National Library of Medicine

Programs and Services

Fiscal Year 1989

U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES

Public Health Service
National Institutes of Health

Further information about the programs described in this administrative report is available from:

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Cover: MEDLINE, a close cousin of the *Index Medicus* begun by Dr. John Shaw Billings in 1879, is used in thousands of medical libraries in the United States. In NLM's own reading room, Billings keeps a watchful eye over succeeding generations of students and health professionals. This full-length, colorful portrait of NLM's first director, in Army uniform and academic gown, was painted by artist Cecilia Beaux in 1895.

National Library of Medicine Programs and Services Fiscal Year 1989

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PREFACE

Fiscal Year 1989 saw important advances in a number of the Library's programs:

- Two new AIDS databases (Specialized Information Services)
- A new major NLM component (National Center for Biotechnology Information)
- Artificial intelligence (Lister Hill Center)
- Restructured resource grants (Extramural Programs)
- The new Toxic Chemical Release Inventory database (Specialized Information Services)

Grateful Med® continues to be improved, and by the end of the fiscal year the Library announced the appearance of a version for the Apple Macintosh.

Complementing Grateful Med is the evolving Unified Medical Language System. The first major product of UMLS™ research is the Metathesaurus-1™, described in the last section of the chapter on Library Operations.

There are many other highlights throughout the report, but I will draw the reader's attention to two in particular: the completion of a study of MEDLINE® use in clinical practice and the appearance of Improving Health Professionals' Access to Information, a report of an outreach planning panel headed by Dr. Michael DeBakey to the Board of Regents. Both are described in the Special Initiatives chapter.

The outreach report emphasizes the importance of collaboration between the NLM and institutions at all levels of the Regional Medical Library Network. I would like to take this opportunity to express my appreciation to all those in the Network whose outreach on our behalf makes the programs and services of the National Library of Medicine known throughout the health professions.

Donald A.B. Lindberg, M.D.
Director

CALENDAR OF EVENTS — FISCAL YEAR 1989

1988
October 6-7: Board of Regents
October 27-28: Literature Selection Technical Review Committee
November: "Going, Going, Gone," preservation exhibit and poster
November: ELHILL 3.3 implemented
November 1: Lecture: "Biotechnology in Forensic Medicine"
November 3-4: Biomedical Library Review Committee
November 4: National Center for Biotechnology Information established
November 21-22: Outreach Planning Panel meeting
November 29: NLM Honor Awards Ceremony
December 14-15: Unified Medical Language System contractors meet at NLM
December 20: Lecture: "Oncogenes, Growth Factors, and Cancer"

1989
January: New resource grants for information access and systems
January: *Index Medicus®* begins publication in two parts
January: *AIDS Bibliography* becomes monthly publication
January: Grateful Med Version 4.0 released
January 3: Exhibit: "The U.S.P.H.S.: The Last Hundred Years"
January 13-14: Outreach Planning Panel meeting
January 23: New TOXNET file: Directory of Biotechnology Information Resources
January 26-27: Board of Regents
January 30: New TOXNET file: Environmental Teratology Info. Center Backfile
February 2-3: Literature Selection Technical Review Committee
February 10: "Hospice and Its Role in Society," lecture by Mary Lindberg
February 21: Friends' reception for Claude Pepper in the Capitol
March 2-3: Outreach Planning Panel meeting
March 8-9: Biomedical Library Review Committee
March 14: Lecture: "Problems in Map Assembly of the Human Genome"
March 17: Friends' reception to honor centenary of the P.H.S. Commissioned Corps
March 20: Dr. Louis W. Sullivan, new HHS Secretary, visits NLM
April: *A Catalogue of Seventeenth Century Printed Books in the NLM* published
April 3: Exhibit: "History of Neurosurgery"
April 28: Visit by Dr. Lu Rushon, Head of Chinese MEDLARS Center
May 1-2: Board of Scientific Counselors
May 30: Lecture: "Tracking Human Immunodeficiency Viruses"
June 2: New TOXNET file: Environmental Mutagen Information Center Backfile
June 6-7: Board of Regents
June 8-9: Literature Selection Technical Review Committee
June 13: "Peer Review in Scientific Journalism," lecture by Dr. David A. Kronick
June 14-15: Biomedical Library Review Committee
June 19: New TOXNET file: Toxic Chemical Release Inventory (TRI)
June 21: Planning Panel on Electronic Imaging meeting
June 26-27: Institutional training grant directors meet at NLM
August: New NLM film, "Pathways..."
September 14-15: Literature Selection Technical Review Committee
September 15: Macintosh version of Grateful Med released
September 18: New MEDLARS databases: AIDSTRIALS and AIDSDRUGS
September 21: Planning Panel on Electronic Imaging meeting
September 26: NIH Research Day

1989 SPECIAL INITIATIVES

Last year's report described five special initiatives—the NLM Long Range Plan, Biotechnology, Outreach, the Unified Medical Language System, and Activities Related to AIDS. With the establishment within the Library of the National Center for Biotechnology Information this "special initiative" has been converted into a permanent and continuing program within the Library that will have now have its own chapter in this report. Progress on the Unified Medical Language System is described this year in the Library Operations chapter.

The special initiatives reported for Fiscal Year 1989 are Outreach, a Critical Incident Technique study of MEDLINE, and Activities Related to AIDS. These cross-divisional subjects are of continuing special importance to the NLM.

Outreach

On June 6, 1989, the NLM Board of Regents reviewed and approved the final report of a study on how health professionals use the National Library of Medicine. The Board commissioned the study in 1988 as a follow-up to the Library's Long Range Plan and asked Dr. Michael E. DeBakey to chair the effort. The pioneering heart surgeon and long-time proponent of improved medical information services was joined on the panel by 30 leading medical educators, scientists, health professionals, medical librarians, and marketing executives. The purpose of the Panel, which met three times in 1988-89, was to consider how to promote awareness of and usage of the NLM's products and services for the benefit of biomedical research and health care delivery.

The panel expressed its concern that NLM's extensive information resources and computerized retrieval services were not being used to maximum effect by physicians and other health professionals. The panelists noted especially the difficulty faced by rural health professionals in keeping abreast of modern medical advances—advances reported in the medical literature cited in the Library's immense databanks. The panel agreed with the October 1987 statement by the Senate Committee on Appropriations that the Nation's investment in biomedical research can be maximized by expanding the NLM's computerized retrieval services and the Regional Medical Library Network.

The panel's major recommendations:

1. The existing 3,000-member Regional Medical Library Network, for more than 20 years an efficient conduit for medical information for health professionals, should forge a new relationship with the National Library of Medicine whereby it can act as a "field force" in bringing the NLM's products and services to the individual health professional. In further support of the RML Network, the NLM should expand its program of "access" grants to community-based health institutions to enable them to connect electronically to national information sources. One such source, the National Science Foundation's scientific computing network, NSFNET, should be linked by NLM to health professionals who can benefit from its services.

2. NLM's ambitious program to integrate and manage a wide variety of computerized medical information sources located within selected academic institutions is highly promising but greatly underfunded. The originally planned number of projects (20) should be funded.

3. To deal with the critical need for community-based health professionals who are skilled in the use of modern information systems, the Library should expand its successful program of training and demonstration grants.

4. The NLM must investigate the information seeking habits of American health professionals, determine how best to increase their awareness of NLM information services, and put in place a permanent "feedback" mechanism to learn from users how these services can be improved. The resulting information can be used by the Library to expand its own research and development program to improve the information services.

The panel's formal report calls for an increase of $26 million to fund the Library's outreach programs in fiscal year 1990. The panel estimated that in 1990 the Library would require an increase of 17 in its staffing to carry out the recommendations.

R. Mehnert

Critical Incident Technique (CIT) Study

The NLM recently completed a study that seeks to answer the question: "Does MEDLINE make a difference?" The question is of fundamental concern to NLM

and medical libraries throughout the world, yet efforts to address it generally rely on scattered anecdotal reports and surveys that can characterize use only very broadly.

The study provides detailed insight into the impact of MEDLINE information on the decisions and actions of health professionals, and fills the long-felt need to document the practical value of MEDLINE for the biomedical community. The results reveal a remarkable diversity in the uses to which MEDLINE is put, and should be useful in such areas as online training, Grateful Med development, and especially for outreach to new user communities.

The Critical Incident Technique (CIT) is a systematic approach to obtaining and analyzing reports of behaviors leading to successful or unsuccessful outcomes on a task or process. The study was carried out with the assistance of the American Institutes for Research (AIR), an organization with extensive experience with the CIT methodology and its application in the field of medicine.

Telephone interviews were conducted with 545 MEDLINE users—65% end users and 35% users of mediated search services—to inquire about specific MEDLINE searches that were especially helpful or especially unsatisfactory. The sample was selected with an eye to getting full representation of all possible uses and impacts of MEDLINE information. End users in the study were identified from NLM's MEDLARS user records, and users of mediated search services were identified with the assistance of two Regional Medical Libraries, at the University of Texas and UCLA. The University of Texas also collaborated in conducting interviews with their users.

In all, the study generated detailed accounts of more than 1100 MEDLINE searches. A standard set of open-ended questions were asked of each person, but with slight variations depending on whether the search was effective or ineffective, and whether or not the interviewee was an end user. For the "End User / Effective Search" protocol, the following questions were asked:

- What was the situation that led you to do this search?
- What specific information were you seeking?
- Why did you choose to do a MEDLINE search instead of consulting some other information source you had available, such as textbooks, journals, or colleagues?
- How did you carry out this search to get the information you needed?
- What information did you obtain as a result of this search?
- In what specific ways was this information helpful in your decision making?
- What was the impact on the situation of having this information?
- What was the outcome of the situation (e.g., in terms of the patient)?

The primary results of the study are presented as detailed inventories, or taxonomies, of: (1) the reasons or motivations for needing information from MEDLINE; (2) why MEDLINE rather than some other information resource was used; (3) the impact of the information on medical decision-making; and (4) the impact of the information on the outcomes of the situation that led to the search. Accounts of searches that were not effective in meeting the information needs were also analyzed in order to understand the reasons behind these unsuccessful searches.

The "motivations" inventory provides insight into the varied circumstances in which information needs arise, while the inventory of impacts on decision-making provides evidence that ready access to MEDLINE information actually "makes a difference." In fact, many physicians indicated that personal access to MEDLINE has made such a significant difference in the way they practice that they believe all medical students should be trained in its use.

The study also shows significant impact on decisions and actions taken in the context of research, teaching, and administrative and medico-legal consulting activities. Administrative and legal uses, for example, involved decisions that affect the safe and effective operation of health facilities and services, the use of investigational drugs and medical devices, environmental safety, research funding, and legal decisions regarding physician, patient, and third party payor responsibilities.

The inventory of impacts on medical outcomes reinforces that MEDLINE has had important beneficial—even life-saving and limb-sparing—consequences for patients, as well as striking benefits in terms of reduced costs of care, the advancement of biomedical research, the quality of medical education, and the efficient functioning of health care institutions. Those not directly involved in health care and biomedical research might tend to assume that access to the journal literature is primarily of academic import. However, the detailed examples of how this information has played a critical role in the outcomes of health care indicates that the impact is much more than academic—in either sense of that term.

The study will be published as a technical report and made available from the National Technical Information Service.

B. Rapp

AIDS-Related Activities

The Health Omnibus Programs Extension Act of 1988 (P.L. 100-607) directed the Secretary of Health and Human Services to make sure that technical information on AIDS is available through a telephone information service to health care professionals and to develop databanks of AIDS-related research and information about

clinical trials on the treatment of AIDS.

NLM is identified in the legislation as having a major role in creating, maintaining, and making available the research-related databases. In addition, the Library's Director has been named to co-chair a Panel on Information Services of the PHS Executive Task Force on AIDS. This Panel will address the information services requirements of the legislation and continuing issues regarding AIDS-related information systems.

The Library currently sponsors three AIDS-related online databases on its MEDLARS network: AIDSLINE™, AIDSDRUGS, and AIDSTRIALS. AIDSLINE became publicly available in August 1988 and was described in last year's Programs and Services. The two new databases, AIDSTRIALS and AIDSDRUGS, are described in this report in the chapter on Specialized Information Services. The Library also continues to publish the monthly *AIDS Bibliography*—the latest in a series of AIDS "literature searches" that began in 1983.

R. Mehnert

LIBRARY OPERATIONS

Lois Ann Colaianni
Associate Director, Library Operations

The primary functions of NLM's Library Operations (LO) Division are to acquire and preserve the world's biomedical literature; to organize this literature through authoritative cataloging and indexing; to disseminate NLM's authoritative bibliographic records in publications, online files, and other machine-readable forms; to lend or copy documents in the NLM collection as a back-up to document delivery service provided by other U. S. biomedical libraries; and to provide reference and research assistance to health professionals. LO also performs research and evaluation projects relevant to its basic functions and maintains an active program of scholarship in the history of medicine.

A staff of more than 250 librarians, technical information specialists, library technicians, subject matter experts, health professionals and administrative support personnel carries out LO's programs and services. The LO staff is organized in four main divisions: Bibliographic Services, Public Services, Technical Services, and History of Medicine; two special units: the Medical Subject Headings Section and the Regional Medical Library Program office; and a small administrative group in the Office of the Associate Director.

Planning and Management

In FY 1989, LO Division Chiefs, Section Heads, and their assistants reviewed and revised the LO Operational Plan, identifying specific objectives in support of the recommendations in NLM's Long Range Plan, the new initiatives outlined by the Outreach Planning Panel, and the maintenance and enhancement of NLM's basic programs and services. Accomplishments related to the NLM Long Range Plan and LO's Operational Plan are described throughout this chapter.

Collection Development

Collection development encompasses establishing and revising literature selection policy, identifying and acquiring biomedical literature in all formats and languages, processing materials as they are received, assessing the effectiveness of the selection and acquisition process, and maintaining and preserving the collection. The NLM collection currently contains 1,916,752 printed books, journal volumes, theses, and pamphlets and 2,590,679 nonprint items, including audiovisuals, software, microforms, prints, photographs, and manuscripts (table 1).

Selection and Collection Assessment. NLM staff select materials for the NLM collection according to the guidelines in the Collection Development Manual of the National Library of Medicine. In the past year, the Library improved the mechanisms for reviewing, revising, and ensuring uniform interpretation of its selection policy. Collection development policy and guidelines for audiovisual materials were modified to conform more closely to guidelines for print materials. Selection guidelines for materials in subjects peripheral to medicine and for significant health related works written for a general audience were also revised and clarified.

Expanding on previous efforts to coordinate its collection development policy with those of the Library of Congress (LC) and the National Agricultural Library (NAL), NLM initiated regular meetings of the chief collection development officers of the three national libraries. One of the first products of this increased cooperation was the development of a joint NLM / NAL / LC statement on collecting policy in the field of biotechnology.

In the past, NLM has conducted a limited number of ad hoc collection evaluation projects. In FY 1989, the Library developed a regular collection assessment program that will ensure a more systematic examination of how successful NLM has been in implementing its collection development policies and how well these policies serve the needs of health professionals and researchers. Specific projects undertaken this year included assessments of parts of NLM's collection in the fields of DNA sequencing, immunology, and paleopathology, a review of general chemistry journals held by NLM, and the beginning of a comprehensive evaluation of NLM's dermatology collection. Results to date indicate that NLM's serials collection is appropriately comprehensive in the fields of DNA sequencing, immunology, and paleopathology. The paleopathology study revealed some deficiencies in NLM's monograph collection in this field, which the Library has taken steps to remedy. Based on the review of general chemistry journals, NLM will cancel about $30,000 worth of subscriptions to titles which currently have little or no biomedical content.

Acquisitions. In FY 1989, NLM added 43,366 volumes and 477,747 other items (e.g., audiovisuals, microforms,

software, pictures, manuscripts) to its collection (table 2). Library staff received and processed 156,231 modern books, serial issues, audiovisual programs, and software packages. NLM's extensive rare book collection was enhanced by the addition of many significant works including Johannes de Ketham, Fasciculus medicinae (Venice, 1500); Joseph Grunpeck, Tractatus de pestilentiali scorra sive mala de Franzos (Nuremberg, 1496-97); William de Saliceto, De salute corporis (Leipzig, 1495); Nicolas Monardes' Segunda parte del libro de las cosas de Indias Occidentales al uso de medicina (Seville, 1571), an early account of drugs from the New World, such as tobacco and sassafras; and Eucharius Roeslin, Des divers travaux et enfantemens des femmes (Paris, 1536), the first dated French edition of a widely used textbook for midwives.

The Library also acquired several significant manuscript collections including the minutes of the Company of Physicians of Padua, Italy from 1382 to 1414; the archives of the Medical Society of the District of Columbia; correspondence and laboratory notebooks of Dr. Otto Schotte, eminent embryologist; and papers of the following distinguished individuals: Florence Mahoney, activist in the promotion of Federal funding for biomedical research, Trendley Dean, D.D.S., first Director of the National Institute for Dental Research and a pioneer in flouridation, Bertram Brown, M.D., former Director of the National Institute of Mental Health, Mike Gorman, medical journalist and activist, and Martin Cummings, M.D., former NLM Director.

Special efforts to expand NLM's collection of public health and biomedical posters continue to be successful; about 1,900 posters were acquired during the year. In 1989, the Library of Congress agreed to new procedures that will speed NLM's receipt of certain health sciences audiovisual programs deposited with the Copyright Office. NLM's acquisition process also benefited from several enhancements to the automated serials processing system.

Collection Preservation and Maintenance. NLM's preservation activities include: preserving and maintaining NLM's own collection; supporting the preservation of important biomedical literature not held by NLM; promotion of more permanent materials in new biomedical publications; and investigating new technologies for preservation of library materials. In FY 1989, NLM's preservation microfilming contractor filmed about 5.7 million pages of brittle books and serial volumes.

The Library borrowed 1,510 volumes from U. S. and foreign libraries to allow the microfilming contractor to film complete runs of brittle serials. A total of 119 rare books, manuscripts, and historical films from NLM's special collections received special conservation or preservation treatment in FY 1989. NLM awarded new contracts to review portions of the serial and book collection to identify brittle volumes to be microfilmed, to inspect the quality of preservation microfilms, and to store NLM's preservation masters off-site. The Library also commissioned a plan for improving the fire protection and security system for the historical collections. Automated support for binding and preservation microfilming of books was substantially improved.

The final report of the preservation needs assessment of U. S. biomedical libraries, conducted by the New York Academy of Medicine, was published by NLM as a technical report through the National Technical Information Service. Information from the survey assisted NLM in preparing the solicitation for the first round of national preservation projects. In FY 1989, preservation project contracts were awarded to Yale University Medical Library to microfilm the diaries of Dr. John H. Fulton, an internationally known scholar in physiology and medical bibliography, and to conserve and microfilm 25 manuscripts from the sixteenth to eighteenth centuries, and to the UCLA Louise Darling Biomedical Library to microfilm and provide phase boxes for 267 bound volumes of Persian and Arabic medical manuscripts. NLM is funding 50 percent of the cost of these projects; the recipient institutions are funding the remainder. A panel of historians, conservators, preservation specialists, and collection development specialists assisted NLM in reviewing the technical merit of preservation proposals received. NLM will refine the procedures for soliciting and reviewing preservation proposals based on this year's experience.

Other FY 1989 activities in support of the National Preservation Program included: developing a policy for distributing copies of materials NLM has preserved, collaborating with the Medical Library Association to publish a special preservation symposium in the *Bulletin of the Medical Library Association,* and distributing NLM's preservation exhibit, posters, brochures, and flyers to many health sciences libraries.

The Library continued its campaign to educate publishers and the biomedical community about the need to use acid-free paper in new publications to limit the growth of the preservation problem facing health sciences libraries. In FY 1989, the Library, in conjunction with the Permanent Paper Task Force appointed by the NLM Board of Regents, mailed a letter to all U. S. and some foreign publishers of journals indexed by NLM requesting information about their use of acid-free paper. Beginning in 1990, all *Index Medicus* journals reported to NLM as both printed on acid-free paper and including a notice to that effect will be specially flagged in the *List of Journals Indexed in Index Medicus,* the *List of Serials Indexed for Online Users,* and SERLINE®. A total of 333 (11 percent) of *Index Medicus* titles will include this flag in 1990. The Library's research in technologies applicable to preservation is described in the report of the Lister Hill Center.

Bibliographic Control

To provide authoritative and effective bibliographic control of the biomedical literature, NLM maintains and enhances the Medical Subject Headings (MeSH®) and the NLM Classification scheme for the shelf arrangement of library materials; catalogs biomedical publications in all formats; and indexes articles from selected biomedical journals.

Thesaurus. MeSH, the hierarchical thesaurus used in cataloging, indexing, and searching NLM's online databases, currently includes 15,846 subject headings. MeSH's supplementary chemical file contains about 53,000 additional terms, most of which are names of chemicals. To ensure that MeSH keeps pace with developments in biomedicine and changes in the usage of biomedical terms, NLM staff review, update, and modify the terminology as necessary. In FY 1989, 413 new MeSH terms and 1,063 new cross-references to existing terms were added for use beginning in 1990. Subjects in which the vocabulary was expanded included AIDS, molecular biology, ophthalmology, epidemiology, and health care technology. Changes to the health care technology vocabulary were the result of a special contract with the Council on Health Care Technology of the National Academy of Science's Institute of Medicine. The Council also provided expert review of proposed changes to MeSH vocabulary in the field of epidemiological research.

Other enhancements to MeSH included systematic editing of the tailored lists of allowable subheadings or qualifiers which are now attached to each MeSH heading and explicit identification of the relationship (e.g., exactly equivalent, narrower than) between each new MeSH cross-reference and the term to which it refers. Both of these changes provide information that will contribute to the development of the Unified Medical Language System (UMLS).

Arrangements were made to incorporate mappings previously established between MeSH and the Library of Congress subject headings in the first version of the UMLS Metathesaurus, which should be available for experimental use in 1990.

Cataloging. NLM's cataloging operation provides original cataloging of new works added to the Library's collection, updates the automated files of NLM's cataloging and name authority records, and maintains the NLM Classification, which is used to assign a shelving location to each cataloged item based on its principal subject. In FY 1989, NLM cataloged a total of 18,733 books, serials, nonprint media, and Cataloging in Publication (CIP) galleys, using a combination of NLM staff, contractors, and interagency agreements with the Library of Congress (table 3). The inventory of uncataloged books was reduced by 1,327 to a total of 7,868 items, most in languages other than English.

Progress was made in improving bibliographic control and access to items in the historical collections. The project to convert the remaining records in the History of Medicine Division's Name Authority File to machine-readable form was completed. Country of publication data were added to the automated cataloging records for the majority of pre-1801 imprints, providing an important new access point to these records for scholars. Beginning in 1989, HMD staff began assigning MeSH headings to newly cataloged nineteenth century works.

A joint LO / Lister Hill Center project to create machine-readable cataloging records and linked videodisc images of all items in NLM's historical picture collection is proceeding rapidly. Abbreviated machine-readable records have been created for all pictures, and procedures for producing both master negatives and videodisc copies of the pictures have been established and tested. Upgrading the machine-readable records to fuller format is under way and actual filming of the picture collection is nearly completed.

A new system for entering and maintaining cataloging data has been developed for full implementation in early FY 1990. It makes extensive use of personal computer workstations and will support downloading of MARC bibliographic records from the Library of Congress catalog files. Work continues on developing a prototype expert cataloger system that will focus initially on providing assistance with name authority work. The Technical Services Section of the Medical Library Association assisted NLM in selecting health sciences libraries to help identify the areas of the NLM Classification most in need of updating and enhancement.

Indexing. NLM's indexing operation involves selecting the journals to be indexed, keyboarding descriptive information and abstracts from the articles to be indexed, indexing the content of the articles, reviewing the accuracy of the keyboarding and indexing, and maintaining the citation databases to correct indexing errors and to annotate citations to articles that have been retracted, corrected, or called into question by commentaries.

The Literature Selection Technical Review Committee (Appendix 6) advises NLM on selecting journals to be indexed in MEDLINE and *Index Medicus.* In FY 1989, the LSTRC reviewed 363 journals, including groups of AIDS and biotechnology journals, and gave 75 of them a sufficiently high priority to warrant their immediate inclusion in MEDLINE and *Index Medicus.* On the basis of reports prepared by professional societies in the field of geriatrics and family medicine, the Committee recommended the selection of three titles in these fields for indexing and the deselection of three others. A LSTRC subcommittee has begun to develop written guidelines on the selection of journals to be indexed.

Almost 373,000 articles were indexed for MEDLINE

during the year; 62 percent contained abstracts (table 4). NLM now enters an English language abstract into MEDLINE for any indexed article in which one is present. NLM staff indexed 12 percent of the more than 352,000 articles indexed for *Index Medicus*; the rest were indexed directly by international MEDLARS centers, through arrangements made by them with U. S. companies, or by NLM contractors.

NLM continues to call attention to retracted or corrected articles cited in MEDLARS. This practice was expanded to include the linking of commentaries (for example, those that cast serious doubts on the reliability of the information presented) to previously indexed citations. In FY 1989, information about 16 retractions, 2,993 published errata notices, and 329 commentaries was added to MEDLARS files. In August 1989 NLM awarded a contract for assistance in linking commentaries to previously indexed citations. As a result, the number of such links added to the MEDLARS databases will increase substantially in FY 1990.

The Library has begun a study of how well NLM's indexing covers the significant points in articles as viewed by knowledgeable health professionals and researchers. In FY 1989, an NLM-wide study team designed the methodology and initiated a small pre-test. The first segment of the full study will focus on indexing of the biotechnology literature.

LO has begun collaborating with the National Center for Biotechnology Information (NCBI) in a pilot project to capture actual sequence data and other information useful to biotechnology researchers as a by-product of NLM's regular indexing process. These data will be incorporated into NCBI's information services and products.

Network Services

NLM's direct services to local and remote users include: (1) dissemination of authoritative bibliographic data in publications, machine-readable formats, and an online retrieval service; (2) reference assistance in response to visitor, telephone, and written requests; (3) provision of documents from the NLM collection to onsite users and to remote health professionals and researchers as a back-up to other U. S. libraries; and (4) direction of the Regional Medical Library Network, which seeks to equalize U. S. health professionals' access to biomedical information irrespective of their geographic location.

Publications. NLM's publications continue to be an important vehicle for worldwide distribution of the Library's authoritative descriptions of the biomedical literature. In FY 1989, NLM produced issues of 26 recurring indexes and catalogs including comprehensive publications such as *Index Medicus*, the *National Library of Medicine Current Catalog*, and the microfiche *Health Science Serials* and more specialized tools, such as the *Bibliography of the History of Medicine.* Some of the subject bibliographies are produced in cooperation with other organizations and distributed by them. The long-awaited *Catalogue of Seventeenth Century Printed Books in the National Library of Medicine* appeared in FY 1989.

There were several significant changes in the format or content of existing publications. Effective with the January 1989 issue, *Index Medicus* is issued in two parts to accommodate the addition of new journals to be indexed and the growth in the number of articles appearing in titles being indexed. At the same time, the Library announced the creation of an Index Medicus Editorial Board, with the NLM director as Editor-in-Chief.

NLM improved the *AIDS Bibliography* by enhancing its subject section and increasing its frequency to monthly. The *National Library of Medicine Audiovisuals Catalog* now includes cataloging records for NLM's historical films as well as its current audiovisual and software collection.

In FY 1989, NLM merged its Specialized Bibliography Series into the Current Bibliographies in Medicine (CBM) and also began including bibliographies produced by the History of Medicine Division and Specialized Information Services in the CBM series. As a result, more NLM-produced bibliographies are available on a single subscription from the Government Printing Office. Topics covered in FY 1989 issues of Current Bibliographies in Medicine include: therapeutic endoscopy and bleeding ulcers; sunlight, ultraviolet radiation and the skin; toxoplasmosis in man and animals; and the history of neurosurgery.

Due to lack of demand, NLM ceased publishing the *NLM Catalog Supplement* and *Health Sciences Audiovisuals,* both microfiche publications, with the 1988 issues.

A study has been begun of the current use of *Index Medicus* and *Abridged Index Medicus.* The purpose of the survey is to determine how these products are used, when and why they are consulted in preference to some form of MEDLINE, and how they and NLM's electronic products can be enhanced to serve users better. The Regional Medical Libraries assisted NLM in the design of the questionnaire, which was then pretested by ten hospital libraries. The RMLs are now surveying samples of *Index Medicus* and *Abridged Index Medicus* subscribers in their Regions. The Region 4 RML at the University of Nebraska will analyze the survey results.

Machine-Readable Databases. To provide the widest possible access to its authoritative data, NLM leases complete databases and subsets of selected databases in machine-readable form. Organizations leasing NLM data include commercial database vendors, international MEDLARS centers, academic health science centers, and a variety of other members of the information industry. These organizations then make NLM data available online or in CD-ROM products. In FY 1989, NLM distributed

more than 4,000 tapes of various databases to domestic and international licensees. New MEDLINE data are now available to licensees every two weeks. Tape license agreements were established with 16 additional institutions; there are now more than 80 organizations leasing MEDLARS data. At the end of the fiscal year, there were 9 commercially available CD-ROM products containing MEDLARS data. In May 1989, *MEDLINE on CD/ROM: National Library of Medicine Evaluation Forum* was published by Learned Information, Inc.

Online Services. NLM provides online access to 42 MEDLARS databases, including the MEDLINE and TOXLINE® backfiles. In FY 1989, the Library's online users accounted for a total of 331,000 hours of online usage, 5.9 percent more than last year. This figure does not reflect use of MEDLARS data on the computer systems of other domestic and international organizations that lease NLM's files. Tables 6 and 7 contain statistics on the number of searches done on each database.

The number of online codes authorized to use NLM's online system continues to increase rapidly. At the end of FY 1989, there were 30,933 active codes, an increase of 49 percent from the end of the previous year. The special student code program continues to be very popular. There are now 5,142 institutional and individual student codes. Individuals now account for 48 percent of all code holders. Seventy-one percent of the individuals who received new codes in FY 1989 indicated an intention to use the Grateful Med microcomputer front-end package to access NLM's online services.

About 17,000 copies of Grateful Med have been sold by the National Technical Information Service since the package was introduced in March 1986. Purchasers automatically receive new versions as they become available. Version 4 of Grateful Med for IBM PC and compatible microcomputers was issued in January 1989. Improvements incorporated in this version included: form screen access to more databases, additional help in selecting appropriate MeSH terms, a Bulletin Board System that allows users to send questions and comments to NLM, the ability to save searches to be rerun later, and support for the use of a "mouse." A tutorial disk developed to explain how to use Grateful Med effectively is now issued to all new or potential Grateful Med users. Work was completed on the first version of Grateful Med for the Apple MacIntosh microcomputer, to be released early in FY 1990. The Mac version will improve access to NLM's databases for an additional segment of the biomedical community.

In addition to enhancing Grateful Med, NLM also made improvements to MEDLARS databases, to the capabilities of ELHILL (the retrieval software used on NLM's mainframe computer system), and to the support mechanisms for NLM's online users. AIDSLINE, a database devoted to citations to the literature about acquired immunodeficiency syndrome, was expanded to include relevant citations from the HEALTH PLANNING & ADMINISTRATION and CANCERLIT® files as well as MEDLINE. DENTALPROJ, a database of ongoing dental research projects developed by the National Institute of Dental Research, became available on NLM's online services network in FY 1989. (See the chapter on Specialized Information Services for information about two new AIDS-related databases and about improvements to several others.)

The ELHILL command language was extended to facilitate the submission of the same search to multiple MEDLARS databases. Access to NLM's system via commercial telecommunications networks was expanded to include Compuserve and Infonet as well as Tymnet and Telenet. As part of its continuing effort to provide more convenient administrative arrangements, NLM now offers master account billing, which summarizes on one bill the usage for online codes issued to multiple users in a single institution. More than 70 master accounts have been established, covering more than 700 codes. The Library has also entered into experimental agreements with two institutions to test an annual flat-rate charge per online code.

As the number of individual users of NLM's online services increases, the number of requests for various types of user support services also increases. Questions received via the Grateful Med Bulletin Board and the telephone service desk range from simple inquiries regarding the range of databases available to complex equipment, telecommunications, or search strategy problems. In FY 1989 NLM analyzed service desk calls from Grateful Med users, messages left after hours on the service desk answering machine, and questions submitted on the Grateful Med Bulletin Board, in addition to the annual two-week survey of all service desk calls. The results of these analyses will be used in the design of automated tools to assist service desk personnel respond more rapidly and effectively to users' questions.

During the past year, NLM continued its efforts to expand awareness of Grateful Med and NLM's online services within the biomedical community. In addition to broadening its program of exhibits and presentations at meetings of health professionals and researchers, the Library trained a group of FASEB Summer Research Conference attendees to demonstrate Grateful Med and NLM databases to their colleagues at summer conferences in Vermont and Colorado. The Library also designed a special short course on the use of Grateful Med which is now offered regularly to NIH staff. The Basics of Searching MEDLINE manual was updated and reissued.

NLM continued its longstanding program of formal training classes for search intermediaries; in FY 1989 a total of 629 individuals received basic or follow-up training from NLM staff or one of the three Regional Medical

Libraries that have contracts with NLM to provide such training. Work was completed on the first version of MEDTUTOR™, a computer-assisted instruction package designed to help library and information specialists learn to search MEDLINE more effectively. MEDTUTOR is now available from NTIS. The Survey of Individual Users of MEDLINE on the NLM System, the report of a 1987/88 study, was issued by NTIS in January 1989.

Reference Services. During the past year, NLM received 61,840 requests for reference assistance, 64 percent from onsite users, 35 percent in telephone calls, and 1 percent in letters (table 8). Improved printed and video instructions in the use of specific reference tools and the introduction of "pathfinder" brochures designed to help onsite users find information have reduced the number of questions NLM receives from onsite users. Work has begun on an automated users' guide for onsite patrons that may further reduce the number of basic questions directed to NLM's reference staff.

In FY 1989, NLM improved service to onsite users by providing access to CD-ROM versions of the indexes to NTIS technical reports and the publications of the Government Printing Office. The Library also expanded onsite access to computer assisted instruction packages in the biomedical sciences. An inventory of the main Reading Room Collection resulted in relocation of many items and better procedures for maintaining records of what is in this collection.

Many remote users who call or write to NLM for reference assistance are not aware of biomedical information resources available to them locally or of the various federal information clearinghouses that serve the general public. In addition to providing some information relevant to the requestor's immediate question, NLM staff members also refer people to other sources of pertinent information. In FY 1989, the NLM Reference staff surveyed the Resource Libraries in the Regional Medical Network to update the directory of services available from these libraries. This directory is used by NLM and network members to assist users in finding nearby sources of biomedical information sources. In an effort to provide back-up reference service for other U. S. biomedical libraries, NLM now offers a search service covering a variety of foreign biomedical databases to which relatively few U. S. libraries have access. During FY 1989, the Reference Section distributed the initial version of MEDSTATS, an expert system designed to help health sciences library staff locate the sources of answers to statistical questions, to several other health sciences libraries for testing and evaluation. Arrangements were made to have the Health Sciences Communication Association publish in early FY 1990 the *Guide to Locating Patient Education Audiovisual Materials* developed by NLM's Reference staff.

Document Delivery. NLM's document delivery service provides materials to remote requestors as a back-up to the service provided by other libraries in the Regional Medical Library Network and also to onsite requestors who are seeking items in NLM's closed stacks (table 5). In FY 1989, NLM received 227,841 interlibrary loan requests, 11 percent more than the previous year. NLM filled 70 percent of the requests it received; if requests for which the requestor was unwilling to pay NLM's charge are removed from the calculation, the Library filled 77 percent of the requests it received. Seventy-seven percent of the requests received by NLM were routed by DOCLINE®, NLM's automated request generation and routing system. NLM received 3,364 requests via telefacsimile transfer; 1,481 of these were for materials needed for clinical emergencies and were processed within two hours.

At the end of the fiscal year, there were 1,819 DOCLINE participants. They entered more than 1.6 million requests into the system during the year, of which 92 percent were filled. DOCLINE is now routing serial requests based on more than 1,120,000 SERHOLD® records representing the holdings of more than 2,500 institutions. DOCLINE enhancements included enabling the use of unique identifiers for HEALTH citations in the automatic generation of requests, expanding the set of statistical reports for system users, and making it possible for NLM staff to send messages to DOCLINE users about other potential sources of requested items that are not available at NLM. NLM staff also developed plans for testing the automatic referral of requests for articles to DOCLINE from individual Grateful Med users. A new DOCLINE Manual was distributed to all system participants.

NLM received 186,513 onsite requests for documents in FY 1989, 11 percent fewer than the number received last year. Eighty-three percent of the onsite requests for materials from the NLM stacks were filled, 84 percent within 30 minutes of receipt. Since the implementation of NLM's automated patron registration and request logging system in February 1988, 16,041 people have registered to request documents onsite at the Library. In July 1989, NLM increased the contract support for document delivery to include photocopying of articles for interlibrary loan and the overnight onsite photocopy service.

Regional Medical Library Program. The purpose of the Regional Library Network is to improve and equalize access to medical information throughout the country by linking health professionals and researchers to the information resources they need—irrespective of their geographic location. The network currently has 3,010 members, including health sciences libraries of every size in all parts of the country. NLM's Regional Medical Library Program Office provides national coordination for the network.

In each of seven multi-state regions, NLM has contracted with a distinguished medical library to coordi-

nate a regional document delivery program, develop outreach services to areas without adequate information services, promote resource sharing among health sciences libraries, encourage and support the use of online services, and foster the development of innovative services to health professionals. The seven Regional Medical Libraries are supported by more than 120 large Resource Libraries, generally in medical schools, and many hospital and special libraries, individually and in consortia. During FY 1989, a PC-based automated system was developed to provide control over and access to key information about RML network members.

The RML Network plays a key role in NLM's outreach strategy. In the Special Initiatives section at the beginning of this report there is a brief description of the expansion of the Network's role in Outreach recommended by NLM's Outreach Planning Panel. The Panel's recommendations have been incorporated into plans for RML enhancement projects for FY 1990 and for the recompetition of the RML contracts which will begin next year.

The following are reports from each of the Regional Medical Libraries summarizing current outreach activities.

Region 1. In the Greater Northeastern Regional Medical Library Program outreach to health professionals this year has focused on exhibiting at health professional meetings and encouraging end-user searching, including end-user training by health sciences librarians throughout the region. The experience of RML staff in demonstrating Grateful Med at the New England Healthcare Assembly in Boston in March clearly indicated a fertile field for information about health sciences libraries in general and about NLM services in particular. RML staff members were surprised to be approached by hospital administrators who were unaware of whether or not their own hospitals provided library services, some of which were already active DOCLINE and MEDLINE participants.

More than 500 physicians and allied health professionals attended the Continuing Education meeting of the Medical Society of the State of New York, in New York City in September, at which Grateful Med was also demonstrated. While some visitors to the exhibit were already familiar with Grateful Med many were interested to know that TOXLINE and the cancer databases were also available via Grateful Med. Brochures with order forms were distributed, and at least one visitor wished to purchase GM on the spot. Physicians and medical educators attending a conference held at The New York Academy of Medicine in June were also very favorably impressed with GM's user-friendly menus, the cost of the package, and the capability of performing inexpensive searches.

In addition to the exhibits and demonstrations sponsored by the RML office itself, a large number of health sciences libraries in Region 1, both Resource and Area libraries and basic health sciences libraries as well, are including GM in their in-house end-user training program.

Outreach plans for the future are being addressed in an enhancement proposal which envisions direct contact with a segment of the health professionals in one state within the region, to test the feasibility of directly contacting physicians to learn their needs and make them aware of services already available.

Region 2. The Southeastern / Atlantic Regional Medical Library (SE / A RMLS), enabled by special enhancement project funding from NLM, expanded its outreach activities to health professionals during the past year. Through the "Impact of Regional / State Exhibits" Enhancement, the SE / A RMLS staff exhibited at the following meetings: The Maryland Academy of Family Physicians in Ocean City, MD; The Mississippi State Medical Association Annual Meeting in Biloxi, MS; The Florida National Dental Congress in Orlando, FL; and The Southern Medical Association 83rd Annual Scientific Assembly in Washington, D.C. Grateful Med sessions were taught at the Maryland Academy of Family Physicians and the Southern Medical Association. Each exhibit booth was devoted to publicizing the products and services of NLM, Grateful Med in particular, and introducing the attendees to the Regional Medical Library Network.

The SE / A RMLS and the West Virginia Hospital Research and Education Foundation have joined forces to improve access to health information for West Virginia's health professionals, especially its rural practitioners. Headed by Linda Jacknowitz, Project Director, the West Virginia CONSULT project's goal is to implement a computer-based information network. A cadre of librarians will travel throughout the state, demonstrating Grateful Med to West Virginia physicians.

Region 3. The primary outreach effort in the Greater Midwest Regional Medical Library Network has been directed toward exhibiting at five national and international health professional meetings. The meetings varied in type from the Medical Students' Association Regional Winter Conference to the 4th World Congress of the International Society for Diseases of the Esophagus. Region 3 also exhibited at the Midwest Chapter / Medical Library Association annual meeting in Indianapolis.

In addition to demonstrating Grateful Med, the exhibit staff distributed NLM fact sheets and RML materials. The volume and quality of booth traffic is significantly improved when Grateful Med or MEDLINE is mentioned by one of the program's speakers, covered in an educational seminar, or indexed in a guide to the exhibits.

The addition of a multilingual senior search analyst has been exceedingly helpful because so often attendees are from other countries. Availability of Grateful Med in other countries spurs interest by attendees. At one inter-

national meeting, particular attention was given to the professionals from England, Australia, and Sweden because the software is available in those countries. NLM fact sheets on Grateful Med and International MEDLARS Centers were distributed so that the health professional could return to their country and make the appropriate contacts.

Region 4. The Midcontinental Regional Medical Library Program (MCRMLP) uses a variety of advertising and direct marketing methods to inform health care professionals about the information services available from RML Network Member libraries.

As a first step, the MCRMLP staff identified a theme on which the remainder of the program would be built. "Real-life patients require real-life answers" was used on a new brochure, exhibit pieces, and an advertisement for health professional journals. The brochure, along with MCRMLP fact sheets and materials produced by the NLM, is used with the exhibit at meetings of health professionals.

The brochure has been mailed directly to groups of health professionals in three of Region 4's six states. Additional groups of health professionals will be targeted with direct mailings during the next year. The advertisement has been run once in each of three journals of state health professional associations. Future plans include placing the ad in consecutive issues of selected journals for more effective contact with health professionals.

The MCRMLP is measuring the effectiveness of each method of outreach by tracking telephone calls from health professionals following exhibits, the appearance of MCRMLP advertisements, and brochure mailings. Data collected will be used to determine which methods are the most effective in reaching health professionals.

Region 5. The South Central Regional Medical Library Program's Regional Advisory Committee (RAC) has formally appointed a Health Care Professional (HCP) Committee, the purpose of which is to involve health professionals more actively in regional activities. At their second meeting in the spring of 1989, the HCP committee agreed to pursue such activities as: submitting articles on information skills to five health care journals; developing a workshop / panel presentation on techniques for case-related teaching to be presented at the 1990 SCRG / MLA Meeting; developing standards for course content in Region 5 medical schools; preparing a library promotional fact sheet to be distributed to residency directors and librarians in the Arkansas AHECs; and requesting inclusion of information skills in current continuing education or accrediting instruments through contact with various health care professional organizations.

Region 5 has exhibited at the following three health care professional meetings: Texas Medical Association, Texas Hospital Association, and Texas Rural Health Association. Grateful Med was highlighted at each, and demonstrations were available at two of the exhibits. Response was enthusiastic at each. Also, a member of the HCP Committee and a member of the RML staff presented information about end-user searching and distributed NLM and regional publications at the UT Southwestern Medical Center Annual Internal Medicine Update.

There are currently two contract enhancements in Region 5. One is with the RML to assist with the NLM's effort to present exhibits at national medical meetings. The other was awarded through the RML to University of Texas Southwestern Library to assist with NLM's Critical Incident Technique study.

Region 5 has submitted an enhancement proposal to establish a link with the health care professionals in the Oklahoma City Area Indian Health Service (IHS). Many of these practitioners are located in underserved or rural areas. Objectives include developing an information service program, linking IHS practitioners to the University of Oklahoma Health Sciences Center Library for ongoing support of information services, and establishing information service nodes for practitioners in outlying service areas.

Region 6. Because of the geographic isolation of health professionals in the Pacific Northwest Regional Health Sciences Library Service (Alaska, Idaho, Montana, Oregon, and Washington), the PNRHSLS has concentrated promotional efforts on rural health professionals. During FY 1989 two projects were emphasized: the Transportable Electronic Library Enhancement (TELE) Project and the Quality Filtering Enhancement Project.

The TELE project is based on the premise that access to health information should be and can be, quickly available to health professionals wherever they may practice, whether in a metropolitan or a rural area. As a corollary, consultation and instruction on efficient information access techniques should also be provided where and when needed. The TELE Project Coordinator, Eve Ruff, provides that service over the phone, by electronic mail, and in person. Consultation is provided on all aspects of information access: software (e.g., Grateful Med), hardware configurations, and systems such as electronic mail and bulletin boards that have been created expressly for accessing health information.

Ms. Ruff has conducted nearly 40 demonstration and training sessions throughout the region, reaching more than 260 rural health professionals, librarians, and administrators. The service has proven to be a very effective means of reaching this underserved population. Many follow-up sessions have been requested for advanced training, and an extension of the project is under consideration.

The Quality Filtering Project is beginning in the fall

of 1989. (The full title of the project is "The Effect of Information Filtering on Physician Satisfaction with Clinical Information from the Library.") As part of this project, RML librarians will be trained to filter library information for quality, using objective criteria. Rural physicians who request information from the RML will receive, by telefacsimile transmission, either filtered or unfiltered information packages. Physician satisfaction will be assessed each time information is supplied. The costs of filtering will be weighed against the level of physician satisfaction. If the project is successful, a training program will be developed to enable the service provided during this test to be offered by librarians in other settings.

Region 7. The Pacific Southwest Regional Medical Library Service (PSRMLS) is involved in an outreach project in Arizona to increase the awareness of health professionals in that state about the variety of biomedical information resources available to them. The project has several components and involves many types of libraries throughout the state.

The first component involves a direct mailing to health professionals, publicizing the availability of information from Arizona's health sciences libraries. This will be sent to specifically targeted groups: nursing home administrators and public health personnel, groups which traditionally have not fully utilized library resources. As a second component, articles will be submitted to various Arizona health professional association publications, each tailored to that association's membership.

Another component of the outreach project is to develop an insert card for the PSRMLS health professional brochure. The card will list Arizona libraries willing to provide services to unaffiliated health professionals, along with a description of those services. The project's final component is the production of a statewide union list of audiovisual materials.

Special Onsite Programs

In addition to the reference and document delivery services provided to onsite patrons, NLM offers a variety of special programs and services to people who come to the Library in Bethesda, including guided tours, briefings on NLM's services and operations, and historical exhibits and symposia. NLM also sponsors a Visiting Historical Scholar Program and conducts a one-year training program for library school graduates with potential for leadership roles in health sciences information.

Public Tours and Briefings. Each year NLM entertains many visitors from throughout the United States and around the world. In FY 1989, LO staff members conducted 138 regular daily tours for a total of 445 visitors. The Office of Inquiries and Publications Management (Office of the Director) arranged special tours and orientation programs for 136 groups (1,624 visitors). NLM staff members also arranged special briefings on library programs and services for many individual visitors.

Historical Programs. The FY 1989 Visiting Historical Scholar was David A. Kronick, Ph.D., Emeritus Professor of Medical Bibliography, University of Texas Health Sciences Center, San Antonio. Each year a recognized historical scholar is selected competitively to spend 6 to 12 months at NLM to engage in research that will use the Library's collections, to give one or more public presentations, to assess segments of NLM's historical collection, and to consult with staff. Dr. Kronick used NLM's collection in his work on the development of the scientific medical journal in the seventeenth and eighteenth centuries. He presented a public lecture on the birth of peer review in scientific journals and a staff seminar on researching the history of medical and scientific journalism; he also assessed NLM's collection and records of early scientific journals.

In FY 1989, the History of Medicine Division prepared several special exhibits, presentations, brochures, and other materials, some in conjunction with the centennial of the Public Health Service Commissioned Corps. Major lobby exhibits were prepared on the history of the Public Health Service and on the history of Neurosurgery (with the American Association of Neurological Surgeons). The Library co-sponsored with several other NIH institutes and the University of California, San Francisco, a working conference on "AIDS and the Historian" and collaborated with the National Eye Institute on a second conference on the history of ophthalmology. Individual staff members continued their research using NLM's historical collections. Staff research was published in several publications and presented at invited lectures throughout the year.

NLM Associate Program. The NLM Associate Program is a one-year competitive program that provides library school graduates an opportunity to learn about NLM's operations, to gain a better understanding of the key issues facing all health sciences libraries, to use new information technologies, and to develop their skills by conducting special projects. Projects undertaken by Associates in FY 1989 included an analysis of service desk calls received from Grateful Med users, several collection assessment studies, an inventory of NLM's Reading Room Collection, and an analysis of the use of the DIRLINE file. Associates also have an opportunity to visit the other national libraries and various types of health sciences libraries or information centers and to attend professional meetings. NLM staff members continue to attend portions of the Associates' formal curriculum.

Six Associates completed the 1988/89 program. A seventh participated in the curriculum phase of the program only. Five of the group accepted or returned to

positions in academic settings; two chose positions in other federal agencies. Four new Associates began the program in September 1989.

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Unified Medical Language System

The Unified Medical Language System (UMLS) project is a major NLM research and development effort designed to facilitate the retrieval and integration of information from many machine-readable information sources, including descriptions of the biomedical literature, clinical records, factual databanks, and knowledge-based systems. The UMLS project is not an attempt to impose either a single standard vocabulary, a single standard record format, or a single medical knowledge base on the biomedical community. The UMLS approach assumes that diversity will continue to exist and seeks to provide products that can compensate for differences in the vocabularies and coding schemes used in different systems as well as for differences in the terminology employed by system users.

NLM staff members in Library Operations, the Office of the Director, and the Lister Hill Center coordinate UMLS activities undertaken by NLM staff and by the six university-based research groups which are working on the project under contract to the Library. In FY 1989, the UMLS project focused on the development of the initial versions of two UMLS components, the Metathesaurus and the Semantic Network. The Metathesaurus will be the central vocabulary component of the UMLS, containing terms from a variety of biomedical vocabularies and classifications.

The first version of the Metathesaurus, called Meta-1™ , will contain all terms in MeSH and DSM-III (the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders) plus a set of terms for clinical problems that occur frequently at four ambulatory care facilities. All SNOMED (Systematized Nomenclature of Medicine), ICD (International Classification of Diseases), and CPT (Current Procedural Terminology) terms that can be related to the base set by lexical matching techniques will also be included, as will LCSH (Library of Congress Subject Headings) terms for which the LO staff has established equivalent MeSH expressions. In FY 1989, preliminary versions of Meta-1 records were computed by Lexical Technology, Inc., one of the UMLS contractors, using machine-readable versions of MeSH, SNOMED, ICD, and CPT. The records are now being reviewed by subject experts under a contract specifically devoted to the editing task.

Every term in Meta-1 is assigned one or more semantic types or categories (e.g., PNEUMONIA is assigned the semantic type "Disease or Syndrome," STAPHYLOCOCCUS is assigned the type "Bacteria"). The UMLS Semantic Network will be a separate structure representing the valid relationships among the semantic types that describe the terms in the Metathesaurus. For example, the semantic type "Bacteria" will have a "can cause" relationship to the semantic type "Disease or Syndrome." In FY 1989, NLM staff and the UMLS contractors collaborated to define the set of semantic types to be used in labeling terms in Meta-1 and as nodes in the Semantic Network. Work is continuing on establishing the valid relationships among the semantic types. Both Meta-1 and the first version of the UMLS Semantic Network are expected to be available for experimental use in mid-1990.

In addition to the substantial progress on building these basic UMLS components, in FY 1989 the UMLS project resulted in the development of prototype systems, enhancements to existing systems, production of research tools, and studies that will provide insight into the information seeking behavior of NLM's user populations. Projects of particular interest included: the Psychtopix system developed and currently in regular use at Yale University Medical School to generate MEDLINE searches automatically from information in machine-readable psychiatric consultation records; the improvements to MeSH and Grateful Med described elsewhere in this report; the development by NLM of a test collection of user queries and retrieved MEDLINE citations with relevance judgments for use in evaluation of proposed UMLS capabilities; the collection and analysis of information about how Massachusetts General Hospital's MicroMeSH system is used to identify appropriate vocabulary and construct MEDLINE searches; and a study by the University of Pittsburgh of questions arising during clinical rounds.

Table 1.
Growth of Collections

Collection	*Previous Total (9/30/88)*	*FY 1989*	*New Total*
Book Materials			
Monographs:			
Before 1500	568	3	571
1501-1600	5,722	13	5,735
1601-1700	10,037	7	10,044
1701-1800	24,274	46	24,320
1801-1870	39,804	39	39,843
Americana	2,337	3	2,340
1870-Present	508,522	14,780	523,302
Theses (historical)	281,794	0	281,794
Pamphlets	172,021	0	172,021
Bound serial volumes	862,655	29,069	891,724
Volumes withdrawn	-34,348	-594	-34,942
Total volumes	1,873,386	43,366	1,916,752
Nonbook Materials			
Microforms:			
Microfilm reels	42,492	5,777	48,269
Number of microfiche	208,012	15,859	223,871
Total microforms	250,504	21,636	272,140
Audiovisuals	46,573	2,025	48,598
Computer software	119	125	244
Pictures	76,073	1,920	77,993
Manuscripts	1,739,663	452,041	2,191,704

* Revised figure

Table 2.
Acquisition Statistics

Acquisitions	*FY 1987*	*FY 1988*	*FY 1989*
Serial titles received	22,293	20,726	21,781
Publications processed:			
Serial pieces	124,898	133,226	137,849
Other	23,696	20,101	18,382
Total	148,594	153,327	156,231
Obligations for:			
Publications	$2,908,000	$3,495,123	$3,526,901
Included for rare books	($115,455)	($156,446)	($182,584)

Table 3.
Cataloging Statistics

Item	*FY 1987*	*FY 1988*	*FY 1989*
Completed Cataloging			
Full	13,869	14,567	11,985
Limited	4,785	5,721	6,748
Total	18,654	20,288	18,733

Table 4.
Bibliographic Services

Services	*FY 1987*	*FY 1988*	*FY 1989*
Citations published in MEDLINE	326,162	329,019	372,806
For *Index Medicus*	298,160	313,963	352,206
Recurring bibliographies	28	28	26
Journals indexed for *Index Medicus*	2,786	2,855	2,888
Abstracts entered	186,572	197,674	233,707

Table 5.
Circulation Statistics

Activity	*FY 1987*	*FY 1988*	*FY 1989*
Requests Received:	479,667	415,137	414,354
Interlibrary Loan	192,559	204,484	227,841
Readers	287,108	210,653	186,513
Requests Filled:	381,994	316,508	310,363
Interlibrary Loan	135,883	143,151	158,840
Photocopy	124,821	131,870	146,679
Original	9,423	9,810	10,753
Audiovisual	1,639	1,471	1,408
Readers	246,111	173,357	151,523
Requests Unfilled:	94,714	96,283	101,009
Interlibrary Loan	56,805	61,333	69,001
Referred	2,972	2,125	2,850
Returned	53,833	59,208	66,151
Reader Service			
Returned as unavailable	37,909	34,950	32,008

Table 6.
Online Searches

DATABASES	*FY 1987*	*FY 1988*	*FY 1989*
AIDSDRUGS	—	—	48
AIDSLINE	—	2,977	18,940
AIDSTRIALS	—	—	95
AVLINE®	11,357	11,937	11,989
BIOETHICS	7,410	7,888	8,196
CANCERLIT®	58,066	54,759	61,070
CANCERPROJ®	1,162	—	—
CATLINE®	145,525	160,129	157,783
CCRIS	2,608	2,894	3,060
CHEMLINE®	26,725	24,907	24,674
CLINPROT®	3,044	2,956	2,763
DBIR™	—	—	657
DENTALPROJ	—	—	121
DIRLINE®	3,887	6,107	7,271
DOCUSER	—	973	2,646
EMICBACK	—	—	331
ETICBACK	—	—	1,316
HEALTH	119,426	121,589	128,658
HISTLINE®	4,555	4,131	4,341
HSDB®	22,407	31,976	32,641
INFORM	184	146	115
INTROMED®	5,825	4,955	692
INTROTOX	146	43	—
MEDLINE	1,722,711	1,895,591	1,782,750
MED86	—	—	567,991
MED83	422,022	526,338	492,092
MED80	291,216	276,753	254,539
MED77	136,132	140,990	144,562
MED75	80,049	16,018	—
MED72	—	75,518	99,358
MED71	60,846	15,731	—
MED66	50,848	64,423	70,202
MESH VOCABULARY	15,693	20,158	20,542
NAME AUTHORITY	3,214	3,120	3,580
PDQRS	32,791	44,822	69,158
POPLINE™	21,085	20,849	22,534
REFLINE	—	31,967	38,799
RTECS®-ELHILL	8,938	2,703	—
RTECS-TOXNET	—	13,693	17,346
SDILINE®	37,241	38,956	39,812
SERLINE	44,835	49,137	53,532
STORED SEARCH	95	83	130
TOXLINE	73,630	68,398	71,101
TOXLINE65	—	—	5,202
TOXBACK76	13,228	—	—
TOXBACK65	9,388	—	—
TOXLIT™	3,520	24,171	20,877
TOXLIT65	1,439	8,742	7,087
TRI	—	—	12,158
YEAR86	302	201	2
	3,441,550	3,776,729	4,260,761

Table 7.
Offline Searches

DATABASES	*FY 1987*	*FY 1988*	*FY 1989*
AIDSLINE	—	5	191
AVLINE	178	208	126
BIOETHICS	27	34	38
CANCERLIT	5,272	3,726	3,842
CANCERPROJ	2	—	—
CATLINE	343	517	558
CHEMLINE	—	4	—
CLINPROT	2	3	2
DIRLINE	1	2	—
DOCUSER	—	—	1
HEALTH	11,596	11,173	11,516
HISTLINE	13	8	6
MEDLINE	10,871	8,960	6,115
MED86	—	—	7,380
MED83	18,376	13,862	8,823
MED80	16,582	11,014	5,971
MED77	10,730	7,332	3,830
MED75	7,606	1,320	—
MED72	—	3,141	2,440
MED71	4,979	871	—
MED66	3,227	2,757	1,510
MESH VOCABULARY	4	7	1
POPLINE	7,842	5,337	5,378
RTECS-ELHILL	11	—	—
RTECS-TOXNET	—	3	—
SDILINE	238,172	231,269	247,812
SERLINE	1	3	6
TOXLINE	14,060	15,474	12,731
TOXLINE65	—	—	35
TOXBACK76	561	—	—
TOXBACK65	516	—	—
TOXLIT	123	366	145
TOXLIT65	110	312	119
	351,205	317,708	318,576

Table 8.
Reference Services

Activity	*FY 1987*	*FY 1988*	*FY 1989*
Reference Section:			
Requests by telephone	25,883	26,429	21,481
Requests by mail	898	743	985
In-person requests	43,185	48,935	39,374
Total	69,966	76,107	61,840

Table 9.
History of Medicine Activities

Activity	*FY 1987*	*FY 1988*	*FY 1989*
Acquisitions:			
Books	162	125	127
Modern manuscripts	18,330	166,429	946,750
Prints and photographs	230	214	3,420
Processing:			
Books cataloged	150	442	346
Modern manuscripts cataloged	18,782	11,625	939
Pictures cataloged	38	138	0
Citations indexed	5,390	5,645	5,479
Pages microfilmed	21,836	48,774	27,140
Public Services:			
Reference questions answered	5,512	10,077	10,244
ILL and pay orders filled	2,880	3,607	2,406
Reader requests filled	9,996	10,416	8,309
Pictures supplied	5,494	6,642	6,045

SPECIALIZED INFORMATION SERVICES

Henry Kissman, Ph.D.
Associate Director

Background

It seems not a year goes by without some environmental event becoming the topic of scientific inquiry, political debate, and cocktail party chatter. This year has given us its fair share of grist for this mill: alar in apples, cyanide-tainted Chilean grapes, the spill of the Exxon tanker *Valdez*, continuing concern over the depletion of good upper atmosphere ozone and the surfeit of bad lower atmosphere ozone. These events have provided great opportunities for drawing battle lines between government agencies, industry, environmental activists, and other interested parties. But one thing all these groups agree on is the need for information.

The Toxicology Information Program (TIP), within NLM's Specialized Information Services Division (SIS), has long been a focal point for information collection and dissemination in the areas of toxicology, environmental health, and hazardous materials. Other government agencies, industry, and a concerned citizenry use its computerized information resources to get data upon which responsible decisions can be based.

The new Toxic Chemical Release Inventory (TRI) data bank, for example, provides data collected by the Environmental Protection Agency (EPA) on the annual estimated releases of toxic chemicals to our environment. This unique, never before available information is now readily accessible through SIS's TOXNET system. The data are already widely sought by local communities, industry, and regulatory agencies. The impact and interpretation of these data is proving controversial, as has been anticipated. TRI has been featured in newspapers and on radio and television broadcasts throughout the country. *USA Today* presented an exclusive three-part cover report (July 31-August 3) on "The Chemicals Next Door," based largely on TRI data. People may not agree about the meaning or consequences of these data, but TRI is the first step in satisfying their "right-to-know" about toxic chemicals in their communities. Further, TRI users automatically have access to all of the other NLM online services.

A number of new databases are being developed, as components of the TOXNET system, in collaboration with the Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR). These include EPA's Integrated Risk Information System (IRIS) and Genetic Toxicology (GENETOX), as well as ATSDR's Toxicological Profiles.

In FY 1989, SIS not only strengthened its resources and services related to toxicology information, but also created new files in rapidly changing areas such as biotechnology and acquired immunodeficiency syndrome (AIDS); these included DBIR (Directory of Biotechnology Information Resources) and databases containing descriptions of clinical trials for AIDS patients (AIDSTRIALS) and of the agents being tested in these trials (AIDSDRUGS).

Opinion polls show the public to be very concerned about the threats posed by hazardous chemicals in their homes, workplaces, and the general environment. Toxicology, biotechnology, AIDS—these are topics that will be investigated, debated, and discussed in the laboratory, on Capitol Hill, in State Houses and at home. As the new decade approaches, SIS will continue to embrace new information-related projects in these and other evolving areas of science.

Databases under ELHILL

CHEMLINE (Chemical Dictionary Online) is an online chemical dictionary and directory file which allows users to identify chemical substances via nomenclature and other identifiers, and to formulate optimum search strategies for other NLM files. Each chemical record has pointers to other files in the ELHILL and TOXNET systems that contain information about that chemical substance. CHEMLINE is updated every two months and regenerated annually. Originally made available in January 1974 with about 59,000 records, the file now contains more than 875,000 records describing chemical substances of biomedical or regulatory interest.

During FY 1989, the scope of CHEMLINE was increased to add coverage of all substances in the MeSH, the AIDSLINE files on ELHILL, and the ETICBACK file on TOXNET. To keep regulatory coverage current, the locator for the EPA Toxic Substances Control Act Inventory of Substances (TSCA) was updated to reflect the latest public version of this database. Data from all sources contributing to CHEMLINE were updated during the regeneration of 1989, including improvements in the coverage of pesticides and drugs of abuse. Preliminary work on a new NLM chemical dictionary and directory exclusively for the databases in the ELHILL system was begun.

TOXLINE (Toxicology Information Online) is an online bibliographic retrieval service produced by merging "toxicology" subsets from some fifteen secondary sources, including Biological Abstracts, Government Reports Announcement and Index (report literature), International Pharmaceutical Abstracts, and MEDLINE.

During FY 1989, the TOXLINE files were regenerated and restructured so that TOXLINE and its backfile, TOXLINE65, now contain data only from sources that do not require royalty charges based on usage. Information from Chemical Abstracts, which does involve payment of usage royalties, is used exclusively to create two other online files, TOXLIT and TOXLIT65. The four databases in the TOXLINE family of services now contain some 2,780,000 records, a ten-fold increase in the number of bibliographic records since TOXLINE was first made available in September 1972.

The TOXLINE regeneration also updated the MeSH vocabulary used to index the portion of the file derived from MEDLINE. It is expected that this same file structure will continue when the file is again regenerated and the MeSH vocabulary is updated in early 1990. Both TOXLINE and TOXLIT have a front and a back file, with the backfiles containing the pre-1981 citations.

Another new feature for TOXLINE this year was the addition of MeSH vocabulary to Biological Abstracts records added to TOXLINE since August 1985, when coverage by this environmentally oriented subfile was expanded substantially. SIS staff developed a program which maps Biological Abstracts' Concept Codes and Biosystematic Codes to the MeSH vocabulary. Terms from these codes and from MeSH are now found in TOXLINE records.

DIRLINE (Directory of Information Resources Online), is an online directory of organizations with information resources and subject expertise who are willing to provide information and help in response to inquiries. This database assists MEDLARS users by providing an alternative resource for information needs not met by bibliographic or factual databases. A contract to MeSH index the entire DIRLINE database began in 1989 and will be completed in early 1990. The availability of MeSH will facilitate online retrieval from DIRLINE.

AIDS-Related Information Activities

Acquired Immunodeficiency Syndrome (AIDS) is a major public health crisis worldwide. The World Health Organization estimates that as many as ten million people are infected with the human immunodeficiency virus (HIV), which causes AIDS. The NLM is contributing to the Government's efforts in combating this disease by expanding its information services in this area.

The Health Omnibus Programs Extension Act of 1988 (PL 100-607), passed by Congress in the fall of 1988, mandated the development of several AIDS-related information services, including a data bank on clinical trials and treatments. In response to that mandate, SIS working with NLM's Office of Computer and Communications Systems, has built two new databases for MEDLARS. AIDSTRIALS contains descriptions of investigational clinical trials being conducted to test the safety and efficacy of various agents against AIDS and AIDS-related diseases. The information contained in this database is provided by the National Institute of Allergy and Infectious Diseases and the Food and Drug Administration. A complementary database, AIDSDRUGS, contains descriptions of the agents being tested in the clinical trials. The information for AIDSDRUGS comes from published literature and includes adverse effects, chemical / physical properties, synonyms, and drug interactions.

TOXNET and its FILES

With funding authorized under the Superfund Amendments and Reauthorization Act (SARA) of 1986, SIS has worked for several years on information activities for the Agency for Toxic Substances and Disease Registry (ATSDR). These include file building and the creation of improved methods of access to information resources in the areas of hazardous wastes and emergency response. The continued development of the TOXNET system, the enhancement of the Hazardous Substances Data Bank (HSDB), and the development of a microcomputer workstation for chemical emergency response (see below) have been the predominant SIS activities under this collaboration.

During 1989, the TOXNET system added four new databases. They were: DBIR (Directory of Biotechnology Information Resources); EMICBACK and ETICBACK (the backfiles of the Environmental Mutagen Information Center and the Environmental Teratology Information Center databases); and the TRI (Toxic Chemical Release Inventory) data bank. TOXNET usage increased substantially this year, and usage of the TOXNET-to-ELHILL Gateway also set new records.

The Hazardous Substances Data Bank (HSDB) is also supported, in part, as a Superfund activity with cofunding from the ATSDR and NLM. Major enhancements included the addition of Express Updates with current literature from primary sources, and of Source Updates, i.e., data extractions from recent editions of standard literature sources, such as handbooks and textbooks. Both activities have significantly increased the amount of new data in the file, as well as the numbers of records enhanced with new data. Improvements in the methodology for building and reviewing records for metal and metal salts have increased the efficiency of these activities.

The Toxic Chemical Release Inventory (TRI) has quickly established itself as a file of major importance.

TRI is mandated by the Emergency Planning and Community Right to Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986). This database (TRI87) contains environmental release data for more than 325 chemicals, with the names and addresses of the industrial facilities reporting estimated releases during 1987. TRI87 became publicly available on June 19, 1989 with considerable media attention. Public interest and online usage have been extremely high. This file incorporates several new TOXNET features designed specifically for it: "novice" menus that allow inexperienced or infrequent users easy access to and friendly searching of the data bank and several powerful commands that allow numerical calculations and manipulations of the data by knowledgeable searchers.

The Chemical Carcinogenesis Research Information System (CCRIS) is maintained by the National Cancer Institute (NCI). This data bank contains test results from carcinogenicity, mutagenicity and tumor promotion studies. CCRIS has expanded this year with the addition of more than 1000 new chemicals.

The Registry of Toxic Effects of Chemical Substances (RTECS) is a data bank based upon a National Institute for Occupational Safety and Health file by the same name, which NLM has restructured and made available for online searching since December 1987. SIS has so far enriched 25,000 RTECS records (of 100,000 in all) with Chemical Abstracts Service (CAS) Registry Numbers.

The Environmental Mutagen Information Center (EMIC) and the Environmental Teratology Information Center (ETIC) files are bibliographic databases produced by the Environmental Mutagen, Carcinogen, and Teratogen Information Program of the Oak Ridge National Laboratory. The EMIC database includes citations to articles that deal with the evaluation of all agents, except ionizing radiation, for mutagenic activity. The ETIC database includes citations to articles concerned with teratology and developmental toxicology. The EMIC and ETIC databases are currently found, in part, as subfiles of TOXLINE. Production of these databases is funded by the ATSDR, the EPA, and NIH's National Institute of Environmental Health Sciences.

During FY 1989, the backfiles, EMICBACK and ETICBACK, were made available on the TOXNET system. A new "ETIC-like" database using MeSH, rather than the indexing terms used in the past, is being developed. Both front files, the new teratology / developmental toxicology database and the EMIC database, will now be developed and maintained on the TOXNET system. An advisory committee, the Teratology Information Users Group, is assisting NLM in developing the content of the new developmental toxicology database.

User Support Services

User support for all online files is an ongoing SIS function. User Guides for the CHEMLINE, TOXLINE, RTECS, HSDB, CCRIS, and DIRLINE files are made available as part of NLM's Online Services Reference Manual. A User Guide has also been prepared for the TRI data bank. In addition, a special files reference manual and other training materials were prepared, under SIS direction, by the Oak Ridge Associated Universities. Fact sheets for all SIS files and other related activities are routinely prepared. The TOXNET Brief Guide was reissued in April 1989. SIS continued to provide training on the use of its online files, both as a part of the MEDLARS Training Program, and for other users at special training sessions and at professional meetings.

The booklet, Health Hotlines, a compilation of organizations with toll-free telephone numbers taken from DIRLINE, was updated and redistributed in April 1989. These organizations provide information and services directly to requesters. This has been a very popular and sought-after service; more than 40,000 booklets have been distributed so far.

In addition, special training in the use of the toxicology files was provided, in conjunction with the ATSDR, to environmental health specialists from ATSDR and selected state agencies. This training is provided, under the direction of SIS, by Oak Ridge Associated Universities in Oak Ridge, Tennessee. In 1989 the program was expanded to train state health officials who in turn would provide training on the use of the NLM toxicology files in their home states. To date, representatives from health agencies in 38 states and two U.S. territories have been trained. In addition, individuals from 11 occupational health clinics and the seven organizational members of the American Minority Professional Health Schools have taken this training.

TOXLEARN™ , a microcomputer-based training program to teach librarians, information scientists, and other users how to search TOXLINE effectively, was issued in FY 1989. MEDTUTOR™ , a similar microcomputer-based training program for MEDLINE, was also completed. Perhaps the most important design feature of both TOXLEARN and MEDTUTOR is their systematic practice and diagnostic feedback. These programs provide an alternative or augmentation to formal classroom training.

Microcomputer Workstation

SIS is collaborating with the ATSDR to build a portable, microcomputer-based workstation that can provide information assistance to emergency response teams responding to hazardous chemical releases or spills. The operational prototype, known as ANSWER™ (an acronym for ATSDR / NLM's Workstation for Emergency

Response), consists of software modules designed to facilitate easy access to useful information by ERT members during emergencies.

The core modules of the Workstation are:

1. A CD / ROM-based database containing information on both hazard management and medical management.
2. A specialized database containing information gleaned from previous chemical emergencies.
3. A modified version of software (Micro-CSIN®) that facilitates searching of diverse remote online databases.
4. A facsimile facility to transmit information to and from an emergency event.
5. Access to weather information from the National Weather Service.
6. A report generation capability for editing, sorting, merging, and transforming retrieved data files.

The Workstation has been made available for testing to 13 sites, including selected state health departments and several poison control centers.

Biotechnology

The Seminar Series in Biotechnology has been continued, with presentations by a series of excellent and informative speakers. Videotapes of the talks were made and distributed to NLM's Regional Medical Libraries and to NLM-sponsored medical informatics training programs. Talks were given by Mr. James Kearney of the FBI on biotechnology in forensic medicine, by Dr. Stuart Aaronson from NCI on the biology of oncogenes, by Dr. Samuel Karlin of Stanford University on problems in map assembly of the human genome, and by Dr. Gerald Myers of the Los Alamos National Laboratory on the evolution of human immunodeficiency viruses. The tapes of this series are available for sale through the National Audiovisual Center (National Archives).

The Directory of Biotechnology Information Resources (DBIR) was first offered in January 1989 as an online file on TOXNET. Several months later it was added as a component file to DIRLINE. It is, thus, now available to the public on the Library's two major online systems. DBIR contains more than 600 entries describing many accessible resources in biotechnology and molecular biology. These resources include databases and services, organizations, repositories, reference publications, and sanctioned nomenclature committees. The Bioinformatics Department of American Type Culture Collection of Rockville, MD, continues as the contractor for this effort.

A survey of industry, regulatory agencies and public interest groups, evaluating the need for a publicly available data bank facility—labeled the Biotechnology Environmental Release Data Bank (BERD)—has been completed. The affirmative results of this survey are currently being evaluated by the interagency BERD Working Group, chaired by SIS. The Working Group will provide advice concerning the need for such a facility to the Office of Science and Technology Policy of the Executive Office of the President.

Information Services to Other Agencies

As described above, SIS continued to provide information support to the ATSDR by building and maintaining computerized information resources supportive of ATSDR's legislative mandates. These resources have also been of utility to communities in both the public and private sectors concerned with protecting human health and the environment.

NLM continues to maintain and deploy other systems of data and information sponsored by various Federal agencies. These include the Chemical Carcinogenesis Research Information System sponsored by the National Cancer Institute, Toxic Chemicals Release Inventory (TRI) and the Toxic Substances Control Act Submissions file (TSCATS), both sponsored by the Environmental Protection Agency, and the Hazardous Substances Data Bank (HSDB) sponsored, in part, by the ATSDR.

SIS provided the Deputy Chair which manages the Subcommittee on Information Coordination (SIC) of the Department of Health and Human Services' Committee to Coordinate Environmental Health and Related Programs (CCEHRP). SIS also represented NLM on CCEHRP's Subcommittees on Environmental Health Risk Assessment; Testing and Test Method Validation; and Research Needs; as well as the Interagency Task Force on Environmental Cancer and Heart and Lung Disease. SIS provided staff support to the National Institute of Environmental Health Sciences Working Group involved in the development of the structure and content of the legislatively mandated Fifth Annual Review of Carcinogens, the Annual Plan and the Review of Current DHHS, DOE, and EPA Research Related to Toxicology, which are prepared and distributed by the NIEHS' National Toxicology Program.

LISTER HILL NATIONAL CENTER FOR BIOMEDICAL COMMUNICATIONS

Daniel R. Masys, M.D.
Director

The Lister Hill National Center for Biomedical Communications (LHNCBC) was established by a joint resolution of Congress in 1968. The Center serves as an intramural research and development division of the National Library of Medicine. LHNCBC research programs apply state-of-the-art computer and communications technologies to the management of biomedical knowledge. Such knowledge can take the form of procedural rules found in expert systems, information in bibliographic and factual databases, as well as signals, images and sound. LHNCBC programs create innovative methods for acquiring, storing, retrieving, analyzing, communicating and presenting information to biomedical researchers and health care professionals.

A Board of Scientific Counselors meets to review the quality and contents of the intramural research programs within the Lister Hill Center. The Board is composed of scientific and technical experts (see Appendix 4 for a list of members) who are prominent leaders in the fields of medicine, computer science, engineering, and health professions education.

The Center is organized in five component branches:

- Computer Science Branch
- Information Technology Branch
- Communications Engineering Branch
- Audiovisual Program Development Branch
- Educational Technology Branch

In 1989 the Lister Hill Center's National Center for Biotechnology Information Branch was elevated to become a new division of the Library. Its activities are described in the next chapter.

Research Program Overview

The research and development programs of the LHNCBC fall into three categories:

1. Computer and information science as applied to the problems of the Library, of biomedical research, and health care delivery;
2. Biomedical image engineering, including image acquisition, processing, storage, retrieval, and communications; and
3. Use of computer technologies for health professions education.

Computer and Information Science

Computer Science Branch

The Computer Science Branch (CSB) performs basic and applied research in computer science and information science, concentrating on the application of artificial intelligence techniques to problems in the representation, retrieval and manipulation of biomedical knowledge. This involves the development of prototype systems and comprehensive models in research areas such as expert systems; natural language systems; machine learning; and automated indexing and cataloging for information classification and retrieval.

Research issues that are important components of CSB programs: knowledge representation, knowledge base structure, knowledge acquisition, the validation of automated consultant systems, the human-machine interface, the use of high-resolution graphics, interactive videodisc capability and the linking of knowledge-based systems to large-scale mainframe databanks. To facilitate such research efforts, CSB has an Artificial Intelligence Laboratory with Sun-4 and VAX file servers; several varieties of workstations and microcomputers; multiple telecommunications networks; and operating systems, relational database management systems, and applications development software. The Branch's staff also develop both interactive and more traditional audiovisual exhibits explaining and illustrating these complex research issues for the lay public.

CSB staff members are actively involved in individual and team research projects, in the artificial intelligence, natural language and advanced database systems aspects of NLM projects such as the Unified Medical Language System initiative, and in the national and international medical informatics and information science research communities. Recognizing the importance of addressing the future of medical informatics by helping to train new researchers, Dr. Kingsland, for several years a preceptor in the eight-week NIH-sponsored "Computers in Clinical Medicine" elective, became overall coordinator of the elective in 1989.

Expert Systems Program. A research program in artificial intelligence concentrating on expert systems was established at LHNCBC in 1984. Expert systems are computer programs that combine knowledge of a particular subject area with inferencing mechanisms enabling them to use this knowledge in problem-solving

situations. Expert systems can be categorized in two primary types: systems to assist experts in coping with conditions of information overload, and systems for the transfer of expertise. The latter systems can amplify the accessibility of specialist-level expertise by encapsulating portions of this expertise and making it available when the human specialists are not. Systems of both types are under active development at the Lister Hill Center.

One focus of the Expert Systems Program is the continuing development and evaluation of the AI/RHEUM consultant system in rheumatology, one of the world's largest medical artificial intelligence systems. AI/RHEUM, described in previous years' reports, is the best known of a series of knowledge-based medical consultant systems using the criteria table form of knowledge representation pioneered by NLM researchers.

The new rheumatology videodisc reported under way last year has been completed. In a two-year project involving multiple subject experts and colleagues and institutions in five states, Expert Systems Program staff working with the Audiovisual Program Development Branch of LHNCBC have produced a new rheumatology videodisc image bank with 6,300 still frames and 15 minutes of motion video sequences to help physician users accurately make patient observations otherwise difficult to illustrate.

Also under development in the AI/RHEUM system is a patient management program offering therapy recommendations for patients having rheumatoid arthritis. Like the diagnostic system, this program uses criteria-based reasoning. Expert Systems Program staff in FY 1989 brought up a version of this program in the HyperCard programming environment on the Macintosh II computer, implementing CTX-like reasoning processes in external commands (XCMD's) linked to HyperCard.

The formal evaluation of AI/RHEUM is progressing. Work in FY 1989 has concentrated on establishing and characterizing the differences in observations and in diagnoses made by physicians at different levels of training and experience when working up the same patient. Establishing this baseline knowledge is important in evaluating whether the nonexpert physician using the expert system as a tool approaches more closely the outcome of the human expert in observation and diagnosis.

The Expert Systems Program also works with knowledge-based consultant systems in other areas of medicine. An example is AI/COAG, which offers diagnostic assistance for problems in human hemostasis. The AI/COAG system performs a differential interpretation of six coagulation laboratory screening tests and offers "Tell Me More" and "Tell Me Reference" information to support its conclusions. A second module acquires and stores a detailed hemostasis history. It prints a summary record for the user, then analyzes the history to determine whether the presence of a hemostatic defect makes a further workup desirable. A third AI/COAG module advises emergency room physicians on blood component replacement therapy for cases of major trauma. Expert Systems Program staff developed a new version of the AI/COAG screening battery interpretation module in the HyperCard programming environment on the Macintosh II in FY 1989.

Expert Systems Program staff, as consultants, are helping to develop a "cataloger's assistant" system to assist in the NLM cataloging process for new acquisitions and of the COACH "expert searcher" system, which will perform some of the functions of an expert medical reference librarian assisting a user in the formulation of queries for MEDLARS searches.

Dr. Kingsland of the Expert Systems Program served in FY 1989 as the overall coordinator for an eight-week elective for third-year and fourth-year medical students titled "Computers in Clinical Medicine." Twelve students from medical schools around the U.S. came to NIH for this elective, which included a seminar series of 32 ninety-minute lectures and work on a research project under the preceptorship of NLM and other NIH professionals. NLM will in FY 1990 further develop this elective, with the goal of exposing young physicians in training to the possibilities of medical informatics both in the clinical setting and in biomedical research.

Natural Language Systems Program. Natural Language Systems (NLS) research concerns the issues implicit in developing natural language processing systems for improved access to biomedical information in computerized databases. The research questions lie at the intersection of the fields of computer science, information science, and linguistics and involve methods and approaches used in all of these fields.

A major emphasis of the project is the development of SPECIALIST, an experimental system for parsing, analyzing, and accessing biomedical text. The parsing system includes morphological, syntactic, and semantic rules and is supported by an extensive lexicon. The parser currently gives a two-level output as it analyzes sentences. The first is a parse tree which shows the detailed constituent structure of the sentence; the second is a representation which more clearly shows the logical relations between elements in the sentence.

Since modeling the domain knowledge required by the system is a continuing focus of interest for project staff, recent work carried out by Dr. McCray and others as part of NLM's UMLS project has direct implications for this work. NLS staff members have recently also begun to analyze a sample of MEDLINE abstracts with the goal of establishing criteria for the automated analysis of the information structure of biomedical abstracts. The experimental SPECIALIST system is implemented

in Quintus Prolog and runs on the Sun-3 and Sun-4 family of workstations.

Project staff members are now integrating the UMLS semantic network with the SPECIALIST system. The semantic network accompanies the UMLS Metathesaurus now being developed (see discussion of UMLS in the chapter on Library Operations). NLS project staff will test the network as a source of domain knowledge for the parsing system, both directly and indirectly through the MeSH structure. The augmentation of the SPECIALIST lexicon with semantic type information has already begun. Initial testing of the semantic network will help determine whether the current level of granularity of the semantic types is sufficient for the task of "understanding" biomedical text. Further, it is expected that the integration of the network with the parsing system will result in suggestions for refinements and additions to the current set of available semantic relationships.

Dr. McCray has recently collaborated with members of NLM's senior staff in the creation of a test collection for research in information retrieval. The test collection consists of requests made by users of the MEDLINE system, MEDLINE citation records retrieved for these requests, and assessments of the relevancy of these citation records to the requests made. The collection includes topics representative of the full MEDLINE database and is available for use by the research community. NLS project staff will continue to carry out experiments with this collection. It is expected that the results of this work will lead to additional insights for improving access to information stored in computerized databases.

The NLS research approach emphasizes the development of computational tools for enhancing the research process. These include a sophisticated tool for building the SPECIALIST lexicon, a tool for interactive access to NLM's MeSH vocabulary, a tool for making explicit the implied relationships between MeSH terms, and a tool for interactive and flexible access to a large medical dictionary. These software tools are in daily use by NLS project staff and by other NLM research groups.

MedIndEx Project. The objective of the MedIndEx Project is to develop and test interactive knowledge-based systems for computer-assisted indexing of medical literature for MEDLINE using MeSH terms. By encoding the indexing scheme in a knowledge base (KB) and using it to assist indexers, the system is expected to facilitate "expert indexing," that is, indexing consistent with published indexing tools upon which indexers currently depend.

Frames, a well known data structure in the field of artificial intelligence, are used for encoding the KB and indexing output. Both indexing rules and medical facts needed for indexing are encoded in KB frames, which can be variously subdivided. Indexers, with MedIndEx system guidance, create for each document a set of indexing frames patterned after KB frames. MedIndEx prompts indexers to consider indexable aspects of a document; processes the indexer's input; provides guidance, validation, and suggestions during the indexing session; and displays KB hierarchies of permissible terms. The KB applies rules not only for producing indexing frames, but also for generating conventional MeSH indexing terms at the level of expert indexing. These will be used in comparing the system to conventional indexing when the KB has been sufficiently developed.

Research on the MedIndEx System prototype has proceeded in two areas: functionality of the user (indexer) interface in the window and mouse environment of the Sun workstation, and development in FY 1989 of the MedIndEx Knowledge Base Management System (KBMS) in this same environment. During FY 1989 the indexing system was enhanced by a stringsearch capability for the user, further consistency checking of indexing frames by the system, improved aliasing for data entry, and automatic saving of canceled indexing frames, with their data, for possible re-use. Work has also begun on an interface to the KBMS that frees the knowledge engineer from reading and writing computer code.

At the ASIS '88 conference in October Susanne Humphrey, leader of the MedIndEx Project, received the 1988 Best JASIS Paper Award for her paper "Knowledge-based indexing of the medical literature: the Indexing Aid Project," published in the May 1987 *Journal of the American Society for Information Science.*

Machine Learning Project. A new LHNCBC research project began in 1989 to investigate the subfield of artificial intelligence known as machine learning. The field encompasses a wide variety of mechanisms for creating computer programs that improve their performance with use. The objective of this project is to develop and apply methods by which programs can automatically acquire knowledge and put it to work.

The underlying motivation for this work arises from the explosive growth of available biomedical information, and the less well acknowledged explosive growth in the number of analytical tools and techniques applied to that information. However, to take full advantage of the anticipated exponential growth of biomedical data and of the increasingly evident interrelationships among previously disparate information sources, dramatic improvements in automated knowledge manipulation, analysis, and inference will be necessary.

Programs like expert systems have already moved from the manipulation of information toward the manipulation of knowledge. The goal of the Machine Learning Project is to create computer programs that not only manipulate knowledge, but can also acquire it themselves. Ideally, a researcher or clinician with a question should be able to have a machine learning program identify where to find relevant information, retrieve that

information (possibly from multiple data sources), and analyze and assemble the information into a complete, accurate, and comprehensible representation of the desired knowledge.

Machine learning research may also help transcend the traditional computer interaction: a user issuing commands and a program responding. In a world of rapidly advancing knowledge, programs will have to do more than retrieve information when asked; they will have to manage information retrieval and inference over time. Once a user has specified a question of interest, a machine learning program should be able to track continuously and intelligently evolving knowledge sources for potentially relevant information. When the program finds relevant information, it should automatically assemble, analyze and send that information to the questioner. These visions are the driving force behind the Machine Learning Project.

Currently, machine learning technologies focus primarily on inducing concept definitions from externally specified datasets. In order to pursue the vision, this project endeavors to advance significantly the state of the art in machine learning, creating a computationally tractable theory of how to use diverse sources of knowledge and deploy diverse (and complex) analytical tools in pursuit of explicitly stated goals. This approach, called knowledge acquisition planning, is in an early stage of development. Although achieving the vision described above is clearly a long term goal which will require fundamental advances in basic computer science, the process of developing the theory and implementing prototypes has already produced some useful results.

A prototype of a knowledge acquisition planner called INVESTIGATOR has been used to explore the molecular evolution of Eucaryotes. The program was able to acquire information about taxonomy and proteins from two remote databases, build hierarchies that made some of the relationships within the datasets explicit, then use a technology called marker-passing to find relationships between the datasets. The selection of the datasets to use and of the algorithms to manipulate them was made automatically, based on a simple question statement: Find proteins that may have played a role in the evolution of Eucaryotes. INVESTIGATOR used basic knowledge about evolution, coupled with knowledge about where to find additional information and when to use various analytical tools (such as the marker passing algorithm) to decide what to do. The same knowledge can be used by INVESTIGATOR to acquire knowledge about a variety of different topics. INVESTIGATOR will be significantly expanded in FY 1990.

Another product of the Machine Learning Project resulted from the need to manage expert protocol data. Building artificial intelligence systems generally requires gathering extensive data about how people do the task to be mechanized. This information comes in the form of interviews, think-aloud protocols, interactive problem-solving sessions and other verbal interactions. Traditionally, the information gathered is painstakingly transcribed and the transcripts are then analyzed by a knowledge engineer. In order to eliminate the transcription step, the staff of the Machine Learning Project designed a computer tool for digitally recording audio onto an optical disk and building an extensive set of indices into the information. Points or passages of the audio can be marked and annotated, and the annotations can be grouped or organized into a hierarchy. The user can hear the original audio segment by simply pointing to an annotation with the mouse.

Not only does this tool obviate the need for transcription, but by retaining the original audio in easily accessible form it preserves potentially valuable nonverbal information such as pauses or "uhmm" sounds. A prototype of this tool called the AKAT (for Audio Knowledge Acquisition Tool) is being developed for the Macintosh computer. The potential uses of the AKAT extend beyond the development of knowledge-based systems; several oral history archives have expressed interest in using the device to improve the accessibility of their collections.

Information Technology Branch

Online Reference Works. The Online Reference Works (ORW) seeks to enhance and improve (1) the extensive and valuable body of information to be found in published medical reference works, and (2) the scholarly process of text creation and maintenance by the establishment of complementary online versions of the published works. An ancillary objective of the program has been to define and prototype a "scholar's workstation" that can serve as an integrated information resource for both the creation and the retrieval of online reference works.

The platform for research in this program has been an experimental text retrieval system known as IRx™ (Information Retrieval Experiment) the basics of which have been described in previous years' reports. IRx supports Natural Language Query (NLQ) searching of databases (e.g., the full-text of *Mendelian Inheritance in Man* (MIM) by Dr. Victor A. McKusick, discussed below) providing a ranked output of search results to the user.

During the last year, work has progressed on the development of IRx.2, an object-oriented version of IRx programmed in the C++ computer language. During the coming year, completion of Version 1 of IRx.2 is expected. Additional efforts are planned for a CD-ROM based client-server model of IRx.2 wherein the full text of reference works would be available locally to the user, while the most current indexes and text would be maintained centrally.

The Information Technology Branch, in collaboration with The Johns Hopkins University Welch Medical Library, continued efforts relating to MIM and is now extending the developing paradigm to more generalized reference works. Salient efforts relating to MIM undertaken this year included a reprogramming of the videodisc graphic annotation facility in C++, and an evaluation of the online annotations feature. The experience with MIM has proved highly informative and successful.

Yet MIM represents a special, and in many aspects limited, case of medical reference works; it has a single author / editor, linear text structure, and no graphics or tables. The new effort explores the requirements of more generalized reference texts and is utilizing *Principals of Ambulatory Medicine* (PAM), Drs. Barker, Burton, and Zieve, editors. The characteristics of PAM that recommend it as a research prototype include: multi-author (over 60), multi-editor, hierarchical text (105 chapters), tables, line-drawings, and images. Progress on PAM this year included the conversion to the ISO Standard Generalized Markup Language (SGML), and the development of facilities to allow the editors to edit submissions for the 3rd edition. IRx.2 is being designed to accept SGML-encoded input so that it will be possible to publish an SGML-encoded reference work in hard copy and online with equal ease. A PC-based prototype of the IRx.2 retrieval strategy for structured text was developed in Prolog and exercised with a chapter from PAM.

Biomedical Image Engineering

Communications Engineering Branch

This research area is concerned with the capture, storage, processing, online retrieval, transmission and display of biomedical documents and medical imagery. Ongoing activities include image compression, image enhancement, image understanding, pseudo-grayscale rendition, image transmission and networks, omnifont text recognition, and man-machine interface design. An example of ongoing applied research is an investigation of advanced imaging as a suitable technique to address the problem of preserving the biomedical collection. In addition, research into imaging techniques that support medical educational packages employing digitized radiographic, dermatological, and other imagery is also being pursued.

Electronic Document Storage and Retrieval (EDSR) Program. The primary motivation for this program is the preservation of the print-based record of biomedical knowledge. A portion of NLM's collection, as in most libraries, is deteriorating. In large part this deterioration is a result of gradual embrittlement caused by the use of acid-containing paper since the middle of the last century as a print medium, which poses the risk of spontaneous destruction of printed works in most collections. While the NLM is implementing preservation by microfilming, a standard means for archiving such endangered materials, the LHNCBC undertook an investigation of advanced electronic imaging (EI) technologies as an alternative means of preservation.

As reported earlier, a major outcome of early EDSR experiments was the realization that a distributed system comprising intelligent standalone workstations for the critical functions of document capture, quality control (QC), and archiving (image transfer from magnetic disk buffer to optical disk) would offer superior performance to a centralized system.

A distributed system of workstations was designed for the implementation of these functions. In FY 1988, the first of these, the Image Retrieval Workstation, was completed. The images retrieved and displayed in conjunction with a Grateful Med search included those of both journal articles and books stored on optical disk. The hardware included an IBM AT-class microcomputer, an optical disk drive, a high-resolution 2200-line bitmapped softcopy display device, and a laser printer. Software was designed to allow a user to search the Library's citation databases, display the citations, and automatically have the document images displayed.

While this workstation is intelligent in the sense that no external computer is required for its local operation, it is not strictly speaking "standalone" since for a brief moment its Grateful Med software makes contact with NLM's mainframe computer to search for citations. Once the citations arrive at the workstation, however, its subsequent operations are indeed completely local. Following this development, other workstations to serve the functions of quality control and archiving were completed in FY 1989.

Since throughput is a significant factor in any operational system that is required to convert large quantities of documents, the initial document capture station (the "bookscanner") was redesigned to allow higher throughput and easier operator interaction with the system. This device is designed specifically to handle bound volumes and brittle material, of particular importance in preservation. From an analysis of the experimental data, a variety of design changes were made: (a) replacing the earlier 2048-element CCD array with a recently available 3456-element array to allow the simultaneous capture of two adjacent pages of an open volume; (b) incorporating a mouse-driven image segmentation feature for rapid bordering that not only improved the esthetics but substantially improved image compression performance; and (c) improving the thresholding and pseudohalftone circuitry.

Linking these intelligent workstations into a distributed network for document conversion presented different choices for optimum operation: a loosely coupled option and a tightly coupled option. Issues that arose in considering these alternatives included the bandwidth

and protocol issues to be dealt with in the tightly coupled case and the organizational and management issues in the loosely coupled case. Both options were implemented and evaluated for performance.

As part of the experiment a cost model was developed. The conversion process is dominated by the two most time-consuming stages, document capture and quality check. This model included as variables the cost of labor, equipment, and media. It also took into account the expected life of the equipment, the number of work shifts per day, and system configuration (i.e., the number of capture and QC workstations). An analysis showed the degree of dependence of the conversion cost per page on the range of values assumed for these independent variables.

This research program allowed detailed investigations in several areas, such as: hardware and software interface design techniques, image data transfer error performance, design factors limiting transfer rate, image compression, and necessary modifications to the optical disk drives to interchangeably handle optical media having different characteristics. These studies have been reported in the technical journal literature.

In summary, this research has yielded several products: (a) a detailed hardware design on a system and a subsystem basis; (b) a complete software package in C and assembly languages to implement the three stages of document conversion, as well as rapid and random image retrieval from local and remote optical disks; (c) a cost analysis; and (d) a throughput performance analysis applicable to a scaled-up version of the prototype system. These findings were presented to the Board of Scientific Counselors in May 1989, accompanied by a three-volume final report entitled "Document Preservation by Electronic Imaging" available through the National Technical Information Service. In addition the research has resulted in over a dozen papers published in the electronic imaging literature.

Machine-Readable Archives in Biomedicine (MRAB) Program. While the EDSR program addressed the problem of efficiently converting the paper documents to electronic bitmapped image form for purposes of permanent storage, the access to the stored material remains at the image level. Although this level of access is certainly faster and more convenient than that available with paper and film archives, EI offers the potential for far greater access than merely to the image. It allows the creation of vast machine-readable text / image databases in very compact space (the equivalent of 350,000 to 400,000 document pages on a single disk, or about 50 million pages on a 128-disk jukebox), the capacity of rapidly and randomly navigating through this store, the ability to apply library processing (indexing and cataloging) to parts of the older literature, and the capability to access this store remotely.

Indeed, as stated by the Commission for Preservation, it would be a step toward achieving "the ultimate vision (which) is the existence of a collective knowledge base, in digitized format, from which individual institutions and scholars can obtain a variety of formats to serve their scholarly objectives and programs."

In May 1989, the LHNCBC presented to the Board of Scientific Counselors the outline of a program to investigate the technologies involved in the creation of a machine-readable archive. There are several considerations supporting such a program, some of which are presented below.

1. This program will demonstrate the potential for making the biomedical literature available in compact and accessible electronic form.
2. It would support certain objectives of the national preservation effort in biomedicine spearheaded by the NLM. Medical libraries would not need to replace their brittle documents with thousands of reels of microfilm. Furthermore, their users would be better served by the access to both bibliographic pointers and content.
3. It would enable far greater access to the older biomedical literature than available today.
4. The availability of the older material in machine-readable form will allow it to be indexed and cataloged to levels that are more sophisticated and useful than at present.
5. It would permit research into historic terms corresponding to modern medical vocabularies.

Making documents machine-readable, in principle, is a result of applying optical character recognition (OCR) technology, which in some form has been commercially available for several years. At the low end of the cost range, there are desktop OCR devices that adequately handle typewritten, uniformly spaced material such as office correspondence. At the high end, there are devices that do omnifont recognition for typeset, proportionately spaced material such as books and journals. However, none can adequately meet all of the following conditions: bound documents, fragile paper, material with poor print to paper contrast, and compound documents with intermixed text and graphics where it is required to save these different data types in a form suitable for display in the original format. For the material under consideration here, all of these factors hold.

The MRAB program intends to address the problem by: (a) developing a prototype system to demonstrate the feasibility of creating, maintaining, and accessing a machine-readable archive of documents, (b) using this prototype as a testbed to answer questions concerning the process of creating this archive, (c) evaluating the role of such an archive at the NLM, and (d) defining the technical specifications for an operational system.

In the first phase of the MRAB, the Lister Hill Center

proposes to demonstrate the ease and versatility of access from remote sites afforded by an electronic image store. The motivation for this part of the effort arises from a current operation: document delivery via the interlibrary loan (ILL) service. While ILL requests are largely serviced by photocopying documents and mailing the photocopies to the requesters, a facsimile (fax) system is also employed to provide speedy delivery of documents for high priority use to remote sites. Research has been initiated in this area, starting with a laboratory investigation of alternative techniques, employing in part prototype systems already developed inhouse, to introduce a higher degree of automation to the document delivery and thereby improve access to the literature.

Biomedical Digital Image Processing (BDIP) Program. The activities in this R&D area are directed toward the development and evaluation of improved techniques to capture, store and display medical images for computer-based educational systems. Biomedical images of interest include both multiple gray level images (e.g., radiographs) and high resolution color (e.g., dermatologic slides). Other images of interest include monochrome and color material from the History of Medicine collection.

An Image Processing Laboratory containing systems for high resolution (2048 x 2048 pixel, 8 bit / pixel) gray scale and color image capture, and a Gould IP8500 Image Processing System hosted by a DEC PDP 11/44 has been developed for the capture and processing of high resolution digitized biomedical imagery. Software developed inhouse allows zoom, scroll and roam through a 2048 x 2048 pixel image, both gray scale and color, with a 1024 x 1024 pixel display. During FY 1989 this laboratory supported a collaborative experiment with the National Center for Health Statistics and UCLA's Division of Medical Imaging. As a participant in this experiment, the laboratory developed systems for format conversion and other processing for high resolution digitized radiographs received from UCLA on tape, to display the images for evaluation and manipulation by radiologists sponsored by the National Center for Health Statistics.

The portable system to retrieve and display high resolution color images (described in last year's report) has been used to field test experimental renderings of dermatologic images. It was deployed at the American Academy of Dermatology's annual conference to compare photographic versus digital electronic image quality. It was also deployed at The Johns Hopkins University Medical School for similar image quality experiments. Another use of this system has been in the evaluation of a method for compressing dermatology images. Compression ratios of about 10, 20, and 30 were achieved at corresponding levels of image quality. Experiments are being planned to use expert observers to determine the maximum level of compression achievable with acceptable image degradation.

The project reported last year to investigate the digital capture and encoding of radiographs and windowing techniques to provide high resolution images in video format on standard television video is now in its second phase. It involves image reconstruction as a technique to produce high resolution manipulable digital color images of histologic specimens. A feasibility experiment was conducted using a tile concept applied to 35mm film. The experiment demonstrated that tile segments can be aligned automatically using cross-correlation into a reconstructed high resolution digital color image.

Computer and Image Technologies for Health Professions Education

Educational Technology Branch

Computer-based Curriculum Delivery Systems (CCDS). Since the CCDS Basic Medical Pathology project introduced the first interactive video program in 1983, the field-testing network has grown from twelve schools with twelve student workstations to 101 schools with an estimated 300 workstations.

The Basic Medical Pathology is the largest and most extensive of the CCDS projects. In FY 1989 four new videodiscs were mastered ("Acute Inflammation: Exudates and Phagocytosis," "Acute Inflammation: Chemical Mediators," "Neoplasia: Benign and Malignant States," and "Neoplasia: Metastasis and Differentiation") and distributed to the network. By the end of the year CCDS had furnished to the test sites more than 700 videodiscs and 800 diskettes containing revised code (Version 3.5) for the pathology engine and 16,000 data files.

The impact of the pathology project can, in part, be judged on the basis of the rapid adoption of its products and the 2,000 student evaluations of the programs that have been received. On a scale of 1 to 5, the students rated the programs 4+ as a learning experience. Comparison of pre- and post-test scores of those students not passing (a 70% score) the pre-test show that students master the material in about one-third the amount of time devoted to it by traditional methods. At least three schools have cancelled all lectures on topics covered by CCDS lessons and others have reduced lecture time and made the CCDS lessons a required part of the course.

Field testing of the orthopaedic programs (Knee Anatomy, Forearm Anatomy, and a simulation entitled "The Chronic Unstable Knee") was completed with the American Academy of Orthopaedic Surgeons (AAOS) taking the lead role in setting up test sites and collecting and analyzing data. As a result of this collaboration, interactive video programs have become a permanent

part of the AAOS annual meeting program and the Academy has decided to create a new division and employ a fulltime senior staff member to be Director of Electronic Media and Evaluation.

Field testing of the Adolescent Depression and Suicide Risk Assessment videodisc program was completed. It has become a required part of clinical clerkships at several medical schools. The program was given to the National Audiovisual Center for public distribution; the first run of videodiscs was sold out quickly and it is being reissued.

Dermatology Visual Database Project. Progress has occurred in two areas prerequisite to applying electronic imaging technology to dermatology: defining image quality requirements and integrating an image collection with computer-based educational technology.

Progress in defining image quality requirements has been accelerated by the development of a PC-based digital color capture and display facility. Color photographic slides can be scanned and displayed as digitized computer graphics at variable levels of spatial and color resolution. Two evaluation studies using 1024 x 1024 pixel display with 32 levels in each of the red, green, and blue color planes were conducted this year. In the first study, 80 dermatologists were asked to identify skin lesion morphology from both electronic images and the original photographic slides. Their performance revealed significantly more errors associated with the electronic image. In the second study, 91 medical students were tested with eight scanned images selected from a teaching slide set as "classic" examples of lesion morphology. They showed no overall difference between using the electronic images and the original slides. A tentative conclusion is that electronic image technology can provide the image quality required for dermatology education.

Progress in integrating an image collection with computer-based educational technology involved the pigmented lesion videodisc premastered in the APDB facilities and the accompanying melanoma tutorial authored for the IBM InfoWindows System. Demonstrations of this application were well received by dermatology educators when exhibited at scientific meetings. The American Academy of Dermatology Committee on Audiovisual Education has reviewed the tutorial content and has offered to evaluate the tutorial and disc in five medical schools.

HMD Archival-Retrieval Picture Project. In FY 1989 the Lister Hill Center undertook a project to create a videodisc collection of images representing the entire historical collection of prints and photos maintained by the History of Medicine Division. A contractor has been photographing black and white and color images from the approximately 60,000 in the collection. Completion of the first 13,000 photos was marked by mastering a videodisc containing the images, and the development of a micrcomputer-based database containing image descriptions linked to videodisc frames.

The Learning Center For Interactive Technology (TLC). The TLC is a "hands on" laboratory where visiting medical educators and scientists can explore the comparative applications and various uses of interactive educational technology in the health sciences. The Learning Center consists of two major activities: (1) a central location where various microcomputer and interactive-video information and educational technologies are demonstrated, reviewed, and evaluated; and (2) a personal microcomputer training facility for NLM staff. Nineteen demonstration carrels displaying a total of 52 interactive programs for the health sciences are available for use by visitors. A video projection station is also in use for small group demonstrations.

In FY 1989 TLC staff provided more than 2,000 demonstrations and "hands on" experience for 775 visitors from the U.S. and foreign countries. This brings the total number of visitors to 2,538 since the Center opened in March 1985. Two monographs were published by Center staff and are available: Videodisc Technology by Eldon J. Ullmer, Ph.D. and Videodisc Repurposing by Craig N. Locatis, Ph.D.

Center staff conducted workshops on interactive technology for health science professionals at four national association meetings: Health Sciences Communications Association, Association for Educational Computer Technology, Medical Interactive Video Consortium, and Symposium for Computer Applications in Medical Care.

In February 1989, E.T.Net (Educational Technology Network) came online through a local Bethesda telephone number and in May became available through Telenet. E.T.Net is an online computer conferencing system to electronically link developers and users of interactive technology in health care education. One of the problems facing health science educators today is a lack of information on the availability and usefulness of health science interactive courseware. E.T.Net is designed to alleviate this problem by enhancing communications among developers and users of health science interactive courseware. Users of E.T.Net are able to share: software, hardware, and videodisc reviews; information on courseware and videodiscs which are available, under development, or which need to be developed; and new applications of interactive hardware to health science education.

E.T.Net is available 24 hours a day at no cost to professionals engaged in the development or use of interactive technology in health science education. Since its debut, 236 health professionals have registered as E.T.Net Users, including colleagues in Canada, Europe, South Africa, and Australia. A pocket E.T.Net Quick

Reference Guide may be requested from the Learning Center for Interactive Technology. The system was demonstrated at the Annual Congress of the American Association for Medical Systems and Informatics and at the International Symposium on Medical Informatics and Education.

The Learning Center Training Facility contains six student microcomputer workstations, a teaching workstation, and a computer screen projector networked in such a way that any of the seven computer screens can be projected at the touch of a button. In FY 1989 30 microcomputer classes providing training for 206 NLM staff and 9 microcomputer software demonstrations for 164 persons were conducted there.

Audiovisual Program Development Branch

Audiovisual Program Support. The Audiovisual Program Development Branch (APDB) applies current and emerging video communications technologies and audiovisual techniques to Lister Hill Center research, development, and demonstration projects and to the information needs of the health sciences community. The APDB operates a videodisc premastering facility employing state-of-the-art video and audio systems to produce high quality and creative materials for the LHNCBC's research and demonstration projects, as well as the NLM's educational and informational programs.

The Branch completed the final premaster videotape of 7 units in the Basic Medical Pathology interactive instructional series. The conversion of these tapes to Level III videodiscs allowed participating medical schools to institute a complete interactive basic pathology course. This series of experimental teaching units drew upon a large number of the Branch's premastering capabilities: videomicroscopes, a video still image transfer system, an electronic videographics / animation system, digital special effects, an electronic character generator, and a computerized editing system.

APDB continues to provide consultation, technical advice, and project management to the History of Medicine Prints and Photographs Collection Videodisc project. Phase 1 of the project was completed this fiscal year, with the conversion to laser videodisc of some 13,000 images from the Library's historical collection of visual materials. The videodisc images were judged to be of excellent quality, after having been photographed on 35mm film, then transferred to one-inch videotape, from which the final videodiscs were made. The final videodiscs will contain the entire library collection, exceeding 55,000 images.

Production consultation, advice, and liaison with content experts were provided to a collaborative LHC / university project which resulted in a laser videodisc containing still images and motion sequences pertinent to the teaching of clinical rheumatology. Several combinations of video and film technologies were employed in the process of transferring 35mm slide images to one-inch premaster videotape, providing both archival film images for possible later use in high definition video format and high quality current videotape images suitable for instructional use in laser videodisc format.

Early in FY 1989, a large number of microscopic images and 35mm slides were edited onto a Dermatopathology videotape, and the resultant premaster tape was then converted to 8-inch laser videodiscs for use by the Lister Hill Center and The Johns Hopkins University Medical School for image quality evaluation.

The Branch continued a collaborative project with Dr. Carl Jaffe, Yale University School of Medicine, editing original nuclear medicine images to one-inch premaster videotape, from which a Level III laser videodisc version was produced. In future efforts, both analog images on videodisc and digital images on CD-ROM will be available on the same delivery system, to permit maximum manipulation of nuclear cardiac images in educational settings.

The Branch remained active during FY 1989 in developing, recording and editing NLM education program materials. Among them:

- "Pathways...," a 17-minute videotape about how NLM is responsive to the needs of health science practitioners, researchers, and librarians as they provide direct help to those in need. A shorter version of this program is also being prepared.
- Twenty short video modules were recorded, narrated, and edited, in collaboration with the Educational Technology Branch, illustrating many of the interactive videodisc programs available in The Learning Center. When premaster videotapes of all such programs have been completed, a Level III laser videodisc, titled "Interactive Technology Sampler," will be produced.
- Six one-minute and six 30-second video vignettes were produced to help celebrate the Public Health Service Commissioned Corps Centennial Year. Copies were distributed by the Office of the Surgeon General to PHS offices throughout the country.
- Four presentations in the continuing Biotechnology Seminar Series were videotaped and edited.
- Two informational video segments were produced featuring the LHNCBC Director: one on Digital Imaging, for the University of Washington, and one on the GENINFO™ system, for BBC Television, in England.
- A special videotape about the Regional Medical Library Network was produced.
- In collaboration with the Association of Neurological Surgeons, Dr. Giovanni Di Chiro and Dr. Julius

Axelrod were interviewed, recorded, and edited on videotape; three more interviews with outstanding neuroscientists are planned for next year.

- A full-day "MEDLINE on CD-ROM Symposium" was videotaped, with individual presentations being edited and made available for NLM distribution.

APDB's Graphic and Still Photography Labs continue to provide visual information materials for the Library. The Graphics Lab is efficiently generating presentation slides and other graphics materials through the creative use of electronic videographics and microcomputer graphics software. The Still Photo Lab has made comparable improvements with new film processors, lighting and camera equipment. The Branch also provides audiovisual support for meetings in the Lister Hill Center Auditorium and the NLM Board of Regents Room.

NATIONAL CENTER FOR BIOTECHNOLOGY INFORMATION

David J. Lipman, M.D.
Director

After several years as a program within the Lister Hill Center, the NLM's activities in biotechnology information were formally established within the National Center for Biotechnology Information (NCBI) with the passage of Public Law 100-607 in November 1988. In March 1989, Dr. David J. Lipman, a research scientist in NIDDK's Mathematical Research Branch, was named Director of the Center. Dr. Lipman came to the NIH in 1981 as a medical staff fellow and is an established leader in the field of molecular sequence analysis.

The creation of the NCBI reflects the importance of developing new information technologies to aid in the understanding of the molecular processes that control health and disease. The Center has been given the responsibility to:

- Create automated systems for storing and analyzing knowledge about molecular biology, biochemistry, and genetics;
- Perform research into advanced methods of computer-based information processing for analyzing the structure and function of biologically important molecules and compounds;
- Facilitate the use of databases and software by biotechnology researchers and medical care personnel;
- Coordinate efforts to gather biotechnology information worldwide.

There are presently 20 senior scientists, postdoctoral fellows, and support staff within the NCBI. These scientists have backgrounds in medicine, molecular biology, biochemistry, genetics, biophysics, structural biology, computer science, and mathematics.

The establishment of the NCBI serves to strengthen a number of ongoing NLM projects and provides resources for new programs. Current NCBI projects are divided into three areas: (1) building new databases and enhancing existing ones which involve genomic information (this includes NLM-developed databases and extramural support for other research information resources); (2) improved information retrieval and analysis techniques for genomic databases; and (3) communication, which includes sponsorship of meetings, workshops, and tutorials on what might broadly be termed computational biology. Within each of these three areas, there are a number of ongoing projects.

Database Building and Enhancement

New linkages have been created between MEDLINE and GenBank, the national DNA sequence database. Since 1987, the Library's MeSH vocabulary has contained cross-references to all keywords in the GenBank file which occur in at least five different GenBank records. This is a first step toward a common search vocabulary that will be able to retrieve both genetic sequence records and the biomedical literature which references the same concepts.

In a related effort, the keywords and taxonomic classification of the Protein Identification Resource (PIR) database have been mapped to MeSH. Linkages between literature references in MEDLINE and records in the major sequence and genetic databases are also being maintained by MeSH indexers and through regular batch updating by NCBI staff. These linkages permit a user to go from a literature citation in MEDLINE to the accession number of a record in a database such as GenBank, PIR, and Human Gene Mapping Library.

Since 1982, the NLM has supported Dr. Victor McKusick's *Mendelian Inheritance in Man* database and developed the text retrieval software (IRx) for its online version (OMIM). The IRx software is also supporting access intramurally at NIH to OMIM and to 14 other sequence and bibliographic databases. As of September 1989, IRx is also being used for the GenBank online service at Intelligenetics in California.

NLM, in conjunction with other NIH institutes and the National Science Foundation, also provides funding for databanks which are major resources for biological research, including GenBank, the Protein Identification Resource, and the Protein DataBank at Brookhaven National Laboratory. The NLM and NSF have sponsored several workshops on the informatics of *E. coli*, attended by leading bacterial geneticists and computer scientists. A number of collaborative database projects are resulting from these workshops.

Software Toolkit

A major mandate of the NCBI is to develop new tools and systems for information retrieval and analysis. The mere accumulation of new data can be futile unless

scientists, research physicians, and biotechnologists are able to retrieve and analyze it using convenient and powerful software tools.

NCBI software development efforts have been directed to developing computer programs that are modular, easily adaptable to other systems, useful in the near term on present machines but also flexible enough to accommodate future advances in software engineering and hardware design. The creation of a software environment that divides large, complex systems into small independent pieces, which still act in concert, is at the cutting edge of software development.

We are exchanging ideas and attempting to coordinate our efforts with other agencies and industry-sponsored groups such as Lawrence Berkeley Laboratories, the NASA Goddard Space Flight Center, and the Object Management Group of the Open Systems Foundation, that are also addressing these issues in their own areas. The NCBI software toolkit will allow for end-user customization, accommodate contributions from extramural sources and make it possible for commercial firms to develop special components and interfaces.

An electronic bulletin board called BITS (Biotechnology Information Toolkit Software) has been established to meet the requests for information on NCBI software efforts. There are currently 65 subscribers representing private industry, government institutions, and academia. BITS is on the INTERNET computer network and serves as an unmoderated forum for exchange of information on software development for molecular biology applications.

The first major application developed for the software toolkit has been completed and consists of a program to construct computerized maps that integrate DNA sequences, restriction site and genetic linkage information. This program, developed with Dr. Kenneth Rudd of the Food and Drug Administration and Dr. Webb Miller of the Department of Computer Science at Pennsylvania State University, has been used to produce an integrated physical / genetic / sequence map of the *E. coli* genome. The integrated map serves as a prototype for analysis of more complex genomes, including those of other model organisms and, ultimately, humans. Such methods are essential not only for aiding in the placement of newly mapped and sequenced genes but also for understanding the organization and regulation of genes.

Other tools under development include advanced methods for finding sequence similarities in database searching and evaluating their statistical significance, simultaneous multiple sequence alignment and sequence motif construction and pattern matching.

Basic Research

Basic scientific research, while an important pursuit in its own right, has repeatedly been shown to provide practical applications. Thus, it was considered essential in the very beginning of the NCBI to have a multidisciplinary group of in-house investigators doing basic research on problems in computational molecular biology. The hope was that these investigators would not only make important contributions to basic science but also serve as a wellspring of new methods for the applied research activities of NCBI. To this end, the NCBI has brought together computer scientists, molecular biologists, mathematicians, biochemists, research physicians, and structural biologists to work on all aspects of the sequences and structures of biological macromolecules.

Several research projects with practical applications are already under way. A new method for creating sequence motifs will have applications for database searching, sequence identification and protein engineering. Recent work on weighting functions for data related by a tree should make possible, for example, more accurate comparative analyses of AIDS viral sequence information.

A sampling of other research projects includes: detection and characterization of repeating sequence patterns in genes required for mitosis, domain organization of eukaryotic transcription factors and other nuclear proteins, molecular modeling and dynamics of a family of proteins that bind small hydrophobic ligands, the kinetics of infectivity of human immunodeficiency virus, development of new algorithms for database searching and approximate pattern-matching, and development of new mathematical models for probability estimation.

NCBI investigators have ongoing collaborations with scientists from a number of other institutions including Stanford University, the University of Arizona, Los Alamos National Laboratory, Washington University in St. Louis, the National Center for Supercomputer Applications at the University of Illinois, the University of Michigan Medical School, the University of North Carolina, the Pennsylvania State University, the Johns Hopkins University School of Medicine, the Food and Drug Administration, the National Cancer Institute and the National Institute of Diabetes and Digestive and Kidney Diseases.

Communication

The Center has fostered scientific communication in the area of computers as applied to molecular biology and genetics by sponsoring meetings and an NLM Biotechnology Lecture Series. As an example, the NCBI sponsored an international symposium and workshop entitled "Macromolecules, Genes and Computers" in August 1989 which was attended by more than 250 leading investigators in various aspects of computational molecular biology. From the Biotechnology Lecture Series, talks by eminent scientists on the tools and

techniques of modern molecular biology are available on videotape as part of NLM's lending collection. Hands-on workshops in the use of laboratory computing tools are presented for NIH scientists in NLM's PC training facility.

Extramural Programs

NLM's Extramural Programs Division has a program of grants for computer analysis of molecular biology data. Its scope is quite broad and includes research into methods and algorithms for improving the efficiency of information retrieval and improving the efficiency of analytical operations which are computationally intensive. Research applications to develop expert systems for annotating and linking databases are encouraged, as are proposals for work on algorithms for structure and function prediction.

Software development for newer machine architectures is within the scope of the program as well, including molecular analysis by neural net techniques, and multiprocessor programming. Postdoctoral training in the cross-disciplinary areas of biology, medicine, and computer science is also supported through the NLM's informatics fellowship program.

New Initiatives

The NCBI has identified several areas for new and continuing support:

- The NCBI will use contract and cooperative agreements to support key molecular biology databanks around the country. The NCBI will concentrate on efforts to integrate sequence information and the biomedical literature in a database that is both highly current and comprehensive. The initial stage of database building has already begun in conjunction with Library Operations.
- The NCBI is developing standards for interchange of sequence, genetic, and physical map data as well as computerized tools for distributed data entry and annotation by investigators.
- The NCBI will sponsor research in universities and industry to develop new methods of information representation and retrieval from factual databases of biological information. A parallel effort will be conducted in the intramural laboratories of the NCBI.
- Intramural research activities will be complemented by a visiting scientist program and an active extramural grant program.

Fertile areas for such research in the next decade will include molecular sequence-to-structure prediction and determination of biologic similarity by expert system techniques. In addition, the NCBI is sponsoring informatics workshops and short courses to instruct molecular biologists and medical researchers in the use of advanced computerized methods of data analysis.

EXTRAMURAL GRANTS AND CONTRACTS

Arthur J. Broering
Acting Associate Director

Using a variety of extramural support mechanisms, the Extramural Programs Division provides comprehensive assistance opportunities to the health science community. This support, authorized by the Medical Library Assistance Act of 1965 and extensions, and by Section 301 of the Public Health Service Act as amended, has assisted authors and scholars, researchers and academicians, librarians, media and communication experts, computer scientists, and information network designers and managers in improving access to health knowledge.

Supported projects range from research on fundamental questions about information in medical decision-making to innovative systems for maintaining and retrieving biotechnology information, to the planning and operation of large-scale institution-wide integrated information networks, to historical writings on significant health topics, to the development of basic information access services at local and smaller health facilities.

Regional Medical Library contracts, as authorized by the Medical Library Assistance Act, are described in the section on Library Operations, and the Special Foreign Currency Program, administered by the Extramural Programs International Programs Branch, is described in the chapter on International Programs.

FY 1989 saw several events that will have significant impact on NLM grant assistance throughout the decade of the nineteen nineties and beyond. For a second consecutive year, $1 million for new, competitive projects in biotechnology research was made available and, as in the previous year, seven such research grants were funded. The grant program's contribution to NLM's biotechnology responsibilities was also enhanced by the transfer of active grant projects and FY 1990 funds from NIH's Division of Research Resources to the Extramural Programs Division ($1.7 million of the $3.8 million transferred was for biotechnology-related research).

NLM established a Fellowship Program for research training in medical informatics in 1989. Current institutional training grant sites cannot absorb significant numbers of additional trainees and, in any case, these institutional awards are approved for just one more year before competitive renewal. It also seems unlikely that FY 1990 appropriation levels will permit another new competition for these relatively large grants even though research training remains an important NLM priority, most recently recommended for expansion by the Board of Regents' Outreach Planning Panel.

The fellowship initiative is desirable for program reasons as well. The fellowship opportunity will attract applicants from a greater geographical area and there is no doubt that more institutions than the current grantees can provide an effective academic and research environment for the medical informatics research training experience. A close monitoring of the fellowship and the institutional training programs over the next few years will provide valuable data about whether the mechanisms enhance career development.

The Board's outreach panel report will especially provide national visibility and direction to the amended Resource Grant Program implemented at the beginning of the fiscal year (see Medical Library Resource Grants section in this chapter).

The report also recognizes the potential associated with the IAIMS (Integrated Academic Information Management System) program. The 1988 review of four Phase III IAIMS projects provided the opportunity to examine in detail the results of the IAIMS process to date. The excitement and profound changes seen in these institutions prompted the IAIMS Special Review Committee to submit a report to the Board of Regents and to the NLM Outreach Planning Panel. The Panel strongly endorsed and supported the recommendations and the need to capitalize on the program's successes, and recommended increased funding.

Finally, the expanded inventory of NLM assistance interests and its increased diversification led, in 1989, to a reorganization of NLM's merit review group, the Biomedical Library Review Committee (BLRC). Constituted in 1970, the Committee reviews for scientific and technical merit the vast majority of applications for NLM grant support. The Committee's membership was expanded this year to 21, with the addition of experts in molecular biology information systems, and was rechartered to provide more flexibility to the peer review process.

Under the new arrangement, three subcommittees now consider research applications in biotechnology information, medical informatics, and medical library projects. The "Flexible Study Section," as the new BLRC structure is known, will facilitate the impartial review of future NLM applications and will lessen the need for ad

hoc review groups. Descriptions of NLM's grant programs, including examples of funded projects, are summarized in the following sections.

Research Grants

For almost 25 years, NLM has offered grant assistance to investigators concerned with health knowledge issues. The body of knowledge related to human health and biology constantly grows and changes; this growth is matched by proliferating information and data systems. To utilize these resources fully in daily professional life is a constant struggle. Addressing these difficulties by exploiting computer and communication sciences is a plausible response, but the technologies themselves raise numerous fundamental problems at the theoretical and practical level.

To address these problems, NLM offers grant support in three separate but related areas. The first two, medical informatics and biotechnology information, are supported under the general NIH research authority, Public Law 301. The third, health information sciences, is authorized by the Medical Library Assistance Act.

Medical informatics is an interdisciplinary field which combines medical specialty knowledge with the information and computer sciences, computational linguistics, and cognitive science, among others. NLM-sponsored investigators contribute impressive reports about their work both in medical journals and at national and international meetings. There is a growing appreciation for medical informatics in academic medicine, as the mediation of clinical and research activities by computer systems becomes increasingly important.

Several outstanding awards were initiated this year: At Brigham and Women's Hospital in Boston, Bryan Bergeron will study the application of graphics-based computer simulations in medical education by developing and testing a number of simulations in various clinical domains. Although each simulation will be internally complete, the programming strategy should facilitate database communications. The need for human-machine interfaces specifically relevant to practitioners' cognitive tasks will be addressed, with development of appropriate tutorial approaches.

At the University of Illinois, Arthur S. Elstein is working to characterize expert clinical decision-making in terms of information processing psychology and behavioral decision theory. The clinical setting is an intensive care unit. Several critical care cases have been developed and administered; preliminary results have been reported. A library of 50 case vignettes is being completed and will be made available to other investigators.

At the University of Washington, Ira Kalet seeks to optimize radiographic treatment for head and neck cancers by developing an expert knowledge base that automatically exchanges messages with a computerized treatment simulation program. In this way, complex treatment planning can be specifically assessed for individual patient and tumor characteristics. In work to date, rules for deciding treatment approaches have been studied, evaluated, and implemented for the system. Related computer science work includes implementation of agenda-based control strategies, development of a rule-based questioning system and extension of the treatment plan representation to include all treatment parameters. A graphic simulation system, of particular utility to clinicians, incorporates 3-dimensional images.

In the area of biotechnology information, research is supported to investigate effective methodologies for organizing and analyzing data relating to molecular control of life processes. Relevant problems include designing and managing databases, retrieving information from multiple factual databases, and pattern-matching algorithms for biological sequences. Recognizing that scientific advances in molecular biology will depend in large part on successful resolution of knowledge and information issues, NLM published a formal request for applications and set aside approximately one million dollars for new grants. Here again, several promising new investigators have been funded.

Bruce Buchanan, at the University of Pittsburgh, is designing a computer-based intelligent assistant for molecular biologists. His hypothesis is that the technology of knowledge-based systems is sufficiently mature to assist in the discovery and interpretation of information relevant to biological research. The workstation will be a highly adaptive and extensible system that will employ techniques from artificial intelligence and will assist the researcher in model building, experiment planning, and hypothesis testing.

At Yale University School of Medicine, Perry Miller is exploring the parallelization of algorithms used in molecular biology, focusing primarily on algorithms for genetic sequence analysis and genetic linkage analysis. His sequence analysis research will focus on the intrinsic parallelizing of an algorithm and the "parallel database search" and "load balancing" issues involved in running an algorithm simultaneously on many sets of input. Using a machine-independent parallel programming language, he will examine how a complex algorithm for performing genetic linkage analysis is best parallelized. He will test and refine the parallelized version using both laboratory data and data from the Human Gene Mapping Library in New Haven.

Research in the health information sciences is authorized by the Medical Library Assistance Act. It is recognized that traditional information disciplines must continue to evolve; their services are essential to the health community. The bibliographic record remains not only the source for current medical knowledge, it is

also the underlying archival structure of the modern life sciences. The continuing work on analysis of retrieval systems, following an intensive competitive review, is consistent with earlier project support on bibliographic retrieval.

At the University of Missouri, Columbia, Mary-Ellen Sievert investigates heuristics and related factors that weaken the effectiveness of full-text computerized bibliographic databases. The project is based on comparative study of a commercial full-text database and MEDLINE, which includes abstracts, but not full text. The goal is to help users exploit the full-text capability through the development of search methods that facilitate both high recall and high precision. Earlier work showed that retrieval based on full text can bring forth more relevant documents, but with a greater number of irrelevant documents as well. The goal now is to study improved heuristics or guides which will help both users and database designers to obtain searches that are both complete and precise.

Training Program

Such research issues call for highly trained and creative persons, able to articulate medicine with computers and health care with information science. There is a particular need in academic medicine for this new discipline—medical informatics. Through its training program, NLM provides grants for research career training in this field.

In 1989, eight institutional awards were made. Each site offers an excellent setting for didactic instruction, involvement in computer science studies, and opportunities for work in advanced information science research. After training, these investigators will study the role of knowledge in professional life, analyze the social structures for managing knowledge, and advance the frontiers of the computer sciences for organizing, retrieving, and utilizing health knowledge.

Forty-two postdoctoral and eleven predoctoral trainees were supported in this year. Of the postdoctorals, 38 were physicians, two had both the M.D. and Ph.D., one had a Ph.D., and one had a D.V.M. The eight training sites and Directors are:

Lael Gatewood, Ph.D.
Professor and Director
Laboratory Medicine and Pathology
Division of Health Computer Sciences
University of Minnesota (Minneapolis)

Robert A. Greenes, M.D., Ph.D.
Director, Decision Systems Laboratory
Department of Radiology
Brigham and Women's Hospital
Boston, MA

Perry L. Miller, M.D., Ph.D.
Director, Medical Informatics Program
Department of Anesthesiology
Yale University School of Medicine
New Haven, CT

Randolph A. Miller, M.D.
Associate Professor of Medicine
Section of Medical Informatics
University of Pittsburgh School of Medicine
Pittsburgh, PA

Charles E. Molnar, Sc.D.
Director, Institute for Biomedical Computing
Washington University
St. Louis, MO

Stephen G. Pauker, M.D.
Chief, Division of Clinical Decision Making
New England Medical Center
Boston, MA

Edward H. Shortliffe, M.D., Ph.D.
Associate Professor of Medicine
Medical Computer Science Group
Stanford University School of Medicine
Stanford, CA

John A. Starkweather, Ph.D.
Professor of Medical Psychology
University of California
San Francisco, CA

Three fellowship awards were made during this year to individuals at academic sites believed to be excellent environments for the proposed medical informatics research training experience: Ohio State University, Columbia University, and the University of Utah.

Publication Grants

Biomedical scientific publication grants provide short-term support for a variety of not-for-profit publications. Together with the international biomedical publication program, which is funded with special foreign currencies authorized under Public Law 480, the Publication Grant Program facilitates access to health information for health professionals and scientists. The Special Foreign Currency Program is described in the chapter on International Programs.

Publications which are prepared and published with NLM support include critical reviews and monographs in health fields, secondary literature tools (such as annotated bibliographies, atlases, and catalogs), publications on biomedical communications and medical informatics,

and scholarly research monographs in the history of the medical sciences.

During FY 1989, 13 Publication Grants were awarded (see table 12). Of these, eight were new awards, including a comprehensive review of the epidemiology of human chromosome disorders and a book on the ethical issues underlying public policy choices surrounding AIDS. The average amount of a Publication Grant in FY 1989—less than $24,000 including both direct and indirect costs—reflects the continuing emphasis in this program upon high quality, but low cost, projects that are scheduled for early publication.

Among supported studies published in FY 1989 was a comprehensive overview on the development of American hospitals in the twentieth century: Rosemary Stevens's *In Sickness and in Wealth* (New York, N.Y.: Basic Books, 1989). The book draws upon a broad range of primary and secondary source materials in exploring major political, social, technological, and economic influences upon hospitals.

Another significant project administered in NLM's Publication Grant Program and co-funded by other NIH components was published in 1989: Stephen P. Strickland's *The Story of the NIH Grants Programs* (Lanham, MD: University Press of America, 1989). This book examines the development and growth of the central, scientific research support instrument of the National Institutes of Health—the extramural grant. The study is substantially based upon a series of detailed oral history interviews with Public Health Service officials and consultants who were involved with the early administration of the NIH extramural programs. (A list of supported publications received in FY 1989 is in Appendix 2.)

Medical Library Resource Grants

The Medical Library Resource Grant Program as it has existed since 1970 came to a close in FY 1989 with the award of nine Resource Improvement Grants and two Resource Project Grants. The Resource Improvement Grants assisted in stimulating collection development in local institutions, primarily hospitals. They were available to single institutions as well as consortia of health-related institutions. Of the nine Improvement Grants awarded in Fiscal Year 1989, seven went to single institutions and two to consortia.

One Resource Project Grant award went to the Fayetteville (NC) Area Health Education Center to develop a learning resource center with space for a microcomputer classroom, a microcomputer laboratory, and storage. The second went to the West Virginia University Health Sciences Library to implement "West Virginia CONSULT," a computer-based statewide health information network. The CONSULT plan divides the state into eight geographic areas with each area having a lead hospital and two to three small institutions. The West Virginia Network for Educational Telecomputing will serve as CONSULT's main telecommunications node and will provide a variety of computer support services.

Based on recommendations of a consultant panel and the Board of Regents, the Resource Grant Program was modified this year to emphasize the use of computer and communications technologies to provide faster and improved access to information resources and services. Two types of grant are offered: the Information Access Grant and the Information Systems Grant.

The Information Access Grant, aimed at smaller health science libraries, is available to single institutions and consortia. For single institutions the grant is for one year and up to $12,000 for projects proposing to improve access to information resources and services to health science personnel. Consortia may apply for support for up to two years; one year of support up to $12,000 is available to groups for planning. For established consortia, the members may proceed directly to project implementation which offers support up to $12,000 per member.

The Information Systems Grant is directed towards larger health science institutions and is intended to facilitate access to health science information emphasizing the utilization of computer and communication technologies but on a scale larger than the Information Access Grant. Projects are designed to foster networking and integration to improve the information infrastructure. Information Systems Grants are available up to three years in the amount of $50,000 to $150,000 per year. The modified Resource Grant Program goes into effect in FY 1990.

The new Resource Grant Program represents just one aspect of an NLM outreach effort which will have priority focus in the Nineties. The Outreach Planning Panel Report states: "Successful access grant projects will serve as models that can be used by other community-based institutions; they must be funded at a level that will enable this vital leverage to occur."

IAIMS Program

Integrated Academic Information Management Systems (IAIMS) are institution-wide computer networks that link and relate library systems with a variety of individual and institutional databases and information files for patient care, research, education, and administration. Resource grants have been made to assist medical centers and health science institutions in planning and development projects that will lead to the implementation of IAIMS. The goal is to create organizational mechanisms within health institutions to manage more effectively the knowledge of medicine, and to provide for a system of comprehensive information access.

Using the Resource Project Grant mechanism, NLM

has provided support for: (1) institution-wide IAIMS planning and policy analysis, (2) model development and testing, and (3) implementation of full-scale IAIMS projects.

Some of the functions undertaken by grantees during planning include preparing a 10-year strategic plan for the institution, developing an institutional information policy, assessing the technological capabilities of the institution, and defining information management needs and requirements. From these activities an IAIMS plan is created to serve as the guide for the second phase of activity, model development.

During FY 1989, IAIMS Phase I planning projects were active at the American College of Obstetricians and Gynecologists, Dartmouth College, Harvard University, Rhode Island Hospital, the University of Michigan, and the University of Pittsburgh.

After planning, Phase II projects support testing integration models on a small scale in research, education, and / or patient care areas. During FY 1989, Phase II activities were active at the Baylor College of Medicine, Duke University, the University of Cincinnati, the University of Maryland, and the University of Utah.

In FY 1989, the first grant awards were made to assist in the full implementation of IAIMS (Phase III). Columbia University and Georgetown University began implementation following highly successful planning and modeling of critical elements of their plans. These institutions are the first full-scale national models of IAIMS, partially fulfilling the commitment made by NLM to the Congress for some five or six such models when the program was begun in 1983. Another competition for implementation support will be conducted in FY 1990.

As mentioned in the introduction to this chapter, a Special Review Committee (SRC) reported their appraisal of the IAIMS Program to the Board of Regents in January 1989. The SRC found clear evidence of the success of the IAIMS concept:

- The IAIMS process has catalyzed subtle, positive changes in institutional culture and behavior, such as new methods and types of cooperation;
- Decentralized local networking within academic units has led to new understanding about how biomedical information can be packaged and managed in electronic formats for greater effectiveness;
- Markedly enlarged and effective roles for the libraries at the IAIMS sites was seen.

The SRC reported that there is no single IAIMS model; many are needed. The report recommended increased funding for the IAIMS program, the creation of a program to train and develop IAIMS leaders, the support of information exchange between IAIMS sites, grant awards for IAIMS-related research, and the support and development of a biomedical communications network to connect academic health science centers.

Related to IAIMS, NLM awarded a five-year contract to the Oregon Health Sciences University (OHSU) to implement a Biomedical Information Communications Center (BICC) to serve the University, the state, and the northwest region of the country. Primary activities over this five-year contract will include establishing a BICC organization and staff, developing campus telecommunications, appointing training faculty, implementing an automated library information resources system, developing Infonet and a Regional Resources System and Network, creating a medical informatics curriculum for OHSU, and developing research programs in health informatics and in technology.

Table 10.
Extramural Grant and Contract Program (dollars in thousands)

Category	*FY 1987*		*FY 1988*		*FY 1989*	
	No.	*$*	*No.*	*$*	*No.*	*$*
Research	40	$6,391	40	$5,857	45	$7,666
Resource projects	15	2,758	15	3,474	14	3,487
Resource improvement	10	195	8	114	9	129
Training	8	2,147	8	2,619	7	2,537
Fellowships	0	0	0	0	3	99
Regional Medical Libraries	7	2,318	7	2,330	7	2,569
Publications*	17	475	12	330	13	346
(IAIMS projects**)	(9)	(2,549)	(9)	(2,822)	(9)	(2,962)
(Med. info. research)	(28)	(4,256)	(25)	(3,865)	(26)	(4,008)
(Biotech. research)	—	—	(7)	(1,000)	(14)	(2,747)
Totals:	97	$14,284	90	$14,724	98	$16,833

*Includes one Special Scientific Project
**Includes both IAIMS resource and research projects

OFFICE OF COMPUTER AND COMMUNICATIONS SYSTEMS

John Anderson
Director, Information Systems

The Office of Computer and Communications Systems (OCCS) provides information processing capability to meet NLM needs and, in so doing, determines and meets the data processing and data communications requirements for: (1) disseminating biomedical information to thousands of institutions and individual health professionals around the nation and world; (2) operating the world's largest library in a single technical area—biomedicine; and (3) providing MIS (Management Information System) services to NLM, including office automation.

OCCS: (1) implements computer and communication systems using cutting-edge technology and state-of-the-art techniques; (2) analyzes, plans, and provides real-time, online, around-the-clock information services for increasingly sophisticated users; (3) schedules and controls maintenance and publication of dozens of databases, each measured in billions of bytes (characters); (4) operates a modern computer center of fully redundant, fail safe hardware and software; (5) conducts performance measurement and capacity planning for computer hardware, operating systems, data base management systems, transaction processors, etc.; and (6) produces and distributes data and software to approximately two dozen international search centers.

The organization of OCCS is a direct reflection of these responsibilities. Computer and communication systems are:

- Developed and implemented by the Development Branch
- Enhanced and maintained by the Applications Services Branch
- Executed on computers under operating system control by the System Support Branch
- Provided as an around-the-clock service by the Computer Services Branch

Systems Support Branch

The Systems Support Branch is responsible for hardware analysis, system software, and data communications. The current NLM production configuration is an IBM 3084-Q with MVS / XA (multiple virtual systems / extended architecture), TCAM, and VTAM. An IBM 3081-K is used for system testing and development. A third system, an IBM 9370-60 with VM (Virtual Machine) and VTAM is used for the PROFS (Professional Office System).

During FY 1989 there was a major effort to expand storage capacity and improve availability and reliability of the IBM 3084 system. Among the highlights:

- Provision of systems software for the 3084, the IBM 3380-K disk storage and 3990 controller, the STC and Memorex solid state disks, Xerox and IBM printers, and the IBM 9370 PROFS system.
- Support of more than 100 software products for use by programmers, users, systems support staff, and MEDLARS III interim systems.
- Implementation of channel to channel adapters of 3081 and 3084 for VTAM networking of 3084 / 3081 / 9370.
- Support of expanded value added network services.
- Operating systems support and communications connectivity for new terminals throughout the NLM.
- Development and distribution of procedures and status information for the mainframe system.
- Program changes to system software as required by ELHILL and MEDLARS III development.
- Expanded use of solid state disks through upgrade to STC 4305s and acquisition of a Memorex 6890.
- Upgrade of the IBM 9370 Model 40 to Model 60 and implementation of PROFS for NLM-wide use in office automation.

This year, working with representatives of four agencies, the OCCS completed the procurement of value-added network data communications services on behalf of the entire Department of Health and Human Services. The total contract calls for expenditures of $73 million dollars over eight years, approximately one half for NLM data communications services. OCCS was asked to head up this project because of its previous work with commercial data communications providers in support of MEDLARS. (In 1973 NLM was the first customer of TYMNET, the first commercial provider of network services).

With this award NLM has assured data communications service for MEDLINE, TOXNET, Grateful Med, and interlibrary loan services through 1997. The other HHS users of the network are: the Health Care Financing Administration (for Medicare and Medicaid claims processing), the Family Support Administration (for its parent locator program), and NIH / Division of Com-

puter Research and Technology (to provide researchers access to its computer utility).

Development Branch

The Development Branch is responsible for analyzing, designing, and implementing computer-based systems to support NLM's library processing requirements. Development activities during the past year include the implementation of a major subsystem of MEDLARS III, expansion of Grateful Med support, enhancements to DOCLINE, and extensions to the Local Area Network services.

The Technical Services System (TESS) is being developed to perform two functions of the Technical Services Division: the Cataloging Front-End (CAFE) subsystem and the Selection and Acquisition (SAAS) subsystem. TESS is a distributed processing system that integrates mainframe computer, personal computer (workstation), database, and local area network technologies.

The CAFE subsystem was successfully implemented in September 1989. SAAS is being developed using the CAFE software as a foundation and is expected to be implemented in spring 1990. The two subsystems will not only share the same architecture, but also a large amount of applications software. The basic approach is to develop a common set of system functions that drive the mainframe, database, LAN, and workstation, and then use them to construct the specific application functions.

The scope and coverage of Grateful Med continues to grow. It is anticipated that there will be more than 1.7 million Grateful Med searches executed this year by 18,000 registered owners of the software. A procurement authority of $1,825,000 for Grateful Med support and development was approved by NIH and multiple contracts were awarded to two contractors. A Macintosh version of Grateful Med, as well as PC Version 4.0, were released.

DOCLINE, NLM's interlibrary loan request and referral system, has continued to grow. The request rate for FY 1989 exceeded 1.6 million requests; more than 1800 libraries use the system. NLM has continued to enhance DOCLINE by improving system performance and reliability, enhancing the message capability, expanding the ELHILL interface to include the HEALTH file, and providing comprehensive statistical reporting.

As the processing power at NLM staff and patron workstations continues to increase, greater requirements are placed on internal communications in terms of throughput and volumes of data traffic. NLM Local Area Networks (LANs) continue to be enhanced to keep pace with demands to share and transfer information among diverse systems. An extensive broadband cable system throughout NLM links workstations with servers and other processing resources using the Novell Netware operating system. Workstations can access internal hosts through gateways or direct links, and other LANs or wide area networks, such as the NLM Ethernet, are accessible by bridges or gateways. The communications facilities form an integrated network which supports office automation, electronic mail, distributed applications, and data processing activities.

Applications Services Branch

The Applications Services Branch (ASB) of OCCS supports the various NLM programs and serves as the nucleus of all automated programming support services. Accomplishments for FY 1989:

- Two new databases became operational, AIDSTRIALS and AIDSDRUGS.
- The AIDS Bibliography and BIOETHICS Bibliography were created.
- ASB worked closely with contractors and Library Operations staff to complete the Model 204 DBMS-based MeSH system.
- The Automated Indexing Management System (AIMS) 'BIB PROCESSING' subsystem was rewritten from ACT / 1 to CICS.
- The AIMS "BINDING" and Literature Selection Technical Review Committee "LSTRC" subsystem software has been developed and made available for user acceptance testing.

Computer Services Branch

The Computer Services Branch provides data processing services and support for subscribers and users of the Library through the NLM's two large mainframe computer systems: the IBM 3084-Q, with performance characteristics of processing 24.4 million instructions per second (MIPS) and an IBM 3081-K with performance characteristics of 13.5 MIPS. In addition, the Computer Services Branch maintains two Data General mini-computers as well as an IBM 9370 in the support of the Library's PROFS system. Operational support is provided around the clock.

The peripheral equipment attached to the IBM 3084 mainframe consists of 188 direct access storage devices with a total online storage capacity of approximately 177 billion bytes or characters of data. In addition, subscriber support of requested database files is through 14 magnetic tape drives, six of these are IBM 3420's and eight are 3480's. Also installed are many telecommunications units to provide easy and quick access into the main MEDLARS data base files.

Annual printer output support exceeds 19 million pages printed locally and over 500,000 pages printed through the use of remote printers. Both high-speed

fanfold, and cut sheet laser printers as well as impact high speed printers are attached to the IBM 3084 mainframe system.

During the past year the Computer Services Branch created and mailed more than 5,000 magnetic tapes of MEDLARS and TOXNET databases to both domestic and foreign subscribers.

INTERNATIONAL PROGRAMS

Richard K. C. Hsieh, Dr. P.H.
Director, International Programs

The Library's international programs are integral to NLM's responsibilities in biomedical information. The U.S. health community depends on NLM's information retrieval system to identify the relevant information from both domestic and international journals. The world's health community is also heavily dependent on NLM's information retrieval system to access biomedical information.

During the past year NLM continued its bilateral cooperative MEDLARS agreements with individual countries; its cooperation with international government organizations such as the World Health Organization (WHO) and the Pan American Health Organization (PAHO), and international nongovernmental organizations such as the International Council for Scientific and Technical Information (ICSTI).

The Special Foreign Currency Program was active in the support of critical reviews and history of medicine projects. Other NLM international activities included training for colleagues from abroad, the NLM publication exchange program (with 346 institutions in 76 countries), as well as receiving numerous professional visitors from abroad.

International MEDLARS Agreements

The Library has MEDLARS agreements with partners in 15 foreign countries and with the Pan American Health Organization (table 11).

Table 11.
International MEDLARS Centers

Tapes	*Tapes/Software*	*Online NLM*
France*	Australia*	PAHO*
Germany	China	Canada
Japan	Sweden	Colombia
PAHO (BIREME)*		Egypt
Switzerland*		France*
		Italy
		Kuwait
		Mexico
		South Africa
		Switzerland*
		United Kingdom

*Combined online / tapes

As reported last year, the Indian government has nominated the National Informatics Centre as the organizational entity to serve as a MEDLARS Center. Although a formal agreement has been reached between NLM and the National Informatics Centre, MEDLARS operation has not yet begun.

The American Institute in Taiwan and the Coordinating Council for North American Affairs have reached an agreement for the Science and Technology Information Center in Taipei to establish a tape center to provide MEDLARS services to health professionals in Taiwan.

The NLM has enjoyed more than 20 years of collaborative activities with the Pan American Health Organization. In 1989, PAHO amended its leasing agreement with NLM to provide online access to MEDLARS databases from Argentina, Chile, Jamaica, and Costa Rica, and soon access will be available to more Latin American countries.

Another collaborative project with PAHO and the University of Chile is the development of a gateway system named BITNIS. This new system makes it possible for health professionals to conduct MEDLINE searches in Argentina, Chile, Mexico and Venezuela. To execute the BITNIS, a MEDLINE search is initiated by using Grateful Med on a personal computer. The search commands created by Grateful Med are transmitted to NLM through the BITNET network. The search results obtained are transmitted back to the originator through BITNET; Grateful Med is then used to edit and present the retrieval. The objective of the BITNIS project is to provide MEDLINE access to health professionals in developing countries where the high cost of international communication services inhibits use.

Collaboration with the WHO

The NLM and the World Health Organization (WHO) continue to cooperate in the publication of the *Quarterly Bibliography of Major Tropical Diseases* and the *Bibliography of Acute Diarrhoeal Diseases.* NLM prepares camera-ready copy from the MEDLINE system, and WHO prints and distributes these to thousands of institutions in the developing countries. Also, NLM provides MEDLINE bibliographies in camera-ready form to PAHO, and PAHO prints and distributes these in the *Bibliography of Respiratory Infections in Children.*

NLM and WHO also continue to collaborate to provide photocopies of journal articles to health professionals in developing countries in Africa, the Eastern Mediterranean, and South East Asia. Library resources in developing countries are usually insufficient and the need for biomedical and health information can be met only by drawing on the collections of the developed world. Even though NLM and WHO continue to provide some photocopies, this arrangement can only partially meet the demand. Unless other resources in developed countries can be found, the need for interlibrary loans to developing countries will continue to grow.

Special Foreign Currency Program

The Library's Special Foreign Currency Program, authorized under Public Law 480, employs U.S.-owned local currencies to support biomedical scientific publications useful to U.S. health professionals.

During FY 1989, 40 projects totaling $556,982 (equivalent in foreign currencies) were active in this NLM international program. About 70 percent of the funding supported projects in India and 30 percent in Poland.

Among the studies published in India was the eighth and final volume of *Bibliography of Ticks and Tickborne Diseases*, prepared by the late Dr. Harry Hoogstraal and staff at the Medical Zoology Department of the U.S. Naval Medical Research Unit #3 in Cairo, Egypt.

Also published in FY 1989 in India was an English-language translation of a monograph by a noted Russian specialist in experimental histology and experimental surgery, Dr. A. N. Studitsky, titled *Transplantation of Muscles in Animals.*

International Meetings

The Library is a member of the International Council for Scientific and Technical Information (ICSTI). This organization serves as a meeting ground for information and abstracting agencies, commercial and governmental, from a number of countries. Common interests include economics of primary and secondary publications, transborder flow of information, electronic publication, standardization and the information needs of developing countries. At the 1989 general meeting of ICSTI held in Orleans, France, NLM was represented by the NLM Deputy Director, who was elected treasurer.

International Visitors

The Library continues to attract many foreign visitors each year, including medical librarians, health professionals, and government officials. Many of these visitors have responsibility for medical, scientific or technical information in their own countries. Their interest in NLM is more than cursory, and they are officially received and briefed on relevant aspects of NLM operations and research. In 1989 visitors came from the following countries:

Afghanistan, Algeria, Argentina, Australia, Burundi, China (PRC), Colombia, Congo, Cote d'Ivoire, Czechoslovakia, Djibouti, Ethiopia, France, Ghana, Haiti, Hungary, India, Indonesia, Iraq, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Luxembourg, Mali, Malta, Mauritius, Mexico, Morocco, New Zealand, The Netherlands, Nigeria, Pakistan, Poland, Portugal, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, St. Lucia, Sweden, Switzerland, Syria, Taiwan, Thailand, Tunisia, Turkey, Uganda, the USSR, West Germany, Yemen, Yugoslavia, Zaire, Zambia, and Zimbabwe.

ADMINISTRATION

Kenneth G. Carney
Executive Officer

Financial Resources

In FY 1989, the Library had a total appropriation of $73,731,000. Table 12 displays the FY 1989 budget authority plus reimbursements from other agencies, and the allocation of these resources by program activity.

Table 12.
Financial Resources and Allocations FY 1989
(in thousands of dollars)

Budget authority:	
Appropriation, NLM	$73,731
Plus: Reimbursements	6,784
Total	80,515
Budget allocation:	
Extramural Programs	16,120
Intramural Programs	57,919
Library Operations	(35,461)
Lister Hill National Center for Biomedical Communications	(15,737)
Toxicology Information	(6,721)
Research Management and Support	6,476
Total	$80,515

Personnel

On November 4, 1988, President Reagan signed Public Law 100-607, a wide-ranging piece of health legislation that included the authorization of the National Center for Biotechnology Information (NCBI) within the National Library of Medicine. The Center's long term goals are to serve as a national focal point for the study of biotechnology information science, to provide access nationwide to all relevant molecular biology electronic data bases, and to develop specifications for future biotechnology data bases. More detail is in the chapter on the NCBI.

David J. Lipman, M.D. was appointed Director of the Center. Dr. Lipman previously served as a Research Scientist in the Mathematical Research Branch of the National Institute of Diabetes and Digestive and Kidney Diseases.

In staffing the new Center, Dr. Lipman was given authority by the NIH to use several special appointment mechanisms. Nine new staff members hold these appointments, which include Staff Fellows, Visiting Scientists, and Visiting Associates. An additional ten employees were also reassigned to the Center or hired using conventional hiring authorities in FY 1989.

Awards

NLM Director, Donald A. B. Lindberg, M.D. was presented on March 17 with the Surgeon General's Medallion by C. Everett Koop in recognition of Dr. Lindberg's support of historical research on the PHS Commissioned Corps. At the same ceremony, Dr. Koop presented the Surgeon General's Exemplary Service Award to four members of NLM's History of Medicine Division—Dr. John Parascandola, Peter B. Hirtle, Margaret M. Kaiser, and Lucy H. Keister—for their contributions to Commissioned Corps centennial projects.

Dr. Lindberg also received the Nathan Davis Award, presented by the American Medical Association for contributions by public officials to the betterment of health care in America. He was the only Federal career employee so honored.

Daniel R. Masys, M.D., Director of the Lister Hill Center, was awarded the Surgeon General's Medallion for his leadership of the Library's research programs at a ceremony at NIH in June.

NIH Merit Awards were presented in 1989 to:

Atsuko Craft, Library Operations, "for intellectual input of the highest quality in the MEDLARS database and assistance in explaining NLM programs to Japanese visitors."

Donald M. Dodson, OCCS, "for superior performance in upgrading and maintaining operating system software for the NLM computer facility."

Jeanne C. Goshorn, Specialized Information Services, "for leadership and direction in administering effective outreach and training programs for the NLM toxicological information files."

Susan Buyer Slater, Office of the Director, "for superior leadership in the development and management of the NLM Long Range Plan."

Ronald F. Stewart, Office of Administration Management Services, "for bringing professional management practices and EEO principles to bear in the OAMS, resulting in improved responsiveness of that office to the service requirements of the Library."

The NLM Director's Awards for 1989 were presented to:

Dr. Dennis E. Black, Office of Administration, "for recognition of exceptional skills in the management of the Library's acquisition function."

Dr. Elliot Siegel, Office of the Director, "for recognition of outstanding success in managing the Library's Planning and Evaluation programs."

The Board of Regents Award was presented to Philip I. Wexler, Division of Specialized Information Services, "for outstanding scholarly work, exemplified by his recently published book titled, Information Resources in Toxicology."

The Medical Library Association (MLA) presented to Lois Ann Colaianni, Associate Director for Library Operations, a share of the MLA President's Award for editing the Handbook of Medical Library Practice, Volume III.

The MLA also presented to Daniel T. Richards, NLM Collection Development Officer, the second Louise Darling Medical for Distinguished Achievement in Collection Development.

Susanne M. Humphrey of the Lister Hill Center was awarded the American Association for Information Science (ASIS) Best Paper Award for her article, "Knowledge-Based Indexing of the Medical Literature."

Equal Employment Opportunity

In the interest of Equal Employment Opportunity (EEO) at the Library, two key initiatives were launched over the past year by the EEO Office and Subcommittees of the NLM EEO Advisory Committee:

- A study on work that is contracted out to determine its impact on minorities, women, and disabled employees is being conducted; and
- A liaison mechanism was developed with African American, Hispanic American, Native American, and Asian American employees. Liaison representatives of these groups participate in EEO Committee meetings and activities thus coordinating various matters of importance to their constituents.

In addition to these initiatives, the standard work of the EEO Office continued. This included monitoring of the Affirmative Action Plan, training supervisors in the fundamentals of EEO, and providing counseling and mediation services to NLM employees. This year, the EEO Committee played a major role in the successful resolution of conflicts between management and employees.

Table 13.
Staff, FY 1989 Full-Time Equivalents (FTEs)

Program	*Full-Time Permanent*	*Other*
Office of the Director	19	2
Office of Inquiries and Publications Management	5	2
Office of Administration	40	3
Office of Computer and Communications Systems	58	4
Extramural Programs	16	2
Lister Hill National Center for Biomedical Communications*	63	13
Specialized Information Services	33	2
Library Operations	218	31
Total	452	59
Total FTE Usage	511	

* Includes biotechnology-related activities

APPENDIX 1: STAFF BIBLIOGRAPHY

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APPENDIX 2: FY 1989 EXTRAMURAL PROGRAMS-SUPPORTED PUBLICATIONS

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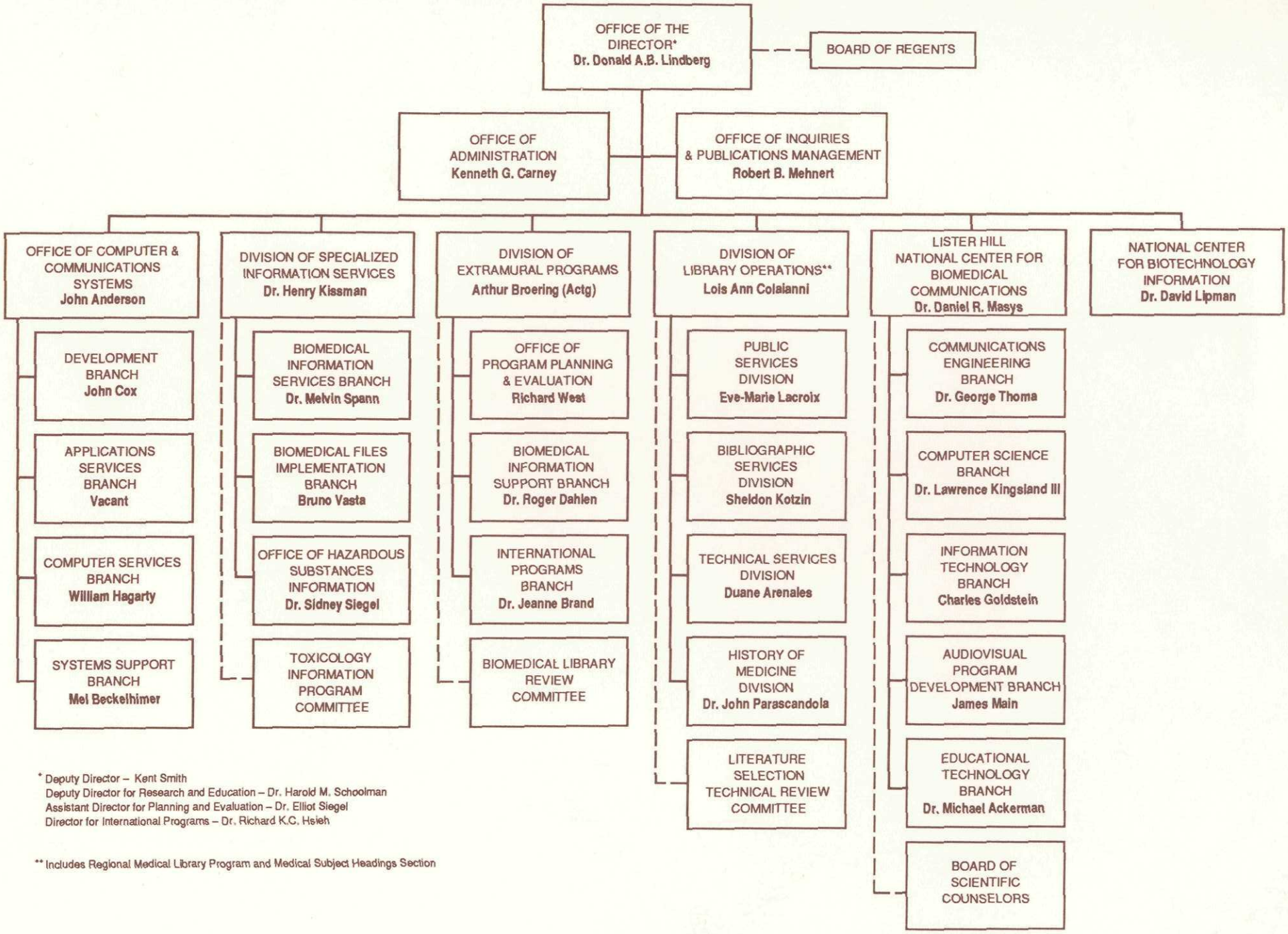

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