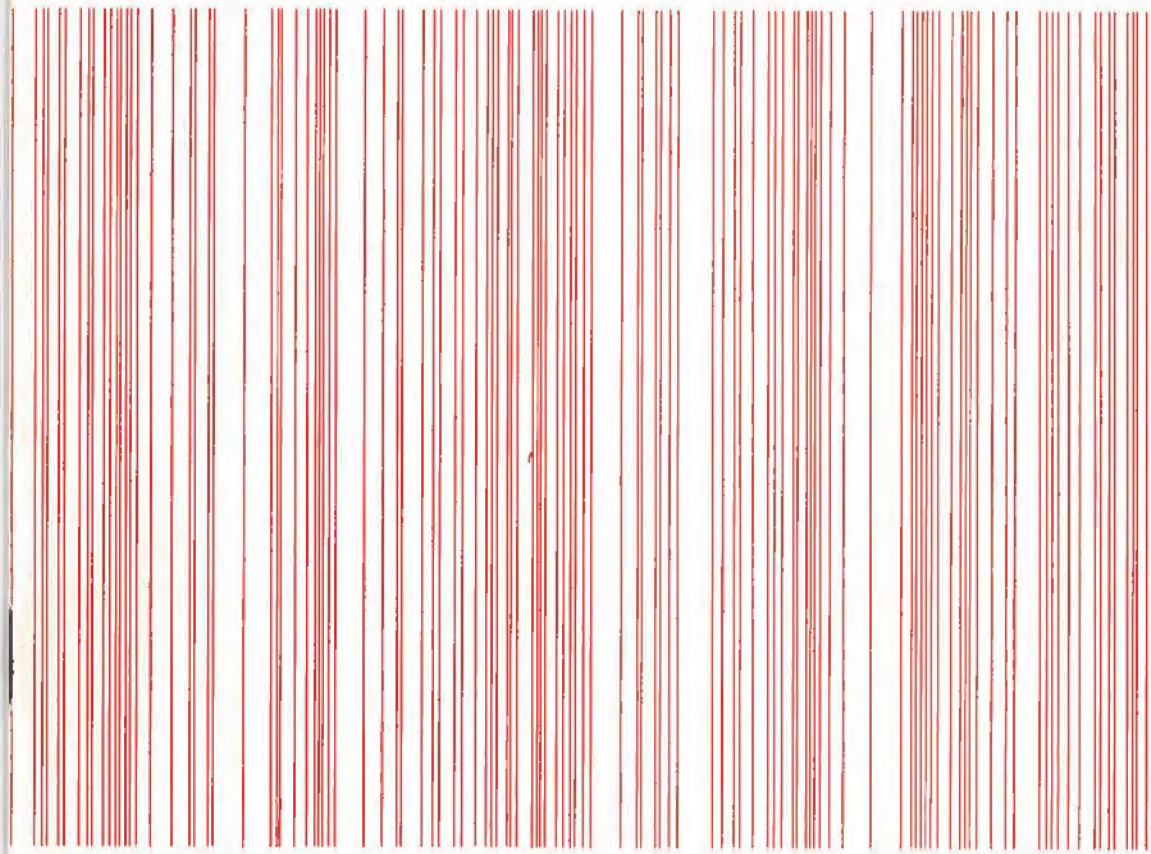
ALUMNI NEWSLETTER

Department of CHEMISTRY and CHEMICAL ENGINEERING

UNIVERSITY OF ILLINOIS at Urbana-Champaign



NO. 4, SUMMER, 1970

Reorganization of the Department

Another step in the long-range reorganization of the department was accomplished in the spring of 1970 when the Board of Trustees approved the formation of a School of Chemical Sciences. The three divisions of our department will become separate departments of Chemistry, Biochemistry, and Chemical Engineering. The school will remain in the College of Liberal Arts and Sciences. Final approval is expected soon from the Illinois Board of Higher Education.

All the departments will have access to the extensive school supported and maintained special facilities as was the policy within the present department. Growth of these facilities will be expanded under the new school. Also the new organization will enable each department to develop its own special interests while retaining close relations within the school.

Inorganic Chemistry at Illinois

Inorganic chemistry has undergone remarkable development during the past fifteen to twenty years. In the early 1950's, the discovery of ferrocene and related compounds opened up the exciting new field of organometallic chemistry of transition elements. At the same time, a renewed interest in the electronic structures of transition metal ions led to extensive development of the chemistry and spectroscopy of coordination compounds. These developments resulted in a rapid expansion of the scope of inorganic research in universities throughout the United States. It is not surprising that Illinois, traditionally a stronghold of American inorganic chemistry, fully shared in this expanded new interest. In the fifteen years from 1955 to 1970, the number of graduate students interested in specializing in inorganic chemistry at Illinois has increased from about thirty to about eighty. The inorganic faculty actively engaged in the direction of thesis research has increased from the "Big Three," Professors Bailar, Audrieth, and Moeller, of 1955 to the present number, eight. The process of development and change, having once begun, is probably here to stay. Organometallic chemistry has continued to expand

and diversify; new physical techniques such as nuclear magnetic resonance and electron spin resonance spectroscopy have broadened the basis for investigations of structures and properties of a wide variety of interesting coordination compounds; powerful new techniques of crystal structure determination have enabled chemists to determine a much wider variety of interesting new structural configurations than before. There are new appreciations of the roles of metal ions in biochemical reactions, and a consequent growing interest in the biochemistry of metallic elements; the continuing development of techniques such as temperature-jump, stopped-flow, and nuclear magnetic resonance spectroscopy have permitted the study of the kinetics and mechanisms of a wide variety of important and interesting rapid reactions.

In a sense, the proliferation of experimental techniques and a broadening of areas of interests have meant that inorganic chemistry has become less of a province and more of an integrated part of the whole of chemistry. Indeed, this is as it should be for inorganic, organic, or any other specialty in chemistry. To speak of inorganic chemistry at Illinois is then to speak of what is only an imaginary classification, and not a set of boundaries meant to be in any way restrictive. Just as a description of the activities of the faculty normally thought of as organic chemists can not be a complete description of organic chemistry at Illinois, this account, however encyclopedic its intent, is not a full account of inorganic chemistry here.

The course offerings in inorganic chemistry at the graduate level now include a course in Introduction into Physical Methods, which is normally taken by all first-year inorganic graduate students. Students may select additional inorganic chemistry courses from a variety of Selected Topics offerings, including Kinetics and Mechanisms, Organometallic Chemistry, Electronic Spectra and Structnre of Transition Metal Complexes, and Coordination Chemistry. At the undergraduate level the offerings include a one-semester lecture course at the junior-senior level, which constitutes an introduction to modern inorganic chemistry, and an inorganic preparations course. This latter course has become quite sophisticated and it includes such aspects as an introduction to high-pressure techniques, the use of inert atmosphere enclosures, and vacuum line techniques.

Course requirements for graduate students in chemistry have been reduced to only a fraction of those which were common a few years ago. A student is expected to take enough inorganic course work to prepare himself adequately for conduct of his own research, and to give him a broad and thorough appreciation of inorganic chemistry. In addition, he and his adviser formulate a plan of supplemental course work in other areas of chemistry and perhaps in mathematics or physics, so that he is prepared to tackle the job of research. The sum total of all this course work is not great, and the student who enters graduate school reasonably prepared can expect to complete his course work, with the exception of a required seminar, by the end of the first year. The language requirement throughout most of the department has been reduced to successful passage of one foreign language examination.

With the gradual weakening (and hopefully the eventual disappearance)

of divisional distinctions, a more or less uniform pattern has been established with respect to requirements for graduate students. The cumulative examination system is in effect. Following successful completion of the cumulative examination requirement, the student who has professed an interest in inorganic chemistry is required to submit to his graduate committee a research proposal of his own devising, generally distinct from the subject of his thesis research. This research proposal and the student's thesis research activities form the basis of an oral examination. We feel this experience is valuable for the student, because it gives him a first-hand opportunity of learning how difficult it can be to devise a plan for original and creative research, and to submit this plan to critical scrutiny. Hopefully, following this "ordeal," the student approaches his thesis research with a renewed appreciation of the pitfalls and opportunities inherent in original research.

The major emphasis in the Ph.D. program is centered upon research activity. This is as it should be, for the Ph.D. program is a process of learning how to formulate interesting and important questions about nature, and how to design, execute, and interpret experiments relevant to these questions. A student who has been properly educated has learned how to ask the right questions, and how to go about answering them.

The senior member of the inorganic faculty is Professor John C. Bailar, Jr., subject of a biographical profile in the January, 1970, issue of the *Alumni Newsletter*. Professor Bailar's research activities continue at a vigorous pace, with major emphasis on studies of homogeneous catalysis in reactions of olefins. In addition, Professor Bailar has continued his innovative studies of solid state reactions, such as the *trans* to *cis* isomerizations of octahedral complexes, and solid state racemizations.

Russell S. Drago, winner of the Texas Instruments award for excellence in inorganic chemical research in 1969, maintains vigorous research activity on a number of fronts. Most fundamental to his work is a long-range interest in the fundamental molecular properties which determine the magnitude of Lewis acid-base interactions in a wide variety of chemical systems. Information about coordination of acids and bases is being obtained through a variety of experimental techniques, including calorimetry, electron spin resonance and nuclear magnetic resonance spectroscopies, electronic and infrared spectroscopy and structure determination. Experimental studies are supplemented by theoretical work including molecular orbital descriptions of acid-base systems.

Theodore L. Brown's research activities are in the area of physical-inorganic chemistry, with emphasis on structural and kinetic properties of organometallic systems. Nuclear magnetic resonance studies of exchange processes have been a subject of major interest; most recently these have been extended to some cobalt compounds of biochemical interest. Nuclear quadrupole resonance studies have provided interesting new information about bonding in some organometallic systems and in transition metal halide complexes. Kinetic and mechanistic studies of transition metal carbonyl systems are also an important segment of his research program.

Galen Stucky is interested in the synthesis and stereochemistry of representative and transition element organometallic compounds, particularly those which can be classified as electron-deficient. Single crystal x-ray and neutron diffraction methods for structural determination, electron spin resonance and nuclear magnetic resonance spectroscopy are all used to characterize the systems of interest. In a series of important structural studies in the past few years, Professor Stucky has clarified the nature of bridge bonding in aluminum, magnesium, and lithium-containing systems, and has elucidated the structures of a variety of important organolithium compounds. In addition, he has been interested in the electronic structures of polymeric metal halides, and particularly in cooperative magnetic behavior in such systems.

Gilbert P. Haight, Jr., in addition to his activities as director of the general chemistry program, maintains an active research program in studies of nitrogen fixation, redox chemistry of oxy-ions of non-metals and transition metals, and oxy-ion redox catalysis. Most recently, he and his colleagues have developed very promising models for metal-sulfur bonding in certain metal-containing enzymes.

Bidentate complexes of ligands such as ethylenediamine are under study by James K. Beattie and his associates. Earlier interpretations of relative stabilities of conformational isomers, and ideas regarding the rates at which ligands undergo conversion from one conformational form to another are being seriously revised as a result of his recent work in this area. Professor Beattie's group is also actively engaged in a variety of kinetic studies. These range from studies of very fast reactions, employing stopped-flow and temperature-jump techniques, as well as a current program underway to evaluate kinetics for fast reactions using variation in circular dichroism as the observable property. Electron transfer reactions involving a change in spin multiplicity are of special interest. The use of nuclear magnetic resonance line shape analysis for the study of electron transfer reactions involving transfer of spin from a diamagnetic to a paramagnetic species is underway.

Two new faculty members are joining the inorganic group in the fall, 1970. David N. Hendrickson received his Ph.D. from the University of California, Berkeley. His thesis research involved use of the new technique of photoelectron spectroscopy. During the 1969-70 academic year, Dr. Hendrickson worked as a postdoctoral fellow in the laboratory of Professor Harry B. Gray at California Institute of Technology. Dr. Hendrickson's interests lie in the area of magnetic susceptibility and photoelectron spectroscopic studies. He intends to carry out single crystal magnetic susceptibility studies, and to investigate various aspects of the use of liquid crystals in spectroscopy. He has a strong interest in the biochemical aspects of metal ion chemistry, particularly in the characterization of metal sites in metallo enzymes.

Dr. E. Kent Barefield comes to Illinois from The Ohio State University, after a one-year postdoctoral stay at the Central Research Laboratories of E. I. du Pont. His thesis research at Ohio State University under the direction of Professor Daryle Busch involved synthesis and characterization of novel ligand systems for transition metal complexes. His research interests

at present include synthesis of new complexes of group VIII transition elements which contains cyclized ligand systems. The intention is to design complexes which will bind small molecules such as N_2 in solution or in the solid state. The design of new complexes which have particular electronic or stereochemical properties, particularly via the study of ligand reactions as synthetic methods, is a closely related area of interest. Another of Dr. Barefield's interests is the synthesis of complexes with unusual oxidation states, such as Ni(I) and Ni(III), and studies of their reactions with oxidizing and reducing agents.

In addition to the above faculty members who are nominally responsible for the conduct of inorganic graduate research and the teaching of inorganic chemistry at both graduate and undergraduate levels, a number of other faculty in the department have a strong interest in one aspect or another of inorganic chemical research. R. Linn Belford is actively engaged in electron spin resonance spectroscopic studies of transition metal complexes. Most recently this work has resulted in detailed analysis of the hyperfine structure in the esr spectra of certain copper complexes, so as to permit evaluation of the electric field gradient at the metal site. In addition to these studies, Dr. Belford is also interested in low-temperature electronic spectra of single crystals, and in structural determination via x-ray crystallography. Dr. Iain Paul, whose major interest is in x-ray structural determination, has determined the structures of a number of interesting organometallic systems. Professor R. A. Marcus maintains an active interest in the field of electron transfer reactions, and in oxidation-reduction processes at electrode surfaces. Professor Marcus' theoretical contributions to the field of electron transfer reactions are among the most important work in this field, and form the basis of much of the present research work in the area. Harry G. Drickamer's high-pressure studies have led to important new findings regarding the effect of pressure on electron transfer within solids, on the energy levels of transition metals in particular kinds of coordination environments. These studies have been carried out most particularly by the use of Mössbauer spectroscopy at very high pressures. Other work in the department with relevance to inorganic chemistry includes the nuclear magnetic resonance studies of Professors Gutowsky and Jonas, and the organometallic research carried out by a number of the organic and biochemistry faculty.

At various times the department hosts visitors from other institutions, or faculty on temporary appointments, who have a special interest in inorganic chemistry. For example, Dr. Bassam Shakhashiri, whose research interests lie in the area of kinetics and mechanism, takes up his new post as director of the general chemistry program at the University of Wisconsin after spending three years in research and teaching at Illinois.

In addition to research, the inorganic faculty are active in many other affairs related to chemistry. Professor Bailar continues his active participation in the affairs of the International Union of Pure and Applied Chemistry. He has served since 1963 as treasurer of this organization, and as a member of the Executive Committee. Professor Brown is presently an associ-

ate editor of the Journal, *Inorganic Chemistry,* and Professor Drago is kept busy answering requests for presentation of his ACS short course on Acids and Bases. The University of Illinois, along with many other institutions of higher learning, is working to promote the opportunities for higher education among disadvantaged minority groups. The Department of Chemistry and Chemical Engineering is anxious to attract qualified black students to graduate work. To this end, Professors Lombardi, Beattie, and Stucky have joined with other departmental faculty in visiting various predominantly black colleges throughout the United States, in order to describe the program at Illinois and to indicate the range of opportunities available to students who may wish to do graduate work.

The facilities of the Department of Chemistry and Chemical Engineering are extraordinarily complete, and provide opportunity for a limitless range of research activity. The nuclear magnetic resonance laboratory contains numerous instruments for 60 MH_z proton and ^{19}F work, a 100 MH_z instrument equipped for study of a variety of nuclei, notably ^{31}P, ^{7}Li, ^{13}C, and ^{11}B. In addition, the recently installed 220 MH_z instrument has proved of great value. Plans for the near future include installation of a Fourier transform accessory. The new mass spectroscopy facility, which will be among the most complete of any at institutions in the country, is nearing completion, and will be of great value to those engaged in synthesis and characterization. We expect to have a complete new laser Raman facility installed in the next few months. This instrument, provided with a variety of sampling accessories, will be of particular use to the inorganic chemists. The very excellent microanalysis laboratory, under the direction of Mr. Joseph Nemeth, continues to be an invaluable component of the department's research facilities. The electronic shop has been growing very rapidly; it now possesses a very sophisticated design and instrument construction capability.

In summary, it should be evident from all of the above that inorganic chemistry is alive and well at Illinois.

Harry G. Drickamer

Long before "interdisciplinary" research was a popular goal, Professor Harry G. Drickamer was doing it with great success. His experimental work with high pressure is widely known to chemical engineers, chemists, physicists, and geophysicists. Recognition has been bestowed in the form of the Ipatieff Prize in 1956 from the American Chemical Society, the Colburn Award in 1947 and the Alpha Chi Sigma Award in 1966 from the American Institute of Chemical Engineers, the Oliver E. Buckley Solid State Physics Prize in 1967 from the American Physical Society, and the Vincent Bendix Award in 1968 from the American Society for Engineering Education. He is a member of the National Academy of Sciences. The University of Illinois has added

its recognition by naming him as one of the early members of its Center for Advanced Study.

It is very difficult for a scientist to receive acclaim from more than one technical society. What is it about Professor Drickamer's work that attracts attention from different disciplines?

With the available pressures, a tremendous compression is possible. Organic solids and alkali metals double in density, and even iron compresses over 20 per cent. This drastic decrease in interatomic distance causes really startling results on electronic behavior. Insulators like iodine become metals, while some metals become semiconductors. Orbitals are displaced and new kinds of chemical bonds appear. Clearly, Professor Drickamer is tampering with nature in a fascinating way.

Professor Drickamer grew up in Cleveland and attended several universities before settling at the University of Michigan. He received his B.S. and Ph.D. there in chemical engineering and then joined the staff at the University of Illinois in 1946. His first appointment was in the Department of Chemical Engineering and this remains his principal home base on campus. Ten or twelve years ago his appointment was broadened and resulted in a new title, Professor of Chemical Engineering and Physical Chemistry. Seven years ago, an additional broadening resulted in graduate standing in the Department of Physics. Today, graduate students in chemical engineering, physical chemistry, and physics work side by side in his laboratories.

Harry G. Drickamer

Professor Drickamer's early work with liquids involved measurements of diffusion, thermal diffusion, light scattering and molecular vibrations to 12,000 atmospheres. The high-pressure optical cell for liquids using sapphire windows was a pioneering effort. Some fifteen years ago, he turned to solid state research, and it is in this area that he has made his greatest contribution. There are three aspects of his experimental program which have made it unique.

First, he has extended the available static pressure range by an order of magnitude. The basic device for this is the supported taper cell which provides the advantages of a high degree of support for the portion at very high pressure while meeting the requirements of simple design and accessibility of the sample for measurement of physical properties.

In the second place, by clever use of a wide variety of pressure transmission materials he and his students have been able to make the type of measurements most essential for understanding electronic structure, including optical absorption and phosphorescence, eletrical resistance, x-ray diffraction and Mössbauer resonance. Examples include the use of sodium chloride as the "fluid" in the optical cell, and a lithium hydride-boron mixture in the x-ray and Mössbauer devices.

The third great achievement has been design of techniques that are sufficiently simple and versatile to permit a wide variety of experiments by students with diverse backgrounds resulting in a vast quantity of new data. A surprising number of the observations represent the first-of-a-kind in each field. A number of important new generalizations concerning the solid state have resulted.

A few of the new discoveries made at Illinois using these unique techniques include the following: (a) Insulating molecular crystals such as iodine, and aromatic hydrocarbons like pentacene, hexacene, and violanthrene become metals at high pressure by continuous broadening and overlap of the conduction and valence bands, without any change of structure. On the other hand, semiconductors like silicon and germanium, as well as the III-V and II-VI compounds with similar structure, exhibit a discontinuous transition to the metallic state with a change, usually to the white tin structure. (b) The heavy alkali metals undergo an interesting transformation in electronic behavior at high pressure. Cesium has a cusp in its resistance near 40 kilobars associated with the promotion of the 6s electron to the 5d shell — in other words, it becomes a "pseudo-transition" metal. Rubidium exhibits similar behavior near 200 kilobars and potassium is apparently approaching such a transition at 600 kilobars. Perhaps it is even more interesting to note that cesium exhibits a second cusp near 150 kilobars probably associated with the promotion of an electron to the empty 4f shell. It appears to transform from a "pseudo-transition" to a "pseudo rare earth" metal. A number of rare earth metals also exhibit electronic transitions. (c) On the other hand, alkaline earth metals like calcium and strontium become semiconductors at high

pressure. This is because the overlapping bands which cause the metallic behavior separate with increasing pressure. (d) Pi electron systems like large aromatic molecules and molecular charge transfer systems react at high to very high pressure to form new cross-linked compounds. One of the current lines of research in the high-pressure group is the sorting out of the structures of these new series of compounds. (e) Recently, Professor Drickamer's group demonstrated some new high-pressure chemistry of iron. Ferric ions reduce to the ferrous state with increasing pressure. The process is reversible, with some hysteresis. The phenomenon can be explained in terms of liquid-to-metal charge transfer. Dramatic changes in spin state of iron are also observed, especially in organometallic compounds. With increase of binding, high-spin compounds tend to pair these spins. On the other hand, tightly bound compounds like ferrocyanides may weaken their bonding due to shifts in the electronic energy levels and transform from low to high spin.

The above sampling of experiments exhibits the breadth of scope of very high-pressure research which has an impact, not only in chemistry and physics, but also in geophysics and biology.

Professor Drickamer's research has led to the publication of over 220 papers. Some sixty-five Ph.D. degrees have been awarded to his students. Although he has great pride in his scientific achievements, he feels that his most important contribution has been in the development of scientific talents in these young men. The graduates recall this period in their careers as being a time of excitement and hard work, culminating in the thrill of discovery.

Environmental Sciences Program

For many years the University of Illinois and the three Illinois State Surveys (Water Survey, Geological Survey, Natural History Survey) have had research programs related to environmental sciences. For some time discussions have been under way as to the establishment of interdisciplinary programs to attract the interest of a wide variety of scientists and scholars in such problems.

In September, 1968, progress was greatly accelerated by the arrival on campus of Professor R. A. Metcalf as Professor of Zoology and Entomology and Head of the Department of Zoology. As Vice-Chancellor of the University of California, Riverside, he had been involved in a large program in ecology. He suggested that by focussing upon a single pollutant, but embarking on a wide-scale systems analysis approach involving all aspects of the physical environment (air, water, and soil) and both plant and animal life, we could establish a program that might eventually be expanded to cover a wider spectrum of problems.

Under the Graduate College, a steering committee was set up to discuss broad policy issues, and a more sharply focussed coordinating committee was appointed to draw up plans on the first project, which was to center around lead as a pollutant. This coordinating committee consists of B. B. Ewing, Professor of Sanitary Engineering and Director of the Water Resources Center, and Professor Metcalf as co-chairmen, together with Glenn W. Salisbury, Director of the Agricultural Experiment Station, J. T. Pfeffer, Professor of Sanitary Engineering, W. R. Boggess, Professor of Forestry, and H. A. Laitinen, Professor of Chemistry. It was decided to establish both an interdisciplinary (problem-focussed facility) and a multi-disciplinary (project-oriented research in various departments) approach. The University administration, through Vice-Chancellor H. E. Carter, committed a small building (the old Water Resources Laboratory near the Physics Building) together with funds for minor alteration and for support of a professional analytical chemist to head the analytical laboratory. Dr. A. M. Hartley will leave the Department of Chemistry and Chemical Engineering in September, 1970, to assume this new responsibility. Technician and research assistant support is being arranged, mainly through outside grants. It is anticipated that a large number of multi-disciplinary projects will make use of the central analytical facility, which Dr. Hartley has already begun to set up.

In February, 1970, Vice-Chancellor Carter appointed an *ad hoc* Committee on Environmental Sciences to advise him on the administrative structure of a broad-scale campus-wide program. Encouragement was received from the State Board of Higher Education, which has issued an edict to the effect that new programs having a visible impact on the problems of society will receive the highest priority. The *ad hoc* committee is composed of four members of the lead project coordinating committee (Professors Ewing, as chairman, Metcalf, Salisbury, and Laitinen) together with Professors J. M. Atkin (Education), E. M. Brenner (Anthropology), F. C. Fliegel (Agricultural Economics), J. C. Frye (Director of State Geological Survey), L. G. Humphreys (Psychology), V. J. Stone (Law), and R. S. Wolfe (Microbiology). The committee has drafted a preliminary proposal which is being submitted to several deans for comment before being publicly announced. Whatever the final administrative structure turns out to be, the program will be of wide scope, involving physical, biological, and social sciences in educational, research, and public service functions. It will deal principally with the interaction between man and the natural environment, as opposed to the built environment, e.g., housing, landscape architecture, etc., which will be studied by other units of the University. It is anticipated that a relatively small core of professional staff members will be augmented by the part-time or occasional participation of a relatively large number of faculty personnel on part-time, adjunct, or "swing" type appointments, or as participants receiving research support for academic projects related to environmental problems. Presumably, a number of existing projects will be incorporated into the new unit. Details such as educational programs and public service functions will be worked out as the program evolves.

Student Participation in the School of Chemical Sciences

In the fall of 1969, Professor Gutowsky appointed an *ad hoc* committee composed of Professors Bailar, chairman, Beak, Beattie, McClure, and Sani to make a recommendation on student participation in the School of Chemical Sciences. This group agreed that increased direct student input would be of substantial benefit and prepared a proposal which recommended participation of students as full members on a number of committees in the School of Chemical Sciences and the establishment of a student committee advisory to other school committees. The proposal was endorsed by the faculty.

A student meeting called to consider the proposal attracted about 20 per cent of the undergraduate and graduate students concentrating in chemical sciences. Those present approved the principle of student participation and elected a committee to meet with the faculty *ad hoc* committee to work out details of the student participation. This group agreed on a proposal which specifies those committees on which students shall serve and the number of graduate and undergraduate students to be elected. A student advisory committee is to be established to meet with the Director on matters of general concern and to provide student consultation with those committees which do not have student members. This proposal has been approved by both faculty and students. Student members of the various committees and of the student advisory committee have been elected by a written canvass of all of the undergraduate and graduate students concentrating in chemical sciences and will begin to serve in September, 1970.

The students' and faculty's common interest in excellence in teaching and research has been apparent in the discussion to date. At times when division within and polarization about the University seem to be encouraged by the simplistic solutions proposed from one viewpoint by some student spokesmen and from another viewpoint by some governmental leaders, the progress that is being made should not be overlooked.

Undergraduate Scholarships and Awards

Scholarships for 1970-71

For the second year, we are giving fifteen $500 undergraduate scholarships to outstanding freshmen in the chemistry and chemical engineering curriculum. The five awarded to freshmen in chemical engineering are again financed by a special grant from the Chrysler Corporation. Three are financed by the Roger Adams Fund which has now grown to over $33,000. Looking back we find there has been about a $5,000 growth in the fund from one Newsletter to the next. Continuation at this rate will enable us to increase the Roger Adams scholarships to four in the 1971-72 year.

The students of Professor Audrieth have inaugurated a memorial fund in the University of Illinois Foundation with the request that one of the freshman scholarships be awarded in Professor Audrieth's memory. The L. F. Audrieth Fund was announced in the January, 1970, Newsletter.

The remaining six scholarships are being financed from departmental funds.

CHRYSLER SCHOLARSHIPS

Todd S. Brethauer, Downers Grove, Illinois — O'Neill High School
Thomas F. Cozza, Western Springs, Illinois — Lyons Township High School
Donald A. Giacherio, Mark, Illinois — Putnam County High School
John K. Keil, East Peoria, Illinois — East Peoria Community High School
Joseph E. Pazero, Jr., Worden, Illinois — Worden High School

ROGER ADAMS SCHOLARSHIPS

Stephen K. Anderson, Decatur, Illinois — MacArthur High School
Diana S. Walton, Pekin, Illinois — Pekin High School
Susan A. Yakes, Rolling Meadows, Illinois — Forest View High School

L. F. AUDRIETH SCHOLARSHIP

Richard L. Sommers, Lake Forest, Illinois — Lake Forest High School

DEPARTMENTAL SCHOLARSHIPS

Lawrence F. Dubas, Hillside, Illinois — Proviso West High School
John L. Hechtel, Westchester, Illinois — Proviso West High School
Rodney K. Huddleston, Loves Park, Illinois — Harlem High School
Geoffrey K. Kolb, Loves Park, Illinois — Harlem High School
Diane M. Schultz, Mount Prospect, Illinois — Prospect High School
James I. Shultz, Lisle, Illinois — Lisle Community High School

Undergraduate Awards, 1970

Each spring the department presents a series of awards to outstanding undergraduates in chemistry and chemical engineering. The award presentation was made April 18, 1970, by Dr. T. L. Brown before the Chemistry 108 class to the following students:

ELLIOTT RITCHIE ALEXANDER AWARD

Mark R. Bertoglio — Highland Park High School
David Damon — Marilyn High School

ALPHA CHI SIGMA PLAQUE

Clifford E. Dykstra — Oaklawn Community High School

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS AWARD

Raymond Vaseleski — Hall High School

AMERICAN INSTITUTE OF CHEMISTS

Robert R. Merkel — Leland Community High School
Terry W. Timm — Thornton Fractional Township South High School

CHEMICAL RUBBER COMPANY ACHIEVEMENT AWARD

Gary M. McClelland — Maine Township High School South

REYNOLD CLAYTON FUSON AWARD

James K. McKechnie — Thornton Fractional Township South High School

ALGERNON DEWATERS GORMAN PRIZE

James P. Yesinowski — La Salle Township High School

IOTA SIGMA PI PRIZE

Susan C. Patterson — Sacred Heart of Mary High School

KENDALL AWARD

Robert R. Merkel — Leland Community High School

MERCK INDEX AWARD

Anne Louise Cahill — Wheaton Central High School
Loren Schreiber — University City High School

PHI LAMBDA UPSILON CUP

Jay L. Freidinger — Pekin Community High School

WORTH HUFF RODEBUSH AWARD

Robert R. Merkel — Leland Community High School

University of Illinois Leads Colleges in Chemistry Degrees

The University of Illinois led the nation last year in doctoral degrees conferred in chemistry, in doctorates in chemistry and chemical engineering combined, and in total of all degrees awarded in chemistry and chemical engineering.

The American Chemical Society committee on professional training report for 1969, tabulated in the society's journal, *Chemical and Engineering News,* shows:

In chemistry doctorates — University of Illinois, 69; University of California at Berkeley, 65; University of Wisconsin at Madison, 55; Purdue University and Massachusetts Institute of Technology, each 49.

In total of doctorates in both chemistry and chemical engineering — University of Illinois, 77; University of California at Berkeley, 75; University of Wisconsin at Madison and Massachusetts Institute of Technology, each 65; Purdue University, 55.

In total of all degrees in chemistry and chemical engineering — bachelor's, master's, and doctor's — University of Illinois, 261; Purdue University, 260; University of California at Berkeley, 252; University of Wisconsin at Madison, 227.

The Employment Picture at Illinois

How are the Illini faring in the current employment cut-back? Will any of our chemists or chemical engineers be caught without employment this year? These are questions which our alumni are asking.

Last October and in early November, the employment outlook seemed much brighter than it had been the preceding year. The number of companies recruiting in the department was about the same as we have had in previous years and, of those which scheduled visits, very few cancelled out during the fall period. However, by December it became obvious that industrial needs for our graduates would be far less than normal. The recruiting schedule set up for spring (February and March) was very light, and subsequent cancellations brought the total down to the lightest recruiting period we have had in the past six years. The lack of interest in Ph.D. candidates, particularly, was very apparent during this period.

Another indication of the seriousness of the decline in employment has been the small number of vacancy notices received through the year by mail. A numerical comparison between those received in the past year and those received in 1965-66 (when we received the highest number of vacancies) follows:

	CHEMISTS				CHEMICAL ENGINEERS			
Degree	*Industrial*		*Academic*		*Industrial*		*Academic*	
Level	*1965-66*	*1969-70*	*1965-66*	*1969-70*	*1965-66*	*1969-70*	*1965-66*	*1969-70*
B.S.	911	433	...	...	793	345	...	...
M.S.	430	198	142	87	293	127	2	0
Ph.D.	576	255	280	291	107	51	4	2

In spite of the discouraging picture, all of our Ph.D. graduates for the academic year are placed except for a few foreign students. Some of these people returned to their own countries by choice, some went to other countries, and two have temporary employment. Three Ph.D.'s (United States citizens) who will finish in October are still seeking employment, although two of these people have offers of temporary employment and it appears that the third will have employment before graduation time. Only two of the B.S. degree chemists to graduate in June were without employment. None of our graduates have had to accept non-chemistry type jobs, although some (particularly at the Ph.D. level) have been disappointed in not having more choices of jobs.

Earlier in the year it was thought that starting salaries were beginning to stabilize. When all figures were in for the year, however, it was found that the upward spiral had continued. A two-year comparison of monthly industrial salary averages for graduates with little or no previous experience is shown below:

Degree Level	CHEMISTS		CHEMICAL ENGINEERS	
	1968-69	*1969-70*	*1968-69*	*1969-70*
B.S.	$760	$795	$868	$926
M.S.	950	950	997	1015
Ph.D.	1250	1285	1308	1394

With regard to academic positions, six chemists and one chemical engineer have reported acceptances thus far. Average starting salaries to chemists were up from $1,105 to $1,125. No chemical engineers accepted academic employment in 1968-69, so there is no comparison figure.

This has been a year of concern, although we have been pleased with the outcome. We have no way of predicting what the next year will bring. However, we have been pleased with the attitudes demonstrated by our students as they faced this, their first major set-back. While we have our share of those who give up too easily and those who, with discouragement, become bitter and disgruntled, we are proud to say that the great majority demonstrate a strength of character with tenacity which will ultimately lead to success. We feel that these are the young men and women who will make invaluable contributions to the future growth of the chemical profession.

Awards and Honors to Alumni and Staff

Robert W. Holley '42

At the commencement held on Saturday, June 20, at the Urbana-Champaign campus of the University of Illinois, Robert W. Holley received an honorary Doctor of Science degree. Dr. Holley is a Resident Fellow and American Cancer Society Professor of Molecular Biology at the Salk Institute for Biological Studies. Born in Urbana, Professor Holley received the Bachelor of Arts degree in Chemistry at the University of Illinois in 1942 and the Doctor of Philosophy degree at Cornell University in 1947, where he did his doctoral research with Professor Alfred T. Blomquist. From 1948 until joining the Salk Institute in 1968, he held appointments in the United States Department of Agriculture and at Cornell University.

In the March 19, 1965, issue of *Science*, there appeared a report by Dr. R. W. Holley and his colleagues on the first structural elucidation of a ribonucleic acid. The complete nucleotide sequence of an alanine transfer RNA, isolated from yeast, had been determined! This structural triumph had its foundation in earlier work, inventive and painstaking, in Dr. Holley's laboratory on the purification of tRNA's, the development of new methods of determining short sequences of oligonucleotides, and the identification of new nucleotides. The importance of this unique structure determination was

realized immediately, since the function of the transfer RNA's is to carry activated amino acids to the site of protein synthesis. The experiments of Dr.

Robert W. Holley

Holley and his colleagues not only proved the primary, or linear, structure of yeast alanine tRNA but provided information as to its secondary structure, so crucial to an understanding of the function. Dr. Holley's work provided the basis for the structure determination of other nucleic acids and serves as the original guide for the synthesis of biologically active nucleic acids.

In recognition of Dr. Holley's work, he shared in the 1968 Nobel Prize in Medicine and Physiology with Dr. Marshall Nirenberg and Dr. H. Gobind Khorana (issue No. 2 of our *Alumni Newsletter,* 1969), and he has also received the Albert Lasker Award in Basic Medical Research and the United States Steel Foundation Award in Molecular Biology. He is a member of the National Academy of Sciences and a fellow of the American Academy of Arts and Sciences.

There have been nine honorary degrees awarded by the University of Illinois to chemists and biochemists during the past two decades. Honorary Doctor of Science degrees have been received by four emeriti: Roger Adams (1957), William C. Rose (1962), Carl S. Marvel (1963), and Reynold C. Fuson (1966), and by an equal number of alumni: Wendell M. Stanley (1959), Edward A. Doisy (1960), Vincent DuVigneaud (1962), and W. Albert Noyes, Jr. (1964). Dr. Holley now joins this illustrious group. As an alumnus of the University of Illinois, Professor Holley, through his brilliant research, has brought distinction to his Alma Mater.

Professor Marvel to Receive the John R. Kuebler Award

Professor C. S. Marvel, better known to many generations of Illinois chemists as "Speed," will receive the John R. Kuebler Award of Alpha Chi Sigma at the biennial conclave of the fraternity this summer. This award is given each year to the man who is adjudged to have contributed most to the profession and to the fraternity.

August 19 will be "Marvel Day" at the fraternity conclave in Austin, Texas. During the afternoon, there will be a symposium on Speed's favorite topic — polymers — at which his former student, C. G. Overberger (Ph.D., Illinois, 1944) will preside. Three distinguished polymer chemists have heen asked to

speak. The award dinner and the presentation will follow the symposium that evening.

Carl S. Marvel

Rudolph A. Marcus

Speed Marvel received the Ph.D. degree at Illinois in 1920 and joined the staff immediately thereafter. He remained as a member of our faculty until his retirement in 1961, when he became a Research Professor at the University of Arizona — the position which he still holds.

In his early days at Illinois, Speed helped organize the Division of Organic Chemical Manufactures, which engaged graduate students in chemistry to make compounds for home use and for sale during the summer months. Since America had little synthetic chemical industry at that time, the "Organic Preps Lab" served a very useful purpose in supplying chemicals to industrial and academic institutions in all parts of the country. This organization persisted for some years, but went out of existence when industrial laboratories were able to supply the demand. Throughout most of his career, Speed has been interested in the chemistry of polymers, and he is probably best known for his work in that field. However, thousands of students at Illinois will remember him best because of his helpful, friendly attitude and his skill as a teacher and counselor.

Speed's interests range far beyond chemistry. He has long been an avid hunter and fisher, and is an authority on American birds. To those alumni who came to Illinois too late to know him here, all we can say is, "You've missed a lot."

Marcus Elected to National Academy of Sciences

Professor Rudolph A. Marcus has been elected to membership in the National Academy of Sciences at their April meeting in Washington, D.C. He is one of fifty new members elected for their distinguished and continuing achievements in original research, bringing to 870 the total recognized as America's foremost scientists.

Dr. Marcus is a physical chemist who came to the University of Illinois in 1964 from the Polytechnic Institute of Brooklyn. His special interests are in chemical kinetics and the mechanics of chemical reactions. He is a native of Montreal receiving his B.S. and Ph.D. degrees from McGill. Last year he was Chairman of the Board of Trustees of the Gordon Research Confer-

ences and an associate member of the University of Illinois Center for Advanced Study. He has served in numerous posts for the American Chemical Society.

Professor Marcus becomes the twenty-first Academy member at the University of Illinois and the eleventh chemist of the Urbana-Champaign campus to be so honored. The other chemists are Roger Adams, Herbert E. Carter, David Y. Curtin, Harry G. Drickamer, Reynold C. Fuson, I. C. Gunsalus, Herbert S. Gutowsky, Nelson J. Leonard, Carl S. Marvel, and William C. Rose.

Other Academy members who are alumni of our department are Alfred T. Blomquist, W. R. Brode, Theodore L. Cairns, Karl Folkers, Philip Handler, J. R. Johnson, S. M. McElwain, Edward A. Doisy, Vincent DuVigneaud, R. W. Holley, and M. M. Stanley.

H. E. Carter

Professor Carter Honored Again — and Again

Professor H. E. Carter, Vice-Chancellor for Academic Affairs on the Urbana-Champaign campus of the University, has received the 1970 Bailey Award of the North Central Section of the American Oil Chemists Society in "recognition of his major contributions to the biochemistry of complex lipids and to the education of young scientists."

For several years, Dr. Carter and his students devoted their attention to the study of lipids and studied the structures of sphingosine, phytosphingosine, phytolylipid, and the cerebrosides, all of which they isolated for the first time.

Professor Carter has been reappointed by President Nixon to the National Science Board, which is the policy making body of the National Science Foundation. He was elected Chairman of the Board, succeeding one of his former graduate students, Dr. Philip Handler (Ph.D., 1939). The Board consists of twenty-four scientists appointed by the President with the advice and consent of the Senate. Professor Carter is one of nine persons appointed to the Board this year, and one of three reappointed to full six-year terms.

Dr. Carter received the American Chemical Society Award in Biological Chemistry sponsored by Eli Lilly and Company in 1943, the Nichols Medal of the Chicago Section of the American Chemical Society in 1965, the American Oil Chemists Society Award in Lipid Chemistry in 1966 and its Spencer

Thomas P. Turchan, President of SOCMA, Dr. Nelson J. Leonard, and Dr. Llewellyn W. Burnett, Chairman of SOCMA's Research and Technical Programs Committee

Award in 1969. He also holds the honorary Sc.D. degree, which was awarded to him by his alma mater, DePauw University, in 1953.

Leonard Wins SOCMA Award

Professor Nelson J. Leonard has been chosen to receive the 1970 Medal for Creative Research in Organic Chemistry, given hy the Synthetic Organic Chemical Manufacturer's Association. This award is designed to honor the man behind the research, rather than the research itself. The presentation was made in June at a meeting of the Association in New York City. Professor Leonard is well known for his synthetic work, especially that in the field of ring compounds. In 1963, he received the American Chemical Society's Award for Creative Work in Synthetic Organic Chemistry, sponsored by SOCMA.

Professor Pirkle Wins Sloan Fellowship

Dr. William H. Pirkle, Assistant Professor of (Organic) Chemistry, has been awarded an Alfred P. Sloan Foundation fellowship for the 1970-71 and 1971-72 school years. These fellowships are awarded to young scientists who show particular promise, and are designed to assist these men and women in their research careers.

Dr. Pirkle earned his bachelor's degree from the University of California in Berkeley and his Ph.D. degree from the University of Rochester. He then did postdoctoral work with Professor E. J. Corey (a staff member at Illinois from 1951 to 1959) before he joined the faculty at Urbana in 1964.

In the last six years, the Sloan Foundation has awarded fellowships to five members of our staff (Peter A. Beak, W. N. Flygare, Jiri Jones, Ian Paul, and

Stanley Smith), to five former staff members (Adam Allerhand, Jay Anderson, John E. Baldwin, Victor Bloomfield, and Robert Bates), and to five alumni (A. Wallace Cordes, Jeremiah P. Freeman, Michael M. Martin, Garry A. Rechnitz, and John G. Verkade).

Mark Chamberlain Is President of Glassboro State

Mark Munroe Chamberlain has been President of Glassboro State College in Glassboro, New Jersey, since last September, and was formally inaugurated on May 2. Until last year, Glassboro State was chiefly a teacher training college, but it has now been officially converted into a general college of liberal arts and sciences. President Chamberlain will guide the college through the critical period of transition.

Mark M. Chamberlain

Dr. Chamberlain did his undergraduate work at Franklin and Marshall College, from which he graduated *magna cum laude* in 1953. He entered the Graduate College at Illinois that fall, and was awarded the Ph.D. in inorganic chemistry in 1956. Upon completion of his graduate work, he joined the staff of Western Reserve University as an instructor. He rose rapidly through the professorial ranks, became Chairman of the Department of Chemistry, and when Western Reserve and Case Institute of Technology united to form Case-Western Reserve University, he became Vice Provost of the new school. It was from the latter post that he moved to the presidency of Glassboro State.

Bailar Medalist

Following the very successful Symposium on Coordination Chemistry last summer honoring Dr. John C. Bailar, Jr. on the occasion of his sixty-fifth birthday, the Bailar students have contributed all of the unused funds to the University of Illinois Foundation to set up a special fund to support a lectureship in inorganic chemistry within the Department of Chemistry and Chemical Engineering. All proceeds of the Festschrift and several other donations have been pledged to the fund.

The annual lecturer will be known as the Bailar Medalist for that year. Selection of the Medalist will be made by the inorganic faculty of the De-

partment of Chemistry and Chemical Engineering in consultation with Dr. Bailar. The annual Medalist is to be an outstanding scientist working in the field of inorganic chemistry and his presence at Illinois is expected to be a high point in the lecture-seminar program of the department. All students of Dr. Bailar and those of his many friends among the alumni who wish to contribute to the Lecturer-Medalist fund may send their checks directly to the University of Illinois Foundation with assignment to the John C. Bailar, Jr. Lectureship Fund.

Recent Graduates

One of the suggestions sent in by alumni was to publish the names and present addresses of those who joined alumni status since the Centennial History was published in 1967. It turns out that this is quite a list and a little beyond the scope of the present Newsletter. So it has been decided to meet the problem part way. With each Newsletter, the roster of Ph.D. graduates since the last letter will be published. To start this, those who received their degress in February, 1970, are published in this Newsletter.

Bertram, Edward Frank Organic Dr. R. M. Coates
"Biogenetic-like Interconversions of Tetra- and Pentacarbocyclic Diterpenoids"
Home address: 1107 83rd Avenue, No. 702, Edmonton 61, Alberta, Canada

Bilson, Elizabeth Jarmay Physical Dr. P. E. Yankwich
"Studies in Chemical Kinetics"
Space Research Center, Cornell University, Ithaca, New York 14850
Home address: 119 Height's Court, Ithaca, New York 14850

Cook, Gerald William Chemical Engineering Dr. T. J. Hanratty
"Turbulent Flow Over Solid Wavy Surfaces"
Chevron Oil Field Research Company, La Havra, California 90631
Home address: 144 South Westchester, Anaheim, California 92803

Dixon, Daniel Benjamin Organic Dr. N. J. Leonard
"Abnormal Ring Expansion and Ring Opening Reactions of Polycyclic Aziridinium Salts"
E. I. DuPont de Nemours Textile Research Laboratory, Chestnut Run, Wilmington, Delaware
Home address: Driftwood Club, Apartment D8, 125 Greenbank Road, Wilmington, Delaware 19808

Engelmann, John Hugh Organic Dr. D. Y. Curtin
"1, 3 Acyl Migrations in 6(5H)-Phenanthridinone and Similar Systems"
Department of Chemistry, State University of New York, Buffalo, New York 14200

Gardiner, Robert Archie Organic Dr. K. L. Rinehart
"Studies on the Alkaloid Slaframine and Synthesis of Model Aminoindolizidines"
E. I. DuPont de Nemours, Jackson Laboratory, P.O. Box 525, Wilmington, Delaware 19711
Home address: 630 Capitol Trail, Apartment F4, Neward, Delaware 19711

Heitz, Walter Lewis Chemical Engineering Dr. J. W. Westwater
"Hydrodynamic Stability of Water and Its Effect on Melting and Freezing"
Shell Development Company, 1400 Fifty-third Street, Emeryville, California
Home address: 4111 Heitz Way, Calistoga, California 94515

Horlick, Gary Analytical Dr. H. V. Malmstadt
"Basic and Practical Considerations in Utilizing a Fourier Transform Spectrometer for Spectral Measurements"
Department of Chemistry, The University of Alberta, Edmonton, Alberta, Canada
Home address: 8510 111th Street, No. 2005, Edmonton, Alberta, Canada

Hsu, Ming-chu Physical Dr. R. W. Woody
"Optical Activity of Heme Proteins"
Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena, California

Johnson, Edward Frank Organic Dr. R. M. Coates
"Kinetic Studies Involving Potentially Aromatic Dipydrobenzazocine Anions"
ESSO Research and Engineering Company, P.O. Box 4255, Baytown, Texas 77520
Home address: 1980 Ninth Avenue, Yuma, Arizona 85364

Kennedy, Frank Scott Biochemistry Dr. J. M. Wood
"Physical and Biological Studies with Free and Protein Bound Vitamin B_{12}"
Oxford University, England (Postdoctorate, one year)
Home address: 626 Balmoral Drive, Shreveport, Louisiana 71106

Kistenmacher, Thomas John Inorganic Dr. G. D. Stucky
"Structural and Spectroscopic Studies of Chloride Complexes from Nonaqueous Solvents"
Division of Chemistry, California Institute of Technology, Pasadena, California 91109

Kirkpatrick, James Willis Analytical Dr. H. V. Malmstadt
"Emission Spectrometric Determination of the Nitrogen Isotope Ratio"
Department of Chemistry, Western Illinois University, Macomb, Illinois 61455
Home address: 124 North Normal Street, Macomb, Illinois 61455

Krueger, Spencer Milton Organic Dr. J. E. Baldwin
"Conformational Effects on Stereoselective Photochemical Isomerizations"
Eastman Kodak Company, Rochester, New York
Home address: 108 Division Street, Algonquin, Illinois 60102

Payet, Charles Robert Organic Dr. Peter Beak
"The Search for Photochemical Intramolecular Interactions of Imines with Other Functional Groups"
Malcolm-Grow Medical Center, Andrews AFB, Maryland
Home address: 912 Poinciana Drive, Indian Lake Estates, Florida 33855

Peavy, Richard Edwin Organic Dr. J. E. Baldwin
"Five-membered Carbocycles Through (3+2)-Cycloaddition Reactions"
E. I. DuPont de Nemours, Wilmington, Delaware
Home address: 544 South Bowman Avenue, Meriun Station, Pennsylvania 19066

Queener, Sherry Fream Biochemistry Dr. I. C. Gunsalus
"Regulation of the Anthranilate Synthase Subunits in *Pseudomonas Putida*"
Medical School, Indiana University, Indianapolis, Indiana

Queener, Stephen Wyatt Biochemistry Dr. I. C. Gunsalus
"Purification and Characterization of the Anthranilate Synthase Subunits in *Pseudomonas Putida*"
Antibiotic Development Division, Eli Lilly and Company, Indianapolis, Indiana

Schlegel, Donald Charles Organic Dr. K. L. Rinehart
"Part I: Synthetic and Degradative Studies of Two Streptovaricin Degradation Products, Streptovarone and Dapmavarone
Part II: Synthetic and Spectral Studies or Highly Substituted 1,4-naphthoquinones"
Sterling-Winthrop Research Institution, Rensselaer, New York 12144

Shermer, William Duane Organic Dr. J. E. Baldwin
"A Symmetrical Carbonyl Ylid Generated from Acetone and 2-Diazopropane"
Monsanto Company, 1700 South Second Street, St. Louis, Missouri 63109
Home address: 7219 Hampton, St. Louis, Missouri 63109

Simpson, David Alexander Organic Dr. Peter Beak
"Product Studies in the Reactions of Chloroformates with Silver Fluoro Salts"
Hercules Research Center, Central Research, Wilmington, Delaware 19703
Home address: 732 Peachtree Road, Apartment L, Claymont, Delaware 19703

So, Hyunsoo Physical Dr. R. L. Belford
"Part I: Electron Spin Resonance Study of Quadrupole Coupling in Copper (II) Complexes
Part II: Triplet State ESR Spectra of Binuclear Vanadyl(IV) Tartrates"
Department of Chemistry, Georgetown University, Washington, D.C. 20007

Sump, Gary Dean Chemical Engineering Dr. J. W. Westwater
"Boiling Heat Transfer from Horizontal Cylinders to Inmiscible Liquid-Liquid Mixtures"
ESSO Production Research, P.O. Box 2189, Houston, Texas 77001

Vanarendonk, Arthur Milford Biochemistry Dr. I. C. Gunsalus
"Interactions of Isocyanides and Cytochrome P-450$_{CAM}$"
General Electric, Electronics Lahoratory, Syracuse, New York 13201
Home address: Glenmore House Apartment 7, Hollyroad Park, Liverpool, New York 13088

Wong, Kin Fai Chemical Engineering Dr. C. A. Eckert
"Molecular Thermodynamics and Solvent Effects on the Diels-Alder Reaction"
Department of Chemistry and Chemical Engineering, University of Illinois, Urbana, Illinois 61801
Home address: 909 South Fifth Street, Champaign, Illinois 61820