SPECIAL FEATURE

CONFERENCE ON THE FUTURE OF ACADEMIC PATHOLOGY

Program of the Conference on the Future of Academic Pathology

September 22, 1976 — *Dante G. Scarpelli, Chairman*

Objectives of the Conference — **Robert E. Stowell**

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2. Inflammatory Diseases — Peter A. Ward, Russell Ross
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Discussion and Recommendations by Participants

Conference on the Future of Academic Pathology

September 22–24, 1976, College Park, Maryland

Robert E. Stowell, MD, PhD, Thomas J. Gill III, MD, Benjamin F. Trump, MD, and Dante G. Scarpelli, MD

CHANGING NATIONAL BIOMEDICAL PRIORITIES are exerting a profound effect on academic medicine through a diminishing of the growth of support of education, training, and research and an increasing regulation of health care activities. The foregoing, coupled with the fact that more than 10 years have elapsed since the state of academic pathology was reviewed and discussed by the academic community (*Lab Invest 13:589, 1964*), led to the organization of this conference.

The conference was held on September 22–24, 1976, at the Center of Adult Education, University of Maryland, College Park, Maryland, under the sponsorship of Universities Associated for Research and Education in Pathology, the Intersociety Committee for Research Potential in Pathology, and the Association of Pathology Chairmen. Eighty invited participants from more than fifty medical schools and government agencies participated. The organizing committee for the conference included Thomas J. Gill III, Rolla B. Hill, Jr., Thomas D. Kinney, Werner H. Kirsten, J. Lowell Orbison, Dante G. Scarpelli, Benjamin F. Trump, Peter A. Ward, and Robert E. Stowell, Chairman.

This résumé of the conference can only cover the high points of the 3-day conference and will not attempt to include the important evening presentations of "National Priorities for Biomedical Research" by Arthur Kornberg or "How to Inform Policymakers Who Set Priorities" by John A. D. Cooper. Space limitations will not permit acknowledgment of the role of all individual participants in this summary of the conference.

This conference considered how shifting emphasis and changing balances of power as new disciplines evolve and the relative importance of other disciplines modify the continuing competition for limited federal, state, and university resources. These changes and the increasing governmental regulation and shifting social and biopolitical forces will alter the future research, teaching, and practice of pathology. Therefore, the participants considered how to plan for and influence these changes in order to make the pathologists' contribution more effective. In view of existing

Address reprint and reference requests to Dr. Robert E. Stowell, Department of Pathology, School of Medicine, University of California, Davis, CA 95616.

and probable future changes, participants sought a clearer definition of the current and future identity of academic pathology. The interrelationships of clinical and anatomic pathology and their subspecialties in teaching, training, and research were defined.

Some of the areas in which pathologists have unique opportunities and resources for their research were discussed. How we should alter and improve teaching and training in pathology was delineated. Having identified future goals to be achieved, the participants considered mechanisms for their accomplishment. Through the development of a plan for continuing implementation of action, we hope to inform and influence the policymakers who establish present and future biomedical priorities.

Recommendations of the Conference

On the basis of presentations of background material by invited speakers, extensive in-depth discussion by interested panel groups, and consideration by all participants in plenary sessions, the conference makes the following recommendations:

I. Relative to Research in Selected Areas in Clinical and Anatomic Human Pathology

1. Developmental and Genetic Disorders

   1.1 To provide a major asset to research on a variety of inherited diseases and human transplantation genetics, sophisticated immunodiagnostic facilities should be developed in the clinical laboratory.

   1.2 To encourage and expand productive research, model programs in reproductive and developmental pathology should be increased; greater effort should be made to collect and organize normative functional and structural data on the human embryo, fetus, and placenta; family and population studies should be included in reproductive and developmental research studies whenever indicated.

2. Inflammatory Diseases

   To enhance the discipline of immunopathology as an important growing subspecialty, further consideration and concerted efforts should be made to establish subspecialty board certification in immunopathology under the aegis of the American Board of Pathology.

3. Neoplastic Diseases

   3.1 To play a more significant role in the application of new research approaches from different disciplines to cancer in

humans, pathologists should identify and exploit the special research potential offered by the study of certain neoplasms of man.

3.2 To develop a program of excellence in cancer research, departments of pathology should recruit persons trained in disciplines other than pathology when this is indicated.

3.3 To further progress in environmental cancer research, persons should be trained in experimental pathology with special expertise in a discipline such as biochemistry, virology, or epidemiology. Specific criteria of scientific competence should be established for personnel involved in the evaluation of the carcinogenic effects of environmental agents.

4. Ischemic Injury

4.1 To provide a major resource for investigating the cellular mechanisms involved in ischemic injury in a variety of organ systems and to participate in collaborative studies oriented toward protective therapeutic interventions,

4.1.1 Better means for access to human tissues including improvements in laws concerning medical examiners should be developed.

4.1.2 Major efforts should be directed toward the early detection and localization of areas of ischemia, even in routine autopsies. This should include new sophisticated methods such as x-ray microanalysis, x-ray fluorescence, and enzyme cytochemistry. Such studies should also be carefully correlated with methods for detecting ischemic areas *in vivo* including use of isotopic scans and serum enzymes.

5. Cardiovascular Diseases

To offer broadly based cardiovascular pathology training programs of excellence, a group (or other appropriate mechanism) should be established to plan and coordinate effective interinstitutional programs, since the full range of training is generally not available in any single institution.

6. Environmental Pathology

6.1 To facilitate the earlier recognition of environmental hazards for man, and to provide a central repository of data and materials for effective use in environmental research,

6.1.1 Suitable agencies should be approached for study of the establishment and support of a national resource service facility to collect and analyze human

pathologic data relating to chemical environmental agents including food additives, pesticides, fungicides, and other toxic agents. This need not conflict with present functions of the Registry for Adverse Reactions to Drugs at the Armed Forces Institute of Pathology.

6.1.2 Studies on methods to improve population monitoring should include analysis of vital statistics data and development of protocols with guidelines for collection of data.

6.2 To define and evaluate the risk/benefit ratio of innovative therapy, all major studies for evaluation of new therapeutic agents for human disease should include comprehensive standardized autopsy studies as a part of the protocol. Pathologic studies such as those in some cooperative evaluations of antineoplastic drugs should be expanded to include other therapeutic agents.

6.3 To create more productive research programs, an increased number of formalized programs to train environmental pathologists with training in epidemiology and biostatistics as well as anatomic, clinical, and experimental pathology should be developed.

7. The Clinical Laboratory as a Resource for Pathology Research

7.1 To obtain a greater academic acceptability of clinical pathology, to increase its use in medical student teaching, and to obtain high quality new faculty in clinical pathology, the necessity for active research should be stressed in all academic clinical laboratories, especially in the areas of metabolic diseases, toxicology and drug metabolism, immunology, and tissue typing.

7.2 To improve the efficacy of academic clinical pathology,

7.2.1 The development of the pathologist as a consultant at the bedside must occur, particularly as a member of specialized health care teams. Training programs in clinical areas and in pathology must have greater interchange because such contact is vital for the generation of research ideas.

7.2.2 More dedicated and sustained institutional and departmental commitments to the development of the discipline of academic clinical pathology and to the research obligation which this entails should be obtained.

7.2.3 Strong emphasis on subspecialization in staffing and training in clinical pathology is desirable.

8. Newer Conceptual Approaches to the Autopsy as a Research Resource

8.1 To develop a rational formula to provide appropriate quality control of diagnosis and practice via the autopsy and to provide funding for this from the health care budget, a representative body of pathologists should formulate a national and interdisciplinary policy and address the promulgation of that policy.

8.2 To examine the problem of the autopsy as a major resource for research and education in academic pathology, a study group should be assigned the task of:

8.2.1 Determining accurate and current cost analysis of autopsies (professional, technical, and facilities).

8.2.2 Identifying and providing information regarding the various sources of financial support available to autopsy services.

8.2.3 Recommending better ways of individual and collective analysis of autopsy cases by clinicians and pathologists and assessment of clinical pathologic correlation.

8.2.4 Reviewing, in collaboration with the other special study groups such as cardiovascular or immunopathology, the current autopsy procedures with regard to its relevance and adequacy for the problem at hand.

8.3 To improve the usefulness of the autopsy and the interaction of a number of individuals in related fields with the team of pathologists, autopsies should be oriented towards and coordinated with specific research projects being carried out at select universities. This could be a source of additional support.

II. Relative to Education in Pathology

9. Undergraduate Teaching and the Transition of the Medical Student Into a Pathologist

9.1 To enhance the effectiveness of undergraduate teaching, we should promulgate:

9.1.1 Excellent undergraduate medical school teaching of broad based courses including both anatomic and clinical pathology. Elective courses, clerkships,

and teaching assistantships for upper-class students are very valuable for sustaining the student's interest in pathology.

9.1.2 Teaching of pathology continuing throughout the 4 years of medical school, including opportunities for experience in the various subspecialties of pathology. Necessary resources (faculty and time) should be made available to provide this extended education in pathology for the undergraduates.

9.1.3 Medical student contact with gross specimens, microscopic slides, electron micrographs, and with the clinical laboratory, including various types of data, is essential.

9.2 To provide the necessary pathologists to meet growing future needs, the attraction of good students into pathology must be encouraged by providing opportunities for in-depth exposure to pathology and pathologists as early as possible in their medical education, even at the level of premedical training.

10. Training of Residents and Fellows

10.1 To improve the training programs for residents, the certification requirements of the American Board of Pathology should provide for both of the following programs:

10.1.1 Four-year program in anatomic or clinical pathology with a core program and flexible component in research, subspecialty training, or additional general training in anatomic or clinical pathology or clinical medicine at the discretion of the individual. Additional subspecialty training beyond the 5 years should be encouraged as appropriate.

10.1.2 Five-year combined program in anatomic and clinical pathology including the core training and additional flexible component as outlined above.

10.2 To improve the quality of training experience, pathology training programs should be limited to institutions that can provide real educational opportunities in addition to service responsibilities for the trainees—a goal which can only be accomplished at university centers or other centers of academic excellence, including hospitals with strong academic affiliations.

11. PhDs in Pathology

11.1 To provide the high caliber of trained personnel needed in

increasing numbers in diverse activities, there should be an increased development of programs of excellence within the pathology departments training PhDs in pathology, who would function as academic pathologists in biomedical science.

11.2 To adequately support such training programs, the National Institute of General Medical Sciences should be strongly encouraged to make postdoctoral training programs for PhDs in pathology a target area for funding. Financial support should also be sought from industrial and other nonfederal sources which require the services of such pathologists.

12. Combined MD–PhD Training

12.1 To maintain the high standards of quality in experimental pathology, training programs should be:

12.1.1 Restricted to those institutions with a critical mass of faculty members in experimental pathology.

12.1.2 Concerned with the needs of clinical pathology in achieving academic excellence and include training in areas of clinical pathology as well as anatomic pathology as a part of a combined pathology residency–PhD, or experimental pathology program.

13. Technical Training of Assistants to Pathologists

To provide leadership in establishing uniformly high standards in training and accreditation of Pathologist's Assistants, an appropriate group should take leadership in organizing a Commission on Pathology Assistants which would address the issues of educational standards, accreditation, certification, and funding. It was suggested that the commission be comprised of several Pathology Assistants and representatives from the major pathology societies.

14. Organization and Support of Academic Departments of Pathology for Training

14.1 To insure excellence in academic pathology, efforts should be aimed at recruiting individuals who exhibit excellence in whatever aspect of pathology they may wish to pursue and in encouraging them to make an academic career their goal and personal commitment rather than recommending any one particular organizational pattern.

14.2 To justify more manpower in academic pathology, more detailed documentation of current and projected needs will be required.

14.3 To ensure that professional fees are appropriately maintained at realistic levels, pathology departments must develop better cost accounting procedures in both clinical and anatomic pathology activities. Other sources of support that now subsidize professional activities can be released to improve other parts of the training program.

14.4 To maintain adequate support for pathology resident training, in the light of recent and pending legislation for decreasing relative emphasis of programs unrelated to primary care, institutional support for pathology training should be maintained at least at its present level and increased progressively as subspecialty pathology programs develop.

15. Continuing Education of Academic Pathologists for a Changing Future

15.1 To enhance their continuing education opportunities, academic pathologists should:

15.1.1 More fully utilize short leaves or mini-sabbaticals for the acquisition of new techniques in research, especially for junior faculty members. As an alternative, visiting professors or consultants should be utilized to bring such new techniques and concepts to institutions.

15.1.2 Establish a better means, such as a central clearing-house, to provide at reasonable intervals complete listings of forthcoming opportunities in continuing education in academic pathology and closely related fields, especially in the subspecialties of clinical pathology.

15.1.3 Provide intensive courses at suitable retreats to help faculty members teaching in areas outside of their special expertise.

15.1.4 Utilize new techniques such as microfiche transparencies to supplement the usual limited journal presentations of detailed photographic and tabular data necessary to evaluate new technique developments.

15.1.5 Participate through their organizations in establishing suitable requirements and standards for relicensure and recertification particularly as they are applied to faculty members engaged in research.

III. General Recommendations Applicable to Many Areas of Pathology Research and Training

16. To improve the utilization for research and teaching purposes of valuable human materials from clinical and anatomic laboratories, groups should:
    16.1 Study and develop protocols for the best methods of collecting, handling, storing, and transporting such tissues and fluids for various purposes including chemical, structural, functional, microbiologic, immunologic, and genetic studies. Safety precautions for hazardous materials should be prescribed.
    16.2 Clarify with the National Institutes of Health and other sources the status and utilization of such materials without undue hinderance from legal problems relative to the patient's informed consent. After fluid and tissue specimens have served the primary diagnostic or monitoring purposes for which they were obtained, they should be readily available to aid biomedical research and teaching.
17. To enhance the future ability of academic pathology to most effectively serve our country's needs, adequate information about the significance of the pathologist's role in research, teaching, and medical practice must be presented in a continuing and increasingly effective manner to policymakers and to those who set priorities for allocation of the limited supply of funds and resources needed by academic pathologists.
18. To increase the effectiveness of research by pathologists and improve the training of future investigators, more adequate, stable, long-term support is necessary from the National Institutes of Health and other federal, state, and local sources as well as from the private sector. Training stipends for pathology postdoctoral MDs for research should be equivalent to those of pathology residents training for service.
19. To assist in implementation and coordination in carrying out the recommendations of this conference, representatives from national organizations interested in academic pathology should form a group to cooperate over a period of years with activities of societies relating to academic pathology.

I. New Conceptual Approaches in Clinical and Anatomic Human Pathology

New approaches to the clinical laboratory and anatomic study of human pathology are evolving as a result of recent conceptual and methodologic advances. Examples of these will be considered in the broad areas of

developmental and genetic disorders, inflammatory diseases, neoplastic diseases, ischemic injury, cardiovascular diseases, and environmental pathology. In addition, utilization of the clinical laboratory and the autopsy for research purposes was discussed. In the pathologist's study of disease, our prime objective is the complete understanding of the biologic, structural, chemical, and physical changes (pathophysiology) involved in its causes, processes, and effects as a basis for improved diagnosis, treatment, and prevention.

Developmental and Genetic Disorders

The pathogenesis of many disease processes begins during fetal development as a result of either events occurring during pregnancy or the genetic constitution of the developing fetus. The pathologist is in a unique position to investigate this area by utilizing material from both the anatomic and clinical pathology laboratories. Three major areas of interest within this field were outlined.

The fetus is exposed to a flux of molecules and cells from the mother, including both antigens and antibodies. The latter play an important role in conferring passive protection to the fetus during early stages of its postnatal life. The antigens, however, interact with the developing system and can alter it. Studies on animals indicate that, depending upon the genetically controlled response of the animal to these molecules, antigens can induce either stimulation or partial paralysis of the immune system. Stimulating the fetal immune system would be of use in developing techniques of vaccination in which the mother could be immunized with a long-acting vaccine in order to confer active protection on her offspring. On the other hand, the interaction of antigens from tumors could induce partial tolerance in the offspring and make them more susceptible to tumors in later life. A number of studies in both animals and man have shown that cells can cross the placenta and colonize the fetus. They can potentially react immunologically against the fetus, causing graft-versus-host reactions which can lead to a variety of lymphoid malignancies.

Secondly, the role of the fetus as a homograft has been explored both experimentally and in man. The questions of why the fetus is not rejected and what is the nature of the immune response to the developing fetus are unanswered. There is some evidence that immunologic factors may play a role in various conditions leading to the premature termination of pregnancy or to abnormal pregnancies. The opportunity to examine the immunologic aspects of pregnancy by evaluating both serum factors and immunologic changes in tissues should provide some insight into these processes.

Finally, investigation of the genetic bases of disease have been greatly enhanced by newer diagnostic techniques. Studies by cell fusion are providing an increasingly detailed gene map of the human chromosomes, particularly those controlling enzymes and cell surface antigens. Chromosome banding by fluorescence or by the Giesma technique have led to a systematic knowledge of the translocations, breaks, etc., that are involved in various pathogenic states. Such studies will expand our knowledge about the pathogenesis of disease and provide diagnostic techniques for clinical counseling.

Genetically-determined susceptibility to disease is a research area where additional exploration through various approaches would appear profitable. In addition, to further characterization of inborn metabolic errors which increase disease susceptibility, less well defined disorders involving instability of the genetic apparatus itself (e.g., "chromosome breakage" syndromes) or defects in immunity warrant added study. The pathologist in the clinical laboratory has access to such patients through clinicians investigating genetic problems and also frequently has many of the special tools needed for study of their defect. Sophisticated immunodiagnostic facilities in the clinical laboratory would also provide a mechanism for the expanded investigation of human transplantation genetics. In addition to direct applications to organ transplants, more research is needed on the genetic basis of the relationships between histocompatibility and nonhistocompatibility antigens. Intriguing results are appearing from the study of animal models, and a strong immunodiagnostic laboratory unit could provide the academic pathologist with the means of pursuing similar studies in man.

Research on aging is an area where there is social pressure for increased effort in the face of a dearth of firm data and few previous, generally-accepted research approaches. The academic pathologist can easily obtain human tissues of all ages as a result of his activity in surgical and anatomic pathology and will find enthusiastic support for any novel and imaginative studies which attempt to answer such questions as: Is there a nonspecific process of cell senescence separable from those of defined diseases? If so, is senescence determined by an intracellular lesion (nuclear?, lysosomal?) or a change in the extracellular milieu?

Discussion emphasized that major research thrusts in developmental and genetic disorders should include: function and pathophysiology of the placenta and uterus; study of mechanisms responsible for congenital anomalies; the role of transplacental passage of molecules, organisms, and cells in inflammation and immune responses; aging as a developmental process; and finally, the usefulness of spontaneous and experimentally

induced animal models for the study of developmental and genetic disorders. In addition, pathologists should assume roles of leadership and productive collaboration and, when necessary, utilize available expertise and/or special training in the modern and sophisticated methodologies of other disciplines such as genetics, molecular biology, pharmacology, etc.

Tissues and body fluids should be used freely for research and teaching after they have served the diagnostic or therapeutic monitoring purposes for which they were originally obtained. These should include surgical specimens, placentas, and tissues from spontaneous and elective abortions and from autopsies of stillborns and other neonates and perinates, as well as all body fluids from the gravid female and the conceptus.

Inflammatory Diseases

An important thrust of current research on the pathology of inflammatory diseases is focused on leukotactic responses which represent important mechanisms leading to the accumulation of leukocytes in the course of inflammatory responses. The complement system is an important source for the generation of leukotactic products, which include the fragments of C3 and C5 and the C567 complex. The C3 and C5 chemotactic fragments can be generated by a variety of proteolytic enzymes, including neutral proteases present in most normal tissues. The C5 chemotatic factors appear to be important in the mediation of immunologically triggered inflammatory reactions (immune complex vasculitis, rheumatoid arthritis). The C3 chemotactic fragment plays a role in non-immunologically-triggered inflammatory reactions, as demonstrated by a requirement for the C3 fragment in the attraction of neutrophils to damaged myocardial tissue in the course of a developing myocardial infarct. Regulation of the leukotactic system occurs by two naturally occurring inhibitors present in low concentration in normal human serum: a cell-directed inhibitor and a chemotactic factor inactivator. In humans with cancer, the former inhibitor is present in high concentrations and may account for the observed defects in the expression of inflammatory reaction to nonspecific stimuli in cancer patients. The second inhibitor is present in high concentration in a variety of diseases, many of which are associated with energy. An appreciation of the leukotactic system has provided explanations for many observations in humans with defects in the expression of the inflammatory response.

The role of the various white blood cells in inflammation and repair, and the antimicrobial mechanisms contained by both granulocytes and cells of the monocytic series, represent a dominant feature of the host reaction to infectious diseases. Studies of the inflammatory process follow-

ing various forms of injury and the reparative process that follow have demonstrated a chronologic sequence of events that include blood coagulation and platelet aggregation and release; immigration of neutrophilic leukocytes and monocytes; the appearance of lymphocytes; and eventually the ingress of fibroblasts and capillaries which form granulation tissue. The significance of this sequence and the role of each cell in the healing process has been delineated.

Studies have elucidated the various mechanisms by which cells such as the neutrophilic leukocyte and monocyte kill various forms of microorganisms through a number of enzyme-mediated pathways. Such work has emphasized the role of the myeloperoxidase-mediated antimicrobial systems that are important in the destruction of certain microorganisms, as well as the role of catalase or other oxygen-dependent antimicrobial systems. The cytotoxicity that myeloperoxidase-mediated systems may effect on other cells, such as tumor cells, has also been investigated.

The possibility that white blood cells, including the thrombocyte, neutrophil, and monocyte, provide factors important for the fibroproliferative response that represents the latter stage of healing has been studied. Growth factors have been identified in the thrombocyte and in the activated macrophage. The growth factor present in the thrombocyte is thought to play a role in stimulating the early phases of cell proliferation following injury and in artherogenesis. The factor elaborated by activated macrophages has been demonstrated to be important in stimulating fibroblast proliferation in cell culture and is also considered to play an important role in prolonging the proliferative and connective tissue–forming response of fibroblasts following various forms of injury. The interrelationships of the various inflammatory cells, and the possible result of superabundant inflammation in inciting various disease states as well as the role of the immune response in inflammation in relation to diseases that have an important immune counterpart are major facets of contemporary research on inflammatory diseases.

Further development of research and service activities in the area of inflammatory diseases should include the following: identification and study of the biology of subpopulations of lymphocytes; the role of nonimmune, humoral, and chemical factors in inflammatory and immune reactions; development of both spontaneous and induced animal models of inflammatory diseases; structural and functional characterization of antibodies and their use as specific diagnostic agents. Strong research and service units of immunopathology as "centers of excellence" should continue to be developed in academic medical centers since these will enhance research on inflammatory diseases. Such units can be organized in

one of two ways: either based in departments of pathology, or as interdisciplinary and interdepartmental cooperative ventures depending on departmental and other factors which will vary from institution to institution. Regardless of the administrative style, efforts should be made to ensure that professional identity and satisfaction of faculty is maintained; the foregoing is often a problem in interdisciplinary interdepartmental units.

Neoplastic Diseases

During the past 20 years we have seen a rapid expansion of research on cancer and a concomitant increase in our understanding of this spectrum of diseases. The foregoing has accrued largely as the result of the application of the tools and techniques of biochemistry and cell biology to experimental studies on nonhuman animals, tissues, and cells, including in some instances primitive life forms. The time is now ripe for these techniques and tools to be applied to the study of human cancer. It is significant in this regard that quantitative assays of estrogen receptors, a research procedure a few years ago, has now become "routine" procedure in a number of pathology laboratories. Much of the basic development of steroid hormone receptor assays and their application to the clinical management of human breast cancer was accomplished by biochemists, physiologists, and clinical endocrinologists; pathologists were conspicuously absent. Their greatest contribution was supplying fresh unfixed tissue for the assays and, of course, providing a morphologic classification of the neoplasms and determining the extent of disease.

The pathologist receives a wealth of normal and diseased human tissues, yet the bulk of these meet the irreversible fate of chemical fixation. Although there are probably many reasons for this, a prime one is clearly that many pathologists still consider pathology as a purely morphologic discipline, this in the face of incontrovertible evidence that structure and function are as two sides of the same coin.

Operating from the premise that nonneoplastic and neoplastic tissues recently removed from patients at surgery or postmortem represent an important resource in which degradation is reversible and which can be maintained by organ and tissue culture, a number of laboratories are involved in functional studies on such material. These include protein synthesis; drug metabolism, including activation of carcinogens and their interaction with nuclear DNA; steroid receptor function; and isozyme patterns in various neoplasms. In view of increased emphasis on the use of human tissues for functional diagnostic, prognostic, and research studies, hospital pathologists must develop the capability to collect and maintain

tissues so that they can be utilized for such studies; hopefully, the pathologists will also be involved in these studies.

The discovery of human papovaviruses of the polyoma virus group has represented an orderly progression of research from mice to rabbits, to monkeys, and finally to man. Pathologists have played important roles in most of these studies. Although the mouse polyoma virus was first discovered by virologists, pathologists identified and characterized the tumors produced by the virus. In the case of the human papovaviruses, pathologists used human pathologic specimens to make the critical discoveries that led to the isolation and characterization of the JC virus, the cause of progressive multifocal leukoencephalopathy. The training and skill of anatomic pathologists and their access to human tissues has given and will continue to give them great opportunities to make important contributions to viral oncology.

Virology was initially the domain of morphologically oriented departments, since inclusion bodies were in general the only method of diagnosis as well as the tool of objective results in experimental work. When viruses became better identified and tissue culture available, virus studies became the domain of microbiology departments. Thus, in the last 20 years the identification, classification, structure, and genetics of many pathogenic viruses has been or is being done by nonpathologists. In this process, explosive and rewarding as it has been, many of the more biologic aspects have been underplayed. The emphasis now is returning to host cells, the properties of which determine the outcome of virus infection, and to the interaction of the virus-infected cells, whether in a vegetative or transformed state, with the rest of the organism which results in a disease. These are clearly problems which can be best solved in a pathology department; on the other hand, it is the responsibility of pathology departments to develop a complex of facilities, methodologies, equipment, and most of all, intellectual preparation and curiosity in which these problems can be attacked from the molecular aspects of the virus–cell interaction to the host response which deals with the virus modified cells. It is only in this framework that the whole pathogenesis of viral disease can be effectively examined. Viral oncology represents an important part, as well as an excellent model for this general approach. It is imperative that academic pathology departments recruit virologists, cell biologists, nucleic acid biochemists, and other appropriate nonpathologists. Such persons should be integrated into the department as full professional colleagues.

It should also be emphasized that the consistent role of a pathologist, even of one trained in classic morphology, is to identify different cell

populations in terms of their functional capacities, among which is that of producing tumors. Therefore, all the methodologies and techniques which attempt to define parameters of malignancy *in vitro*, for example, should be of primary interest to pathologists; in this aspect the pathologist can act not only as an individual who can critically judge and correlate the various approaches to his or her own understanding of the relationship between cells and tissue *in vivo* but as a guide in the development of new approaches. For these reasons the problem of cell sorting and the development of complex techniques and instrumentation which accompany it should be clearly the domain of pathologists, because they are the persons who can relate their findings to primary sources.

It was recommended that a panel or some other effective mechanism be established to implement the following actions relating the areas of endeavor in the basic and clinical interfaces of pathology with oncology: a) Cancer research should be a major activity of academic pathology involving anatomic, clinical, and experimental pathology programs. b) Research should be encouraged in cancer etiology, pathogenesis, diagnosis, and therapy. c) Rewarding areas of research which should be emphasized include a more precise morphologic and functional definition of the cells involved in tumorigenesis, identification of early markers of neoplastic transformation, identification of regulatory mechanisms involved in cell growth and differentiation, classification of neoplastic diseases utilizing current methods for the study of cancer cell biology, development and application of methods to identify populations at high risk for the development of cancer, and finally, development of methods and criteria for defining effects of environmental carcinogens.

Ischemic Injury

Ischemic injury is central to the pathogenesis of heart disease, stroke, and trauma. It occurs when cells are partially or completely deprived of their blood supply. Infarcts typically have areas ranging from complete, or nearly complete, ischemia at the center to partial ischemia at the periphery. Recent studies have also indicated the potential importance of incomplete recovery of flow in the microcirculation following relief of ischemia which is apparently at least partly due to ischemic effects on vascular endothelium.

Following initiation, three phases exist: 1) a reversible phase, 2) a transitional phase where the cell dies or passes a point of irreversibility, and 3) a phase of necrosis. The duration of the reversible phase is highly dependent on temperature and tissue type.

Currently much effort is being devoted to the study of the critical intracellular events that lead to the point of irreversibility. The problem is difficult because so many cellular functions are altered or arrested during this period.

Several lines of evidence indicate that the solution lies in the realm of two closely related membrane phenomena—energy conservation and ion transport. In the mitochondrion these two functions seem to be inseparably related and in the cell membrane ion transport represents a major locus of energy utilization. Very rapidly following ischemia, the mitochondria cease functioning as the supply of oxygen becomes limiting. This results in rapid depletion of cellular ATP levels, which is reversible in this phase. In many cells, glycogen and glycolytic intermediates are utilized, with the resulting accumulation of lactate and reduction of cellullar pH. Almost simultaneously, changes appear in the mitochondrial inner membrane that are associated with increased permeability and uncoupling of oxidative phosphorylation and mitochondrial swelling. Recent studies using x-ray microprobe analysis indicate that important ion shifts occur in the mitochondrial inner compartment at this time. The respiratory assemblies seem to remain intact, while alterations in inner membrane lipid appear to correlate with altered permeability. Later, at about the time of the point of irreversibility, mitochondria are incapable of responding to a pulse of oxygen by extruding protons; such changes may be the result of altered lipid–protein interactions.

Plasma membrane changes also occur which no doubt also play an important role in ischemic cell injury. During the reversible phase there are marked ion shifts since the membrane pumps are inactive. These include a rise in cell Na^+ and Ca^{2+} and a decrease in K^+ and Mg^{2+}. K^+ losses are often extremely rapid and readily reversible, while loss of Mg^{2+} is a relatively late event that may be intimately involved with loss of viability. Eventually the cell membrane pumps responsible for the delicate balance are irreversibly lost and become a limiting factor. Furthermore, passive permeability of cell membrane may also be altered. Further studies will be needed to clarify these points. It has also become quite evident that during reflow following ischemia, or in areas of partial ischemia, much greater ion and water shifts may occur. These may be of great importance *in vivo*, for example, in the myocardium where they may relate to the production of fatal arrhythmias.

During the necrotic phase the rate of cell change is much slower. One of the hallmarks of this phase in all cells and tissues in a variety of species studied is the presence of large flocculent or amorphous densities in the

mitochondrial matrix. These, according to recent evidence, represent denatured protein and should be clearly distinguished from mitochondrial calcification which, in passing, does not occur in completely ischemic areas but rather at the edges of infarcts or following reflow. Recent data suggest that release of hydrolytic enzymes from lysosomes is a late event, occurring during the necrotic phase and therefore apparently not responsible for initiating loss of reversibility. Similarly, although inhibition of macromolecular synthesis occurs early in the initiation phase, it does not seem to relate to the loss of viability since complete inhibition of protein or nucleic acid synthesis does not result in acute cell death—a fact also shown by classic and recent enucleation experiments on eukaryotic cells.

In summary: It can be said that the critical events following ischemia involve ion regulation and energy conservation by cellular membranes; increasingly these functions are being found to be inseparable. The key event in the loss of reversibility seems to involve a defect in these functions that is incapable of being repaired—even when blood flow is restored. Much current evidence favors a role of ion movements in the critical events.

The conference, considering future directions of basic and applied research on ischemic cell injury, largely limited its discussions to myocardial ischemia and recommended the following: a) continued emphasis on basic research aimed at identifying the critical event(s) leading to irreversible injury and cell death and finding better methods for localizing early infarcts, e.g., in the myocardium using methods such as x-ray microanalysis and b) the development of therapeutic interventions aimed at reducing infarct size, including 1) increased substrate delivery, 2) calcium antagonists, 3) agents such as mannitol to protect vascular endothelium, 4) agents such as hyaluronidase which may improve oxygen diffusion, and 5) agents which control the inflammatory response and stabilizers of cell membranes.

Cardiovascular Diseases

The pathologist is in a uniquely appropriate position to contribute to studies of human disease in general and cardiovascular disease in particular, situated as he is between basic science and clinical medicine. It is reasonable to expect that his collaborative efforts as a basic scientist working with clinicians, or as a "clinician" working with basic science techniques, will have an increasing impact in the future. There has been a remarkable proliferation of new diagnostic procedures in cardiovascular medicine, including infarct scanning, echocardiography, cineangiocardiography, coronary arteriography, and serum isoenzyme analysis; and of

apparently effective therapeutic approaches, both medical and surgical. The pathologist should be able to a) monitor the predictions made by the new diagnostic tools and the success of the new therapeutic techniques, b) recognize important human heart disease problems and study their pathogenesis in animal models, and c) by utilizing appropriate basic science techniques to study human disease specimens acquired either by biopsy or postmortem. Clinical–pathologic collaborative efforts such as have been afforded by the MIRU (myocardial infarct unit) operations, now supported as SCOR (specialized center of research) units by the NIH, should increase and may be expected to lead not only to interdepartmental collaboration but also to interinstitutional studies on a nationwide basis.

Areas of cardiovascular research to which pathologists have made significant contributions in the recent past and which can be predicted to be of increasing future importance include the following: a) Studies of atherosclerosis in which new approaches have been made by studies of the monoclonal mutant nature of the intimal plaque, the role of endothelial cell injury, factors affecting smooth muscle proliferation in different vascular segments, regression of atherosclerosis in experimental animals, and the role of cell surface LDL receptors in fibroblast cholesterol synthesis. b) Methods to protect the ischemic myocardium involving attempts to limit tissue damage following coronary occlusion, and thus prevent the main cause of death after myocardial infarction—that is, pump failure. These methods include use of adrenal corticosteroids, hypertonic mannitol, beta blocking agents, intraaortic balloon counter pulsation, and oxygen treatment. The no-reflow concept is of interest in the understanding of this problem. c) Studies of the cause of sudden death. d) Clinical pathologic correlation studies of the conducting system of the heart. e) Recognition and definition of the various cardiomyopathies, including effects of alcohol, catecholamines, and virsuses. f) Development of techniques to diagnose early myocardial necrosis such as clinical isoenzymes (CPK and LDH); g) postmortem histochemical, potassium/sodium ratios; and "wavy" fibers. g) The definition of a myocardial infarct as a variant of subendocardial necrosis, myocytolysis, and myofibrillar degeneration and its relation to coronary artery sclerosis and thrombosis (what comes first—coronary thrombosis or myocardial infarction?). h) The role of viruses and immunopathologic factors in heart disease (for example in Dressler's syndrome). i) Nature of "floppy value" syndrome. j) Mechanisms of dissecting aneurysm of the aorta. k) The pathology of small arteries. and l) Host reactions to biomaterials used and being developed for intracardiac prostheses.

As a final statement of future directions and needs in cardiovascular

pathology, we should recognize the shortage of well-trained cardiovascular pathologists.

Environmental Pathology

Research in environmental pathology is receiving rapidly increasing interest from scientists as well as the general public. Such studies are on the interface between pathology and many other disciplines. Research in environmental pathology should emphasize the detailed study of disease processes associated with occupation, medical therapy (iatrogenic diseases), trauma, forensic pathology, and toxicology. Special attention should be paid to possible geographic or temporal specificity; the nature of injury; synergistic or additive multifactorial effects; host factors (genetic, racial, age); host response; and finally repair and recovery mechanisms.

Increased collaborative efforts between various disciplines appropriate to the study of environmental diseases—particularly epidemiology, toxicology, and pathology—should be encouraged. Although much of the environmental pathology research is being done by veterinarians and scientists without a background in human medicine, the field needs workers with a medical pathology background.

The Clinical Laboratory as a Resource for Research by Pathologists

Although there is nationally an extremely large investment in clinical laboratory services, there is a poor understanding of the value and significance of laboratory tests which constitutes a serious defect in medical practice. Overall, clinical laboratories are poorly utilized for research, if at all, despite the important fundamental and practical values to be obtained from such investigative studies. The reasons for this include fragmentation and the takeover of laboratories by clinical departments which lack the background and disciplines involved in this most effective use. This has occurred as a result of neglect of clinical laboratories by many pathology departments and their overconcentration in anatomic pathology.

More research aimed at a better understanding of "normal" laboratory values is needed. This should include the recognition and significance of compartmentation, the recognition of constant rates as opposed to servo (feedback) mechanisms; in short, the important area of "human chemical physiology." A second area of increased thrust should include the significance of multivariant screening by cluster analysis with an aim to reverse the overutilization of conventional tests in determining causes of certain conditions; for example, hypercalcemia. The benefits of such studies are essential to improvement of medical practice.

There should also be increased effort to translate basic research methods toward clinically applicable forms. Similarly, newly described laboratory methods must be critically analyzed for specificity and diagnostic validity.

The conference recognized the unique importance of the clinical laboratory and other investigators, particularly in that materials can be obtained serially. Research on immunology and tissue typing should be explored in relation to the extensive basic animal studies.

Newer Conceptual Approaches to the Autopsy as a Research Resource

The image of the autopsy service should be improved by the support of the senior faculty and by assigning experienced residents. Where possible, the physical facility should be brought closer to the clinical service to foster interaction. Regular conferences should be held to discuss and review materials.

The thinking and orientation of the faculty have to be changed in order to be aware of the possibility of biologic studies on autopsy tissue. Fixation for light microscopy should not be the only measure undertaken. Full use should be made of all the resources which modern biology has made available in the performance of autopsies in an academic setting.

II. Education in Pathology

Undergraduate Teaching and the Transition of the Medical Student Into a Pathologist

Courses in anatomic and clinical pathology provide a transition between basic science and clinical medicine. Although these courses may offer practical information, they also provide the student with fundamental insights into the morphologic and biochemical mechanisms and the manifestations of disease and, in so doing, have a subtle influence on his eventual decision-making, whether as a clinician or pathologist. The background defines the physician as a professional and clinical scientist rather than as a clinical technician. Secondly, the ability to interpret data in an anatomic or clinical pathology laboratory is immeasurably improved by knowledge of the mechanism by which the data are obtained. Finally, the type of knowledge obtained from pathology courses provide a foundation for continuing education throughout the physician's professional life. This latter area, incidently, is one in which pathologists should become more involved.

Among the dominant recent deleterious developments in teaching patterns which continue to influence the impact of pathology on the student are a) The 3-year curriculum (now on the wane?). b) Diminishing time in

the curriculum being utilized for learning pathology (and most other basic sciences). c) Decreasing time for basic science electives. d) Increasing emphasis on multidisciplinary teaching of pathology and other basic sciences combined with clinical subjects such as clinical pathophysiology. e) Increasing effort to develop "family practice" oriented curriculum. f) Increasing use of techniques and methods that insulate the teacher from the student.

At the same time, several approaches have been found to offset some of these current trends in medical education and to increase the student's appreciation of pathology and interaction with pathologists. These include a) The enrichment of premedical (college) biology curricula by courses taught by pathologists. b) Employment of some premedical students in both diagnostic and research laboratories under conditions providing close personal day-to-day contact with the pathologist. c) Project oriented research apprenticeships in undergraduate elective courses leading to a "degree with honor" for particularly capable and interested premedical students. d) The extension of pathology teaching, both "required" and "elective," throughout the medical school years utilizing pathobiology and immunopathology in the first year; clinical pathophysiology and related electives in the second year; surgical pathology, OB-GYN pathology, pediatric, and perinatal pathology, etc., in the third year; and pathology clerkships and teaching apprenticeships in the fourth year. e) Utilizing (employment) of premedical and medical students as weekend and evening "dieners"—i.e., autopsy assistants—under conditions in which there is close contact between the senior pathologist, the pathology resident, and the student. f) Utilization of fourth year medical students as teaching assistants for courses in cellular pathobiology, clinical pathophysiology, elective autopsy courses, etc., under conditions in which there is close contact between the senior pathologist and the student.

A course in general pathology must be taught to the medical students during the preclinical years. Information relevant to pathology can and should be contributed by basic and clinical scientists in other fields. However, the pathologist (anatomic and clinical) does have a special and necessary point of view and approach, and this should be the controlling force in such a course. Some exposure to specific organ pathology should occur during the preclinical years. In clinical pathology, the students should be taught how to use the clinical laboratory effectively, including optimal selection of tests, their interpretation, and how to deal with the multitude of data to be requested and received from the clinical laboratory. They should also understand how this information correlates with basic science.

There are many ways in which pathology teaching can be extended into the third and fourth years. These include elective courses in the various subspecialties of pathology, clinical pathologic conferences, and various elective clerkships. While performing their clinical clerkships, students should be continuously exposed to the discipline of pathology as it relates to their patients. Students should be welcome in the various research laboratories to perform elective research projects. Excellent courses in clinical laboratory utilization should be developed.

Photographs, although useful, cannot adequately substitute for microscopic slides, electron micrographs, or gross specimens. Similarly, some exposure to the clinical laboratory itself should occur so that students do understand how data are obtained, although they need not learn how to perform most tests or acquire detailed practical proficiency. Autopsies play an important role in undergraduate pathology teaching, and it is highly desirable that medical students participate in this activity.

There are definitely not enough high caliber students entering into careers in academic pathology. An effective mechanism for attracting good students is by having stimulating teaching programs and, most important, by providing opportunities for frequent in-depth exposure to pathology and creative pathologists throughout all years of medical school.

Training of Residents and Fellows

A pathology training program should be based on an assessment of the current status of clinical medicine, the current role of pathology in research and teaching, and on provision for services and the projected role of pathology in these areas in 5 to 10 years in the future. The problems of reorienting our training programs to meet present and future needs are difficult yet resolvable; the time remaining is short but adequate if bold, imaginative, cooperative, and concerted actions are taken. For example, establish programs and pathways for multiple areas of subspecialty training; provide time for research training and subspecialty training as an integral part of the program; in certain subspecialty areas provide an opportunity for interdigitation of anatomic and clinical pathology at an appropriate point in the program; provide sufficient staff members to reflect the subspecialty requirements of pathology and to provide sufficient time for research by the individual staff members; create imaginative approaches to the autopsy service which will fulfill present day and future training and research needs.

The current estimates of manpower shortages in pathology are definite underestimates in terms of future needs (*Fed Proc 35:1963, 1976*; *Am J*

Clin Pathol 65:909, 1976). A major reason for the increase in manpower needs is the requirement for subspecialization in pathology. Future programs should have maximum flexibility so that pathologists for clinical practice or academic environments can be produced by the same general or core program. Although the American Board of Pathology currently allows substantial flexibility in its requirements, unfortunately the interpretation of these requirements has resulted in a somewhat stereotyped 2 + 2 year type of program. There is still, and will continue to be, a significant need in this country for generally trained pathologists in community hospitals. Laboratory research or at least the research approach should be part of resident training. The need for a year in clinical medicine was discussed and although not formulated into a recommendation, the desirability of this for many being trained in general pathology as well as the need for increased communication and understanding between pathologist and clinician was emphasized.

PhDs in Pathology

PhD programs in pathology are a valuable source of additional biomedical personnel to help meet the needs for interdisciplinary exploitation of clinical pathology materials essential to fundamental biomedical research. They would also provide a strong link with other basic science areas, thus promoting interdepartmental as well as interdisciplinary collaboration among the faculty. It was pointed out that PhDs in pathology could also find employment in departments of biology, pharmacology, biochemistry, and other basic sciences as well as in government and industry. There are numerous job opportunities, and unemployment is said to be virtually nonexistent for PhDs in pathology.

In the light of these needs, it was felt strongly that PhD pathology training programs should be expanded. No effort was made to describe a comprehensive curriculum, but it was the consensus that the PhD pathology student must have a minimum of core courses in general pathology and cell biology, as well as exposure to clinical material through pathologic conferences and seminars. Specific curricula should be developed within individual departments and would include advanced courses in pathology in areas which reflect the specific strengths of the staff (e.g., immunopathology, membrane pathology, carcinogenesis, etc.) as well as graduate level courses in subjects such as immunology, molecular biology, biochemistry, genetics, microbiology, and biostatistics. Graduate courses available in other departments should be utilized where appropriate, but the disease-oriented training, which is the essential feature of the pro-

gram, would be carried out throughout the program under the direction of the Department of Pathology. To familiarize the students with these activities, rotations under the direction of a member of the Department of Pathology would constitute a major part of the program.

The PhD in pathology should be considered a primary basic degree, to be followed by further postdoctoral training (as residency training follows the MD degree). The postdoctoral training would be essential in providing various tracks for the PhD pathologist, creating an opportunity for further specialization in divisions of clinical, anatomic, and experimental pathology. There appear to be adequate postdoctoral training opportunities for individuals obtaining PhDs in pathology.

It seems appropriate that MD pathologists and PhD pathologists would function in teams in which their services and research interests would be meshed. These well-trained PhDs in pathology could help satisfy the anticipated need for additional academic pathologists, as indicated by current manpower estimates. It is not anticipated that the PhD in pathology would be involved in the practice of medicine.

Combined MD–PhD Training

The attainment of a PhD, either subsequent to or in conjunction with a MD, may or may not provide any advantage in terms of employment or financial reward. At present the second doctoral degree is not necessary, although it may be desirable. This may not be the case in the future when formalized documentation may be required by some regulatory body. Research skills could be obtained either through training culminating in a PhD or by extensive full-time research. PhD training does provide a rigorous format which develops attitudes and scholarly approaches towards scientific investigation and an alternative approach to problem solving unlike that obtained through medical education. For those individual trainees who choose an area of research requiring extensive course work, they might as well take these courses for credit and fulfill the requirements for a PhD.

Financial support for trainee activities can best be met through federal grants or awards such as the National Research Service Awards, both institutional and individual, and interdisciplinary training grants in pathobiology at predoctoral and postdoctoral levels.

The discipline in which the PhD degree is sought would be dependent on the skills by the trainee. In job placement, most scientists are going to be evaluated on the extent and quality of their training and experience rather than on the basis of the area in which they chose to matriculate.

Technical Training of Assistants to Pathologists

The great demand for Pathologist's Assistants far exceeds the supply. In this country, there are presently six degree programs and approximately 30 assistants are graduated each year. However, there is still much variation in the curriculum among the various programs. A Pathologist's Assistant is a professional person who is qualified by academic and practical training to provide service in anatomic pathology under the direction of a qualified pathologist who is responsible for the performance of the assistant. A recent survey of 37 graduates shows that 29 assist in autopsies, 18 examine gross surgical specimens, 17 are involved with administration, 8 with teaching, 1 with cytology, and 1 with histology. Many assistants have multiple duties.

A development of uniform standards for training programs was considered highly desirable. It was thought that the minimum academic level should be the BS degree and that requirements for admission should be either the AA degree or equivalent experience. A strong accrediting agency which would set high standards for programs would in turn influence the requirements for certification, and such standards for accreditation should be set before considering certification.

There is a continuing, growing need for qualified Pathologist's Assistants trained in standardized degree programs. The need for more such assistants corresponds to the present and projected shortage of pathologists and coincides with a related change in the modern approach of the pathologist.

Patterns of Organization and Support of Departments of Pathology for Training

Departments of Pathology must be organized to meet their prime objectives. Because of competition for the limited supply of facilities, support, and time, objectives must be clearly visualized and ordered in priority. There are organizational needs to reflect their far-ranging missions. Most departments of pathology do not have sufficient staff, space, and money. The result has been either a weak, diffuse response at all levels or a response in strength in a restricted area, either in the basic science or clinical application areas of responsibility.

Since the search into the basic mechanisms of disease, using all the tools of biochemistry, biophysics and other fundamental sciences, has only started and, also, since the application of science and technology to the control of human disease is likely to grow in attractiveness and power, pathology's opportunities in both of its major sectors is loaded with promise. The departments of pathology must reassume leadership in all

areas of pathology in order for this promise to begin to be met. A well-balanced clinical mission will be able to most vigorously exploit these opportunities and to provide this leadership.

We are entering an era of stringent governmental control over the health care sector in general, and over medical education specifically. The number of house staff physicians, the scope of training programs in primary versus tertiary care, the approved training institutions and their geographic distribution as well as the salary levels will all be subject to regulatory controls outside academic institutions. A most significant challenge we face is preserving the quality and integrity of the education, research, and service programs of our pathology departments in the face of these forces. In the future, the percentage of residency positions in primary health care, which does not include pathology, will probably increase. The limited choices for support for training academic pathologists in the next decade will include a) increased utilization of National Research Service Awards and institutional training grants from NIH, which will require some reorganization of department activities; b) increasing use of departmental funds (income for opening training opportunities); c) support from research grants and contracts to establish investigators for limited periods; d) medical school support for training of academic pathologists to allow a qualified candidate to pursue scholarly activities outside the PhD programs; and e) mobilization of private resources for training support.

Because various departments and schools have differing needs and objectives, it was not considered appropriate to give general recommendations that would apply to all institutions. A variety of approaches now exists in the organizational patterns of departments of pathology for insuring excellence in their training programs, each of which has its own advantages, but also often times reflects unique local problems of resource allocations.

Continuing Education of Academic Pathologists for a Changing Future

The variety of methods by which academic pathologists can meet their needs in continuing education includes activities of professional societies, books and journals, seminars, appropriate use of sabbaticals, and the programs of federal agencies such as the National Institutes of Health and the Armed Forces Institute of Pathology. Although there are adequate opportunities for continuing education in the field of pathology, there is need for a periodic compilation by a central clearinghouse or agency which would provide for easy scheduling and realistic planning and budgeting of time. Particular emphasis should be placed on strengthening

opportunities for continued education in clinical pathology and its subspecialties, particularly in the academic setting.

There is a need for more retreats and courses such as those at the Given Institute. The need for in-depth instruction in areas in general pathology for faculty who are required to teach in areas outside of their own special interests could be met by this mechanism. Continued development of new programmed instructions, study sets, and audiovisual materials in the academic setting for use by both students and faculty should be encouraged. In general, the medical literature adequately serves the needs of pathology and the academic pathologist. However, the present limitations of journals in the thorough documentation of data, tables, methodology, and photographs used to present new techniques leaves something to be desired. The adaptation of microfiche for providing tables and color photographs is a possible solution to the problem. Also, consideration must be given to the fact that individuals differ in the way(s) in which they learn most effectively.

Because of the rapid proliferation of new techniques and concepts, departments in schools should be encouraged to provide alternatives to the usual sabbatical leave. Leaves of 1 to 3 months' length should be considered, particularly for the younger faculty. This recommendation for short leaves would not replace the usual sabbatical, which is an essential part of academic institutions. The move on the part of some institutions to eliminate sabbaticals should be actively discouraged. In institutions in which their pathologists are not eligible for sabbaticals, such leaves should be encouraged.

Academic pathology needs more input into standards for relicensure and reaccreditation. Representatives to groups such as the Intersociety Council should represent the views and needs of the academic community in this arena. Concern was expressed that appropriate recognition be given for teaching activities, for research, and for other scholarly activities to fulfill requirements for continuing education on the part of the academic pathologist. Licensure and reaccreditation are a present reality and active participation by academic pathology in the development of standards and accrediting methods would prevent their being subjected to inappropriate evaluation. Adequate staff and support must also be provided for academic pathologists to meet the increasing instructional needs in the continuing education of all physicians.

III. Discussion and Implementation of Plans

The challenge for the future lies in the credible reaffirmation and implementation of pathology's traditional role as the bridge between the

clinical disciplines and the basic sciences. The lines of the challenge were clearly drawn: pathology must compete as a basic science on an equal footing with its companion basic sciences and must compete as a clinical discipline in the terms of medical knowledge, service efficiency, and cost effectiveness with the other clinical disciplines.

The successful response to this challenge is going to require more flexible and imaginative patterns of development. Less than excellent research cannot be excused on the basis of the burdens of clinical responsibilities. Clinical service cannot be excessively broad and superficial—rather, it must provide the definitive understanding of the expert, and it must be done in an imaginative and efficient fashion. In addition to implementing new patterns of organization, outstanding people must be recruited into the field of pathology. To do this we must have exciting and intellectually sound training programs and the field must provide challenging and satisfying career opportunities. The achievement of these objectives, especially in a time of stable budgets, requires that we set priorities and that we realize the importance of the political process as well as the academic process in the pursuit of our goals.

In the historical evolution of pathology, few medical schools have committed the positions and the resources required for a viable basic science department. The hospitals have often sought to obtain broadly ranging anatomic and clinical pathology services from a small group of people; hence, they have not committed the resources for an adequately staffed department and for the development of specialization within the department. To a considerable degree, this situation has been abetted by the emergence of the large teaching hospital, which has taken on many aspects of its own life that are not necessarily related to the academic aspirations of the university.

The delineation between the university phase and the hospital phase of medical education has not been clearly drawn. The university phase consists of the purely academic training in college and in the basic medical sciences during medical school, while the hospital phase consists of undergraduate and postgraduate clinical training. Pathology has a role in both phases and must be organized in the manner to develop each one adequately. In practical terms, this means that pathology must have the space and budget that the other basic sciences have within the medical school, and it must have adequate support for personnel and facilities in order to develop a range of specialty services within the hospital setting. Both components of pathology must be closely interrelated without one's being dominant over the other, otherwise they cannot provide adequate interchange and stimulation to act as a scientific, educational, and service

bridge. This balance will require a dichotomy of organization that must be skillfully managed so that a schism between the basic science and hospital roles of pathology will not be created. Some feel that this is probably best done through two divisions—Experimental Pathology and Hospital Pathology—within the same department. The two divisions should have separate funding and should have some clearly defined and distinct goals as well as some shared goals.

As part of the development of pathology as a basic science, PhD programs in experimental pathology should be strengthened. The graduates of such programs have an important role in the academic component of pathology and in widely ranging areas of research in government and in industry. Although pathology must always be hospitable to scientists trained in other areas who want to enter the field, it must always have strong and reputable training programs in experimental pathology. The emphasis in experimental pathology is on the study of disease mechanisms, and the techniques utilized are selected from a wide range of the basic sciences. Training programs in pathology should provide broad instruction in various scientific disciplines plus intensive experience in the selected area(s) which would reflect the scientific expertise of the particular department. This type of program requires skillful management so that rigor in scientific training will be maintained while the perspective of the student will not be unduly narrowed.

The clinical activities of pathology have been greatly hampered by the large quantity and variety of service demanded from relatively few people. While there is always a role for the generalist in any field of medicine, increased specialization within the field of pathology is long overdue. The way in which scientific and clinical advances have been made in medicine necessitates that the pathologist specialize in order to provide authoritative clinical services and to add new knowledge to his field. In the training for this specialization, a broad background should not be neglected in the early years of the pathologist's education. Also, clinical experience, especially that related to the pathologist's field of specialization, is an important component of his training.

These admonitions are nowhere more important than in the field of clinical pathology. The management expertise that is required to run a service dealing with a high volume of testing is considerable if the service is to be viable. On the other hand, clinical pathology has been dominated by undue preoccupation with the management approach, and there has been little appreciation of the tremendous potential for basic research and clinical investigation that it provides. Planning for the growth of clinical pathology in the future must address both the improvement of its aca-

demic base and the continued development of new tests and new methodologies that are needed for more sophisticated diagnoses and for monitoring therapy. The only way in which the staggering increase in the volume of testing can remain economically feasible is by employing automated methods and more incisive tests. The need for more research and for an increased quantity and variety of tests must be met with strict attention to their costs and with the full realization that controls on reimbursement rates are probably going to become even more stringent. This situation presents a considerable challenge to the clinical pathologist which, if it is not met creatively and effectively, presents grim alternatives: either clinical pathology will be lost to other fields of medicine and to nonphysicians or the great technologic benefits of modern medicine, many of which involve laboratory tests, will not be available for patient care because of prohibitive costs.

As is true in many fields of medicine, the great facilitator of progress over the past 20 years has been support by the National Institutes of Health. In some cases, including that of pathology, funding has been obtained on a departmental basis, and this type of funding allowed broadly based developments without attention to specific objectives. It is clear that these days are over. Funding from the National Institutes of Health is going to be even more carefully restricted to research and to training in research. Support for clinical training will have to come from a mix of hospital and patient care monies.

The emphasis on obtaining support from the National Institutes of Health will be on excellence and breadth of scientific approach. These trends are illustrated by the National Institute of General Medical Sciences' programs in Cellular and Molecular Basis of Disease and in Basic Pathobiology. The programs are clearly of special interest to pathologists, but until now they have not attracted as much interest from pathologists or groups led by pathologists as is desirable. In addition, considerable funding comes through support for categorical research such as that in cancer, immunology, and virology. Approximately 37% of the funds awarded by the two pathology study sections go to departments of pathology, and 5 to 15% of the funds dispensed by other study sections play a prominent role in funding departments of pathology. This base of research funding must be expanded by the development of appropriate programs within departments of pathology and by clear selection of research areas where a critical mass of people can be assembled in order to compete on the basis of scientific excellence at the national level. There are ample opportunities for training in the form of institutional and individual postdoctoral training grants, research career development

awards, and medical scientists training programs. Departments of pathology must develop programs that attract outstanding trainees; this again means conscious development of excellence in certain areas and recruitment of an adequate number of faculty members to form a critical mass for research and teaching.

The emergence of these new and very clear guidelines are going to have a substantial effect on the structure of departments of pathology. Pathologists individually and departments of pathology collectively must consciously select certain areas of research in which they are going to concentrate. It is no longer feasible to have each person within a department working in a separate area, since this mode of operation will not lead to the development of the critical mass needed for excellence in research and research training. The old attitude of pathology's encompassing everything must be clearly set aside, and the selection of research priorities must consciously be made and implemented.

A most important task facing academic pathology at present is to organize an effective way in which it can have reasonably unified voices with which to speak on matters on interfaces with other areas of medicine and with which to influence the formulation of national biomedical policy. There must also be a forum to discuss the problems concerning academic pathology and to scrutinize continuously what is being done to implement the recommendations made by this Conference and by other groups.

As its most important recommendation, this Conference unanimously proposed the establishment of a group for coordination and implementation on a continuing basis of the proposals adopted at this Conference and to foster the goals of academic pathology, as discussed above. It was recommended that this group have representation from the major national groups concerned with academic pathology as well as the Pathology Study Sections. Appointed representatives should have at least 10 years of academic activity ahead of them. This group, in cooperation with others, would provide an increased effectiveness in promulgating and achieving the goals of academic pathology. Although other societies are working on some of the problems facing the future of academic pathology, there is a need for more help of a coordinated nature.

Another major recommendation dealt with the critical manpower needs in academic pathology. The current estimates of manpower needs (*Am J Clin Pathol, 65:909, 1976*; *Gill TJ III, Fed Proc 35:1963, 1976*) may well be underestimates of existing needs and may not project adequately for the future. The goals for the future should be based on realistic estimates of the research and educational needs of a well-balanced academic department of pathology and on realistic estimates of the number of personnel

needed to provide the hospital service expected. Much larger departments are needed on the university side to attain the critical mass to develop excellence in research, which will attract considerable outside support, and many more pathologists are needed on the clinical side to develop the subspecialization required for the delivery of proper medical services and for the development of new services. The future manpower needs for academic departments of pathology can be established and justified by several different methods. However, it is important that such estimates be made soon so that a rational approach for the development of adequate manpower can be proposed and nationwide standards can be set.

A clear message of the conference was that pathologists must act together *now*, through both academic and political processes, to achieve the goals of academic pathology.

Participants and Guests at the Conference

Robert E. Anderson, *University of New Mexico School of Medicine* (S)
Edward R. Arquilla, *University of California, Irvine, College of Medicine* (R)
J. Douglas Balentine, *Medical University of South Carolina College of Medicine*
Edward A. Barker, *University of Washington School of Medicine*
Klaus G. Bensch, *Stanford University School of Medicine*
Ellis S. Benson, *University of Minnesota Medical School—Minneapolis* (S)
Colin M. Bloor, *University of California, San Diego, School of Medicine* (R)
Kenneth M. Brinkhous, *University of North Carolina School of Medicine* (M)
John D. Broome, *State University of New York, Downstate Medical Center, College of Medicine* (M)
L. Maximilian Buja, *University of Texas Health Science Center at Dallas, Southwestern Medical School* (R)
James M. Byers III, *University of Arizona College of Medicine*
J. R. Carter, *Case Western Reserve University School of Medicine* (S)
A. Bleakley Chandler, *Medical College of Georgia School of Medicine* (R)
John A. D. Cooper, *President, Association of American Medical Colleges* (guest speaker)
Elgin C. Cowart, Jr., *Armed Forces Institute of Pathology*
J. E. Craighead, *University of Vermont College of Medicine* (M)
Vittorio Defendi, *New York University School of Medicine* (S)
Shirley G. Driscoll, *Harvard Medical School* (R)
Alden W. Dudley, Jr., *University of South Alabama College of Medicine* (M)
Robert H. Ebert, *Dean, Harvard Medical School* (guest speaker)
Nelson Fausto, *Brown University Program in Medicine* (R)
Martin H. Flax, *Tufts University School of Medicine* (M)
Leo T. Furcht, *University of Minnesota Medical School—Minneapolis* (R)
Thomas J. Gill III, *University of Pittsburgh School of Medicine* (S)
Stanley Goldfarb, *University of Wisconsin Medical School*
Louis D. Green, *Meharry Medical College, School of Medicine* (R)
Donald B. Hackel, *Duke University School of Medicine* (S)
Gordon R. Hennigar, *Medical University of South Carolina, College of Medicine*
Rolla B. Hill, Jr., *State University of New York, Upstate Medical Center, College of Medicine* (M)
Leonard Jarett, *Washington University School of Medicine*
Peter Jatlow, *Yale University School of Medicine* (M)

Lewis D. Johnson, *Emory University School of Medicine* (R)
Raymond T. Jones, *University of Maryland School of Medicine*
David G. Kaufman, *University of North Carolina School of Medicine*
Thomas H. Kent, *University of Iowa College of Medicine*
Thomas D. Kinney, *Duke University School of Medicine* (M)
Ruth L. Kirschstein, *National Institute of General Medical Sciences* (guest speaker)
Werner H. Kirsten, *University of Chicago Pritzker School of Medicine* (S)
Arthur Kornberg, *Stanford University School of Medicine* (guest speaker)
Paul E. Lacy, *Washington University School of Medicine* (S)
Charles T. Ladoulis, *University of Pittsburgh School of Medicine*
Alvin E. Lewis, *University of California, Davis, School of Medicine* (M)
Daniel S. Longnecker, *Dartmouth Medical School*
Malcolm H. McGavran, *Baylor College of Medicine* (M)
Wolfgang J. Mergner, *University of Maryland School of Medicine,* (R)
Charles W. Moncure, *Medical College of Virginia Commonwealth University, School of Medicine* (R)
Azorides R. Morales, *University of Miami School of Medicine*
Sigurd J. Normann, *University of Florida School of Medicine* (R)
Peter C. Nowell, *University of Pennsylvania School of Medicine* (S)
J. Lowell Orbison, *University of Rochester School of Medicine and Dentistry* (M)
David L. Page, *Vanderbilt University School of Medicine*
Bernard J. Panner, *University of Rochester School of Medicine and Dentistry* (M)
James R. Patrick, *Medical College of Ohio at Toledo* (R)
Stanley F. Patten, *University of Rochester School of Medicine and Dentistry* (M)
George D. Penick, *University of Iowa College of Medicine*
Bruce S. Rabin, *University of Pittsburgh School of Medicine*
Alan S. Rabson, *National Cancer Institute, National Institutes of Health* (S)
James A. Robb, *University of California, San Diego, School of Medicine* (R)
Russell Ross, *University of Washington School of Medicine* (S)
Umberto Saffiotti, *National Cancer Institute, National Institutes of Health* (M)
Andrew J. Saladino, *University of Maryland School of Medicine*
Charles H. Sander, *Michigan State University College of Human Medicine*
Dante G. Scarpelli, *Northwestern University Medical School* (S)
John A. Shadduck, *University of Texas Health Science Center at Dallas, Southwestern Medical School* (R)
Herschel Sidransky, *University of South Florida College of Medicine* (R)
Henry Simpkins, *University of Colorado School of Medicine*
David E. Smith, *National Board of Medical Examiners*
Bernard E. Statland, *University of North Carolina School of Medicine*
Wellington B. Stewart, *University of Missouri—Columbia School of Medicine*
Robert E. Stowell, *University of California, Davis, School of Medicine* (S)
Harold E. Taylor, *University of Ottawa Faculty of Medicine*
Louis B. Thomas, *National Cancer Institute, National Institutes of Health* (M)
David D. Thompson, *Director, New York Hospital* (guest speaker)
Frank M. Townsend, *University of Texas Health Science Center at San Antonio Medical School*
Benjamin F. Trump, *University of Maryland School of Medicine* (S)
Julien L. Van Lancker, *University of California, Los Angeles, School of Medicine* (S)
James A. Waldron, *Vanderbilt University School of Medicine*
Nancy E. Warner, *University of Southern California School of Medicine*
Marjorie J. Williams, *Veterans Administration Central Office* (R)
Robert W. Wissler, *University of Chicago Pritzker School of Medicine* (S)
Raymond Yesner, *Yale University School of Medicine—Veterans Administration Hospital* (S)

Following the names of participants, (S) designates invited speaker; (M), moderator; and (R), recorder of panel discussion groups