Washington University's new five-million-dollar student center and performing arts building, the Mallinckrodt Center, was formally dedicated in ceremonies held October 12. The dedication featured a preview of music, dance, and drama, representative of the Edison Theatre's year-round programming. Members of the University's Women's Society were hostesses at a gala reception following the dedication. (See Mallinckrodt Center, page 2.)
<table>
<thead>
<tr>
<th>Mallinckrodt Center</th>
<th>2</th>
<th>The new crossroads of the campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eli and Lee Robins</td>
<td>16</td>
<td>Pioneers in psychiatry</td>
</tr>
<tr>
<td>Annual Report</td>
<td>21</td>
<td>With comments by the Chancellor</td>
</tr>
<tr>
<td>for 1972-73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-man Show</td>
<td>37</td>
<td>Exhibition by two faculty artists</td>
</tr>
<tr>
<td>Butterflies, Genes,</td>
<td>42</td>
<td>A population biologist in the Rockies</td>
</tr>
<tr>
<td>and Miners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Medicine</td>
<td>50</td>
<td>On a new medical specialty</td>
</tr>
</tbody>
</table>

COVER: The new Mallinckrodt Center and Edison Theatre complex has become the crossroads of campus and community and the focal point of campus life.

Photo credits: pages 42-49 by Elizabeth Johnson and Dorothy Brockhoff; Page 13 (top) Gail Cisna; (lower right) Paul Schmolke; all others by Herb Weitman.
The University's new Mallinckrodt Center was formerly dedicated October 12, culminating years of effort to establish a student union and performing arts center on campus. Named after the Edward Mallinckrodt, Jr., family, the five-million-dollar building, located on Forsyth Boulevard, houses the University's Samuel B. and Charles B. Edison Theatre, offices for performing arts faculty and staff, student government and student affairs personnel, a bookstore, cafeteria, conference rooms, and lounges. Before the Center's construction, the University had no adequate central meeting place or theatre. Yet despite the limitations that they have struggled under, the performing arts on campus today are thriving. Hundreds of students had to be turned away from the beginning acting and dance classes this year. Herbert Metz, associate professor of drama, explained that "A building cannot create excellence; it can merely make more of it possible to be expressed, and can house it more comfortably and attractively." The Performing Arts Area has a good foundation to build and expand upon, and a spacious, adaptable theatre and supporting facilities to work with. A five-week Festival of the Arts to celebrate the opening of the Center began the dedication weekend and will run through November 19. It is featuring a variety of drama, music, and dance events which are all open to the public.
ALLINCKRODT CENTER was designed by Smith and Entzeroth and Robert Vickery, associated architects. Built of reinforced concrete with a facade of precast red granite textured panels, the building is integrated with Karl D. Umrath Hall to form a central outdoor plaza. One of the Center's most striking features is a three-story, glass-walled pedestrian gallery, located on what, before the construction of the building, was a natural walkway for thousands of students. The gallery opens to all major facilities in the Center and provides a dramatic show case for many works of art.
The Center
THE CENTER is a natural campus gathering place. Students, faculty, and staff come to relax, meet friends, study, browse in the bookstore, have coffee, eat, rehearse or attend performing arts events, and get information on coming campus and community activities. The three-level pedestrian gallery provides easy access to all major facilities in the Center. All kinds of people can be found in and around the building—on benches, chairs, stairways, and floors, alone or in pairs or groups, making themselves at home in the long-awaited and much needed Center.
AN OUTDOOR brick-paved plaza and amphitheatre provide a natural setting for drama, music, and dance performances as well as space to sit and stroll. Last summer, Phyllis Lamhut, New York dancer-choreographer, imaginatively used the outdoor facilities for a student dance concert she directed. A touring summer children's theatre presented a show in the amphitheatre, and future outdoor performances are anticipated. Designed to be a teaching theatre, the new building also incorporates many other features suggested by faculty and students in the performing arts. Additional supporting facilities for the theatre include drama and dance studios, dressing rooms, scenery and costume workshops, an audio-visual room, and a reading-seminar room.
THE BOOKSTORE has three levels which house textbooks, trade books, and supplies. Twice as large as the former bookstore, which was located in cramped quarters in the basement of South Brookings Hall, the new store is an interesting place to browse. In addition to books and supplies, there are posters, candles, records, greeting cards, toiletries, small gifts, and candy. Another popular spot in the Center is the cafeteria on the lower level. It provides a convenient and pleasant place for people to visit and have coffee, snacks, or meals.
The Center
Mistress of Ceremonies for the dedication was alumna Mary Wickes, noted actress and comedienne.
THE SAMUEL B. and Charles B. Edison Theatre is an exciting new facility for the performing arts on campus. At maximum capacity, it seats 739 in a thrust stage configuration. With movable walls and seating arrangements, it can be converted into a 527-seat theatre, with a 40-foot proscenium stage, or a 656-seat theatre with a 60-foot wide open stage. This flexibility makes it possible to stage and experiment with a wide variety of drama, music, and dance productions. Richard Palmer, chairman of the Performing Arts Area and Director of Theatre, explained that student usage was the primary consideration in designing the technical equipment for the theatre. "We have the means for elaborate staging effects, particularly with light, but all equipment can be operated by students and serves as a teaching tool." The theatre was inaugurated October 12 with a preview of music, dance, and drama representative of the Center's year-round programming. Washington University alumna Mary Wickes, prominent television, stage, and movie actress, was mistress of ceremonies. Previewed were: "The Caucasian Chalk Circle" (the Performing Arts Area opening play), and performances by the University Dance Theatre, the University Madrigal Singers, the St. Louis String Quartet, and the University Opera Studio.
Eli and Lee Robins

One of this country's leading psychiatrists commented that Eli and Lee Robins "have questioned very fundamental premises in clinical psychiatry and have undertaken empirical studies that have changed many views." Eli Robins, head of the Washington University Department of Psychiatry, has done research in brain biochemistry as well as clinical psychiatry, including basic diagnostic techniques. His wife, Lee Robins, professor of sociology in psychiatry and professor of sociology, has studied childhood factors which influence psychiatric disorders in adults, sociopathic personality, and drug abuse.

It is appropriate that Eli Robins, chairman of Washington University’s Department of Psychiatry, and his wife, Lee Robins, who holds appointments in psychiatry and sociology, have based their distinguished careers in the state of Missouri. The reason that they are held in such high esteem in a field that has been known best for its intriguing theories has not been for their own theorizing, but rather for their steadfast skepticism and empirical approaches. They are polite and low key, but when confronted with generalizations their reactions nearly always boil down to, “Well, you’ll have to show me first.” They cast skeptical eyes at their own studies and at the data of others. They carefully qualify claims they might make about their findings, a tendency that is anathema to many journalists.

In fact, when their empirical approach to psychiatry first became known in the profession, it didn’t make them eligible for popularity awards among many of their peers. Over the past twenty-five years, they have not only demanded that generalizations be backed by solid data, but they, personally, and the Washington University Psychiatry Department, collectively, have produced such carefully documented studies that they have earned respect among both clinicians and researchers. Some idea of their impact in the field of psychiatry was articulated by eminent psychiatrists who have neither collaborated with Eli Robins nor Lee Robins, nor necessarily shared any set approach with them.

“They’ve often been alone in their work,” said Dr. Daniel X. Freedman, chairman of psychiatry at the University of Chicago and editor of the Archives of General Psychiatry. “Fundamentally,” he continued, “Eli has been a pioneer in fashioning an academic department of psychiatry in which research and new knowledge were primary goals. That kind of department has been, and is, rare. Psychiatry as an academic field in medical schools is a relatively recent phenomenon. It is the last major branch of medicine to be firmly ensconced in medical schools.”

“Eli and Lee’s work in descriptive psychiatry—everyone recognizes their department’s biochemical sophistication—has been a key in helping the field to focus on the problem of establishing criteria in diagnosis. This in turn has been terribly important in setting research goals. Their department, which is one of the ten or so leading academic departments in the country, was one of the first after World War II to become known for the seeking of new knowledge. In carefully followed-through research, you usually find the Robins in the forefront,” Dr. Freedman said.

Dr. Frederick K. Goodwin, Chief of the Psychiatry Section, Laboratory of Clinical Science, National Institutes of Mental Health, said, “In general, the Robins’ contribution has been substantial and has been increasingly recognized in the last few years. Until it was recognized, their work was isolated from the mainstream of psychiatry.” Dr. Goodwin said that for many years the mainstream of psychiatry has been a psychoanalytic and psychodynamic approach, in which the important base is the concept of the unconscious and the ways in which it interacts with events in current, daily life. Those who have this base treat the general symptoms of a patient from that perspective.

“Under Eli Robins,” Dr. Goodwin continued, “the Washington University Psychiatry Department has followed a classic medical model instead. In other words, their approach is that psychiatrists should think about people having specific illnesses. Eli has looked for patterns among the many illnesses, and beyond that, for biochemical implications. Washington University’s Psychiatry Department is on the right track in regard to the more severely affected patients. Its work has brought more precision in the diagnosis of mental illness.”

Dr. Leon Eisenberg, chief of psychiatry at Massachusetts General Hospital and professor of psychiatry at Harvard University, said, “By any criteria, Eli Robins has built one of the most outstanding psychiatry departments in the world. It has produced an enormous amount of first-rate research. The Robins have questioned very fundamental premises in clinical psychiatry and have undertaken empirical studies that have changed many views.” Dr. Eisenberg referred to a recent survey by American and British scientists who found “a particular indifference to diagnosis in this country.” “Eli Robins’ department has done more than any other group to reverse that trend,” he said.

Within the Washington University Psychiatry Department, the other faculty members obviously have a great deal of respect for the Robins. There is a lot of pride in the quality of research done by the department as a whole. One professor,
Dr. Donald Goodwin, does an annual check on the number and the quality of papers by the department. The number averages out to more than 100 papers a year, which possibly makes the department the most productive American psychiatric institution.

"More important," Dr. Goodwin pointed out, "these reports were published by refereed journals, which means every manuscript is subjected to criticism by professionals in the speciality of the author." In 1971 and 1972, faculty members published 103 papers on clinical and therapeutic subjects; thirty-six on social psychiatry and epidemiology; nineteen on genetics; twenty on psychology and neuropsychology, and forty-nine on biochemistry and electron microscopy.

Waiting to confer with Eli Robins one day this fall was a professor of mathematics, Mitchell Taibleson, who holds a joint appointment in the Department of Psychiatry. Noting his questioner’s surprise at seeing him there, he said, "Well, if it weren't for the broad approach to science that Eli and Lee have, you probably wouldn't find a mathematician in the department is broadly based because we don't think that we know the causes of psychiatric illnesses," he said. "Classification is vastly undervalued because of past emphasis placed on environmental factors or on causation. For some reason, it was fashionable to think that if you believed in the latter you couldn't believe in classification; but the profession as a whole had better start worrying about classification, no matter what one group or another believes the cause of an illness might be."

The view of Dr. Robins and his associates was underscored recently when the previously mentioned British and American scientists found, in a comparative survey of psychiatric diagnosis in the two nations, that in the United States there has been frequent overdiagnosis of schizophrenia and frequent underdiagnosis of depressive illness.

Dr. Robins and his associates use five basic steps which they feel are requisite to making precise diagnoses: (1) a thorough clinical description of the disorder, (2) laboratory tests whenever possible, (3) separation of the suspected illness from others with which it might be confused, (4) a follow-up study to validate the diagnosis and, indeed, to give a basis for it, (5) a family history, since it is known that most psychiatric disorders tend to run in families.

In applying this approach to the so-called "affective disorders" (manic and depressive illnesses), Dr. Robins and his associates have shown important distinctions among patients who are exhibiting symptoms of depression. In one group of patients, depressive illness is the central disorder; in a second group, depression alternates with manic phases.

Back in the late 1940's, as a Harvard medical student intern and resident in psychiatry, Dr. Robins was aware of basic problems in clinical diagnosis, but it was a concern about his lack of knowledge of brain chemistry which brought him to Washington University in 1949. At that time, if precise diagnosis of psychiatric illness was considered a crashing bore, biochemistry was outright heresy.

"Most of my colleagues thought I was out of my mind to study brain biochemistry," Dr. Robins said, "But I was convinced before I finished my clinical psychiatric training that I should know more about the chemistry of the brain. The reason I came to Washington University was that Dr. Edwin Gildea, who headed the Psychiatry Department had a reputa-
tion for allowing people the freedom to follow their own research interests. He expected productivity, but he didn't try to impose any dogma on department members. That was very unusual for those days."

Professor Gildea introduced Dr. Robins to Dr. Oliver Lowry, head of the Department of Pharmacology and one of the leading biochemists in the world. To work with Professor Lowry, Dr. Robins received a National Institute of Mental Health Fellowship in brain biochemistry, probably the first such fellowship awarded to a psychiatrist by the institute. Because of the main trends in psychiatry at that time, it was astounding to Dr. Lowry that a psychiatrist would want to learn something about biochemistry.

"Eli was convinced," said Dr. Lowry "that psychiatrists themselves had to contribute to knowledge of the brain's chemistry. And since that time, he has made a number of important contributions in biochemistry while also doing outstanding clinical research. He was indeed a pioneer in insisting that valuable advances in psychiatry would have to come from objective studies. Medicine has never advanced until individuals like him have said, 'Let's get the facts.'"

Research in the biochemistry of brain tissue intensified after the development of phenothiazine drugs in the 1950's. This family of drugs did not cure but helped dramatically to alleviate symptoms of schizophrenia. A natural corollary is that if drugs could have such an effect, a thorough understanding of their chemical interaction within the nervous system might point to biochemical causes of illness. So far, no clear-cut biochemical process has been identified as the cause of a given psychiatric illness; but the encouraging effects of drugs on a variety of disorders and the gradual elucidation of how the nervous system functions at the molecular level are compelling reasons to intensify biochemical studies.

Dr. Robins pointed out that it could take ten, twenty, or thirty years, to tie a definite biochemical event to, say, schizophrenia or depressive illness. When and if that happens, however, it would be one of the greatest advances in medicine. If, for lack of funds or motivation, scientists fail to keep on producing the fundamental data for researchers in the 1980's to build on, then, in Dr. Robins opinion, the inevitable linking of biochemical events to certain psychiatric illnesses may be postponed for a very long time indeed. Despite his intense commitment to biochemical research, Dr. Robins maintains skepticism to many of the chemical reports which have been published. "In this field there has been an over-abundance of unverified research," he added.

The skepticism of Dr. Robins and Dr. Marcel T. Saghir led to a significant study published in August in a book, Male and Female Homosexuality. Their survey of 146 homosexuals and a control group of eighty heterosexuals questions traditional social and psychiatric attitudes about homosexuals. A review from the August 21 Medical Post states in part:

What does come through clearly in the Saghir and Robins book (which Dr. George Winokur, head of psychiatry at the University of Iowa, predicts may become the classic psychiatric work on the homosexual condition) is that homosexuality is not curable simply because homosexuals are not sick. They are merely different. The authors point out that many homosexuals present little or no psychopathology and those who do are rarely disabled by their disorder: 'A condition cannot be made into a disease by simple intuition, moral indignation, and proclamation.'

Lee Robins' long-term studies of school children have also questioned traditional attitudes and pointed the way to priorities in potential treatment in prevention of juvenile delinquency and severely antisocial adult behavior. She discussed her research at her home in Clayton, Missouri, this fall, after frying hamburgers for the family luncheon. After lunch, she was a little weary because of a heavy cold, but that didn't seem to dampen her natural friendliness. "Let's talk on the outside porch—the wind will blow the germs away," she said. Her conversation about her field was spontaneous and ironic—quite different from the factual, down-to-business style of her research reports.

"Liberals like ourselves," she smiled, "tend to assume that the answers to preventing severe behavior problems are known. But the sad truth is that there haven't been any good programs to produce conclusive evidence. Of about a half-dozen very carefully controlled programs, none has worked. Just because we haven't had a successful demonstration, though, doesn't mean we don't have a chance. One of the problems is that the programs so far have been short-term. For example, Marion Blank at the Einstein Medical Center in Philadelphia showed that the IQ's of four-year-old children could be improved dramatically by one-to-one tutoring, but we don't know whether this program affected the children's behavior later in life because she couldn't get government funds to do a follow-up study."

"Almost nothing is known about the stages of development of undesirable or so-called juvenile delinquent behavior," she continued. "What is heartening, though, is that so many children turn out all right. In our studies to find indicators in young children that point to serious trouble later in life, we find that at least 50 per cent of the kids won't get into serious trouble, no matter how many indicators they have."

In one of Dr. Robins' studies—eventually published in a
book, Deviant Children Grown Up—524 children from St. Louis inner-city schools, who also were patients at the St. Louis Child Guidance Clinic, were followed into adulthood to see whether specific behavioral characteristics as children could be used to predict trouble in adulthood. This group of children had serious behavioral problems. Another group of 100 children, who had not been referred to the clinic or elsewhere for psychiatric treatment and who had not exhibited severe behavior problems—the control group—was selected at random from children in the same inner-city schools. "Controls are dangerous," Dr. Robins said. "They often show that you were wrong in your assumptions."

Dr. Robins' study was the first carefully controlled, long-range research to establish the danger-potential for a particular group of children. The study showed that only 4 per cent of the control children had five or more adult antisocial symptoms, contrasted with 45 per cent of the group with early and severe behavior problems. Eighty per cent of the latter group had some psychiatric disorders as adults, contrasted with 48 per cent of the control group. Thirty-four per cent of them had disabling psychiatric disorders as adults, contrasted with only 8 per cent of the control group.

The symptoms of the danger-prone group as adults showed up in high rates of arrest, frequent loss of jobs, hospitalization for psychiatric disorders, high divorce rates, alcohol and drug abuse, and alienation from friends and society. The most reliable behavioral predictor of severe adult problems was the manifestation of symptoms early in grade school, including frequent thefts and fighting, refusal to accept authority, difficulty in learning to read, and truancy. About one-third of this group had been diagnosed in adulthood as being so-called sociopathic personalities. This psychiatric phenomenon is the classic "ne'er-do-well," who always is in trouble: theft, drinking, loss of jobs, as well as being a person who is often hostile, irritable, depressed, or paranoid.

"These individuals are not only hard on society, but very hard on themselves. They are of average or above-average intelligence, but they are so unreliable that not even the Mafia would want one working for them," Dr. Robins said.

In this phase of the follow-up study, the first done on sociopaths, an interesting fact was uncovered. "By the time sociopaths reached their forties, some of them were relatively settled down. About a third were holding on to their jobs and their tempers. Sociopathy turns out to be mainly a young man's problem. For some, it is burned out by middle age," Dr. Robins said.

Lee Robins and her associates also collected data on normal black males who had been born and brought up in St. Louis. The researchers also studied the parents and the children of this group. It was the first study to cover school and public records over three generations, and it provided some interesting findings. None of the offspring was delinquent unless at least one parent had been arrested. Contrary to the widely held belief that delinquency is skyrocketing everywhere, the study revealed that there had been no increase in the rate of delinquency from fathers to sons in this inner-city group, not even in the number of narcotics offenses.

In further study of the fathers of these children, it was discovered that among twenty-two young men who had been addicted to heroin, only three of them were found to be still addicted in their early thirties. This clashed with the general belief that heroin addiction is permanent. It was the first time that addicts outside of a treatment center or prison setting had been studied.

Further study of drug abuse among a non-institutional population was provided in 1972 when the United States Special Action Office for Drug Abuse Prevention asked Dr. Robins to do a study to see what the drug treatment needs of returning Vietnam veterans might be.

"The most interesting finding in this study," she said, "is that it looks very much like, once Vietnam was over, the veterans returned to whatever drugs they had been using before. Those who were using drugs before they went to Vietnam resumed taking the same drugs at home, even though they had used heroin in Vietnam. A very low proportion of veterans who used heroin regularly in Vietnam were using it eight to ten months after returning to the states. It will be interesting to see what the same group will be doing three years after returning home, and to compare them with a control group that didn't go to Vietnam—a study we will do next year."

A few years ago, when Dr. Robins was chairman of the Advisory Board of the St. Louis Child Guidance Clinic, the board launched a program in the early treatment of children having difficulties in school. They hoped that intensified tutoring and other special help for first grade children could interrupt the cycle of failure and misbehavior that so often predicts life-long maladjustment.

"We planned to attack all the factors we could that interfere with a child's success," Dr. Robins said. "The city didn't have the money, so I helped to draft a proposal to the federal government for funds. I was very pleased with the proposal, but it was turned down. The problem is that the government won't fund programs unless they have reasonable assurance that the local government will assume the costs for a long-term project. With local funds being so scarce, city councils won't allocate money unless they have proof that what you're doing will work. It's a circular game."
Annual Report
Washington University
1972/1973

Comments By The Chancellor
FOREWORD

Presented here is a condensed report of the operations of Washington University during the fiscal year ending June 30, 1973. It includes both the details of the University's financial operations and a summary of the activities, programs, and accomplishments that its financial resources made possible. The year covered in this report was one of the most significant in the University's 120-year history. It was a year, after the turmoil of the late sixties and early seventies, in which the whole University community could focus its efforts on the institution's threefold purpose of teaching, research, and community service. It was a year highlighted by the unprecedented $60 million challenge grant of the Danforth Foundation—a challenge and an opportunity that all concerned with Washington University are determined to meet.

This past year was saddened by the tragic and untimely death of Howard A. Stamper, vice chairman of the Board of Trustees. In Howard Stamper, Washington University lost one of its wisest and most cherished friends. His influence will live on for many years to come—at Washington University and throughout the world.

Charles Allen Thomas
Chairman
Board of Trustees

CONTENTS

ANNUAL REPORT, 1972-73
Overview
Students and Educational Programs
Faculty and Research
Community Service
Financial Condition of the University
  Total Expenditures and Support
  Current Operations of Separate Fiscal Units
University Assets
University Investments
Statement of Assets, Liabilities, and Fund Balances

COMMENTS BY THE CHANCELLOR
A BACKWARD GLANCE at the year just ended must of necessity abstract and put in summary form the experiences of thousands of separate individuals that make up a lively and vital community. Washington University is a community that exists because of the hopes, the dreams, the imagination, the hard work, and the generosity of many thousands of individuals. It is impossible for any annual report to do justice to more than an infinitesimal fraction of the total.

**Overview**

Several highlights stand out. In 1972-73, Washington University granted 1268 bachelor degrees and 1256 graduate degrees, a total of 2524 degrees, the largest number ever awarded in a single year.

After five years of hard work and inconvenience, the School of Dentistry completed a thorough renovation which has transformed an antiquated building into a modern teaching and patient-care facility with new equipment throughout.

The East Pavilion of Barnes Hospital was dedicated. This twelve-story addition, owned jointly by Barnes Hospital and Washington University, is a testimony to the spirit of cooperative enterprise that pervades the Medical Center. It provides badly needed operating rooms and comfortable new quarters for patients formerly cared for in Maternity and McMillan hospitals and other parts of the Medical Center. These two older hospital buildings are being remodeled to provide modern laboratories and office space for several departments of the School of Medicine.

In March, the Danforth Foundation announced a gift of $60 million to the general endowment of Washington University, provided that a like amount can be raised over a five-year period. These funds will allow for stabilizing the budget and meeting the challenges that lie ahead.

Students and faculty continued to attract national honors. The McDonnell Professor of Physics, Robert M. Walker, was elected to the National Academy of Sciences. In the medical area, Dr. David M. Kipnis, appointed Busch Professor and Chairman of the John Milliken Department of Medicine last December, was selected by the British Diabetic Association to give the twenty-third Banting Memorial Lecture at the University of Sussex, England—the third faculty member from Washington University to be so honored. Again this spring, a Washington University student—an economics major, Michael Cannon—was named a Rhodes Scholar.

Washington University made local news and created some excitement last fall during its successful football season. The team won six out of nine games; three players were mentioned for All American teams.
The variety of individual activities of a vital university cannot be catalogued, only illustrated. One student spent the second semester of his sophomore year doing research as an intern with Senator Jacob Javits of New York. A doctoral candidate received a $5000 Ford Foundation fellowship for her dissertation in the area of ethnic studies. Published last year was a book by Donald Finkel, poet-in-residence, based on his experiences in Antarctica, which he visited as a guest of the National Science Foundation. David Zimmerman, a scholar in the Laboratory of Space Physics, developed definitive dating techniques which enabled him to authenticate for the New York Metropolitan Museum of Art that its prize example of classical Greek bronze sculpture was not a forgery as charged.

Students and Educational Programs

One of the encouraging aspects of the year was the rise in enrollments in the full-time divisions of the University, at a time when many institutions were experiencing decreases. A total of 8156 students was registered. With the inclusion of registrations in the School of Continuing Education, the total reached 11,159. The freshman class in the fall of 1972 numbered 1013; in the fall of 1973 this number is approximately 1060.

Undergraduates represent both a broad geographic mix and a strong local group. In the fall of 1972, one-fourth of the entering class came from metropolitan St. Louis. The remainder represented most of the states. Students from sixty-three foreign countries were enrolled on the Hilltop campus; more than 700 persons from abroad were associated with the University.

The Schools of Dentistry, Medicine, and Law report their largest enrollments ever, as well as dramatic increases in the number of applications. This growth has been made possible primarily by the enlarged facilities each of these schools has acquired in recent years. Applications and enrollments in other divisions of the University have not fluctuated markedly. In spite of substantial cutbacks in external aid for graduate students, enrollments in the Graduate School of Arts and Sciences and in the School of Social Work were maintained. One hundred-sixteen Ph.D. degrees were awarded by the Faculty of Arts and Sciences. By August, 111 of these individuals had positions directly related to their Ph.D. training.

Developments in the offerings and programs of the various schools of the University continued during the year. The School of Business and Public Administration undertook a thorough evaluation of its undergraduate program that resulted in the reinstatement of a full four-year curriculum. For the first time since 1967, a freshman class was admitted directly into the School instead of having to wait until the junior year. Forty-five individuals availed themselves of this opportunity. The reemphasis on an undergraduate program was made in response to growing interest among incoming students. Freshmen at Washington University now have the option of enrolling in the Schools of Arts and Sciences, Architecture, Engineering, Fine Arts, or Business Administration.
The School of Engineering and Applied Science recently announced a cooperative program with selected colleges. This "Three-Two Plan" will enable the student to receive two bachelor degrees at the end of five years. Under this plan, the student will spend three years at a liberal arts college before transferring to the School of Engineering for two years of intensive engineering study. The student will then receive a bachelor's degree from the liberal arts college and an engineering baccalaureate from Washington University. The concept of combining liberal education with professional training in a coordinated joint degree program is particularly timely because of the involvement of engineers in social, political, economic, and environmental matters. Ultimately fifty or sixty liberal arts colleges are expected to participate in this joint venture.

The School of Law is adding a fresh dimension to its curriculum. After considerable discussion and planning, the faculty is instituting a course in clinical law. The program enables second- and third-year students to gain practical experience by working with lawyers in the community and with agencies such as the Legal Aid Society of the City and County of St. Louis and the Public Defender's Office.

An interdisciplinary program, believed to be the first of its kind in the country, was established last fall when the Schools of Architecture and of Social Work undertook a joint effort to develop professionals responsive to specific community needs. The program leads to two master's degrees—one in architecture and the other in social work. It is the outgrowth of a demand for socially oriented architects with alternative solutions to the special building problems of many groups and communities.

In another area, an exciting new doctoral program has been developed by the Department of Chinese and Japanese and the Committee on Comparative Literature. It offers the student an opportunity to incorporate within the broad context of Comparative Literature the study of Chinese and Japanese literature and culture. This combination of studies may be unique in the country.

In dentistry, as in medicine, group practice is becoming increasingly popular as an efficient and economic method of providing dental care. In view of this development, the School of Dentistry has adapted the curriculum to simulate a group practice arrangement for teaching and clinic operation.

Study abroad has become increasingly popular. During the year, the schools of Fine Arts and of Architecture joined the College of Arts and Sciences in offering opportunities for study abroad. Twenty-five juniors in fine arts spent the 1972 fall semester in San Miguel de Allende, Mexico. The program was well received and is available again this fall. In addition, a group of architectural students took part in a 1973 summer Design Studio in San Miguel, which was led by four renowned architects from Switzerland, Mexico, and the United States.

Faculty and Research

The educational programs of the University form the common bond of interest for the clusters of faculty in various schools and departments. At the same time, faculty members pursue a tremendous diversity of individual research and creative activity. In the fall of 1972, the full-time faculty on the Hilltop campus numbered 536. The full-time medical and dental faculty was 482. More than one thousand part-time faculty also assisted in teaching.

The volume of scholarly productivity by the faculty is reflected in a bibliography of publications by the Hilltop faculty recently compiled by the staff of Olin Library. More than a thousand listings of books, articles, and reports appear for the period from July, 1971, to December, 1972. Approximately one hundred faculty members served as editors or on editorial boards of scholarly journals. Creative work of the faculty last year also included a number of published musical compositions and seven special art exhibitions in St. Louis and other parts of the country.

The talents of the faculty are evident in their ability to attract considerable funding from federal and private sources for research and education projects. The grants and contracts awarded to Washington University in 1972-73 totaled $34,516,662 for 560 projects. In recent years, Washington University, despite being one of the smallest of the major research universities, has ranked from twenty-fifth to twenty-seventh in the nation in terms of federal commitments to universities.

The full scope of research and creative endeavor defies adequate summary. The bibliography of faculty publications and the report of sponsored projects prepared by the Office of Research are available for the interested reader. A small sampling is offered here, adding to the examples described in the Annual Report for 1971-72.

An area of study receiving increased attention is the earth sciences. New knowledge from space exploration, both manned and unmanned, is leading to an ever-growing understanding of this planet and its relation to the universe. To strengthen efforts in this field, the Department of Earth Sciences, under the chairmanship of Harold L. Levin, has added four junior faculty members with special expertise in physics and chemistry as applied to terrestrial and lunar material. In much of their work they will collaborate with the Laboratory for Space Physics.

A field of research and teaching that engages many parts of the University has to do with alcohol and drugs. Faculty members at the School of Medicine, the School of Social Work, the Social Science Institute, and in a number of departments of the Graduate School of Arts and Sciences are seeking answers to problems of alcoholism and drug addiction. Three samples illustrate the range of their activities.

Last year, the School of Medicine was awarded $1.2 million by the National Institute of Mental Health to establish a drug abuse research facility. The primary goal of this research is to determine the way in which addictive drugs affect the brain. At the same time, Dr. James A. Halikas of the Department of Psychiatry, was appointed by the N.I.M.H. as its first Career Teacher in Narcotic and Drug Abuse.
A study that has attracted broad national attention was conducted by Washington University under the direction of Lee N. Robins, Professor of Sociology in Psychiatry. Dr. Robins' research, financed by a federal grant, delved into drug use among men who had served in Vietnam. The investigation concluded that drug addiction occurred in a much lower percentage of the veterans than was expected. The men were studied eight to twelve months after their return to this country.

Also creating considerable interest is the National Alcoholism Training Program for Professionals at Washington University, funded by the National Institutes of Health. It is administered by David J. Pittman, Professor of Sociology and Director of the Social Science Institute, and Laura E. Root, Adjunct Assistant Professor of Social Work and Research Associate at the Institute. The only such program in the country, it is devoted to helping professionals who work with alcoholics to improve their skills.

On a wholly different front, several of the faculty are furthering their research by conducting digs or excavations in various parts of the world. One is Patty Jo Watson, Professor of Anthropology, who is concerned with investigating the kind of life prehistoric people led after they ceased their nomadic wanderings and adopted an agrarian culture. For two summers, she has directed research on a series of pueblo sites in New Mexico. She and her colleagues are attempting to determine how various Indian populations in the area lived between 1200 and 1350 A.D.

Another is Assistant Professor Sarantis Symeonoglou, who is perpetuating the University's long tradition of digging in Greece. His account of Mycenaean finds from Thebes has been published in Kademeia I, one of a Series in Mediterranean Archaeology.

Closer to home are digs at Cahokia Mounds in Illinois. Washington University investigators are making a materials study to gain an idea of craft activities and of the tools used by the Indians there about a thousand years ago. The study should provide some idea of how agriculture was conducted and the size of the population that could be supported.

The intellectual life of students and faculty is enhanced by distinguished visitors to the campus—authorities in various fields, leading men-of-letters, prominent lecturers. Among these are the Fannie Hurst Visiting Professors. During the past year there were three: Francis Ferguson, noted critic, author of numerous books and plays, and a senior fellow at Princeton University; J. F. Kermode, Lord Northcliffe Professor of Modern English Literature at University College, London; and Howard Moss, poet and poetry editor of The New Yorker.

Community Service

The University's greatest service, of course, is education. One aspect, which attracts considerable community participation, is continuing education. Evening courses and summer school enable many people to meet specific educational goals or to satisfy the thirst for knowledge that tantalizes so many adults throughout their lives. Last year 6464 individuals were enrolled in evening courses and 2906 in summer school. In addition, some 8100 persons attended 136 conferences and special short courses offered by the Division of Professional and Community Programs.

The Washington University Medical Center is a major health resource of people in the St. Louis area. Last year, the faculty and young physicians under their supervision handled 231,000 patient visits to the clinics and emergency rooms of the Medical Center. Hospitals in the Center supplied 624,000 days of care and free medical services totaling $6.3 million. Dental faculty and students furnished continuing dental care in the clinics for 4750 persons. In all, they treated patients having a total of 45,122 appointments during the year.

These are services of the highest order. Many other specific programs of help to the community could be mentioned. Here are just a few:

The Urban Law Annual, edited by law students with
Professor Daniel R. Mandelker as advisor, has achieved a national and international circulation of 1500 copies annually. Now in its sixth year, it consists of leading articles on law reform.

Technical assistance in rebuilding the Jeff-Vander-Lou community of the inner city has been provided by students and faculty of the School of Social Work. Ralph Garber, while Dean of the School, was given a special Jeff-Vander-Lou Award in appreciation for his services as a consultant in dealing with problems of the ghetto.

The Osage County Dental Clinic in Linn, Missouri, manned by students from the School of Dentistry and Dr. Richard D. Morrison of the faculty, was open every Thursday last spring. Set up in a dental van owned by the Missouri Division of Health, the clinic is designed to give good care to children from low-income families.

A multimedia exhibition called "Art in a Time-Space Dimension" was assembled by students in the School of Fine Arts in collaboration with engineers, computer technicians, electronic specialists, and scientists on the Washington University campus. This traveling show was exhibited in eight communities across the state after its debut in Steinberg Hall. The exhibit was made possible by funds from the National Endowment for the Arts and the Missouri State Council on the Arts.

Washington University's contributions to the cultural life of St. Louis and the surrounding area are notable. For some time now, activities in the performing arts have attracted widespread attention. The Madrigal Singers, well known locally, are a favorite of alumni groups all across the country. The student *commedia dell'arte* troupe, which grew out of one of the theatre style classes, performed by special invitation in Spoleto, Italy, the summer of '72. A composition by Harold Blumenfeld of the Department of Music was presented in Graham Chapel with the Gregg Smith Singers and the Madrigal Singers. It was enthusiastically reviewed by the local press. Dance and dramatic performances have drawn large audiences.

To build on this momentum and to take full advantage of the new performing arts center, two committees have been appointed: a University Committee on Theatre and Theatre Arts, chaired by University Professor of Biology Thomas S. Hall, and a University Committee on the Arts, chaired by Dean Lucian Krukowski of the School of Fine Arts.

In May, the University announced a fifteen-concert chamber music series to be held in the Edison Theatre during the year. The series is sponsored jointly by Washington University and the St. Louis Symphony Orchestra. It represents a significant extension of last year's five-concert string quartet series presented in Steinberg Hall to sell-out audiences. The music critic of the *St. Louis Post Dispatch*, Frank Peters, says "the series is unprecedented among American orchestras and will apparently constitute the fullest chamber-music season in any city outside New York." Beginning this fall, the Mallinckrodt Center and the Edison Theatre will add significantly to the quality of campus and community life.
Financial Condition of the University

Generous financing does not insure a great university, but inadequate finances can make excellence impossible. Fortunately, Washington University's finances in fiscal year 1972-73 served as a strong base for its activities. At the same time rising costs in specific areas of the University presented the challenge for increased support in the future.

The following overall view presents total expenditures and income, the operations of the University's separate fiscal units, the University's assets, and its investments. Total expenditures and income figures over a ten-year period provide perspective on the steady growth of the sums involved.

TOTAL EXPENDITURES AND INCOME

Expenditures

The total operating expenditures of Washington University in fiscal year 1973 amounted to $87,098,000, excluding transfers to noncurrent funds. The costs in 1972 were $81,832,000.

Capital expenditures for buildings were $4,446,000. Investments in all physical facilities, including land, equipment, and library acquisitions, increased $3,355,000.

Included in operating expenditures is student aid, amounting to $7,720,000, from University income and from governmental and private sources. Loan aid represents funds of another sort. Student loans issued during fiscal year 1973 totaled $1,824,000.

Income

The University has four major sources of support for the activities represented by its expenditures. These are:

Operating Revenue

Total income from payments made by those who benefited directly from the University's operation amounted to $43,935,000. Student tuition and fees accounted for $19,918,000. Patient and laboratory fees for medical services provided by faculty and staff amounted to $7,584,000. Income from organized activities in the medical center, such as the Edward Mallinckrodt Institute of Radiology, was $7,888,000. The auxiliary enterprises, including residence halls, food service, and bookstores, had income of $4,978,000. Other miscellaneous operating revenues totaled $3,567,000.

Governmental Grants and Contracts

Much of the research done by the University is supported by grants and contracts from governmental agencies, mostly Federal, for specific sponsored projects. Total income from governmental sources in fiscal 1973 was $32,985,000, an increase of $3,400,000 over the previous year. Included in the total is $3,190,000 for scholarships and traineeships. The Federal Government in addition provided $1,522,000 of the loan funds issued in fiscal year 1973.

Private Gifts and Grants

Support from private, non-governmental sources applied to operating expenditures in fiscal year 1973 totaled $8,681,000. Grants for sponsored projects accounted for $4,061,000 of that amount. Private, unrestricted support available for general operations was $4,620,000. This latter figure includes $3,000,000 from the Danforth Foundation. The ten-year chart reflects a large Ford Foundation grant for the years 1966-70.

The total gifts and grants received in fiscal year 1973 amounted to $15,909,000. A separate chart presents a breakdown of the total by source and purpose. Major purposes besides general operations and sponsored projects are plant and endowment. Major sources are alumni, individuals, business corporations, and foundations.

Income from Endowment

The investment of endowed funds resulted in income of $6,363,000 used to support operating expenditures.
OPERATIONS OF SEPARATE FISCAL UNITS

Washington University has long pursued the policy of making its professional schools independent fiscal units wherever possible. Each independent fiscal unit is responsible for supporting with its own income the expenditures related to its operation; each maintains its own reserve of funds that carries forward from year to year.

The schools of Medicine, Law, Dentistry, and Social Work are independent units. The School of Engineering is in the process of joining them, operating for the first time in fiscal 1973 on a modified reserve basis. It receives a subsidy from the central fiscal unit, the amount of which will decrease annually until the School of Engineering is a completely independent unit. Because of the subsidy, the present summary includes Engineering in the operations of the central fiscal unit. The Schools of Architecture, Arts and Sciences, Business Administration, Engineering, Fine Arts, and Continuing Education, plus general University activities and services, such as Olin Library, constitute the rest of the central fiscal unit. The most meaningful report of Washington University financial affairs can be given by presenting separately the summary of expenditures and income for the current operating funds of each unit. The summaries are somewhat similar to the profit and loss statements used in business accounting. The central unit is reimbursed for services rendered to the independent units.

Each of the independent fiscal units ended the year with income in excess of operating expenditures and transfers to non-current funds. The expenses of the central fiscal unit were in excess of its income by $1,036,000. As explained in the next section, the surpluses of the independent units were not applied to the central unit.

SUMMARY OF CURRENT FUNDS
EXPENDITURES AND REVENUES FOR SEPARATE FISCAL UNITS OF THE UNIVERSITY, FISCAL YEAR 1973

<table>
<thead>
<tr>
<th>Thousands of Dollars</th>
<th>Central Fiscal Unit</th>
<th>School of Medicine and Related Activities</th>
<th>School of Dentistry</th>
<th>School of Law</th>
<th>School of Social Work</th>
<th>Other Independent Organized Activities</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditures:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruction and research</td>
<td>$13,758</td>
<td>$10,388</td>
<td>$ 991</td>
<td>$ 819</td>
<td>$ 552</td>
<td></td>
<td>$26,508</td>
</tr>
<tr>
<td>Sponsored research and programs</td>
<td>6,618</td>
<td>21,795</td>
<td>898</td>
<td>13</td>
<td>429</td>
<td></td>
<td>$29,753</td>
</tr>
<tr>
<td>Libraries and museums</td>
<td>2,077</td>
<td>553</td>
<td>29</td>
<td>145</td>
<td>86</td>
<td></td>
<td>$ 2,890</td>
</tr>
<tr>
<td>Student aid</td>
<td>3,880</td>
<td>243</td>
<td>55</td>
<td>209</td>
<td>71</td>
<td></td>
<td>$ 4,458</td>
</tr>
<tr>
<td>Operation and maintenance of physical plant</td>
<td>2,930</td>
<td>2,120</td>
<td>153</td>
<td>162</td>
<td>133</td>
<td></td>
<td>$ 5,406</td>
</tr>
<tr>
<td>Organized activities</td>
<td></td>
<td>5,088</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 7,151</td>
</tr>
<tr>
<td>Auxiliary enterprises</td>
<td>4,664</td>
<td>492</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 5,156</td>
</tr>
<tr>
<td>General administration and student services</td>
<td>4,200</td>
<td>1,264</td>
<td>64</td>
<td>132</td>
<td>100</td>
<td></td>
<td>$ 5,776</td>
</tr>
<tr>
<td>Total expenditures</td>
<td>38,127</td>
<td>42,663</td>
<td>2,190</td>
<td>1,480</td>
<td>1,371</td>
<td>1,267</td>
<td>$87,098</td>
</tr>
<tr>
<td>Transfers to plant and other funds</td>
<td>210</td>
<td>2,997</td>
<td>33</td>
<td>64</td>
<td>3</td>
<td>75</td>
<td>$ 3,382</td>
</tr>
<tr>
<td>Total expenditures and transfers</td>
<td>38,337</td>
<td>45,660</td>
<td>2,223</td>
<td>1,544</td>
<td>1,374</td>
<td>1,342</td>
<td>$90,480</td>
</tr>
<tr>
<td>Revenues:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuition and fees</td>
<td>15,817</td>
<td>1,613</td>
<td>648</td>
<td>1,239</td>
<td>601</td>
<td></td>
<td>$19,918</td>
</tr>
<tr>
<td>Grants and contracts, including all overhead</td>
<td>9,206</td>
<td>26,414</td>
<td>947</td>
<td>21</td>
<td>458</td>
<td></td>
<td>$37,046</td>
</tr>
<tr>
<td>Patient and laboratory fees</td>
<td>7,059</td>
<td>525</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 7,584</td>
</tr>
<tr>
<td>Organized activities</td>
<td>6,466</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 7,888</td>
</tr>
<tr>
<td>Auxiliary enterprises</td>
<td>4,372</td>
<td>606</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$ 4,978</td>
</tr>
<tr>
<td>Other income</td>
<td>1,762</td>
<td>1,780</td>
<td>16</td>
<td>5</td>
<td>4</td>
<td></td>
<td>$ 3,567</td>
</tr>
<tr>
<td>Endowment income*</td>
<td>2,621</td>
<td>3,060</td>
<td>14</td>
<td>358</td>
<td>310</td>
<td></td>
<td>$ 6,363</td>
</tr>
<tr>
<td>Gifts applied to current operations</td>
<td>3,523</td>
<td>991</td>
<td>75</td>
<td>27</td>
<td>4</td>
<td></td>
<td>$ 4,620</td>
</tr>
<tr>
<td>Total revenues</td>
<td>37,301</td>
<td>47,989</td>
<td>2,225</td>
<td>1,650</td>
<td>1,377</td>
<td>1,422</td>
<td>$91,964</td>
</tr>
<tr>
<td>Revenues less expenditures and transfers</td>
<td>$(1,036)</td>
<td>$ 2,329</td>
<td>$ 2</td>
<td>$ 106</td>
<td>$ 3</td>
<td>$ 80</td>
<td>$ 1,484</td>
</tr>
</tbody>
</table>

(a) Endowment at market value with income for:

| Support of current operations | $55,999          | $81,101                                  | $ 215              | $6,763       | $5,248             |                                     | $149,326 |
| Other purposes              | 6,633            | 5,517                                   | 33                 | 23           |                      |                                     | $12,206 |
| Total endowment             | $62,632          | $86,618                                  | $ 248              | $6,786       | $5,248             |                                     | $161,532 |

(b) Other independent organized activities are Computer Systems Laboratory and the Euclid Power Plant
UNIVERSITY ASSETS

The financial resources of not-for-profit institutions such as universities are kept in the form of funds, a specific fund being established when money is given or designated for a special purpose. The thousands of funds for which the University is accountable are handled in four major groupings: current funds, student loan funds, endowment funds, and plant funds. Except for income from endowment, the resources in the three special-purpose groupings are legally not available to offset ongoing operating expenditures of current funds. The summary of assets, liabilities, and fund balances presents the assets and any claims against them for the four fund groupings as of June 30, 1973.

The endowment funds had a book value of $136,510,000, up $7,085,000 from the year before. The market value was $161,489,000. The amount of the market value associated with each of the separate fiscal units is presented along with the summary of expenditures and income for each unit.

The plant funds totaled $147,558,000. Of that amount, $133,887,000 was invested in land, building, and equipment. Total borrowing for physical plant facilities was $17,244,000—$11,533,000 of which represents Housing and Urban Development bonds for student housing and dining facilities.

Student loan funds totaled $9,913,000. Notes receivable from current and former students amounted to $8,767,000. The Federal Government provided $7,319,000 of that amount.

A distinction in current funds is made between general and restricted funds. The general, or unrestricted, current funds consist of revenues from the various income-producing operations of the University, plus unrestricted gifts and unrestricted earnings from endowment. Expenditure of these general funds is left to the discretion of the University. A large number of other funds available for current operations restrict expenditures to special, designated purposes during the year, such as research supported by grants and contracts. General and restricted funds are combined in the overview of current operations of the separate fiscal units presented above. They are kept distinct in a reporting of assets.

Total assets of the current funds as of June 30, 1973, were $26,247,000. The restricted current funds portion was $11,094,000. The general current funds had total assets of $15,153,000. Accounts payable and other such liabilities against these funds amounted to $3,459,000. Another $2,546,000 of the general current funds assets was encumbered or otherwise administratively committed for specific future purposes. Gifts to the University which are awaiting designation of purpose amounted to $4,557,000. The reserves that are uncommitted totalled $8,932,000. To be deducted from that amount is the deficit of $4,341,000, accumulated over several years of insufficient income to cover the expenditures of the central fiscal unit.

The uncommitted reserves are those built up over the years by the independent fiscal units. By long-established policy of the Board of Trustees, these reserves are held available for use in future operations of the fiscal units by which they were generated. Their presence removed the necessity for the central fiscal unit to go to lending agencies outside the University to obtain the additional funds necessary to meet its expenditures. The central fiscal unit has an obligation to return to the independent units the amount drawn from their reserves.

### SUMMARY OF ASSETS, LIABILITIES, AND FUND BALANCES AS OF JUNE 30, 1973

<table>
<thead>
<tr>
<th></th>
<th>Current Funds</th>
<th>Student Loan Funds</th>
<th>Endowment Funds</th>
<th>Plant Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Restricted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assets:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash and securities maturing within thirty days</td>
<td>$4,937</td>
<td>$3,615</td>
<td>$1,058</td>
<td>$4,924</td>
</tr>
<tr>
<td>Investments</td>
<td>6,673</td>
<td>6,147</td>
<td>118</td>
<td>131,628</td>
</tr>
<tr>
<td>Receivables</td>
<td>2,266</td>
<td>1,328</td>
<td>8,767</td>
<td></td>
</tr>
<tr>
<td>Plant</td>
<td>1,277</td>
<td>4</td>
<td>14</td>
<td>310</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total assets</td>
<td>$15,153</td>
<td>$11,094</td>
<td>$9,957</td>
<td>$136,862</td>
</tr>
<tr>
<td>Liabilities and Fund Balances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liabilities</td>
<td>$3,459</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficit</td>
<td>(4,341)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encumbered and committed reserves</td>
<td>2,546</td>
<td>987</td>
<td>17,244</td>
<td></td>
</tr>
<tr>
<td>Uncommitted reserves of independent units</td>
<td>8,932</td>
<td>135,875</td>
<td>130,314</td>
<td></td>
</tr>
<tr>
<td>Gifts awaiting designation</td>
<td>4,557</td>
<td>3,823</td>
<td>9,913</td>
<td></td>
</tr>
<tr>
<td>Balance of funds</td>
<td>7,271</td>
<td>9,913</td>
<td>135,875</td>
<td>130,314</td>
</tr>
<tr>
<td>Total liabilities and fund balances</td>
<td>$15,153</td>
<td>$11,094</td>
<td>$9,957</td>
<td>$136,862</td>
</tr>
</tbody>
</table>
UNIVERSITY INVESTMENTS

The total investments of the University include funds available in the three fund groups besides endowment. Income from all investments totaled approximately $8,361,000, an increase of $473,000 over the year before. The short-term interest rates during the latter part of the fiscal year contributed to the increase in income for those funds normally invested in short-term paper.

The market value of all investments was approximately $199,904,000 on June 30, 1973, compared to $195,794,000 a year before. The endowment investments had a market value of $161,489,000. The endowment investments held by the University are presented in the accompanying chart.

The Capital Pool, consisting of funds functioning as endowment invested in common stocks with an objective of maximum appreciation, declined in market value approximately $1,971,000, net of additions, and totaled $39,907,000. The market value of regular endowment declined approximately $3,821,000, net of additions, and was approximately $121,581,000 on June 30.

Endowment Fund Investments Held by the University
(Includes Capital Fund Beginning July 1, 1968)
The preceding pages have presented facts and observations describing the year just ended. This information is important. Yet values and judgments less easily reported determine the character of a university. Washington University is a community of scholars and learners, of individuals engaged in the often lonely task of adding to knowledge and deepening understanding. Yet Washington University is also an institution, a corporate entity, that must adapt and change to live successfully in a world in flux. This year's comments will focus on a few examples of these necessary adaptations, not because they reflect the essence of a university, but because they are timely and of interest to our many supporters.

Academic Activities

The central purpose of Washington University, of course, does not change from year to year. The institution exists to foster the discovery and teaching of knowledge necessary to a society continually shaping its future. It strives to be a productive environment for reflection and creativity in the sciences, the humanities, and the arts. The success of the University with these objectives depends not primarily on administrative arrangements but on the vitality of the total University community. When the academic community is strong, the focus and mode of expression of the central teaching and learning functions are being continually developed and updated. Since knowledge and understanding are in a flux, new needs and opportunities arise constantly. Faculty and students must be ready and willing to respond in imaginative and creative ways. To me the excitement of Washington University is seeing this process at work.

Medium size is an advantage. Washington University is large enough to have a full spectrum of disciplines represented in sufficient strength to stimulate creative exchange within departments, yet it is not so large that distance and the weight of numbers in each individual discipline lead to isolation. When fresh insights frequently bring together previously compartmentalized areas of knowledge, the faculty can respond with informal exchange, out of which grows cross-disciplinary research and teaching. Academic programs can retain the kind of flexibility that permits students to pursue interests falling outside of conventional categories.

Recent developments in the life sciences at Washington University may serve as an example. The fields of knowledge related to biology and medicine are in a period of explosive growth. These sciences are contributing not only to remarkable improvements in human health and well-being but also to new understanding of our environment and, indeed, of the very nature of man himself. Boundaries between specialties in the life sciences are becoming blurred as new concepts emerge. What not long ago was knowledge for advanced graduate students has become basic education for undergraduates or even for high school students. The need for realignment of faculty relationships and of study programs has become increasingly evident.

The University has now taken a major step in response by the formation of a new Division of Biology and Biomedical Sciences, bringing into one grouping a number of related branches of knowledge which have been the responsibilities of different faculties. These are the Department of Biology on the Hilltop campus, which has been responsible for all undergraduate teaching, and the Medical School departments of Anatomy, Biological Chemistry, Microbiology, Pharmacology, and Physiology, which have been responsible for the education of medical students. In addition, the yet-to-be formed McDonnell Department of Genetics will be a part of the Division. The Division will coordinate the recruitment of personnel. It will assume major responsibility for the recruitment and education of graduate students and for curricular planning for undergraduate and medical students. The medical faculty will be accessible to undergraduates, and the faculty of the Department of Biology will be available to medical students. New opportunities for cooperative research will be opened. The new Division, to be headed by Dr. P. Roy Vagelos, will permit appropriate responses to the opportunities and challenges of the 1970's.

University Accountability

In recent years, the costs of higher education have escalated. Simultaneously, there has been growing national concern about what benefits accrue to society in return for
Educators are being asked difficult questions not only about the various purposes for which resources are used but also about the expected and actual results. The questions are reasonable and proper. The call for increased accountability and the more detailed reporting which it necessitates are being given sympathetic, thoughtful, and careful response by Washington University. Some of the administrative staff have worked closely with organizations such as the National Center for Higher Education Management Systems. The system of accountability that will inevitably emerge must be realistic and flexible with room for the private colleges and universities to remain healthy, lively, and primarily responsible to their own boards. The dilemma is that the available tools of cost accounting cannot adequately quantify the life of the mind and of intellectual and personal growth. It is a challenge to all of us to find a reasonable solution.

Underlying the concern about accountability is the need to make sure that institutions of higher education are using their resources as wisely and effectively as possible. A promising internal management approach involves increasing accountability and effectiveness through decentralization of administration. This past year, two schools of the University marked important stages in the process of gaining financial stability. In March, the School of Dentistry celebrated the completion of a massive renovation of its physical plant and thus climaxed a thorough rejuvenation. Five years ago the school was running a large deficit. Its physical plant was dilapidated. Closure was seriously considered. At that time the dean and the faculty were given the responsibility for improving the school while at the same time achieving a balanced budget. This responsibility was backed up with the authority to make budgetary allocations and to retain control over any excess of annual income over expenditures as a reserve for unspecified future uses. In other words, Dentistry joined the schools of Law, Medicine, and Social Work as a "reserve school." The dean and faculty responded to the challenge of finding new income and tightening expenditures. Their success is now history. The school has strengthened its academic program, achieved financial stability, and rebuilt its facilities. The future appears bright.

This past year the School of Engineering began the process of putting its financial affairs on a similar basis. It will receive a decreasing subsidy in the coming years as it moves to balance income and expenditures. It will retain control of any operating surplus. Hence, it presently has a modified reserve status. Under this arrangement, the dean and the faculty have every incentive to balance the budget because any savings are realized by the school and not by the more remote University administration. Those closest to the day-to-day operation are often in the best position to decide how to put together funding and where to cut costs in order to achieve optimum effectiveness.

The path to better management need not be found only in more centralized control but also may lie in greater participation by all decision-makers. Better fixing of responsibility and rewards is an imperative for improving accountability throughout the University.

A management improvement effort of another sort is also taking place within the University. This past year, Washington University began a work-improvement process that promises significant strides in increasing the productivity of a wide range of administrative activities. The program, called Operations Improvement, was launched with the assistance of a consultant who has successfully operated similar programs in many large businesses. Administrative staff at all levels are involved in small groups that meet a number of times to discuss work methods and management behavior. Improvement is a challenge for all, and each participant is encouraged to develop one or more action plans aimed at yielding greater productivity.

Cost reduction is not the sole objective. The program involves a great many people and keeps the impetus for change close to those who are responsible for each area of activity. Such added responsibility becomes for many a form of job enrichment. Self-generated change can and does help staff members derive greater meaning and satisfaction from their work.

Accessibility to Students

The rising tuition rates at private universities are well known. Better control of costs has not and, under present economic circumstances, cannot fully offset the effects of inflation. I consider the annual decision about what rate to charge students one of the most difficult. Washington University has to remain accessible to able students from a wide variety of backgrounds; diversity in the student body is an important influence in the educational process. Rising tuition threatens the economic viability of this education for a number of families. Yet the financial pressures to increase tuition are inescapable. I have regretted following up previous announcements of higher tuition with the announcement of still another increase next year.

Clearly, a carefully administered program of financial aids for students has to be of great concern to the University. Scholarships are basic to such a program. Last year 37 per cent of the undergraduate student body was receiving scholarship aid that averaged about $1650 for each recipient. Some of the necessary funds come from contributions and endowment income, but most represent an offset against tuition income.

The limited amount of scholarship funds available to the University is inevitably leading to greater reliance on funds that replenish themselves in the form of repayable loans. Now, almost all scholarships are supplemented with the offer of a loan. Last year 38 per cent of the undergraduates borrowed an average of $800. The loan program has been heavily dependent on funds from the Na-
tional Defense Education Act, a federal program the future of which is unclear.

This past year, Washington University took action to become an authorized lender under the new Federally Insured Student Loan Program. In the past students have been able to obtain a federal guarantee for their personal efforts in negotiating a loan with a community bank. The University will now be able to offer greater guidance and help with this form of aid. Last year Washington University students, primarily graduate students, negotiated with banks for $959,000 of federally insured loans.

The tradition of working while studying is a long and honorable one. Washington University is able to offer a great many students the opportunity to aid themselves in this manner. Approximately one thousand undergraduates work in part-time jobs providing a variety of necessary services.
Comments by the Chancellor

The vitality of the University does depend greatly on keeping it accessible to students with academic ability. Creative and wise administration of the financial aids resources that are now available can maintain such accessibility to a great extent. Expansion of those resources, however, has to be among the highest priority needs of Washington University.

One bright spot should be noted. The academic year 1973-74 will be the first year of operation of the landmark State of Missouri undergraduate student grant program, for which the University and other members of the Independent Colleges and Universities of Missouri worked over several years. This program will provide awards to needy Missouri students attending Missouri colleges and universities. It will add to the existing financial aid resources—University funds, federal grant and loan funds, work-study funds—from which packages of student assistance are put together.

It is too early to assess how this program will operate with respect to individual institutions. Compared to the state scholarship activity in some other states, it is modestly funded ($3,500,000); the maximum grant available for a student at a private institution is $900. Experience elsewhere has demonstrated that states can play a materially useful role in the student assistance field. In so doing, the range of college choice for the student in need is widened. In addition, there is lessening of pressure on public institutions by a fuller utilization of spaces available in private institutions of higher education. A successful program should be of benefit to the students, to the private institutions, and to the taxpayers of the state.

The federal Education Amendments of 1972 revised the federal approach to undergraduate student assistance by the creation of a new form of student entitlement, based on need, called Basic Educational Opportunity Grants. Partial funding of this program for the 1973-74 academic year will give some opportunity to study its effect on the student financial aid picture at different kinds of institutions. This initial experience may suggest important revisions in the total federal student aid approach.

Challenge to University Supporters

In March the Danforth Foundation made a well-publicized challenge grant to Washington University of $60 million. The full amount will come to the University if a matching $60 million can be raised before June 30, 1978. The total grant from the Danforth Foundation will go to increase the general endowment.

The background of this grant is of some importance. Starting in 1965, the "central budget" schools of the Hilltop campus (Architecture, Arts and Sciences, Business, Engineering, and Fine Arts) have lived in a precarious state. A major part of the income for the operating budget came from foundation grants awarded for five-year periods, first from the Ford Foundation and then from the Danforth Foundation. Withdrawal of such funds would have meant serious collapse of the basic academic programs. The new endowment grant, if earned, will replace the short-term funds and provide a base for the University's future. The matching challenge was made in the expectation that the many supporters of Washington University would respond and would provide the financial needs for building on that base.

After accepting the grant, the Board of Trustees of Washington University responded enthusiastically and energetically to the challenge of raising the necessary funds. Board Chairman Charles A. Thomas appointed a Strategy Committee to plan the overall approach. As a first action, that Committee established a Major Gifts Committee. David R. Calhoun graciously accepted the chairmanship of that group for the first year. Solicitation has started.

The time since the March announcement of the grant has also been used to identify the priority needs in the next five years. The goal for current operations, both for general operating expenses and for special projects, totals $20 million. Contributions to endowment for the support of professorships, research, scholarships, and libraries are the largest category of need with a goal of $25 million. Construction of several new facilities and renovation of present buildings will require capital funding of $15 million.

As I explained at the time the grant was announced, the Danforth Foundation's contribution to Washington University in itself does not permit the University to do anything new or different. It gives the University staying power by undergirding gains of the past with permanent instead of temporary funding. Additional generous support will be needed if the University is to continue as a dynamic and responsive center of teaching and learning.

Washington University was founded five generations ago by a group of St. Louis citizens committed to providing for the education of rising generations. The support of many alumni and friends acting out of their own private convictions has been a vital force in enabling the University to develop over the years into a regionally and nationally important center of learning and advancement of knowledge.

One of the joys of working with Washington University is the sense that the enterprise is of value. The value arises not only from students taught, services rendered, new knowledge added to the sum of human experience. There is something additional. Central to our great nation are the many separately controlled, independent institutions and enterprises that make up the whole. Time and again Americans have turned away from centralized and governmental control. The private colleges and universities with their separate traditions and responsibilities are an important part of this great mix. Part of our responsibility is to hand on to the next generation a society as active, as lively, and as free as that given to us. The preservation of strong, private institutions is a contribution to that end.

William H. Danforth
Chancellor
October, 1973
TWO-MAN SHOW

Stories of artists who have been neglected in their own time and then acclaimed posthumously are legion. Such a fate is not that of Washington University School of Fine Arts faculty members Howard Jones and Arthur Osver. Collectively, they have participated in 150 exhibitions, the latest of which, the first "Mid-America Invitational," was jointly sponsored by The St. Louis Art Museum and The Nelson Gallery-Atkins Museum in Kansas City.

This prestigious show was developed, as St. Louis Post-Dispatch critic, George McCue, succinctly put it, to serve as "a staging for artists of whom it can be said that their exhibitions can do as much for the museum as the museum can do for them." It opened in late June in St. Louis, ran through most of July, and then moved in August to Kansas City, where it closed on September 16.

Bringing Jones and Osver together in a special show was a felicitous decision. It focused attention on two creative spirits who have been widely acclaimed, each for his own style. Jones, a multi-media exponent, is best known for his light and sound projects, while Osver is a painter whose canvases, for the past three years, have depicted highly personal interpretations of the Grand Palais in Paris. Artists of their time, both have been profoundly influenced by technology, but neither has lost touch with nature. The results in Jones's case are unusual works of art "actively involved with time, change, and interval." Osver, on the other hand, has worked most recently with latex and acrylics to produce paintings "of elegance and refinement with a certain degree of rationality."
TWO-MAN SHOW

Artist Howard Jones with "Waterfall," a sound piece based on tape edited and filtered from original tapes of waterfalls. The effect was meant to be brook-like rather than fiercely roaring as at Niagara.
"Linear Relay" is a forty-two-foot-long aluminum case containing exposed speakers divided into eight-foot modular sections which can extend around corners and along walls, ceiling, or floor.

A rapt listener presses her ear against "Air 44," a twenty-four-foot-long wall piece. An individual passing by the seventeen exposed speakers hears different parts of the spectrum of "white sound."

"Retinal Bypass," also called "Thinking Color" by its creator, consists of a white room, two amplifiers, and two tape replay decks. A recorded voice proclaims the names of colors which the participant conjures up from memory or association.
Osver's "GP: 11-72." He says that the paintings in this group are all "based primarily on a light-dark relationship."

Arthur Osver codes his Grand Palais paintings. This one is "GP: 4-71," which means that it was painted in the fourth month of 1971.
Osver estimates that he has done at least sixty Grand Palais paintings in the last three years, most of which are quite large.

The Grand Palais paintings are based on a number of photographs of this building which Osver took in 1967. He says that he used a great deal of brown, olive drab, and gray because he conceives of them as “industrial colors.” “GP: 5-71.”

“GP: 8-72” shows convolutions which the organizer of the Jones-Osver show, Emily Rauh Pulitzer, former curator of The St. Louis Art Museum, observed “were related to their architectural origin.”
Washington University scientist George Brooks Johnson, Jr., is a butterfly collector, but not for the usual reasons. He nets species of the genus Colias to pursue fundamental research which may ultimately upset established genetic theory. Dr. Johnson captures his quarry as it flies high in the Rockies in an area which he is battling to preserve from all those, including strip-miners, who would sully it.
The order Lepidoptera is estimated to include at least 120,000 species of butterflies and moths, many of them beautifully iridescent. For collectors like the celebrated novelist Vladimir Nabokov, the curiously exotic representatives within this group have a special fascination, but it is an ordinary family of butterflies, the Pieridae, which is of particular concern to Washington University scientist George Brooks Johnson, Jr.

The members of this clan which interest him most are species of the genus Colias, famous throughout the world as the ubiquitous "sulphur" butterflies because of their yellow or orange-colored wings. Over a period of the last four and one-half years, Dr. Johnson, an assistant professor of biology, has been concerned with fundamental research on Colias which has caused him to become involved not only in a scientific controversy which could ultimately upset established genetic theory, but in a determined battle to save a part of the Colorado Rockies.

Measuring five-feet-eleven in his mountain boots and weighing in at 145 pounds, Professor Johnson does not look every inch the fighter, but rather, with his titian beard and butterfly net, like an undernourished Viking on a rather weird safari. At 31 and only one year out of graduate school, Dr. Johnson, if he were a more cautious man, might have preferred the serenity of his laboratory to the hulabaloo of conflict, but he is, by his own admission, a maverick. For three of his eight years as a graduate student, he studied molecular biology in the world-famous laboratory of Charles Yanofsky at Stanford, and then, abruptly, he threw up what less audacious young men might have considered the pinnacle of opportunities, and began to study the natural history of Colias with Dr. Ward Watt at Stanford.

After three years of study with Dr. Watt, Johnson emerged from Stanford with a Ph.D. degree and expertise in the area of population biology, a field encompassing ecology, evolution, and systematics which has flowered in the last ten years. Dr. Johnson, however, because of his rigorous training in molecular biology, is a very special kind of population biologist. Traditionally, as Caryl P. Haskins pointed out in a recent New York Times book review, "The gulf between those oriented especially to molecular biology and those primarily concerned with questions of evolution, of population genetics, and even of evolutionary taxonomy, was dangerously deep, and general understanding of the phenomena suffered severely."

Now a synthesis is taking place, and George B. Johnson is
representative of the new hybrid breed which is coming on fast. He also happens to have a thorough grounding in mathematics, as Dr. Peter H. Raven, another of his mentors at Stanford and now director of the Missouri Botanical Garden, took pains to stress recently. "I'm not saying he could be an innovator in math," Professor Raven now on the Washington University faculty said, "but he knows enough to be able to talk to the people who are."

Dr. Johnson is, in short, a man who does not, either by training or temperament, fit easily into any particular pigeonhole. When filing a proposal for a $40,000 grant which he received recently from the National Science Foundation, he dutifully characterized himself as a population biologist, but he tends to think of himself as an "evolutionary" biologist. Dr. Johnson was hired last year to teach genetics at the University, but he prefers to offer a course in tandem with Dr. Raven on evolutionary biology. And sometimes when pressed, he confesses that he thinks of himself simply as an experimental scientist—period. "It wouldn't matter whether I was doing physics or biology—I'd be reasonably happy. It's just that biology is a bit more fun."

Fun, defined in the Johnsonian sense, is doing something you like to do. Work, then, is fun—Dr. Johnson leaves no doubt about that. If it ceases to be, he walks out as he did in the Yanofsky lab when he decided that he wanted to live outdoors a part of the time. When asked to explain why he is so absorbed in his current research, Professor Johnson answered with characteristic candor, "Because I enjoy it!" Quite obviously, he enjoys a lot of other things, including baiting earnest questioners, playing poker, which he describes as "the real world in a crazy sort of way," interacting with people, reading science fiction, talking about C. P. Snow (his favorite novelist), and listening to Vivaldi ("because I was conditioned by a roommate who was a music nut").

That he has time for any of these enthusiasms is a source of wonder, for he is an indefatigable worker who gets up at four a.m. to prepare his lectures, and not infrequently labors for twenty-five hours at a stretch in his lab. "Intense" is the way his colleagues invariably describe him, and he is intense about those issues which matter most to him. These days he is most concerned about disproving what he calls "a really gorgeous theory in genetics" and preserving "what has got to be," according to Dr. Johnson, "one of the most beautiful parcels of land in all of Colorado."

At first glance the two would seem to be disparate problems, but they are inextricably intertwined. The core of the scientific dispute revolves around the basic question of whether or not there is substantial genetic variability in natural populations expressed at the molecular level. A powerful group of geneticists, traditionally trained, maintain that "there is very little variability at this level in natural populations that makes any difference." Dr. Johnson and a growing number of investigators, trained in molecular biology, argue that there is a substantial amount of genetic variability at the molecular level which does have important significance.

To the layman, this controversy, at first glance, might seem inconsequential, but at stake are basic assumptions about evolution first proclaimed by Charles Darwin in 1859. Dr. Johnson holds, as Darwin did, "that evolution is selection upon variability," maintaining that "if there is no selection going on in natural populations then there can be no evolution." Those who oppose this view would not deny that there is some selection going on, but they contend that what they call random events account for most evolution at the molecular level. Because they place so much emphasis on mere chance, the latter group is characterized by Dr. Johnson as "non-Darwinian."

In an attempt to resolve this controversy, Dr. Johnson is working with populations of Colias butterflies which live on the western slopes of the Rockies about twenty-five miles from the boom town of Crested Butte, Colorado. His base of operations is one square mile (640 acres) in the region known as the Copper Creek Basin. Originally, Dr. Johnson had hoped to buy this land in order to control access up the valley and protect his research area, but after two years of costly negotiation, the Colorado School Board, which had title to it decided not to sell. In the fall of 1972, however, it agreed to lease the land for two twenty-year periods to the Copper Creek Wilderness Conservancy, which Dr. Johnson formed while this transaction was in progress. Dr. Raven and the famed ecologist Paul Ehrlich are members of the board of directors.

The Conservancy, a corporation, doesn't get much for the $320 yearly rent which Dr. Johnson pays out of his own pocket under terms of this agreement. "You get the legal right to be there and protest when the state does something stupid with the land, but that's about all. The state reserves the mineral, water, and grazing rights as well as the right of access, which means that not only can I not keep people off, except informally, but that the state can keep people on my land if that suits its purpose."

Dr. Johnson sees his land and the national forest which abuts it threatened not only by the bulldozer which is ravaging the good earth with sickening speed as ski fever, with its
resultant condominium craze, sweeps across Colorado, but also by a mining company. Not long after Dr. Johnson arrived on the scene several years ago, this firm began surveying Copper Creek in an attempt to find molybdenum, an alloy used to make structural steel for items such as jet airplanes. Should high grade ore be found there, Dr. Johnson conceded that the company will find a way to bring it out. Meanwhile, however, he is doing everything he can to slow the miners down, including spending over three thousand dollars of his own money so far to save this square mile of land.

As this article goes to press, Dr. Johnson is waiting for a decree to be handed down which would grant his corporation and the Rocky Mountain Biological Laboratory nearby rights to control the environmental quality of this region. Once they secure these rights, Dr. Johnson believes that the company would have a much more difficult time strip-mining for molybdenum because a great deal of pollution usually results from such an operation. Meanwhile, he is filing a petition with the National Forest Service which would make the entire Copper Creek drainage area (some 10,000 acres, including his leased square mile of land) a natural area. If the government could be persuaded to take this action, then mining, grazing, and timbering would be forbidden, and the land would retain its wild, rugged beauty.

His consuming ambition is to persuade the National Forest Service to accept the principle that non-use of wilderness acreage is absolutely vital if a portion of this country's heritage is to be preserved. "You've got to do that with some land or you won't have any left," he observed. "The odds of my success here aren't good, but the possible reward is great. To save a natural area and be able to carry on research there undisturbed, even though everything else is allowed to go to pot, is reason enough for fighting. I don't mind being stubborn against long odds. I just don't like sitting on my tail."

Dr. Johnson seldom does. A restless, impatient man, his manner is abrupt and his pace is hurried, whether he is dashing down the quiet halls of Monsanto Laboratory on campus during the academic year or bounding up and down the Rockies at his summer camp in Colorado. He gives the impression of being absorbed in thought, and he is. The perplexities of his crucial struggle to save his Colorado land disturb him, of course, but for the most part he has disciplined himself to leave the day-to-day resolution of this problem to his clever, young, Colorado lawyer, Lynn French.
What accounts for his distracted air and engrosses him completely is the question of why are there so many forms of particular enzymes in a natural population. Enzymes are the protein products of genes. In a cell, they serve as catalysts to regulate the vital chemical reactions.

Up until about ten years ago no one knew enough to zero in on this question because biochemical techniques for surveying enzyme variation in natural populations had not yet been perfected. Before that time, theoreticians had predicted that variation in a typical gene should not be more than about a tenth of one percent, and that you wouldn’t expect to find even that small amount of variation in all genes at the same time. They reasoned, on the basis of a complicated hypothesis, according to Dr. Johnson, “that there were forces in nature that obliged you to pay a price for maintaining variability, and that when you pay too high a price you wipe out your population. Because the populations are obviously still there, it follows, according to this theory, that the organisms can’t be paying such a high price. Therefore, there must not be much variability.” The theory was built on impeccable logic, but there were no data to substantiate it.

Then two events occurred which shook up this beautiful theory. The atom bombs exploded at Hiroshima and Nagasaki, and inevitably after the Second World War “some people had the gall to ask,” Dr. Johnson explained, “what we had done to the Japanese in terms of destroying them genetically as well as just blasting them to hell.” A commission of distinguished scientists went to Japan and addressed themselves to this problem. They concluded that we had probably done a lot of genetic damage, but they were unable to say how much. The group was asked, “Why don’t you know how much?” They answered, “Because we don’t know how much variation there is in a natural population.” That admission was unsettling to say the least.

Hard on the heels of this occurrence came the development of a new technique for looking at enzymes. Called zone electrophoresis, it involves grinding up a butterfly, for example, and putting its homogenized remains on the end of a gel-filled tube. Next, an electric current is passed through that gel. All the protein enzymes in that butterfly are charged entities, and so each of them then moves at a characteristic rate.

“In other words,” Dr. Johnson made clear, “the unique characteristics of that protein determine how fast it will move down the gel. These movements are recorded as distinct bands, so that there is a separate position (or band) on the scale for each unique kind of protein. This is tremendously important,” Dr. Johnson continued, “because for the first time you have a way of looking discreetly (and the emphasis should be on the word discreetly) at each of all the different enzymes in the butterfly, and thus at the genes that make them.”

When scientists began doing that, they discovered that there was an incredible amount of gene variation in natural populations. Thirty percent of all the enzymes they looked at had variations, and the variation was at the very high level of about ten per cent. To illustrate this point concretely, Dr. Johnson suggested that one imagine that there were five butterflies outside Redstock Hall. Each has a diploid arrangement of its genes, which simply means that this insect, like man, has two copies of all its genes. Now imagine that you are looking at the same enzyme in these five butterflies with the electrophoresis technique. Only three of the butterflies would be found to have similar forms of this enzyme, with the same charge and moving at the same rate on the gel scale. A fourth butterfly will have a fifty-fifty split. The enzyme in one of its genes will exhibit exactly the same charge as that found in the other butterflies; the other enzyme will have a slightly different charge and be a mutant. In the fifth butterfly, both genes would be of the mutant type. Thus, of the ten enzymes in the five pairs or ten genes of these butterflies, only seven will be normal while three will be mutant types, giving you the frequency mentioned earlier—30 percent.

“How,” Dr. Johnson inquired, “do you explain this high rate of variability? Or, to put the question another way, how can you make the original theory which says that there should be little genetic variation agree with this new data? What you can do,” Dr. Johnson said, “is insist that populations can get along with all this variation because it isn’t really variation at all.” Theoreticians who continue to cling to the original hypothesis of little variation at the genetic level maintain that the many differences seen in enzymes mean nothing because the forms do not function differently.

“We would argue,” Dr. Johnson continued, “that these changes in the charge of the enzyme reflect major changes in how the protein works. We contend, moreover, that the fact that there are a lot of these different forms of the same enzyme in a population is very, very important.

In scientific circles, this phenomenon of variation in the form of a specific enzyme is known as enzyme polymorphism. Dr. Johnson, through his research on butterflies in the...
Colias meadii, a high-mountain butterfly usually found above timberline.

The East River meanders behind Dr. Johnson as he searches for montane species of Colias which live in this broad Colorado valley.
BUTTERFLIES, GENES, AND MINERS

Dr. Johnson knows from Dr. Watt's work that these butterflies fly only at body temperatures between about 85-100 degrees. If a cloud covers the sun and the temperature drops below that level, the butterflies are grounded. He also knows that the temperature pattern of the environment is much more predictable in the alpine area than in the montane region. On the top of the mountain it is consistently "bad." In the montane area, it often varies unpredictably. What the evidence shows so far, and what Dr. Johnson hopes to prove conclusively in the next few years, is that butterfly populations which live in unpredictable environments tend to be more variable. Most of the butterflies he is sampling at the top of the mountain have a special form of alpha glycerophosphate dehydrogenase, which seems to enable them to fly at slightly lower temperatures than the majority of butterflies lower down the mountain. Such an enzyme form would give them a terrific advantage in mating and finding food. Thus, at the top of the mountain you find a predominance of the so-called "cold" form of the enzyme. Selection, just as Darwin understood it, is taking place.

You find butterflies with various forms of the same enzyme in the montane region. Since the mother butterfly doesn't know what kind of environment her progeny will inherit, she makes offspring with at least three different forms of alpha glycerophosphate dehydrogenase—a cold type, an intermediate type, and a type that permits the butterfly to adapt better to a slightly warmer temperature window characteristic of the lowlands.

In the montane region, butterfly children are produced with different forms of this enzyme in order that at least some of them will survive. "The price you pay is that you are making an awful lot of less fit individuals just so you can be sure that some of them will survive. What we are saying and what my research indicates thus far is that this gene variability is an evolutionary response to the variabilities of the environment," Dr. Johnson explained.

Such research requires highly specialized knowledge, great technical skill, and, of course, a plentiful supply of butterflies. This past summer, Dr. Johnson and four students, whom he paid personally, caught about 700 butterflies. Their wings were carefully coded to indicate where they had been netted, and each was then dropped live into a minute, transparent envelope and carried back to camp, sometimes in an ordinary Band-Aid box. There, in a tent equipped with a 2500-watt gasoline powered generator to supply electricity, each butterfly (minus his wings) was individually ground up in a mechanical homogenizer. The remains of each insect were mixed with a buffer solution, and then the coffee-like liquid containing the precious enzymes was poured into four or five capillary tubes and spun in a centrifuge at very high speeds. These were put back in the envelope with the coded wings and placed in a liquid nitrogen container.

They stayed in this "deep-freeze" until late in August, when Dr. Johnson toted the large storage vat out of the mountains on his back and transferred it to his Volkswagen for the trip back to St. Louis, where the enzymes are now undergoing painstaking examination. Eventually, Dr. Johnson hopes to supplement his Colorado catches with butterflies bred in his laboratory.

Laymen who are accustomed to seeing stereotyped photographs of scientists peering casually through microscopes in sterile labs may find it hard to believe that such enormous effort in the field is sometimes required to carry out scientific research. But few, it seems reasonable to assume, would question its value when they understand that if Dr. Johnson is able to validate his basic assumptions, he has an excellent chance of becoming the first scientist to prove conclusively that enzyme polymorphism is being maintained by selection. This discovery could have far-reaching implications. Not only would it provide a clearer understanding of pure genetics, but also it could, in time, lead to significant, practical applications in both medicine and agronomy.
Dr. Leonard Jarett, MD '62, professor of pathology and medicine, heads the Laboratory Medicine Division and is director of Barnes Hospital's Central Diagnostic Laboratories.

One of Dr. Jarett's research interests is the mechanism of insulin action on fat cells. Here, he and his associates, research technicians Judy Roy and Robert Smith, work on isolated fat cells.
Laboratory Medicine

A bridge discipline between the basic sciences, technology, and clinical medicine, the rapidly developing field of laboratory medicine uses laboratory tests and procedures to assist in the diagnosis of disease and the management of therapy. At Washington University, the Division of Laboratory Medicine, established in 1969, performs original research in various fields, teaches medical students and trains interns and residents, makes available to the patient-care physicians the latest findings and techniques in medical testing, and provides the supervising professional staff for Barnes Hospital's Central Diagnostic Laboratories.

The development of laboratory medicine as a medical specialty and the trend toward centralizing diagnostic laboratories are the results of a tremendous growth in the use, complexity, and sophistication of medical laboratory tests and procedures in the years since World War II.

Medical tests were few and simple in the years before the war and could be performed in a doctor's office or with relatively simple equipment in a hospital laboratory. New technology, the application of the computer to medicine, and above all, the concentration of medical research at the molecular level, have worked a revolution in laboratory medicine. The number of medical tests performed in this country has been doubling every four to five years since World War II, and it is estimated that currently between 13 to 15 per cent of the national health care dollar is being spent on laboratory tests.

At the Washington University School of Medicine, Laboratory Medicine was established as a division of the departments of Pathology and Medicine in January, 1969. It was formed to provide an academic base for this new field and to provide full-time professional supervision and guidance for the Central Diagnostic Laboratories recently established in the Washington University Medical Center by Barnes Hospital.

In addition to its patient-service functions with the Diagnostic Laboratories, the Division teaches medical students, trains physicians and other scientists in basic and applied research in many areas of medicine and the biological and physical sciences, as well as the clinical aspects of laboratory medicine; and makes available to patient-care physicians the latest findings, techniques, and applications of medical laboratory tests.

Dr. Leonard Jarett, professor of pathology and medicine and director of the Barnes Central Diagnostic Laboratories, heads the Division of Laboratory Medicine. He received his M.D. from Washington University in 1962.

The present staff of the Laboratory Medicine Division, in addition to Dr. Jarett, includes John Lewis, Ph.D., a physicist who is in charge of computer operations and biomedical instrumentation development; Dr. Laurence A. Sherman, director of the blood bank; Dr. C. Elliott Bell, Jr., who heads the clinical immunology area; Dr. J. Joseph Marr, director of the microbiology area; and Dr. Johann H. Joist, who heads the hemostasis and thrombosis area.

George S. Kobayashi is assistant director of the microbiology area, and Jack H. Ladenson and James E. Davis are assistant directors of the chemistry laboratory. All three are Ph.D.'s.

Dr. Jarett defines laboratory medicine as that field of medicine that uses laboratory tests and procedures to assist in the diagnosis of disease and the management of therapy. "Laboratory medicine," he points out, "is truly a bridge discipline between the basic sciences, both biological and physical, advanced technology, and clinical medicine. This is best exemplified by the training program for physicians, Ph.D.'s, and graduate students in biomedical engineering.

"The day-to-day operational tools of laboratory medicine," he adds, "are the research tools of basic science and the most sophisticated technology applied to clinical situations."

Although there are other medical schools in the country which offer specialty training in laboratory medicine, Dr. Jarett feels that the newly established program at Washington University is exceptional. It is not organized as classic clinical pathology training programs have been in the past, but instead offers an extremely flexible program,
Dr. Jack H. Ladenson, assistant director of the Division's chemistry laboratory, conducts experiments in calcium metabolism, employing complex equipment that measures free calcium.

The Division's chemistry laboratory employs a high degree of automation to perform medical tests formerly done by hand. Using eighteen different tests, the equipment can process sixty samples an hour.

James E. Davis, Ph.D., an assistant director of the chemistry laboratory, in his office in the Laboratory Medicine Division. Dr. Davis's main research is centered on efforts to standardize enzyme tests.
with the intent of producing unique individuals, expert in both the basic and the clinical aspects of the area of the trainee's choosing.

"The essence of our program," Dr. Jarett says, "is that it is not tightly structured, but instead tries to give each trainee a solid foundation in the subject and then encourages him to explore any area of the field that excites his interest."

"We want to be sure," he adds, "that whether the trainee goes into academic medicine or clinical practice, he will understand the principles of the basic sciences and disease at the molecular level. We are not trying to turn out super-technicians, but, instead, fully prepared medical scientists with a thorough grounding in research and medicine."

Physicians may enter the program directly from medical school as interns, or after internship or residency in another specialty. Trainees also can enter the program for two years of post-doctoral training in a specific area of laboratory medicine, after earning a Ph.D. in biochemistry, microbiology, genetics, or other areas of the sciences.

During the first two years, the physician's training program blends service in the operation of the Diagnostic Laboratories with research. He rotates through each of the different areas, learning how the entire facility functions and, at the same time, helping to solve problems and performing needed service. During this period, he is encouraged to do research with a senior member of the Division or with a researcher in any of the divisions of Pathology or Medicine.

At the end of his second year, the trainee is expected to have decided in which of the areas of research he will concentrate: clinical chemistry, microbiology, hematology, blood-banking, or clinical immunology.

While concentrating on research in that area, the trainee becomes a junior staff member of the Division and participates in the professional supervision of the Diagnostic Laboratories. When the trainee develops an interest in a special field, he is encouraged to take additional training in that area. A trainee with a special interest in clinical microbiology, for instance, can arrange to take a year's fellowship in infectious diseases and then return to the Division.

"What makes the Washington University program unusual," Dr. Jarett asserts, "is the role of research as a basic teaching tool. Of course, this approach is typical of all programs of the Washington University School of Medicine."

Among the areas where current research in the Division is being focused are characterization of tumor-specific antigens for lung cancer, the mechanism of insulin action, computer applications to enzyme kinetics and data analysis, regulation of platelet function in clotting processes, therapy for blood clots, the role of ionized calcium in homeostasis, and the effects of antimicrobial agents on biomedical processes.

As members of a teaching division of the School of Medicine, the Laboratory Medicine staff has the responsibility for participation in the teaching of freshman biochemistry and sophomore pathology, pathophysiology, and laboratory diagnosis. It also offers a senior elective course in laboratory medicine. Begun last year, the elective course has been oversubscribed and will be offered twice this year to meet the demand. The staff also participates in the teaching of various graduate courses.

At the Barnes Hospital Diagnostic Laboratories, about 3000 test requests are processed each day. That 3000 figure represents requests, not answers—one request may ask for dozens of answers. Dr. Jarett estimates that the Laboratories are currently providing about 10,000 answers per day in chemistry alone, and that millions of test answers are provided annually.

Such volumes of data could not have been generated in the first place if it were not for the advances in basic science; the tests could not be performed if it were not for technological advances in instrumentation and automation; and the results could not be processed without the computer.

Tests that formerly were done laboriously and slowly by hand are now automated with enormously greater accuracy, uniformity, reliability, and speed. Test results now arrive at the patient's bedside and to the attending physician's attention at a speed that would have been unthinkable a few years ago.

Computerizing the operations of the Diagnostic Laboratories has greatly reduced errors and improved quality. The
In research directed toward learning the effects of antimicrobial agents on biochemical processes, Dr. J. Joseph Marr, director of the microbiology area, works with human parasites.

The Barnes Blood Bank is the largest and most sophisticated such facility in this area. Working 24 hours a day, seven days a week, the facility processes 20,000 units of blood per year.

Dr. C. Elliot Bell, Jr., heads the clinical immunology area. He is shown here reading the results of an immunoelectrophoresis determination.
The computer system installed at Barnes is the first such system in the Midwest. Not only does it eliminate lengthy hand calculations, but it provides instantaneous data and double checks constantly to determine that test results are matched with the right patient.

Three times a day, test results on every patient are printed out and distributed. Overnight, cumulative reports, containing the results of every test made on each patient since he entered the hospital, are compiled and placed in the patient’s charts. A physician or technician can ask the computer for information on any patient at any time and within seconds get the test result flashed on a screen—along with normal high and low levels for that patient.

Because of the computer’s almost unlimited ability to compare numbers, computers can look at all available data on a patient and compare it instantly with large populations of other patients. Information gleaned from the millions of tests performed annually is stored in computer memory banks and is instantly available. Such a wealth of test data should enable physicians to recognize patterns that currently cannot be detected in the individual patient.

“Medicine in general deals with individuals,” Dr. Jarett points out, “but laboratory medicine deals with populations.” The enormous quantities of test data that can be compiled in a centralized laboratory makes it possible to define test result ranges within extremely narrow parameters, to compare an individual’s test results with thousands of other patients, and to determine each individual’s own norms within population ranges.

“An individual has a narrower range than the population range,” Dr. Jarett says, “and the computer in the future can be programmed to watch for these differences and measure them.”

Because of the central importance of the computer to laboratory medicine, all staff members and trainees must take courses in computer technology and biostatistics. The University’s Biomedical Computer Laboratories provides introductory training in computer science, and the trainees work closely throughout their training with the Division’s own computer facilities and experts.

“The purpose is not to turn out computer experts,” Dr. Jarett states, “but to give everyone in the program a clear and thorough knowledge of what the computer can do and what it cannot.”

As the demands on the Laboratories grow and the number and complexity of tests increase, present facilities have inevitably grown inadequate. To meet these future demands, the Barnes Hospital board recently approved plans for a new building contiguous to the present Diagnostic Laboratories. The Laboratories will occupy the second and third floors of the new building, scheduled for completion in about two-and-a-half years. The new facilities will provide additional research space, permit training more interns and residents, and will almost triple the Laboratories’ direct patient services.

In Dr. Jarett’s words, “The new building will provide the facilities for a truly first-class scientific environment.” When the new building is completed, Dr. Jarett is confident that “the area will grow to become the dominant laboratory medicine facility in the country.”

All funding for the new facilities will be provided by Barnes Hospital. Research funds are obtained through the Washington University School of Medicine, but funding of the Central Diagnostic Laboratory is a Barnes Hospital responsibility. “It is this cooperative effort,” Dr. Jarett states, “that will allow us to attain the excellence found throughout the Washington University Medical Center.”

In the final analysis, the Division of Laboratory Medicine, like all of medicine, functions to reduce human suffering and to save human lives. The real question to ask about any medical activity is what is it doing for the patient?

In essence, the Division is providing the patient with the latest and most effective laboratory tests and procedures and is maintaining the highest possible standards of quality. As medical researchers learn more and more about disease, greater and greater accuracy and sophistication in tests are required. Not just diagnosis, but proper treatment depends greatly on reliable tests.

The blood bank, operated as part of the Central Diagnostic Laboratories, is typical of the kind of vital patient services that are being provided. The most sophisticated facility of its kind in this part of the country, the blood bank operates twenty-four hours a day, seven days a week, handling some 20,000 units of blood per year.

In another and equally important way, the Division and the Laboratories serve the patient through their educational responsibility to the physician to keep him informed of new tests, to help him interpret the results, and to enable him to use the potent tools laboratory medicine can offer him.

As complex as laboratory medicine seems today, it is still in its infancy. In the years ahead, advances in the basic sciences, in computer and instrumentation technology, and in clinical medicine will require levels of expertise, sophistication, and insight far beyond anything we can visualize today.
Comment

A DREAM COME TRUE

OFFICIAL DEDICATION of the splendid, new Mallinckrodt Center and Edison Theatre on October 12 was, to anyone who has been around this campus any length of time, a dream come true.

For years, for decades, it has been realized that the one important ingredient missing from this campus was a truly first-class student center and an adequate and professional theatre. Almost since the beginning of the University, this need has been apparent. The present splendid building resulted from the Robert Vickery and Smith and Entzeroth design. Before that, the Washington University Magazine and its predecessor, The Washington University Alumni Bulletin, every few issues, it seems, ran a new artist's conception of the "Student Union and Theatre."

Through the years, the Center has remained a top priority item, but, year after year, the necessary funds were not forthcoming. It is true that there were other items on the priority list that realistically commanded first attention: better faculty salaries; increased scholarship funds; adequate laboratory facilities to keep up with modern science and technology; and above all, the Olin Library.

Many, many people helped to make the Mallinckrodt Center and Edison Theatre a reality. The Board of Trustees, long ago, pledged their support; the faculty, all along, recognized the need; the alumni have long been a moving force toward the building's completion. Most of all, perhaps, have been the generations of students who worked toward achieving the goal. Students through the years organized "Student Union" committees, raised funds on their own, and worked in every way to help achieve the objective. What is remarkable is that, until very recently, those students who worked so hard to make the Center a reality, knew that personally they would never enjoy its benefits; that they would be gone before the ground was broken.

The Mallinckrodt Center is a living monument to many Washington University chancellors. Arthur Holly Compton recognized the vital importance of the facility to the University and insisted that it be included among the very top priority items in the Second Century development drive; Chancellor Ethan Shepley was another strong advocate of the project and knew that it was essential to the success of the plan he inspired to turn the "South Forty" into a residential area and to turn Washington University from a local "streetcar college" into a national institution attracting students from throughout the world; Chancellor Danforth presided over the dedication of a facility, the need for which was as real and urgent to him as to his predecessors.

IT WAS Chancellor Thomas H. Eliot, however, who turned the dream into reality. When Chancellor Eliot left the University, he had only one regret: that the university center and theatre that he envisioned was not yet in existence. It must have been a matter of great satisfaction to him to go to the site his very last day as chancellor and to turn over the first spadeful of dirt to symbolize ground-breaking for the actual building.

Chancellor Eliot returned to the campus on October 12. It was fitting, indeed, that he was present. Also on hand were many, many others who contributed their parts to the project, including Mrs. Arthur Holly Compton, representing her husband to whom the concept was so important; members of the Board of Trustees, who never wavered in their determination to get the job done; University graduates, who had gone on to fame in the performing arts, like Mistress of Ceremonies Mary Wickes; representatives of the many generous donors who, in the last analysis, made the building possible; and finally, representatives of the student body, who through the years gave their support and lent their enthusiasm.

The Mallinckrodt Center and the Edison Theatre are real and are being used with a zeal and enthusiasm that exceeds anything that was ever anticipated. It all proves that if you dream hard enough, and work hard enough, your dreams can come true.

T HIS is the first issue of the Washington University Magazine since 1956 that was not designed by Peter Geist. Geist, who attended the University's School of Fine Arts from 1931 to 1934 and joined the faculty there in 1950, is on leave of absence. Geist came to the faculty after winning a national reputation as art director of a major advertising agency.

The Magazine's new designer is Stan Gellman, BFA 60. Gellman began working on University publications as a student of Geist's and has designed most of the University's publications over the past decade. Gellman works in the Geistian tradition; that is, like Geist, he puts content before design and uses design as a subtle but essential way of getting the message across.

Peter Geist is now living on his beloved island of Matinicus, twenty-three miles off the coast of Maine. There, he is busy doing free-lance design, painting and sketching, and allowing plenty of time for reading, ocean-observing, bird-watching, and consuming fresh Maine lobster.

All told, Geist designed some seventy-one issues of the Magazine over a span of more than seventeen years. In every one of those years, the Magazine was cited for excellence by the American Alumni Council in competition with alumni magazines throughout the United States and Canada. One of the most important reasons for the Magazine's national recognition was the clean, imaginative, and readable format that resulted from Peter Geist's design.

Speaking of awards, the Washington University Magazine was honored again this year by the American Alumni Council. In competition with some 800 American and Canadian publications, it was one of twenty-five college and university periodicals cited by AAC for "superior achievement in alumni publishing." Herb Weitman, B.S.B.A 50, whose photographs have been an essential ingredient of the Magazine for even longer than has Geist's design, again walked off with the lion's share of photographic awards. Of the twenty-five "Best Photographs of the Year," chosen by AAC, ten were by Herb Weitman.

—F0'B
Fred Conway, who retired four years ago after 46 years on the faculty of the University's School of Fine Arts, died in August. It was 1916 when Fred Conway first came to Washington University as a student and he is certain to be a living spirit, a strong influence, and a happily remembered legend in the year 2016.

Conway won an international reputation as a muralist and an easel painter, a portrait artist, and a master of the water color. He won numerous national and international prizes, his murals adorn prominent public buildings, his paintings and water colors grace the walls of museums and private homes throughout the country. He is remembered as a great teacher by generations of Washington University students.

Fred Conway once remarked, "Unless you're one of those rare ones who have been touched by the hand of God, you've just got to work like hell." Fred Conway did "work like hell" for more than half a century, but those who knew him would say that he was also "one of those rare ones who have been touched by the hand of God."