statistics and experimental design; D. S. Robson, statistics and biometrical genetics; S. R. Searle, statistics and computing; D. L. Solomon, statistics and biomathematics.

Plant Breeding: R. E. Anderson, sugarbeets; C. C. Lowe and R. P. Murphy, forage crops; W. D. Pardee, extension and pure seed programs; C. O. Grogan, corn; N. F. Jensen, small grains; H. M. Munger and D. H. Wallace, vegetable crops; R. L. Plaisted, potatoes; L. V. Crowder, international agriculture.

Courses

Plant Breeding

503 Methods of Plant Breeding I. Fall term. Credit three hours. Prerequisite: Biological Sciences 101-102 or 103-104 and 281, and a course in at least one of the following: field crops, vegetable crops, floriculture, or pomology. Mr. Murphy.

Principles and practices of plant breeding. Each of the possible variety forms is described, and the methods of producing them are discussed.

[504 Applied Methods and Techniques I.] Fall term. Credit two hours. Given in alternate years. S-U grades exclusively. Prerequisite: 503 or permission of the instructor. Mr. Crowder and staff. Not given in 1971-72.

Designed to acquaint students with the field, greenhouse, and laboratory techniques used in plant breeding research. Will include experience with modes of pollination, male sterility and incompatibility factors, immunology, polyploidy, chemical mutagens and ionizing radiation as related to higher plants, use of colchicine in *in vitro* embryo culture, seed certification, and technology.]

505 Physiological Genetics of Crop Plants. Spring term. Credit three hours. Mr. Wallace.

Genetic, biochemical, and molecular mechanisms controlling plant variation in physiological phenomena such as photosynthesis, respiration, translocation, self-incompatibility, male sterility, seed dormancy, and heterosis will be discussed. Biochemical and molecular mechanisms through which environmental factors like temperature, light, mineral elements, and water interact with genetics to alter phenotypic expressions of plant growth and development will also be covered. These genetic, physiological, biochemical, and

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environmental phenomena will be presented from data obtained through studies with higher plants. Emphasis will be upon physiological variation that can be exploited in plant breeding.

506 International Crop Breeding and Improvement. Fall term. Credit two hours. Given in alternate years. Prerequisite: 503 or consent of the instructors. Mr. Crowder.

Discussion of plant breeding principles and procedures that have been evolved and applied in breeding certain groups of crops, based on mode of pollination and the predominant type of gene action, especially as related to situations found in different parts of the world. Particular attention will be given to alternate approaches in breeding and crop improvement programs in developing countries and to cropping systems and agronomic practices which influence crop productivity. Specific reference materials and examples will be drawn from current activities in tropical agricultural regions. Student participation is expected.

507 Research Orientation. Spring term. Credit two hours. Prerequisite: 503. Mr. Grogan and staff.

Designed to acquaint the student with the various facets of research in plant breeding. Particular attention will be given to the organizations engaged in plant breeding, sources and kinds of support, preparation of project outlines and reports, philosophies of selected past and present plant breeders, real and hypothetical research problems, varietal release procedures and policies, preparation of a publication, aids in oral presentation, and seeking a position.

[512 Experimental Methods. Spring term. Credit two hours. Given in alternate years. Prerequisite: 511 or consent of the instructor. Mr. Lowe. Not given in 1971-72.

Use of statistical methods and application of experimental designs and plot techniques to problems in plant breeding and related agricultural research.]

515 Methods of Plant Breeding II. Spring term. Credit two hours. Given in alternate years. Prerequisite: 503 and 511, or equivalent. Mr. Plaisted.

An introduction to quantitative genetics and its application to the understanding of various plant breeding and selection procedures. Topics covered will be the estimation and understanding of coefficients of inbreeding, genetic components of variation, heritability, general and specific combining ability, and genetic advance.

516 Advanced Topics in Plant Genetics and Breeding. Fall term. Credit one hour. Given in alternate years. Two-hour lecture and work-

shop discussion to be arranged. Mr. Jensen and invited participants.

Study in depth of advanced research and other topics of special relevance to plant genetics and breeding. Examples of research topics are: somatic hybridization, host-pathogen relationships, parameters of yield, mutation or radiation breeding, uses of male sterility, world germ-plasm resources, mass selection, plant competition and population dynamics.

450 Special Problems in Research. Fall, spring, or summer term. Credit one or more hours by arrangement with instructor. Members of the departmental staff.

622 Seminar. Fall and spring terms. Without credit. Members of the departmental staff and graduate students.

Statistics and Biometry

200 Statistics and the World We Live In. Spring term. Credit three hours.

407 Introductory Computer Techniques for Statistics and Biology. Fall term. Credit two hours. Prerequisite or corequisite: an introductory course in statistics. Mr. Searle.

Introduction to uses of computers in statistics: calculation of elementary statistical analyses, techniques of sampling and simulation, and availability of library programs. CUPL, the Cornell University Programming Language, will be taught and used for problem solving; use may also be made of some library programs.

408 Probability and Statistics I. Fall term. Credit three hours. Prerequisite: Mathematics 112 or consent of the instructor. Mr. Solomon.

Statistical theory is developed for the analysis of discrete data. The concepts of statistical inference are introduced with emphasis on discrete distributions and their applications in biology. Concepts and techniques from probability theory including conditional probability, moments, probability generating functions, and Markov chains are introduced as needed.

409 Probability and Statistics II. Spring term. Credit three hours. Prerequisite: 408. Mr. Solomon.

The concepts developed in 408 are extended to the analysis of data from continuous distributions. Emphasis on biological applications is maintained.

[411 Stochastic Models in Biology. Spring term. Credit three hours. Given in alternate years. Prerequisite: 409. Discussion period arranged. Not given in 1971-72.

An introduction to stochastic processes in biology. The necessary mathematics and sta-

tistics will be introduced as needed. Recurrent events, random walk models, Markovian processes, birth-and-death processes, epidemic processes, competition and predation, diffusion processes, and other models currently used in biological theory will be discussed and applied. Special emphasis will be given the various processes applied to genetics.]

[412 Deterministic Models in Biology. Spring term. Credit three hours. Given in alternate years. Prerequisite: 409. Not given in 1971-72.

An introduction to deterministic mathematical models in biology. The application will be from the biological viewpoint. The necessary mathematics will be introduced as needed. Finite differences, differential equations, logistic, growth and decay, and other deterministic models corresponding to those introduced in 411 will be discussed.]

417 Matrix Algebra. Fall term. Credit three hours. Prerequisite: equivalent of one year of college algebra. Mr. Searle.

Basic matrix algebra with applications in biology and statistics. Arithmetic procedures and other matrix operations; rank and linear independence, latent roots and vectors, solving linear equations, generalized inverses, direct sums and products. Use of matrices in regression analysis and linear statistical models.

499 Special Problems in Statistics and Biometry. Fall, spring, or summer term. Credit one or more hours by arrangement with instructor. Prerequisite: permission to register. Biometrics unit staff.

510 Statistical Methods I. Fall term. Credit four hours. Prerequisite: permission of the instructor.

The distributions of statistics encountered in biological and other fields are considered from the point of view of elementary probability notions and by sampling from known populations. The results, with principles of experimentation, are applied to the conduct of experiments and interpretation of results. Topics include point and interval estimation, tests of hypotheses and of significance, the treatment of discrete data, methods involving rank sum procedures, the consideration of normal populations, the one-way analysis of variance and simple linear regression. Emphasis is placed on basic statistical principles, criteria for selection of statistical techniques, and the application of these techniques to a wide variety of biological situations.

511 Statistical Methods II. Spring term. Credit four hours. Prerequisite: 510 or equivalent.

The work of 510 is continued. Topics include multiple and curvilinear regression, complex analyses of variance and covariance. The analysis of variance discussion considers treatment designs, single degree of freedom contrasts, the simpler experimental designs, sampling errors, fixed, mixed and random models, and the effect of disproportionate numbers. When appropriate, the computer is considered as the reasonable way to have calculations done.

[513 Design of Experiments I. Fall term. Credit four hours. Prerequisite: 417 and 511, or equivalent. Mr. Federer. Given in alternate years. Not given in 1971-72.

Principles and techniques of experimentation; theoretical concepts; extensions and variations of the completely randomized, randomized complete block, and latin square designs; the factorial experiment and confounding; fractional replication including response surface designs, lattice designs, cross-over designs, augmented and other designs; covariance analyses; error rates; test and interval estimation for ranked means; sample size; variance component analyses; unequal number analyses; the place of orthogonality in design; and advanced statistical methodology under various fixed, mixed, and random models.]

[514 Design of Experiments II. Spring term. Credit four hours. Prerequisite: 513. Mr. Federer. Not given in 1971-72.

A continuation of the work in 513 with emphasis on the role of confounding in experimental and treatment designs. Generalized forms of analyses and construction are presented, followed by a discussion from selected topics on long-term experiments, combination of results from several experiments, sequential experimentation, variance component analyses, estimation procedures, linear hypotheses, heritability studies, multivariate analyses, unequal numbers analyses, and related topics.]

517 Linear Models. Spring term. Credit three hours. S-U grades. Prerequisite: 417, 511, and Mathematics 370 or 371. Mr. Searle.

Introduction to multinomial variables and distribution of quadratic forms; linear statistical models, estimable functions and testable hypotheses; regression models, experimental design models, variance components models, and combinations thereof.

518 Selected Topics in Biometry. Spring term. Credit three hours. Prerequisite: 511 or equivalent. Mr. Robson.

Topics include the principles and methodology of bioassay, discriminant functions, sequential analysis, nonparametric methods, mark-recapture methods, and path analysis.

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520 Design of Experiments III. Fall term. Credit three hours. Prerequisite: 417 and Mathematics 431-432 or the equivalent. Messrs. Federer, Hedayat, and Raktoe.

A mathematical development of the prop-

erties, construction, and analysis of experiment and treatment designs. Proofs to be given for known results and problems to be formulated in mathematical terms.

Plant Pathology

Faculty

Philip A. Arneson, Durward F. Bateman, Steven V. Beer, Carl W. Boothroyd, Bill B. Brodie, Robert S. Dickey, A. Watson Dimock, R. Kenneth Horst, Warren T. Johnson, Edward D. Jones, George C. Kent, Richard P. Korf, James W. Lorbeer, William F. Mai, Roy L. Millar, William F. Rochow, A. Frank Ross, Otto E. Schultz, Arden F. Sherf, Wayne A. Sinclair, H. David Thurston, Hans D. Van Etten, Robert E. Wilkinson

At Geneva

Alvin J. Braun, Samuel W. Braverman, Robert M. Gilmer, John D. Gilpatrick, John J. Natti, William T. Schroeder, Michael Szkolnik, Jerry K. Ueymoto

At Farmingdale

Martin B. Harrison, Charles E. Williamson

At Riverhead

Robert C. Cetas

Field Representative

Roy L. Millar, 360 Plant Science Building

MAJOR AND MINOR SUBJECTS

Plant Pathology

Mycology

A student majoring in one of these subjects is generally advised not to minor in the other.

ADMISSION REQUIREMENTS. The applicant must hold a baccalaureate degree from an accredited college or university. Broad training in the biological and physical sciences is essential; course work or experience in plant pathology is not required. Admission is based on quality of undergraduate work and promise as a graduate student, rather than on numbers and types of courses completed. The applicant must present his scores on the Graduate Record Examinations Aptitude Test.

LANGUAGE REQUIREMENTS. There is no general foreign language requirement for the M.S. and Ph.D. degrees; however, competence in one or more foreign languages may be required by the chairman of the Special Committee.

EXAMINATIONS. Every student majoring in plant pathology or mycology is expected to take an oral, or oral and written, qualifying

examination within the first twelve months after registration. This examination, required by the Field, is designed to assist the student and his Committee in charting the student's program of study. A candidate for the M.S. degree will be held responsible for a terminal thesis and subject matter examination. A student in the Ph.D. degree program must pass a comprehensive admission to candidacy examination, designed to test his knowledge of subject matter pertinent to the doctoral degree. It may be oral, or oral and written, and will be administered by the Special Committee. An oral final examination on the thesis is required for the Ph.D. degree.

FINANCIAL AID. A number of fellowships and scholarships are available, and many assistantships are awarded by the Department.

RESEARCH AND STUDY OPPORTUNITIES. Excellent opportunities for graduate study and research are offered in all phases of plant pathology and mycology. Students become familiar with the basic principles of disease as caused by the major groups of plant pathogens (e.g., bacteria, fungi, nematodes, mycoplasmas, and viruses). Excellent equipment and facilities are available for research under the guidance of specialists in the department. Summer field trips with staff members give students experience in diagnosing diseases and in observing up-to-date control practices. All students are expected to obtain teaching experience in plant pathology and to become familiar with extension techniques.

Students electing plant pathology as their major may work with any of several staff members in crop-oriented research, e.g., diseases of forage, fruit, ornamentals, potatoes, vegetables, shade trees and shrubs, small grains, corn, and turf grasses; or in research programs with staff members in specific areas of plant pathology, e.g., bacteriology, epidemiology, nematology, physiology of disease, virology, and tropical plant pathology. Students electing a major in mycology will find a stimulating program of research and teaching in mycology. They may concentrate their research in cytology, genetics, morphology, physiology, or taxonomy.

An outstanding mycological and plant pathological herbarium, superior library facilities, excellent controlled-environment facilities, modern equipment, and cooperation with

faculties of related fields enable students to follow a broad range of research programs.

Further information concerning the Field is given in a brochure *Graduate Study in Plant Pathology and Mycology at Cornell*, which may be obtained by writing the Field Representative.

Special Interests of the Faculty

- P. A. Arneson: extension, fruit diseases.
- D. F. Bateman: teaching and research, disease and pathogen physiology.
- S. V. Beer: research, fruit diseases, disease physiology.
- C. W. Boothroyd: teaching, general plant pathology; research, corn diseases, soil-borne pathogens.
- B. B. Brodie: research, nematology.
- R. S. Dickey: teaching and research, phytopathogenic bacteria.
- A. W. Dimock: research, soil-borne pathogens, relation of environmental factors to disease development and disease control.
- R. K. Horst: extension and research, diseases of florist and ornamental plants.
- W. T. Johnson: extension, pests of trees and shrubs on home grounds, 4-H Club work.
- E. D. Jones: extension and research, diseases of potatoes, potato certification, foundation seed programs.
- G. C. Kent: teaching, advanced plant pathology; research, diseases of cereal crops, pathological histology, epidemiology.
- R. P. Korf: teaching, mycology; research, taxonomy, morphology, cytology, ecology, and physiology of fungi.
- J. W. Lorbeer: teaching, mycology; research, diseases of vegetables, soil-borne pathogens, fungi genetics, epidemiology.
- W. F. Mai: teaching, nematology; research, etiology and control of diseases caused by nematodes, nematode physiology and taxonomy.
- R. L. Millar: teaching, general plant pathology; research, physiology of infection, diseases of field and forage crops.
- W. F. Rochow: research, virus diseases of cereal crops, aphid transmission of plant viruses.
- A. F. Ross: teaching, plant virology; research, viruses and virus diseases, interaction of plant viruses.
- O. E. Schultz: extension, diseases of potatoes, grain, and forage crops.
- A. F. Sherf: extension, vegetable diseases.
- W. A. Sinclair: teaching, extension and research, diseases of trees and shrubs.
- H. D. Thurston: teaching and research, tropical plant diseases and control.
- H. D. Van Etten: research, disease and pathogen physiology.
- R. E. Wilkinson: research, diseases of vegetable crops, virus diseases, disease control.

Off-campus:

- A. J. Braun: research, small fruit diseases, nematology, virology, fungicides.
- S. W. Braverman: research, plant introductions, disease resistance.
- R. C. Cetas: research, vegetable and potato diseases, fungicides, breeding for resistance.
- R. M. Gilmer: research, deciduous fruit diseases, virology.
- J. D. Gilpatrick: research, fungus diseases, fungicides.
- M. B. Harrison: research, diseases caused by nematodes, turf diseases, soil fumigation.
- J. J. Natti: research, vegetable diseases, fungicides, breeding for resistance.
- W. T. Schroeder: research, vegetable diseases, fungicides, breeding for resistance.
- M. Szkolnik: research, fruit diseases, fungicides, systemics.
- C. E. Williamson: research and extension, diseases of florist crops, nematology, soil fumigation.
- J. K. Ueymoto: research, virology.

Courses

301 General Plant Pathology. Every fall and alternate spring terms. Credit four hours. For graduates who have had no formal course work in plant pathology. Prerequisite: Biological Sciences 101-102 or 103, or equivalent. Mr. Boothroyd. Not given in spring, 1972.

An introductory course dealing with the nature, cause, and control of disease in plants. Representative diseases of cultivated crops are studied in the laboratory.

309 Comparative Morphology of Fungi. Fall term. Credit four hours. For graduates who have had no formal course work in mycology. Prerequisite: a one-year sequence of botany or equivalent, and permission to register. Mr. Korf.

An introductory course in mycology. Emphasis is placed on morphology rather than on taxonomy.

403 Pathology of Trees and Shrubs. Spring term. Credit three hours. Prerequisite: an introductory course in plant pathology and permission to register. Mr. Sinclair.

For students who desire some specialized knowledge of diseases of trees and shrubs and their diagnosis and control.

501 Advanced Plant Pathology. Fall term. Credit five hours. Prerequisite: an introductory course in plant pathology and permission to register. Mr. Millar.

Designed to acquaint the student with the basic principles and techniques of the science of phytopathology and to provide an adequate foundation for successful prosecution of research in this area.

98 Plant Pathology

[502 Principles of Plant Disease Control. Spring term. Credit three hours. Offered in alternate years. Enrollment limited to 24 students. Prerequisite: 501 or equivalent, and permission to register. Not offered in 1971-72.

For graduate students who expect to teach or perform research in educational institutions, experiment stations, or agricultural chemical companies in connection with the development and use of plant disease control materials and methods. Emphasis is placed upon the philosophies underlying the principles of plant disease control. Objectives are to help students interested in plant protection equip themselves not only to apply existing methods and materials but to improve upon them by developing new ideas, especially in situations where control of plant diseases requires new approaches.]

505 Plant Virology. Fall term. Credit three hours; in special cases, permission may be obtained to enroll for lectures only (two hours credit). For students with majors or minors in plant pathology and, in special cases, for other graduate students interested in virology. Prerequisite: 501 or permission to register. Mr. Ross.

Designed to provide advanced graduate students with basic information on the plant viruses and on the diseases they cause.

506 Plant Nematology. Spring term. Credit three hours. Offered in alternate years. For graduate students with majors or minors in plant pathology and, in special cases, other students interested in nematology. Prerequisite: 501 or permission to register. Two lectures and one two-hour laboratory period a week. Mr. Mai.

Anatomy, morphology, and taxonomy of plant parasitic forms and nonparasitic soil-inhabiting forms of nematodes are studied. Plant pathogenic forms also are considered from the standpoint of host-pathogen relationships, host ranges, life cycles, and the symptoms they cause. Principles and methods of control are discussed.

[507 Bacterial Plant Pathogens. Spring term. Credit two hours. Offered in alternate years. For graduate students with majors or minors in plant pathology; others by permission only. Prerequisite: 501 or permission to register. Mr. Dickey. Not offered in 1971-72.

Designed to provide students with basic information on bacterial plant diseases and phytopathogenic bacteria. The laboratory will include some of the more important techniques used in the study of bacterial plant pathogens.]

508 Disease and Pathogen Physiology. Fall term. Credit three hours. Offered in alternate years. For graduate students with majors or

minors in plant pathology; others by permission only. Prerequisite: 501, Biological Sciences 240 and 431, and permission to register. Mr. Bateman.

Designed to provide students with insight into the mechanisms of pathogenesis and altered metabolism of diseased plants.

531 Special Problems in Mycology or Plant Pathology. Fall or spring term, or both. Credit three or five hours each term. Registration by permission. Three to five weekly laboratory periods of three hours each. Staff members.

For work in mycology, modern techniques and the experimental approach are stressed in areas such as physiology, developmental morphology, genetic systems, or cytotoxonomy.

For work in plant pathology, for minor thesis or problems, or for students wishing to develop familiarity with modern techniques in some phase of the science.

541 Philosophy of Plant Pathology. Fall term. Credit two hours. Offered in alternate years. Designed for Ph.D. students majoring in plant pathology. Prerequisite: 501, 569, and at least two other courses from 502, 505, 506, 507, and 508, or permission to register. Mr. Kent.

Examination of the concepts of plant pathology as they relate to basic and applied research problems, teaching, and extension.

579 Advanced Mycology. Spring term. Credit four hours. Given in alternate years. Prerequisite: 309 or equivalent, a course in genetics, and permission of the instructor. Mr. Korf.

A detailed study of the biology and taxonomy of the major groups of plant pathogenic fungi (rusts, smuts, Fungi Imperfecti, Peronosporales) with emphasis on mechanisms of variation in fungi. Optional field trips.

[599 Taxonomy of Fungi. Fall term. Credit four hours. Given in alternate years. Prerequisite: 309 or equivalent, a course in genetics, a course in plant or animal taxonomy, and permission of the instructor. Mr. Korf. Not offered in 1971-72.

Emphasis is placed on the principles of taxonomy and nomenclature, critical evaluation of keys and monographs, and practice in identification. The Discomycetes, from which most examples are drawn, are treated in detail. Required field trips.]

645-654 Current Topics. Fall and spring terms. Credit to be arranged. For graduate students with special interests in a particular area. Prerequisite: permission to register.

Weekly discussions of current topics in special areas of plant pathology and mycol-

ogy. Students will be required to do extensive reading of current literature and to present oral and written reports.

645 Plant Virology. Messrs. Ross and Rochow.

646 Plant Nematology. Messrs. Brodie, Harrison, and Mai.

647 Bacterial Plant Pathogens. Mr. Dickey.

648 Physiology of Plant Diseases. Messrs. Bateman and Millar.

649 Mycology. Mr. Korf.
1971-72: fall term, Gasteromycetes; spring term, Zygomycetes. (Not offered in 1972-73.) 1973-74: fall term, Agaricales; spring term, Plectomycetes and Pyrenomycetes. 1974-75: fall term, Aphyllophorales and Tremellales; spring term, lichens. 1975-76: fall term, Mycetozoa and Hemiascomycetes; spring term, water molds.

650 Diseases of Vegetable Crops. Messrs. Lorbeer and Wilkinson.

653 Pathology of Trees and Shrubs. Mr. Sinclair.

654 Diseases of Florist Crops. Mr. Horst.

655 Plant Diseases in Tropical Agricultural Development. Mr. Thurston.

656 Environment and Disease Development. Mr. Dimock.

661 Seminar. Fall and spring terms. Credit one hour. Required of all graduate students taking work in the department. Mr. Mai.

671 Plant Pathology Colloquium. Fall and spring terms. Credit one hour. Staff and graduate students.

Biological Sciences 498 Virology. (See the listing in this *Announcement* for the Field of Microbiology.)

Pomology

Faculty

G. D. Blanpied, L. L. Creasy, L. J. Edgerton, G. H. Oberly, L. E. Powell, Jr., R. M. Smock, J. P. Tomkins

At Geneva

J. C. Cain, J. N. Cummins, O. F. Curtis, Jr., J. Einset, C. G. Forshey, W. J. Kender, R. C. Lamb, D. K. Ourecky, N. J. Shaulis, R. D. Way

Field Representative

L. E. Powell, Jr., 121 Plant Science Building

MAJOR AND MINOR SUBJECT

Pomology

GENERAL REQUIREMENTS. An applicant to this Field need not have done his undergraduate work in horticulture. It is important, however, that he have a good background in the basic sciences and an interest in fruit plants. A knowledge of botanical and chemical subjects is particularly helpful. During his graduate work the student is expected to become well acquainted with the field of pomology and with other fields closely allied to his thesis problem. A candidate for the M.S. degree is required to pass a final examination. A student registered in a Ph.D. degree program must take a qualifying examination in addition to the examinations required by the Graduate School (see p. 11).

MAJOR AND MINOR SUBJECTS. Pomology is approved as a major subject and as a

minor subject when the major is in another Field. However, pomology, vegetable crops, and floriculture are generally not permitted as major-minor combinations.

LANGUAGE REQUIREMENT. There is no general foreign language requirement for the M.S. and Ph.D. degrees; however, competence in one or more foreign languages may be required by the chairman of the Special Committee.

RESEARCH AND STUDY OPPORTUNITIES.

Cornell University has two Departments of Pomology under its jurisdiction: one on the main Ithaca campus and one on its Geneva campus, fifty miles away at the New York State Agricultural Experiment Station. Members of these Departments are currently engaged in a great variety of research projects concerning growth-regulating substances, post-harvest physiology, mineral nutrition, cold hardiness, rest period, root initiation, root-stocks, fruit set and development, fruit breeding, plant pigments, and general cultural practices. Students satisfy their course work requirements at Ithaca but, depending on their thesis problem, may conduct their research at either the Ithaca or the Geneva campus. Ordinarily one to two years are required to meet the requirements of a Master's degree and three to four years for the Ph.D. degree, although individual students may progress at a faster or slower rate.

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Courses

401 Advanced Pomology. Fall term. Credit three hours. Offered in alternate years. Prerequisite: Pomology 101 and 102 and Biological Sciences 242. Mr. Creasy.

A comprehensive study of the sources of knowledge and practices in pomology. The results of experience and research pertaining to pomology are discussed, with special reference to their application in the solution of problems in commercial fruit-growing.

501 Special Topics in Experimental Pomology. Spring term. Credit three hours. Offered in alternate years. Messrs. Blanpied, Creasy, Edgerton, Oberly, Powell, and Smock.

The student is expected to review critically and to evaluate the more important original papers relating to various phases of pomological research. Recent experimental methods applicable to the topic are fully considered.

502 Research. Fall, spring, or both terms. Credit two or more hours a term. Prerequisite: 401. Messrs. Blanpied, Creasy, Edgerton, Oberly, Powell, Smock, and Tomkins.

504 Growth and Development of Woody Plants. Spring term. Credit two hours. Offered in alternate years. Prerequisite: an introductory course in plant physiology. Mr. Powell.

An advanced course dealing primarily with the growth and development of woody plants, with particular reference to fruit trees. Physiological responses will be emphasized, but morphological, cytological, and biochemical changes will be considered.

600 Seminar. Fall and spring terms. Without credit. Required of students taking 502, and graduate students in pomology. Members of the Departmental staff.

Psychology

Faculty

Henry A. Alker, Alfred L. Baldwin, Clara P. Baldwin, Harley A. Bernbach, Jack Bradbury, Urie Bronfenbrenner, Bert R. Brown, John Condry, Richard B. Darlington, William C. Dilger, John Doris, Harold Feldman, Eleanor J. Gibson, James J. Gibson, Herbert Ginsburg, Marvin D. Glock, Leopold W. Gruenfeld, Bruce P. Halpern, John S. Harding, Dalva E. Hedlund, Robert E. Johnston, Stephen C. Jones, William W. Lambert, Lee C. Lee, Eric H. Lennberg, Harry Levin, David A. Levitsky, Thomas M. Lodahl, James B. Maas, Robert B. MacLeod, George W. McConkie, Anne McIntyre, Leo Meltzer, Jason Millman, Murray P. Narditch, Ulric Neisser, Joy D. Osofsky, Marion Potts, Dennis T. Regan, Henry N. Ricciuti, Richard E. Ripple, John R. Roberts, Bernard C. Rosen, Ned Rosen, Thomas A. Ryan, Fred Stollnitz, George J. Suci, Lawrence K. Williams, Gordon W. Wilcox

Field Representative

Bruce P. Halpern, Morrill Hall

MAJOR AND MINOR SUBJECTS

Developmental Psychology
Differential Psychology and Psychological Tests
Experimental Psychology
Experimental Psychopathology
History and Systems of Psychology
Mathematical Psychology
Personality and Social Psychology
Physiological Psychology
Psycholinguistics

The following are available only as minor subjects:

Comparative Psychology
General Psychology
Industrial Psychology

Applicants for admission in Psychology are required to submit scores for the Graduate Record Examination (Advanced Test in Psychology and Aptitude Test) and for the Miller Analogies Test. An undergraduate major in psychology is desirable, but not required. Records of applicants are judged in terms of performance in mathematics and natural sciences as well as in psychology. Candidates for a terminal Master's degree are not accepted.

Special requirements of the Field, such as a statistics or language requirement, are determined by a conference consisting of the graduate students and the faculty in the Field. The student selects his program of study individually, in consultation with his Special Committee. All students will have some supervised teaching experience during their term of study.

The examination for admission to candidacy is normally taken during the third year of graduate work and is both written and oral. The final examination for the Ph.D. is an oral defense of the thesis. All oral examinations are administered by the Special Committee with the addition of one member appointed by the Field Representative.

RESEARCH FACILITIES. The top two floors of Morrill Hall contain offices, classrooms, and teaching laboratories of the Field. Graduate and faculty research is conducted at the Cornell Research Park, at White Hall, and at Liddell Laboratory.

Most experimental research using human subjects is done at the Research Park. A large newly equipped shop is also located there.

White Hall provides special rooms for research in problems of perception and cognition and well-equipped, one-way observation rooms for experiments in social psychology. Cooperation at the local schools permits field research in the area of Developmental Psychology.

The Howard S. Liddell Laboratory of Comparative and Physiological Psychology includes an electrophysiological laboratory, shops, darkroom, surgery, histology laboratory, and facilities for research with monkeys, dogs, and other laboratory animals.

FINANCIAL AID. In addition to general fellowships open to all Fields, teaching fellowships and research assistantships, the following fellowships are specifically for students in this Field:

National Institutes of Health Traineeships in Experimental and Social Psychology—Stipend \$1,800 to \$2,400 plus tuition and General Fee.
John Wallace Dallenbach Fellowship in Experimental Psychology—Stipend \$2,700 plus tuition and General Fee.

Areas of Specialization

Developmental Psychology

A. L. Baldwin, C. P. Baldwin, U. Bronfenbrenner, H. Feldman, E. J. Gibson, H. Ginsburg, M. D. Glick, J. S. Harding, L. C. Lee, E. Lenneberg, H. Levin, J. D. Osofsky, M. Potts, H. Ricciuti, R. E. Ripple, and G. J. Suci.

Specialization in this area normally involves participation in a program jointly sponsored by the Fields of Psychology and Human Development and Family Studies. The program, which emphasizes cognitive development, may be entered via either Field. Training in research skills in both Fields is recommended. Current research interests of the faculty include development of language, perception and thinking, intellectual development in natural settings, conceptual and affective behavior in infancy, behavioral maturation, and cognitive socialization.

Differential Psychology and Psychological Tests

H. A. Alker, R. B. Darlington, D. E. Hedlund, and J. Millman.

Training within the Field of Psychology

emphasizes psychometric theory—test theory, scaling, and factor analysis—and its applications both in psychological research and in practical settings. Excellent relations are maintained with the Fields of Education and Human Development and Family Studies, where training in the use of specific tests is offered.

Experimental Psychology

H. A. Bernbach, E. J. Gibson, J. J. Gibson, B. P. Halpern, E. Lenneberg, H. Levin, J. B. Maas, R. B. MacLeod, G. W. McConkie, U. Neisser, R. E. Ripple, T. A. Ryan, F. Stollnitz, and G. W. Wilcox.

Experimental psychology is the study of basic processes in both humans and animals: learning, memory, motivation, perception, sensitivity, and thinking. An individual student will usually develop a special interest in one of these basic processes, although he should be familiar with the whole area. Both experimental method and the facts and theories derived from experimental observation are stressed. Some of the problems now under investigation are the nature of discrimination, attention, the perceiving of the environment, perceptual learning and development, the transmission of (visual and acoustic) information, memory, the development of concepts, the formation of learning sets, classical and instrumental conditioning, and the acquisition of helplessness and fear.

Experimental Psychopathology

H. A. Alker.

This area is concerned primarily with research on animal subjects relating to the effects of stress upon emotional behavior, disruption of performance, and "experimental neurosis," and the relation of these phenomena to human psychopathology.

History and Systems of Psychology

H. A. Alker and R. B. MacLeod.

This area is usually studied as a minor in conjunction with major specialization in one of the substantive subjects of psychology. Students who major in history and systems are expected to take a substantial minor in history or philosophy of science. A reading knowledge of the relevant foreign languages is considered essential for both majors and minors.

Mathematical Psychology

H. A. Bernbach and G. W. Wilcox.

The objective of this subject as a major is to train psychologists to develop theories and relations in their chosen area of interest, and to express these in mathematical form. Requirements for majors are a very strong

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minor in the empirical content area of their choice, a dissertation that combines original empirical work in the content area with the application of mathematical models, computer experience, and training in mathematics at roughly the M.A. level.

The minor program is intended to give students the mathematical tools necessary to support their major area of interest. Courses in mathematics will generally be recommended in addition to departmental courses in mathematical behavior theory and methodology.

Personality and Social Psychology

H. A. Alker, U. Bronfenbrenner, B. R. Brown, J. S. Harding, D. E. Hedlund, S. C. Jones, W. W. Lambert, A. McIntyre, L. Meltzer, M. P. Naditch, D. Regan, B. Rosen, N. Rosen, and L. K. Williams.

Students may place varying emphases on personality and on social psychology, even concentrating exclusively upon one or the other aspect if they wish. Staff research interests in personality include: aggressive behavior, anxiety and defenses, experimental psychodynamics, personality assessment, and emotional communication. Social psychology is taught jointly by members of the Graduate Fields of Psychology and Sociology. Majors admitted via Psychology often choose one minor within Sociology. Other relevant minors include anthropology, child development, organizational behavior, and statistics. Some current research interests of the faculty include: character development in the Soviet Union, nonverbal communication, new approaches to observation methodology, interpersonal evaluations, guilt and persuasion, attitude change, and cross-cultural studies of socialization.

Physiological Psychology

J. Bradbury, B. P. Halpern, D. A. Levitsky, and E. Lenneberg.

The student is expected to develop his skill in a variety of biological techniques as well as to become firmly grounded in the experimental analysis of behavior. Students are advised to have one of their minor subjects in physiology, biochemistry, neurobiology and behavior, evolutionary biology, veterinary medicine, or physics. Research interests include brain-behavior relationships and sensory psychophysiology.

Psycholinguistics

E. J. Gibson, E. Lenneberg, H. Levin, R. B. MacLeod, and U. Neisser.

This area combines aspects of psychology and linguistics in the study of the psychological representation of language, the acquisition of language, and its use in cognition

and communication. Some of the interests currently pursued in the Department are: the effects of linguistic structure on linguistic and nonlinguistic behavior, the generality of language-processing mechanisms in other mental operations, the nature of the switching mechanisms in dialect and language choice, the acquisition of reading skill, and the genesis of language investigated by means of developmental and comparative methods.

Students majoring in psycholinguistics frequently select general linguistics as a minor.

Comparative Psychology

J. Bradbury, W. C. Dilger, and F. Stollnitz.

Comparative psychology is the study of similarities and differences in the behavior of various species. Staff research interests include evolution of behavior, primate behavior, classical and instrumental conditioning, discrimination learning and perception, and pathological behavior.

General Psychology

Staff.

General psychology is designed as a minor for students majoring in some other Field, who wish to study some special combination of topics which overlaps with several of the areas listed above.

Industrial Psychology

D. E. Hedlund, J. B. Maas, T. A. Ryan, and L. K. Williams.

This area may be elected as a minor subject by students in Psychology or other Fields such as Industrial and Labor Relations, Business and Public Administration, and Engineering. The emphasis is on research methods and results concerning the efficiency of performance, development of skill in complex tasks, effects of environment and methods of work, motivation, job satisfaction, and the evaluation of performance.

Courses

301 An Information Processing Approach to Psychology. Spring term. Credit three hours. Prerequisite: one year of mathematics or a physical science or consent of the instructor. Mr. Bernbach.

Introductory treatment of human behavior as the behavior of an information processing system. Topics covered include input and coding of information (detection and perception), storage and retrieval of information (learning and memory), and output processes (skill learning and performance). Also covered is a treatment of behavior as a choice among alternatives and the bases of such choices (motivation).

305 Perception. Fall term. Credit four hours. Prerequisite: two courses in psychology, including 101. Mr. Neisser.

The basic phenomena of visual and auditory perception studied in terms of the stimulus variables on which they depend and of the mechanisms involved. Topics include the detection of weak stimuli, perceptual constancy and illusion, visual and auditory space perception, motion, and perceptual adaptation.

306 Learning. Spring term. Credit four hours. Prerequisite: 101 or 201, or 301, or consent of the instructor. Mr. Stollnitz.

The fundamental conditions and principles of learning, both animal and human. The basic phenomena of operant conditioning, discrimination learning, motor learning, and verbal learning will be studied experimentally. Traditional and contemporary theories of learning will be reviewed, and selected experimental literature will be discussed with special emphasis upon recent developments in the field.

307 Motivation. Fall term. Credit four hours. Prerequisite: 101 and 201, or 306, or consent of the instructor. Mr. Alker.

Factors controlling the initiation, direction, and intensity of activity. Methods of research with emphasis upon experimental and statistical controls. Evaluation of evidence on major theories of motivation such as field theory, psychoanalysis, and behavioristic drive theory.

309 Development of Perception and Attention. Spring term. Credit four hours. Prerequisite: 201 or 210 or 305 or consent of the instructor. Mrs. Gibson.

Selection and processing of stimulus information—objects, space, events, and coded stimuli—in evolution and in human development; theories of perceptual learning.

310 Human Learning and Memory. Fall term. Credit three hours. Mr. Bernbach.

Basic process of human learning and memory, particularly for simple verbal material. Emphasis on the storage and retrieval of information as the fundamental unit of learning.

313 Cognitive Processes. Fall term. Credit four hours. Prerequisite: six hours of psychology or consent of the instructor. Mr. Baldwin.

An examination of the mental processes involved in language learning and use, concept formation, and problem solving; and the relation between language and thinking. Students are required to carry out a supervised experimental or observational study.

323 Physiological Psychology. Fall term. Credit three hours. Prerequisite: 201 or a

300-level laboratory course in psychology, Biological Sciences 101-102 or equivalent, and Chem 103-104 or equivalent. Mr. Halpern.

A selective examination of neural, endocrine, and biochemical functions related to emotion, memory, learning, perception, hunger, and thirst.

323A Physiological Psychology Laboratory. Fall term. Credit three hours. Prerequisite: concurrent registration in 323, 201, and 327 or Biological Sciences 320. Mr. Halpern.

Experiments will be done on physiological aspects of conditioning in vertebrates and invertebrates, memory, interactions between hormones and behavior, and effects of brain lesions on perceptual and alimentary behavior. A final original experiment will be planned and carried out.

325 Abnormal Psychology. Fall term. Credit four hours. Prerequisite: nine hours of psychology, or consent of the instructor.

An introduction to the study of disordered behavior. Description of major syndromes, investigations and theories of etiology, and approaches to treatment will be covered in an attempt to introduce the student to major concepts and problems in this area.

326 Comparative Psychology. Fall term. Credit four hours. Prerequisite: 101 or 201 or Biological Sciences 320, or consent of the instructors. Mr. Stollnitz and Mrs. Gibson.

Similarities and differences in the behavior of animals ranging from the unicellular forms to man. Psychological and ethological approaches to animal behavior will be discussed. Topics will include discrimination, learning, communication, and social behavior, stressing both species-specific and general trends in phylogeny.

327 Behavioral Maturation (Biological Sciences 327). Fall term. Credit four hours. Prerequisite: familiarity with psychological theories of learning and development and one year of college biology. Mr. Lenneberg.

Emergence of behavior will be studied in the light of developmental biology, including behavior genetics, neuroembryology and morphogenesis, physical maturation of the brain, transformation and allometry, as well as retarding influences from the environment.

350 Statistics and Research Design. Spring term. Credit four hours. Prerequisite: a course in the behavioral sciences. Mr. Darlington.

Devoted about equally to elementary applied statistics (both estimation and hypothesis testing) through one-way analysis of variance, and to general problems in the design and analysis of research projects.

381 Social Psychology (Sociology 381). Either term. Credit four hours. Prerequisite:

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three hours of psychology and three hours of sociology. Mr. Lambert.

Analysis of the history, concepts, methods, and theories used to describe and conceptualize the ways in which people react to one another in social settings and in the laboratory. Students will work individually or as teams on projects, using experimental or other empirical methods. The topics for lectures and reading will include socialization, attitude change, communication, interpersonal influence, impression formation, leadership, and propaganda.

385 Theories of Personality (Sociology 385). Fall term. Credit four hours. Prerequisite: 101 or 102 or consent of the instructor. Mr. Lambert.

A critical survey of the concept of personality in literature, the social sciences, and psychology. A number of the modern specialists will be discussed at some length, and recent empirical and experimental work that has grown out of their thought will be analyzed. The empirical relation of personality notions to some philosophical beliefs and literary production will be considered. The emphasis will be mainly upon "normal" personality.

387 Psychological Aspects of Political Behavior (Sociology 387). Fall term. Credit four hours. Prerequisite: a course in social psychology, or consent of the instructor. Mr. Alker.

A survey covering student activism, dogmatism, political paranoia, determinants of "left" and "right" ideology, Machiavellianism, autocratic vs. democratic leadership, need for power, group polarization and consensus, political socialization and psychocultural theories of war. An empirical, hypothesis-testing approach will be adopted.

401 Psychological Testing I. Spring term. Credit four hours. Prerequisite: six hours in psychology and a course in elementary statistics. Mr. Darlington.

Emphasis is on the logical and mathematical problems in the interpretation, evaluation, and construction of tests. No training will be given in administering tests.

402 Psychological Testing II. Spring term. Credit four hours. Prerequisite: 401 or consent of the instructor. Mr. Darlington.

A more advanced treatment of the topics discussed in Psychology 401.

410 Individual Differences and Personality. Spring term. Credit four hours. Prerequisite: seven hours of psychology, or consent of the instructor. Mr. Alker.

A selective survey of individual differences in personality, intelligence, creativity, psycho-

pathology, learning, motivation, perception, and attitude change. Attention will be given to the conflict between experimental and correlational or observational research approaches. Related topics in the methodology of assessment will also be considered.

416 Psychology of Language. Spring term. Credit four hours. Prerequisite: 313 or consent of the instructor.

An advanced treatment of the nature of the human capacity for language, the reading process, social and psychological aspects of bilingualism, speech perception and production. Instruction will be supplemented by experimental exercises.

424 Brain and Behavior (Biological Sciences 424). Spring term. Credit four hours. Prerequisite: familiarity with theories of perception, memory, and physiological psychology, or permission of the instructor. Mr. Lenneberg.

A theoretical introduction to human neurology for psychologists. This survey of clinical symptoms and their etiology is designed to enable students to make use of knowledge of diseases for research purposes.

426 Experimental Psychopathology. Spring term. Credit four hours. Prerequisite: consent of the instructor.

The application of experimental methods to behavior disorders. A survey of current investigations of etiology and treatment with special emphasis upon a scientific approach to pathology.

427 Sensory Function (Biological Sciences 427). Fall term. Credit three hours. Prerequisite: Biological Sciences 320 or permission of the instructors. Mr. Halpern and Mr. Tapper.

Sensory receptors and the central nervous system transformation of afferent activity will be considered in relation to human and animal psychophysical data and to the adaptive significance of behavior. The receptor will be examined in terms of anatomy, biochemistry, biophysics of transduction, and the central nervous system control of peripheral input. Offered in alternate years.

427A Sensory Function Laboratory (Biological Sciences 427A). Fall term. Credit two hours. Prerequisite: 427 (or concurrent registration) and permission of the instructors. Enrollment limited to 15 students. Mr. Halpern and Mr. Tapper.

Experiments on the principles of receptor function and afferent neural activity. Offered in alternate years.

429 Psychophysics and Scaling. Spring term. Credit four hours. Prerequisite: one year of calculus and a course in experimental psy-

chology, or consent of the instructor. Mr. Wilcox.

Emphasis on the theory and application of quantification procedures in psychology. Topics include measurement theory, psychophysical scaling procedures, signal detection theory, receptor sensitivity, auditory and visual discrimination, and multidimensional scaling methods.

432 Social Psychological Aspects of Social Change. Spring term. Credit four hours. Mr. Naditch.

A critical analysis of social psychological theories of social change. The development of social change theories and of the personality and social systems approach to understanding social change by examination of the utility of these approaches for understanding contemporary social phenomena.

462 Discrimination Learning. Fall term. Credit four hours. Prerequisite: 306 or equivalent. Mr. Stollnitz.

Theories of discrimination learning will be examined in the light of data. Discrimination performance of human and nonhuman subjects in acquisition, reversal, transfer, and learning-set experiments will be included. Laboratory work will emphasize individual projects.

465 Mathematical Behavior Theory. Fall term. Credit four hours. Prerequisite: one year of calculus. Mr. Wilcox.

The purpose of this course is to give a brief overview of current developments in mathematical psychology and to develop techniques for the application of mathematics to psychological theory. Topics covered include choice behavior, decision theory, psychophysics, memory and learning theory, and information processing models of behavior.

466 Theories of Vision. Spring term. Credit four hours. Prerequisite: consent of the instructor. Mr. Gibson.

471-472 Statistical Methods in Psychology. Throughout the year. Credit four hours each term. Prerequisite: 101 or 201 or Human Development and Family Studies 115 or consent of the instructor; 471 is prerequisite to 472. Mr. Ryan.

An analysis of the methods for treating various kinds of psychological data. Fall term: tests of significance and confidence limits, analysis of variance and correlation. Spring term: complex designs in analysis of variance, analysis of trends and covariance, multiple and curvilinear correlation, introduction to factor analysis.

476 Instrumentation for Psychological Research. Fall term. Credit three hours. Enrollment limited to 10 students. Prerequisite:

consent of the instructor. Lecture and laboratory totaling three hours. Messrs. Wilcox, Stollnitz, and staff.

Principles and use of basic circuitry, digital logic, amplifiers and transducers, mechanical and optical devices, photography.

480 Attitudes and Attitude Change (Sociology 480). Spring term. Credit four hours. Prerequisite: three hours of psychology and three hours of sociology. Mr. Regan.

A systematic survey of theory and research on attitudes and attitude change.

481 Advanced Social Psychology (Sociology 481). Fall term. Credit four hours. Prerequisite: a course in social psychology or consent of the instructor. Mr. Regan.

Emphasis is on the empirical study of social psychological phenomena. Students will be introduced to empirical laboratory and field methods used in social psychology. Substantive problems will provide the focus for the demonstration and use of these techniques.

483 Social Interaction (Sociology 483). Fall term. Credit four hours. Prerequisite: written consent of the instructor, three hours in psychology, and three hours in sociology.

A field and laboratory course dealing with the major dimensions of interpersonal perception and behavior. The relation of these dimensions to self-conception, social roles, group structure and dynamics is examined. Contemporary research is stressed in the readings. Student projects are an integral part of the course.

484 Experimental Group Dynamics (Sociology 484). Spring term. Credit four hours. Prerequisite: a course in statistics and a course in social or experimental psychology. Mr. Meltzer.

A practicum. Supervised research experience in the design, execution, and analysis of experimental research on topics such as group cohesiveness, group pressures, group goals, leadership, group performance, and interpersonal influence and communication.

486 Groups as Socializing Agents (Sociology 486). Spring term. Credit four hours. Prerequisite: consent of the instructor. Mr. Bronfenbrenner.

The seminar examines critically existing theory and research on the role of groups in shaping the behavior and values of their members. Particular attention is focused on such processes as modeling, social reinforcement, and pressure to conform in enduring social structures such as the family, the peer group, work teams, and business organizations. Students are expected to work independently in assembling and evaluating material relevant to particular issues.

106 Psychology

489 Seminar: Selected Topics in Social Psychology (Sociology 489). Either term. Credit four hours. Prerequisite: consent of the instructor, three hours of psychology, and three hours of social psychology or sociology. Fall term: Mr. Jones; spring term: staff.

A small discussion seminar dealing with issues in both social and personality psychology. Fall term: initial discussions will focus on specific areas of the field such as interpersonal evaluation, attitude change, and group processes. Subsequently, the discussions will become more general and raise such questions as: What are the major themes social psychologists should be studying? What are the appropriate units of analysis of social behavior? Spring term topics to be announced.

490 Persistent Problems in Psychology. Fall term. Credit four hours.

496 Supervised Study. Either term. Credit two hours. Staff.

497 Supervised Study. Either term. Credit four hours. Staff.

Biological Sciences 320 Neurobiology and Behavior. Spring term. Credit three hours. Prerequisite: Biological Sciences 101-102 or 103-104. Messrs. Camhi, Eisner, Emlen, Gilbert, Halpern, Howland, O'Brien, Rosenblatt, and Mrs. Salpeter.

Biological Sciences 421 Comparative Vertebrate Ethology. Fall term. Credit three hours. Prerequisite: Biological Sciences 101-102, or 103-104 and permission of the instructor. Mr. Dilger.

Biological Sciences 521-522 Brain Mechanisms and Models. Throughout the year. Credit four hours a term. Prerequisite: one year of calculus and one year of biological sciences or psychology, and consent of the instructor. Mr. Rosenblatt, with assistance of guest lecturers.

Graduate Courses and Seminars

Primarily for graduate students, but may be taken by qualified undergraduates with the consent of the instructor. Approximately five graduate courses or seminars will be offered each term, the selection to be determined by the needs of the students. Prior to the registration period, the list of courses and seminars for the following term will be posted, specifying instructors, topics to be covered, and hours of meeting. Only grades of S or U will be given in the courses listed below.

501-502 General Seminar for Beginning Graduate Students. Either term. Credit three hours.

511-512 Perception. Either term. Credit four hours.

513-514 Learning. Either term. Credit four hours.

515-516 Motivation. Either term. Credit four hours.

517-518 Language and Thinking. Either term. Credit four hours.

521-522 Psychobiology. Either term. Credit four hours.

523-524 Physiological Psychology. Either term. Credit four hours.

525-526 Mathematical Psychology. Either term. Credit four hours.

531-532 History of Psychology. Either term. Credit four hours.

541-542 Statistical Methods. Either term. Credit four hours.

543-544 Psychological Tests. Either term. Credit four hours.

545-546 Methods in Social Psychology. Either term. Credit four hours.

547-548 Methods of Child Study. Either term. Credit four hours.

561-562 Human Development and Behavior. Either term. Credit four hours.

575-576 Personality. Either term. Credit four hours.

577-578 Industrial Psychology. Either term. Credit four hours.

581-582 Experimental Psychology. Either term. Credit four hours.

583-584 Proseminar in Social Psychology (Sociology 583-584). Either term. Credit four hours. Prerequisite: graduate major in social psychology or minor in social psychology and consent of instructor.

585 Social Structure and Personality (Sociology 585). Fall term. Credit four hours. Mr. B. Rosen.

A discussion seminar examining the impact of structural factors on personality development, and on the ways in which individual internal states and behavior patterns affect the functioning of social systems.

591-592 Educational Psychology. Either term. Credit four hours.

595-596 The Teaching of Psychology. Either term. Credit four hours.

601-602 Practicum in the Teaching of Psychology. Either term. Supervisor and credit hours to be individually arranged.

611-612 Practicum in Research. Either term. Apprenticeship in research with individual staff members. The problem, the supervisor, and credit hours are to be individually arranged.

621-622 Thesis Research. Either term. Supervisor and credit hours to be individually arranged.

681-682 Seminar in Social Psychology. Either term. Credit four hours.

Research-oriented analysis of selected topics in social psychology.

683 Research Practicum in Social Psychology. Fall term. Credit four hours.

685 Seminar: Social Psychology of Modernization (Sociology 685). Spring term. Credit four hours. Mr. B. Rosen.

An analysis of the interacting effects of social structure and personality on social change in developing countries.

Statistics

Faculty

Robert E. Bechhofer, Isadore Blumen, Lawrence D. Brown, Mark Brown, Roger Farrell, Walter T. Federer, Ivor Francis, Harry Kesten, Jack Kiefer, Philip J. McCarthy, Narahari U. Prabhu, Douglas S. Robson, Shayle R. Searle, Daniel Solomon, Frank L. Spitzer, Howard M. Taylor 3rd, Lionel Weiss.

Field Representative

Isadore Blumen, 360 Ives Hall.

MAJOR SUBJECT

Statistics

MINOR SUBJECTS

Provisions for minoring in statistics are given in the descriptions of the Fields of Operations Research, Industrial and Labor Relations, Mathematics, and Plant Breeding and Biometry contained in the *Announcements* of the various areas of the Graduate School.

ADMISSION REQUIREMENTS. Since one of the principal aims of graduate work in the Field of Statistics is that of training individuals who will have a thorough knowledge of the theoretical basis of modern statistical method and will have demonstrated ability to make significant contributions to this theory, applicants should ordinarily have obtained nearly the equivalent of an undergraduate major in mathematics. It is strongly recommended that applicants resident in the United States during the year before entering the Graduate School present scores on the Graduate Record Examination Aptitude Test.

LANGUAGE REQUIREMENT. There is no foreign language requirement for the M.S. degree. A candidate for the Ph.D. degree must demonstrate reading ability in one language besides English, chosen from among French, German, or Russian.

PROGRAM OF STUDY. A student majoring in the Field of Statistics must complete a graduate sequence of courses in mathematical statistics which has been approved by his Special Committee. Other course work will be chosen from among the offerings of the members of the Field, as listed below. A doctoral student in the Field ordinarily has two minor subjects but may, in consultation with the chairman of his Special Committee, choose to work in one minor subject. One minor subject will often be in an area of interest to the student in which the methods of statistics find extensive application. A second minor is usually devoted to mathematics, computing, or a similar subject.

PH.D. EXAMINATIONS. In addition to the admission to candidacy examination, which will ordinarily be administered by the student's Special Committee during or at the end of the third year of graduate study, and the final examination on the thesis, the student will be given a qualifying examination. This examination will occur shortly after the first year of graduate study. It will serve to determine the ability of the candidate to pursue doctoral studies and to assist the Special Committee in developing a program of study for the candidate.

TEACHING AND RESEARCH INTERESTS OF THE FACULTY. In extremely broad terms, the teaching and research interests of faculty members are in the following general areas: biological applications of probability and statistics (Federer, Robson, Searle, Solomon); engineering and operations research applications of probability and statistics (Bechhofer, M. Brown, Prabhu, Taylor, Weiss); mathematical theory of probability and statistics (L. D. Brown, Farrell, Kesten, Kiefer, Spitzer); social science applications of prob-

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ability and statistics (Blumen, Francis, McCarthy).

Some of the more specific areas of current interest are: analysis and probability theory (M. Brown, Kesten, Spitzer); design and analysis of experiments (Bechhofer, Federer, Kiefer, Robson, Searle); high-speed computing (Francis, Searle); mathematical theory of statistics (Farrell, Kiefer, Solomon); multiple decision procedures (Bechhofer); multivariate analysis (Blumen, Francis); nonparametric statistics (Blumen, Weiss); queuing and inventory theory (Prabhu); sampling theory (McCarthy, Robson); sequential sampling methods (Kiefer, Weiss); statistical control theory (Taylor); statistical genetics (Federer, Robson, Searle).

Courses

Descriptions of the following courses may be found in the *Announcements* of the various areas of the Graduate School under the Fields with which they are identified. In those sections reference is also made to several advanced seminars, both formal and informal, whose content varies from year to year.

Advanced Undergraduate and Master's Level Courses

OPERATIONS RESEARCH

- 9460 Introduction to Probability Theory with Engineering Applications.
- 9470 Introduction to Statistical Theory with Engineering Applications.
- 9512 Statistical Methods in Quality and Reliability Control.
- 9570 Intermediate Engineering Statistics.

INDUSTRIAL AND LABOR RELATIONS

- 310 Design of Sample Surveys.
- 311 Statistics II.
- 410 Techniques of Multivariate Analysis.
- 411 Statistical Analysis of Qualitative Data.

MATHEMATICS

- 371 Basic Probability.
- 472 Statistics.
- 473 Statistics.

PLANT BREEDING AND BIOMETRY

- 411 Stochastic Models in Biology.
- 417 Matrix Algebra in Biology and Statistics.
- 510 Statistical Methods I.
- 511 Statistical Methods II.

Advanced Master's and Doctor's Level Courses

OPERATIONS RESEARCH

- 9560 Applied Stochastic Processes.
- 9561 Queuing Theory.
- 9562 Inventory Theory.
- 9565 Time Series Analysis.
- 9571 Design of Experiments.
- 9572 Statistical Decision Theory.
- 9573 Statistical Multiple-Decision Procedures.

INDUSTRIAL AND LABOR RELATIONS

- 610 Economic and Social Statistics.
- 614 Theory of Sampling.

MATHEMATICS

- 571 Probability.
- 572 Probability.
- 574 Statistical Analysis.
- 575 Information Theory.
- 673 Analysis of Variance.
- 674 Design of Experiments.
- 675 Statistical Estimation.
- 676 Decision Functions.
- 677-678 Stochastic Processes.

PLANT BREEDING AND BIOMETRY

- 513 Design of Experiments I.
- 514 Design of Experiments II.
- 517 Linear Models.
- 518 Special Topics in Biometry.
- 519 Statistical Genetics.

Vegetable Crops

Faculty

Elmer E. Ewing, John D. Hartman, Francis M. R. Isenberg, William C. Kelly, Philip A. Minges, Peter L. Minotti, Henry M. Munger, Edwin B. Oyer, Jim L. Ozburn, Roger F. Sandsted, Raymond Sheldrake, Robert D. Sweet, Leonard D. Topoleski, Donald H. Wallace

At Geneva

Donald W. Barton, Michael H. Dickson, Gerald A. Marx, Nathan H. Peck, Richard W. Robinson, Stanton Shannon, Morrill T. Vittum

At Riverhead

Stewart L. Dallyn

Field Representative

Edwin B. Oyer, 148 Plant Science Building

MAJOR AND MINOR SUBJECT

Vegetable Crops

ADMISSION REQUIREMENTS. Admission to the Field is based on the quality and nature of the applicant's prior training as well as on letters of recommendation. It is not necessary

for the previous training to have been in horticulture. More important is a good background in biological and agricultural sciences together with an interest in economic plants. Farm experience is an advantage.

LANGUAGE REQUIREMENTS. Although there is no specific foreign language requirement by the Field, the Special Committee may recommend or require proficiency in a foreign language in individual instances, depending on the candidate's objectives and previous training.

EXAMINATION REQUIREMENTS. For the Ph.D. degree the Field requires three oral examinations: a qualifying examination, an admission to candidacy examination, and a final examination on the thesis. In certain cases the Special Committee may require additional examinations.

The qualifying examination is taken early in the program, preferably no later than the second term of residence, and is utilized in planning the student's future course of study. Those in a Cornell M.S. degree program can utilize the final examination for that degree as a qualifying examination, provided a representative of the second minor subject participates in the examination.

The admission to candidacy examination covers primarily course work. It must be taken at least two terms in advance of the anticipated date of completion of the thesis investigation.

The final thesis examination is taken upon completion of the written presentation of the thesis research.

TEACHING EXPERIENCE. All M.S. and Ph.D. degree candidates in the Field of Vegetable Crops will be encouraged to obtain teaching experience before the granting of the degree.

RESEARCH AND STUDY OPPORTUNITIES. Research and study in this Field involve the application of scientific knowledge and methods to the solution of problems in the production, handling, processing, and marketing of vegetables, including potatoes and dry beans. The graduate program provides training not only in research but also in teaching and extension. Many staff members do teaching and/or extension in addition to research. They may be selected as Special Committee chairmen or members. Assistantships are available for training in research, teaching, and extension.

Members of the staff are competent to direct research in many subjects and problems. The following is a partial listing of their interests.

Professors Kelly, Minges, Oyer, and Sandsted: vegetable crop physiology and production.

Professors Barton, Dickson, Marx, Munger, Robinson, and Wallace: breeding, genetics, and variety performance.

Professor Sweet: chemical weed control.

Professor Isenberg: postharvest physiology, biological aspects of handling and marketing vegetables.

Professor Hartman: biological and food technological aspects of marketing, objective and subjective measurement of color, flavor, and texture.

Professor Sheldrake: greenhouse crops; structure, systems, soil management, and nutrition.

Professor Topoleski: youth extension work, pollen physiology and incompatibility.

Professor Vittum: climatology and soil-plant-water relationships.

Professor Peck: mineral nutrition, fertilization, and cultural practices.

Professors Ozbun and Shannon: biochemistry, nutrition, and physiology.

Professor Minotti: mineral nutrition, muck studies, breeding.

Professor Dallyn: potatoes—blackspot, storage, sprout inhibitors, cooking quality; other vegetables—cultural methods, fertilization, irrigation, chemical weed control.

Professor Ewing: potatoes, especially the interrelations among plant growth substances, enzyme and nucleic acid metabolism, and changes in plants and tubers.

Courses

Specific course requirements are determined on an individual basis by the Special Committee. The courses listed below are usually taken by Ph.D. degree candidates. For those with little specialized course work in vegetable crops, additional courses at the 100–200 level are suggested. (See the *Announcement of the College of Agriculture* for details.)

401 Vegetable Crop Physiology. Fall term. Credit five hours. Prerequisite: 211 and Biological Sciences 240 or equivalent. Mr. Kelly.

The physiological bases of cultural practice and the application of these principles to problems in vegetable production. Original literature is used to illustrate the principles involved. Experimental material is studied in the laboratory to amplify lecture topics. Subjects discussed include: mineral nutrition as influenced by fertilization programs and crop sequence; nutrient interactions and induced deficiencies; growth and development; flowering; fruit setting; growth correlation; senescence; sex expression; photoperiodism; vernalization; and environmental factors affecting growth.

[413 Kinds and Varieties of Vegetables. Fall term of even-numbered years. Credit

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three hours. Prerequisite: permission to register; the student must notify the instructor of intention to take this course early in September. Two days of laboratory work preceding the beginning of regular instruction are required. Mr. Minges. Not given in 1971-72.]

429 Special Topics in Plant Science Extension. Spring term of even-numbered years. Credit one hour. (Additional credit by special arrangement.) Mr. Minges.

Designed for students in the several plant science specialties who wish to acquire a knowledge of extension activities in preparation for careers in extension and associated work, such as research and technical work in both public and commercial organizations. Topics are related to extension in other countries as well as in the United States. Staff members from other plant science departments collaborate in teaching the course.

Veterinary Medicine

Faculty

Max J. G. Appel, William J. Arion, Arthur L. Aronson, James A. Baker, John Bentinck-Smith, Emmett N. Bergman, Clyde I. Boyer, Jr., Timothy H. Brasmer, Dorsey W. Bruner, Bruce W. Calnek, Samuel G. Campbell, Leland E. Carmichael, Alison P. Casarett, Leroy Coggins, Cyril L. Comar, Peter H. Craig, John F. Cummings, Donald D. Delahanty, Alexander de Lahunta, Alan Dobson, Henry O. Dunn, Howard E. Evans, Julius Fabricant, Francis H. Fox, Edgar L. Gasteiger, Jack C. Geary, Jay R. Georgi, James H. Gillespie, Robert E. Habel, N. Bruce Haynes, Harold F. Hintz, Stephen B. Hitchner, Robert F. Kahrs, Francis A. Kallfelz, John M. King, Robert W. Kirk, Lennart P. Krook, Kyu M. Lee, Frederick W. Lengemann, Philip P. Levine, George Lust, Kenneth McEntee, Louis L. Nangeroni, Neil L. Norcross, Fernando M. Noronha, Malcolm C. Peckham, George C. Poppensiek, John Post, Charles G. Rickard, Stephen J. Roberts, George E. Ross, Jr., O. Wolfgang Sack, Herbert F. Schryver, Fredric W. Scott, Alvin F. Sellers, Ben E. Sheffy, Charles E. Stevens, Daniel N. Tapper, John B. Tasker, John C. Thompson, Jr., Robert H. Wasserman, John H. Whitlock, Alexander Winter, John F. Wootton

Field Representative

Lennart P. Krook, E-311 Veterinary College

MAJOR AND MINOR SUBJECTS

Animal Physiology
Immunochemistry
Parasitology
Pathogenic Bacteriology
Physical Biology (including Radiation Biology)
Veterinary Anatomy

[501 Research Methods in Applied Plant Science. Spring term of odd-numbered years. Credit three hours. Prerequisite: permission of instructor. Mr. Kelly. Not given in 1971-72.]

601 Seminar. Fall and spring terms. Required of graduate students taking either a major or minor in this Department. Members of Departmental staff.

610 Special Topics in Vegetable Crops. Fall and spring terms. Credit to be arranged. For graduate students with special interest in plant physiology. Prerequisite: permission to register. Mr. Ozbun.

Weekly discussions of current topics in plant physiology as related to vegetable crops. Students will be required to present oral reports on current literature and to prepare and present a research proposal.

Veterinary Medicine

Veterinary Obstetrics and Diseases of the Reproductive Organs
Veterinary Pathology
Veterinary Pharmacology
Veterinary Surgery
Veterinary Virology

An applicant from a country other than the United States or Canada is requested to include in his credentials the results of the Graduate Record Examinations Aptitude Test unless that examination is not given in reasonable proximity to the student's home. When the Graduate Record Examinations are not available, students are requested to submit instead the results of the College Entrance Examination Board Scholastic Aptitude Tests. In the clinical areas, only candidates with the D.V.M. degree are accepted for graduate work.

The Field of Veterinary Medicine does not require reading knowledge of a foreign language. It should be noted, however, that each Ph.D. Committee may impose such a requirement.

In addition to the admission to candidacy and final thesis examinations required by the Graduate School, all Ph.D. degree candidates must pass a qualifying examination required by the Field. The latter precedes the admission to candidacy examination and usually occurs during the second semester of work.

Facilities for graduate study and research in all areas of basic and applied veterinary medicine offer many unique opportunities. In addition to the excellent University libraries, the College has a specialized collection of more than 51,000 volumes and 800 current periodicals. A large and varied clinic repre-

senting all domestic animals is available as a source of material. In addition to the animal quarters, pastures, and laboratories on the main campus, the College operates several farms and research facilities within close proximity. These include the virus disease laboratories, poultry disease facilities, sheep and cattle disease farms, and the radiation biology laboratory.

Graduate students may work for the M.S. or Ph.D. degree, or the D.Sc. in V.M. (Doctor of Science in Veterinary Medicine). The latter degree is characterized by a professional rather than a research objective. (See the *Announcement of the New York Veterinary College* for a full description of the requirements.) A student who holds the D.V.M. degree from a recognized college in the United States or Canada may transfer one year's residence credit for that work toward the Ph.D. degree.

Courses

Anatomy

Professors Cummings, de Lahunta, Evans, Habel, Sack.

Facilities are available for the techniques of gross and microscopic anatomy, including histochemistry and electron microscopy. A large collection of serially sectioned embryos of domestic and laboratory animals is available for study. Students have the opportunity to gain valuable experience and stimulation by taking part in teaching activities. The research interests of the faculty are:

Neurology of mammalian animals, including the clinical and pathological study of diseases of the nervous system, and experimental neuroanatomy: Drs. Cummings and de Lahunta.

Mammalian embryology, teratology, and development: Dr. Evans.

Gross and microscopic functional anatomy of the digestive system, particularly of ruminants: Drs. Cummings, Habel, and Sack.

Gross comparative anatomy: Dr. Evans.

Applied anatomy of domestic mammals: Dr. Habel.

The basic requirements for a major in veterinary anatomy include: (1) satisfactory completion of the professional courses in gross, microscopic, neuro-, and developmental anatomy of the domestic animals, or equivalent formal instruction; (2) participation in the departmental seminars; (3) advanced course work selected from the offerings of the University to suit the special objectives of the student; (4) a thesis which gives evidence of a thorough review of the literature and a competent treatment of the research problem.

505 Neuroanatomy. Spring term. Credit two hours. Dr. de Lahunta.

The structure and function of the nervous system of domestic animals are studied by functional systems. Clinical cases with pertinent lesions are demonstrated with each system.

507 Developmental Anatomy and Histology. Fall term. Credit four hours. Prerequisite: course work equivalent to that required for admission to the Veterinary College, plus completion of, or concurrent registration in, 501 or 900. A limited number of nonveterinary students will be admitted by permission of the instructor. Drs. Cummings and de Lahunta.

The study of development is designed to provide a foundation for the understanding of definitive anatomy and the formation of anomalies. The latter part of the course is devoted to cytology and histology, illustrated with material from domestic animals.

508 Microscopic Anatomy. Spring term. Credit four hours. Prerequisite: 507 and completion of, or concurrent registration in, 502 or 900. A limited number of nonveterinary students will be admitted by permission of the instructor. Dr. Cummings.

The microscopic structure of the tissues and organs of domestic animals is studied. Illustrated lectures are presented to relate structure to function, correlate microscopic and gross anatomy, and establish a foundation for subsequent studies in physiology and pathology. Slides of tissues and organs are provided.

605-606 Advanced Anatomy. Fall and spring terms. Credit to be arranged. Prerequisite: 501, 502, 507, and 508 or similar preparation in comparative anatomy and histology. Drs. Cummings, de Lahunta, Evans, Habel, and Sack.

An opportunity for advanced study under personal direction.

900 Vertebrate Morphology. Fall term. Credit three hours. Prerequisite: a course in zoology or biology. Dr. Evans.

Designed for graduate students in animal science, nutrition, and conservation. A dissection of the dog serves as the basis for a functional consideration of the component parts of mammalian organ systems. This is followed by a dissection of the fetal and adult cow, and other species of interest are presented to the class. Demonstrations, films, and student presentations are included throughout the term.

Avian Diseases

Professors Calnek, Fabricant, Hitchner, Levine, Peckham.

The facilities for research in avian diseases on the campus include offices, diagnostic and general laboratories, and a disease isolation

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building holding tight pens. A poultry disease research farm located on Snyder Hill, three miles from the campus, contains a well-equipped laboratory building and many small isolation buildings for work with less contagious diseases. A disease-free breeding flock is also maintained for production of chickens and fertile eggs. Field material from the Ithaca and the four regional branch diagnostic laboratories is readily available.

The Veterinary College, in cooperation with the Long Island Duck Research Cooperative, Incorporated, operates a fully equipped diagnostic and research laboratory for duck diseases at Eastport, Long Island. Living quarters at the laboratory are available for graduate students and investigators.

The subject of avian diseases provides excellent opportunity for training in research methods. Graduate students may choose as their major subject advanced work in parasitology, pathogenic bacteriology, pathology, or virology. A graduate student may take work in any of the above areas as a minor subject by special arrangement.

750 Diseases of Poultry. Spring term. Credit three hours.

Diseases of domestic poultry and other birds are studied with special emphasis on differential diagnosis and control. Fresh and preserved specimens from the Poultry Diagnosis Clinic are presented during the laboratory period.

896-897 Clinics Ancillary. Fall and spring terms.

A poultry disease diagnostic clinic open five and one-half days per week receives specimens from the surrounding area submitted by poultrymen, veterinarians, and poultry service men. Postmortem examinations and microbiological techniques are employed to arrive at a diagnosis and to render assistance for disease control on the farm.

Large Animal Medicine, Obstetrics, and Surgery

Professors Bentinck-Smith, Delahanty, Fox, Geary, Hintz, Kahrs, McEntee, Norcross, Roberts, Schryver, Tasker, Winter, and Research Associate Dunn.

Courses are offered covering the general subjects of medicine, obstetrics, radiology, and surgery. The patients in the Ambulatory Clinic, the Large Animal Surgical Clinics, and the Mastitis Control Program supply an abundant source of valuable research material that is studied in cooperation with other departments in the College. This is particularly true in bacteriology, virology, parasitology, pathology, neurology, and metabolic diseases.

The Department has strong research programs in mastitis, especially in the field of immunochemistry, reproductive diseases of cattle, and nutrition in relation to bone and joint diseases of horses.

The graduate program is designed to provide training in research methods in preparation for a career in teaching or research.

636 Clinical Pathology. Spring term. Credit two hours. Drs. Bentinck-Smith and Tasker.

The application of the techniques of hematology, urinalysis, cytology, semen examinations, and other laboratory procedures in diagnosis; the biochemical changes in the blood and other fluids in disease; the study of pathological alterations in clinical cases.

740 Epidemiological Methods. Fall term. Credit two hours. Dr. Kahrs.

A lecture course dealing with health and disease from a herd, flock, community, or population standpoint and emphasizing the use of knowledge about etiology, transmission, and distribution of disease in the development of preventive measures and control programs.

938 Reproductive Pathology. Fall term of even-numbered years. Credit two hours. Prerequisite: 630, 631, 632, and 633. Dr. McEntee.

This is an advanced course in reproductive pathology of both male and female domestic animals with equal emphasis on gross and microscopic lesions of their genital tracts.

944 Immunochemistry. (See description under Microbiology, p. 113.)

970-971 Advanced Work in Reproductive Pathology and Bacteriology, Medicine, Obstetrics, and Surgery. Fall and spring terms. Credit one to three hours, as arranged. Drs. Bentinck-Smith, Delahanty, Dunn, Fox, Hintz, McEntee, Roberts, Schryver, Tasker, and Winter.

Properly prepared students may undertake special problems or receive special assignments in the field of reproductive pathology, microbiology, equine nutrition, medicine, obstetrics, and surgery.

The remainder of the courses offered by the Department of Large Animal Medicine, Obstetrics, and Surgery are primarily designed for the veterinary undergraduate student. Since most of these students are in at least their fifth or sixth year of college, the offerings are at a graduate level; most of them have as prerequisites many basic undergraduate Veterinary College courses and are not generally open to nonveterinary graduate students. See the *Announcement of the New York State Veterinary College* or consult the professors offering the courses for more detailed information.

670 Fundamentals of Roentgenology.

671, 770 Obstetrics and Genital Diseases.

771, 772, 870, 871 Diseases of Large Animals.

773, 774, 775 General and Special Surgery and Surgical Exercises.

872 Jurisprudence, Ethics, and Business Methods.

Microbiology

Professors Appel, Baker, Bruner, Campbell, Carmichael, Gillespie, Kahrs, Lee, Lust, Norcross, Poppensiek, Scott, Sheffy, Winter.

The laboratories are well equipped with modern apparatus providing opportunity for advanced work for students who are properly prepared in pathogenic microbiology, immunity, immunochemistry, and virology.

340 Pathogenic Bacteriology. Spring term of odd-numbered years. Credit four hours. Drs. Gillespie and Winter.

Includes microbiology, virology, and immunology.

941 Serology. Spring term of even-numbered years. Credit two hours. Limited to 8 students, with preference given to graduate students. Permission to register must be obtained before the end of the preceding (fall) term. Prerequisite: 340 or 640, and 641. Drs. Bruner and Campbell.

Includes complement fixation, conglutination complement absorption, hemagglutination inhibition, precipitation, fluorescent antibody techniques, neonatal isoerythrolysis, and the antigenic analysis of *Salmonella* cultures.

942-943 Advanced Work in Bacteriology, Virology, or Immunology. Fall and spring terms. Credit one to three hours, by arrangement.

Special problems or special assignments for properly prepared students.

944 Immunochemistry. Spring term of even-numbered years. Credit three hours. Registration by permission. Dr. Norcross.

Lectures include quantitative aspects of the antibody-antigen reaction, physical and chemical properties of antibodies and antigens, the mechanisms of hypersensitivity, and tissue immunity. Laboratory experiments illustrate the phenomena covered in the lectures and familiarize the student with selected immunochemical techniques.

945 Animal Virology and Tissue Culture Methods. Spring term of odd-numbered years. Credit one to four hours, by arrange-

ment. Three credit hours for two lectures and one discussion section; one credit hour for one laboratory period. Prerequisite: 340 and/or 630 and 640, except under special circumstances. Permission to register required. Drs. Lee and Carmichael.

Lectures will include the biology of animal viruses with emphasis on topics of general significance. Laboratory exercises emphasize methods of tissue culture preservation of cell lines, and the application of tissue culture methods to virology.

946 Microbiology Seminar. Fall and spring terms. No credit. Required of all graduate students majoring or minoring in microbiology. Dr. Scott.

Pathology

Professors Boyer, Coggins, Georgi, King, Krook, Noronha, Post, Rickard, Whitlock.

The laboratories are well equipped for advanced work in pathological anatomy, histochemistry, parasitology, tissue culture, and electron microscopy. The Department operates diagnostic facilities in which a large number of specimens for pathological, microbiological, and serological examinations are submitted. Emphasis is placed on necropsy pathology, nutritional pathology, parasite ecology, laboratory animal disease, and cancer research.

630 General Pathology, Lectures. Fall term. Credit two hours. Prerequisite: 507 and 508 or equivalent; at least one year's work in anatomy and physiology also is desirable. In special cases of students majoring in biology who expect to take no further work in pathology, these prerequisites may be waived in part; however, 630 will not then be accepted as a prerequisite for other courses. Dr. Rickard.

The biological processes involved in various kinds of disease are studied. This includes degenerative, circulatory, and inflammatory diseases, as well as a consideration in depth of the causes and manifestations of cancer.

631 General Pathology, Laboratory. Fall term. Credit two hours. Prerequisite: 630 must be taken simultaneously or have been completed previously. Dr. Rickard.

Covers the same subject matter as 630.

632 Special Pathology Lectures. Spring term. Credit two hours. Prerequisite: 631. Dr. King.

A systematic study of the diseases of each body system—respiratory, urogenital, skeletal, etc.

633 Special Pathology Laboratory. Spring term. Credit three hours. Prerequisite: 632

114 Veterinary Medicine

must be taken simultaneously or have been completed previously. Dr. King.

Accompanies 632.

635 Animal Parasitology. Spring term. Credit two hours. Prerequisite: a course in zoology or biology. Dr. Whitlock.

A systematic study of the helminth and arthropod parasites of domestic animals, with particular emphasis on the identification and bionomics of the forms of veterinary importance.

731 Applied Parasitology. Fall term. Credit three hours. Open only to veterinary students. Prerequisite: 635. Dr. Georgi.

An organized study of the parasitic diseases of domestic animals, with particular emphasis on the features of diagnostic importance. Special attention will be given to the laboratory and postmortem techniques that are of value in applied parasitology.

930 Pathology Seminar. Fall and spring terms. No credit. Required of all graduate students in pathology.

931 Pathology of Nutritional Diseases. Spring term. Credit three hours. Designed primarily for graduate students of nutrition. Prerequisite: 630 and 631. Dr. Krook.

932-933 Advanced Work in Animal Parasitology. Fall and spring terms. Credit one to three hours, by arrangement. Prerequisite: 635. Drs. Whitlock and Georgi.

Special problems concerning the parasites of domestic animals.

936-937 Advanced Work in Pathology. Fall and spring terms. Credit one to three hours, by arrangement.

Special problems or special assignments for properly prepared students.

938 Reproductive Pathology. Fall term of even-numbered years. Credit two hours. Prerequisite: 630, 631, 632, and 633. Dr. McEntee.

939 Introduction to Laboratory Animal Medicine. Spring term of even-numbered years. Credit two hours. Registration by permission. Dr. Boyer.

A graduate course designed primarily to emphasize the use of laboratory animals as tools in biological research. Dogs, cats, mice, rats, guinea pigs, hamsters, rabbits, non-human primates, poultry and several unusual species will be considered. The course will provide an introduction to management and disease control, as well as information on certain aspects of the comparative anatomy, ecology, behavior, and genetics of these animals. The selection of species for research as well as an appreciation of the scope and methodology of the field of laboratory animal medicine will be covered.

Physical Biology

Professors Casarett, Comar, Craig, Gasteiger, Kallfelz, Lengemann, Nangeroni, Tapper, Thompson, Wasserman.

Master's degree and doctoral candidates may be accepted with a major in physical biology (or radiation biology). Emphasis is given to the development of methods and application of physical concepts to problems of normal and abnormal metabolism. Excellent facilities are available for work with laboratory and domestic animals and especially in all aspects of the use and effects of radiation. Currently active research areas include: fission product metabolism; biological effects of radiation; mineral metabolism; transport processes; central nervous system physiology; receptor physiology; use of radioisotopes in biological and clinical research; problems of radioactive contamination of the food chain.

Candidates are expected to have a strong background in biological sciences and either to have had, or to be in a position to take, one year of the following courses: physical chemistry, physics, biometry, and calculus.

It is recommended that those candidates for the Master's degree who expect to become candidates for the doctorate study one or more foreign languages.

920 Elements of Physical Biology. Fall term. Credit three hours. Prerequisite: basic courses in physics, chemistry, biology, and calculus, or consent of the instructor. Dr. Comar and staff.

Lectures on atomic and molecular aspects of matter; informational macromolecules, membrane and transport phenomena; irreversible thermodynamics; photobiology; biological coding and control; kinetic analysis and control theory.

921 Radioisotopes in Biological Research—Principles and Practice. Spring term. Credit four hours. Prerequisite: a course in quantitative chemistry and permission of the instructor. Dr. Lengemann and staff.

Lectures, demonstrations, and laboratory on the fundamentals of atomic energy procedures and applications to biological research.

922 Biological Effects of Radiation. Fall term. Credit three hours. Dr. Casarett.

Lectures and demonstrations on radiation physics, radiation chemistry, radiation effects at the cellular level, radiation effects in multicellular organisms, genetic effects of radiation, and radioprotective and radiomimetic substances.

923 Biological Membranes and Nutrient Transfer. Spring term. Credit two hours.

Given in alternate years. Prerequisite: animal or plant physiology, quantitative and organic chemistry, physics, and consent of the instructor; cellular physiology and elementary physical chemistry desirable. Dr. Wasserman.

An introduction to elementary biophysical properties of biological membranes, theoretical aspects of permeability and transport, and mechanisms of transfer of inorganic and organic substances across intestine, placenta, kidney, erythrocytes, bacteria, and other biological systems.

924 Functional Organization of the Nervous System. Fall term. Credit three hours for lecture, two hours for laboratory. Prerequisite: physiology, organic chemistry, physics, and/or consent of the instructor; physical chemistry and neuroanatomy desirable. Dr. Gasteiger.

Function of the nervous system will be considered primarily from an electrophysiological viewpoint. Where appropriate, important studies of reflexology, chemical and feedback control, and comparative anatomy will be utilized. Laboratory studies will include electrical activity of cells, reflexes, decerebrate rigidity, acoustic microphonic response, subcortical stimulation, and evoked and spontaneous cortical activity.

925 Physiology, Biochemistry, and Biophysics of Mineralized Tissue (Special Topics). Fall term. Credit two hours. Prerequisite: animal physiology, biochemistry, and elements of physical biology, or permission of the instructor; anatomy and histology recommended. Drs. Comar, Corradino, Craig, Taylor, and Wasserman.

Introduction to the histology, anatomy, and pathology of bones and teeth, kinetics of bones and bone minerals, biochemistry of calcification, factors affecting calcium and bone metabolism (parathyroid hormone, calcitonin, vitamin D, trace elements, etc.), bone-seeking radionuclides, and calcium homeostatic mechanisms.

926 Physical Biology Graduate Seminar. Fall and spring terms. Credit one hour. Dr. Comar and staff.

927 Special Topics in Physical and Radiation Biology. Fall and spring terms. Credit one hour fall term, three hours spring term. Dr. Casarett.

928 Experimental Physiology for Graduate Students. Fall term. Credit three hours. Given in alternate years. Prerequisite: 510, 501, and 502, or 900, or Biological Sciences 321-322 and Biochemistry 401; also coregistration in 610 and consent of the instructor. Registration limited. Dr. Nangeroni.

Physiology, Biochemistry, and Pharmacology

Professors Arion, Aronson, Bergman, Dobson, Sellers, Stevens, Wootton.

Opportunities are offered for study toward the M.S. and Ph.D. degrees in the areas of physiological chemistry, physiology, and pharmacology. Areas of active research include enzyme kinetic studies, absorption from the digestive tract, carbohydrate and fat metabolic studies in ruminants, chelation of heavy metals in the animal body, chelate toxicity, electrolyte metabolism in digestive tract disease in ruminants, and gastric blood flow.

The M.S. degree is advised prior to undertaking work for the Ph.D. degree in the majority of instances. The minor subjects for the Master's and Ph.D. degrees are taken in departments outside the department of the major.

511 Physiology. Spring term. Credit three hours. Prerequisite: 510, 501, and 502, or Veterinary Medicine 900, or Biological Sciences 321-322 and Biochemistry 401. Drs. Bergman, Dobson, Sellers, and Stevens.

Physiology of cells, muscle, nerve, nervous system, digestive system, urine secretion, and temperature regulation.

610 Physiology. Fall term. Credit three hours. Prerequisite: 511. Drs. Bergman and Sellers.

Physiology of blood, lymph, circulation, respiration, endocrine organs, and reproduction.

612 Pharmacology. Spring term. Credit six hours. Prerequisite: Veterinary Anatomy 501, 502, 505, 507, 508; Physiology 510, 511, 610, 611; Pathology 630 and 631, or consent of the instructor. Dr. Aronson.

Primary emphasis is on the physiological disposition and mechanism of action of drugs.

613 Toxicology. Spring term. Credit one hour. Prerequisite: consent of the instructor. Dr. Aronson.

910 Special Problems in Physiology. Fall term. Credit to be arranged.

911 Special Problems in Physiology. Spring term. Credit to be arranged.

912 Research. Fall term. Credit to be arranged.

913 Research. Spring term. Credit to be arranged.

915 Methods in Physiological Research. Spring term. Credit four hours. Prerequisite:

116 Zoology

Biological Sciences 414 and a course in biochemistry, or 928, or equivalent and consent of the instructor. Enrollment limited. Dr. Sellers and staff.

The course will emphasize principles and application of physiological methods for measurement of organ and tissue functions related to digestion, absorption, distribution, metabolism, and excretion.

916 Physiological Disposition of Drugs and Poisons. Spring term. Credit three hours. Prerequisite: a course in biochemistry and consent of the instructor.

Lectures on the absorption, distribution, metabolism, excretion, and selective toxicity of drugs as well as consideration of environmental aspects of the problem of toxicology.

917 Physiology. Spring term. Prerequisite: Physiology 510, Veterinary Anatomy 501 and 502, or 900 or Zoology 311, and Biochemistry 433. (Laboratory: register for 928.) Drs. Bergman, Dobson, Sellers, and Stevens.

Lectures and demonstrations on cellular physiology, muscle, nervous system, digestive system, urine secretion, blood and lymph.

918 Physiology. Fall term. Credit three hours. Prerequisite: Physiology 511. Drs. Bergman and Sellers.

Lectures and demonstrations on circulation, respiration, endocrine organs, temperature regulation, and reproduction.

Small Animal Medicine and Surgery

Drs. Brasmer, Kirk, Ross.

Graduate students may elect to work for the M.S. degree, the Ph.D. degree, or the D.Sc. in V.M. Special subjects of study include general and advanced canine medicine, general canine surgery, canine orthopedic surgery, canine thoracic surgery, canine ophthalmology, and breeding diseases of small animals. Basic work in any one of these special areas will be reviewed, and advanced work will be given on an assignment basis. Minor subjects are required in one or more areas of the basic sciences.

Because of the close integration of the Small Animal Clinic with the Department, the graduate student can have access to research material for whatever project he might like to undertake. The facilities are adequate for graduate study and research through the cooperation of other departments within the College.

Zoology

Faculty

John M. Anderson, Antonie W. Blackler, Stephen E. Bloom, LaMont C. Cole, Howard E. Evans, Perry W. Gilbert, Jack W. Hudson, Samuel L. Leonard, Edward C. Raney, Bernard V. Travis, William A. Wimsatt

Field Representative

William A. Wimsatt, G-45 Emerson Hall

MAJOR AND MINOR SUBJECTS

Animal Cytology

Comparative and Functional Anatomy

Ecology

Embryology

Endocrinology

Histology

Invertebrate Zoology

ADMISSION REQUIREMENTS. Applicants must submit scores of the Graduate Record Examinations Aptitude and Advanced Biology Tests. It is important that the tests be taken as early as possible in the year of application and that scores be submitted not later than mid-February.

All applicants should have completed the equivalent of a well-rounded college major in zoology and should have some foundation in the particular phase of zoology they desire to

pursue. Courses in organic chemistry, elementary physics, and calculus should also have been completed. Although exceptional students may be admitted without having finished one or more of these requirements, they should then expect to remain in residence beyond the minimum period to make up the deficiencies.

LANGUAGE REQUIREMENT. There is no Field language requirement for the Master's degree, but proficiency in French, German, or Russian (in addition to English) is required of all candidates for the Ph.D. degree. Proficiency consists in either passing the ETS Graduate School Foreign Language Test at the level recommended by the Field, or completion of two terms of the Cornell 130-level reading courses in the appropriate language with a grade for *each* semester of C or better. Substitution of other languages may be allowed in special cases, but only upon the recommendation of the candidate's Special Committee. The Special Committee may, in certain instances, require a second language or a higher level of proficiency in a single language. The language requirement should normally be fulfilled before the student takes the admission to candidacy examination.

EXAMINATION REQUIREMENTS. Examinations specified by the Graduate School are described on p. 11 of this *Announcement*. In addition, all new candidates entering a Ph.D. program will be expected to take a prescription examination not later than the beginning of their second term of residence. The examiners will consist of the candidate's Special Committee, including the Field-assigned member (see below) in those cases where one has been appointed.

SPECIAL COMMITTEE. An additional voting member will be appointed to the Special Committee of each doctoral candidate by the Field of Zoology.

TEACHING. All Ph.D. candidates are expected to perform in a teaching capacity for a minimum of two semesters.

RESEARCH AND STUDY OPPORTUNITIES. The Field of Zoology offers excellent opportunities for graduate study and research in all phases of zoology, but particularly in the descriptive and experimental aspects of the following special subjects: comparative and vertebrate anatomy with emphasis on the functional approach, developmental biology, endocrinology, general ecology, cytology, histology and descriptive embryology, invertebrate zoology, parasitology, and systematics and biology of fish.

Members of the staff are especially qualified to direct research in subjects listed, but research need not be limited to these subjects. Faculty research interests are broad; in general they may be summarized as follows:

- J. M. Anderson: general and comparative anatomy of invertebrates, with emphasis on the functional histology and histochemistry of organ systems.
- A. W. Blackler: origin of sex cells and nucleocytoplasmic interaction in development.

- S. E. Bloom: cytology and cytogenetics of avian species; applications of cytochemistry and cytophotometry in the animal and plant sciences.
- L. C. Cole: general ecology, with special emphasis on population phenomena and the mathematical theory of populations.
- H. E. Evans: comparative vertebrate morphology and the prenatal development of the dog.
- P. W. Gilbert: vertebrate functional anatomy, i.e., correlation of habits and activities of vertebrates with their morphology; biology of elasmobranch fishes with emphasis on reproductive patterns and sense organs.
- J. W. Hudson: environmental physiology, comparative physiology, respiration, hibernation, temperature regulation, particularly of mammals.
- S. L. Leonard: general endocrinology with special emphasis on the anatomical, physiological, and biochemical aspects of the mechanisms of hormone action, reproduction, growth and metabolism.
- E. C. Raney: systematics, life history, and behavior of Eastern North American freshwater and shore fishes.
- B. V. Travis: biology and control of arthropods affecting man, taxonomy of parasitic protozoa.
- W. A. Wimsatt: vertebrate histology with emphasis on histophysiological, histochemical and ultrastructural aspects of reproduction, digestion, placentation, and hibernation.

Courses

Courses of graduate interest may be found throughout the University. For examples in biological sciences, consult other biological Fields in this *Announcement* or in the *Announcement of the College of Agriculture*.

Biology

Field Representative
Lowell D. Uhler, 204 Stimson Hall

For those students who are teaching or intend to become teachers, and who are in need of additional subject matter in the biological sciences.

A graduate program leading to the professional degree Master of Science for Teachers (M.S.T.) is available for the student who needs more subject matter in biology. The degree requires a minimum of thirty credit hours in

residence of which at least twenty-two hours of course work must be in biology. A candidate must complete, or have completed: a course in organic chemistry, including laboratory work; a first-year introductory course in earth sciences; and a first-year introductory course in calculus and/or statistics and/or physics. The first-year introductory course in chemistry may not be counted toward the required thirty hours. If the student has not completed the above requirements in the physical and earth sciences, they will be added to his requirements for the degree.



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Graduate School Calendar, 1970-71

FALL TERM

	1970-71
Registration, new students	Sept. 10
Registration, continuing students	Sept. 11
Fall term instruction begins, 7:30 a.m.	Sept. 14
Last day for filing statement-of-courses forms and change-of-committee forms and for new students to file nomination-of-committee forms	Sept. 25
Last day for old students to take admission-to-candidacy examinations in order to have them considered as of the beginning of the term	Oct. 15
Citizenship recess:	
Instruction suspended, 1:10 p.m.	Oct. 24
Instruction resumed, 7:30 a.m.	Nov. 5
Last day for change of course registration	Nov. 20
Thanksgiving Day, a holiday	Nov. 26
Christmas recess:	
Instruction suspended, 4:30 p.m.	Dec. 22
Instruction resumed, 7:30 a.m.	Jan. 4
Fall term instruction ends, 1:10 p.m.	Jan. 9
Independent study period begins, 2:00 p.m.	Jan. 9
Final examinations begin	Jan. 13
Last day for completing all requirements for a January degree	Jan. 15
Final examinations end	Jan. 20
Interession begins	Jan. 21

SPRING TERM

Registration, new and rejoining students	Jan. 28
Registration, continuing students	Jan. 29
Spring term instruction begins, 7:30 a.m.	Feb. 1
Last day for filing fellowship and scholarship applications for the following year	Feb. 1
Last day for filing statement-of-courses forms and change-of-committee forms and for new students to file nomination-of-committee forms	Feb. 12
Last day for old students to take admission-to-candidacy examinations to have them considered as of the beginning of the term	March 1
Spring recess:	
Instruction suspended, 1:10 p.m.	March 27
Instruction resumed, 7:30 a.m.	April 5
Last day for change of course registration	April 9
Spring term instruction ends, 1:10 p.m.	May 15
Independent study period begins	May 17
Final examinations begin	May 24
Last day for completing all requirements for a June degree	May 24
Final examinations end	June 1
Commencement Day	June 7

SUMMER

Summer Research period begins	June 2
Registration for Summer Session	June 21 (8-week)
	June 30 (6-week)
Last day for filing statement-of-courses forms and change-of-committee forms and for new students to file nomination-of-committee forms	July 7
Summer Session ends	Aug. 13
Last day for completing all requirements for September degree	Aug. 27
Summer Research period ends	Sept. 10

Graduate School Calendar, 1971-72 (Tentative)

FALL TERM

1971-72

Registration, new students	Sept. 9
Registration, continuing	Sept. 10
Fall term instruction begins, 7:30 a.m.	Sept. 13
Last day for filing statement-of-courses forms and change-of-committee forms and for new students to file nomination-of-committee forms	Sept. 24
Last day for old students to take admission-to-candidacy examinations in order to have them considered as of the beginning of the term	Oct. 14
Last day for change of course registration	Nov. 19
Thanksgiving recess:	
Instruction suspended, 1:10 p.m.	Nov. 24
Instruction resumed, 7:30 a.m.	Nov. 29
Fall term classes end, 1:10 p.m.	Dec. 18
Christmas recess	Dec. 18
Last day for completing all requirements for a January degree	Jan. 7
Independent study period begins	Jan. 3
Final examinations begin	Jan. 10
Final examinations end	Jan. 18
Intersession begins	Jan. 19

SPRING TERM

Registration, new students	Jan. 27
Registration, continuing students	Jan. 28
Spring term instruction begins, 7:30 a.m.	Jan. 31
Last day for filing fellowship and scholarship applications for the following year	Feb. 1
Last day for filing statement-of-courses forms and change-of-committee forms and for new students to file nomination-of-committee forms	Feb. 11
Last day for old students to take admission-to-candidacy examinations to have them considered as of the beginning of the term	Feb. 28
Spring recess:	
Instruction suspended, 1:10 p.m.	March 25
Instruction resumed, 7:30 a.m.	April 3
Last day for change of course registration	April 7
Spring term classes end, 1:10 p.m.	May 13
Independent study period begins	May 15
Last day for completing all requirements for a June degree	May 22
Final examinations begin	May 22
Final examinations end	May 30
Commencement	June 5

SUMMER

Summer Research period begins	May 31
Registration for Summer Session	June 19 (8-week)
	June 28 (6-week)
Last day for filing statement-of-courses forms and change of-committee forms and for new students to file nomination-of-committee forms	July 5
Summer Session ends	Aug. 11
Last day for completing all requirements for a September degree	Aug. 28
Summer Research period ends	Sept. 8