

A large number of tissues are collected for diagnostic or therapeutic reasons. These tissues are usually sent to a clinical, diagnostic or pathology laboratory for examination. These laboratories may be located at GME teaching institutions, physicians' offices, community hospitals, or independent laboratories. These tissues may sometimes be used for research, educational, and quality-control purposes, though the vast majority are not. Most patients sign a general consent stating that after completion of any diagnostic tests, some of the sample can be saved/used for research purposes.

To be accredited, laboratories must keep pathological specimens for a minimum amount of time. The Clinical Laboratory Improvement Amendments of 1988 (CLIA) set forth the conditions that laboratories must meet to be certified to perform testing on human specimens. CLIA stipulates that laboratories must retain cytology slides for a minimum of five years, histopathology slides for a minimum of 10 years, and paraffin blocks for a minimum of two years (CLIA, 1996). In addition, some states have regulations that require retention of pathology specimens for longer than the time specified in the CLIA regulations. For example, New York, which has some of the most stringent regulations, requires that laboratories retain abnormal cytology slides for 10 years, cytology slides with no abnormalities for five years, and histopathology slides and paraffin blocks for 20 years. Once the regulated length of time for storage is met, institutions may continue to store pathology specimens based on the room they have for storage, the philosophy of the institution, and several other variables.

PATHOLOGY DEPARTMENTS AT GRADUATE MEDICAL EDUCATION TEACHING INSTITUTIONS

Medical education in the United States can be divided into three major phases. The first phase, medical school, provides instruction in the sciences that underlie medical practice and in the application of those sciences to health care. In 1997, there were 125 medical schools in the United States (including three in

Puerto Rico) (American Medical Association, 1997). The second phase, graduate medical education (GME), prepares physicians for independent practice in a medical specialty. GME programs, usually called residency programs, are based in hospitals or other health-care institutions, some of which have and some of which lack formal relationships with medical schools. GME teaching institutions include medical schools, U.S. armed forces hospitals, VA medical centers, the Public Health Service, state, county, and city hospitals, nonprofit institutions, and health maintenance organizations. In 1997, 1,687 accredited GME teaching institutions operated in the United States (including 22 programs in Puerto Rico) (American Medical Association, 1997). Continuing medical education (CME), the third phase of medical education, updates medical professionals' education throughout their careers.

Collectively, pathology departments at GME teaching institutions constitute the largest and oldest stores of tissue samples in the United States. Two techniques were used to estimate the total number of cases accessioned per year at all GME institutions and the number of tissues stored at each institution. The first estimate used information found in the American Medical Association's Graduate Medical Education Directory 1997–1998 about residency programs in pathology at GME institutions (American Medical Association, 1997). However, information was not available about all pathology specialties. Therefore, a second estimate was made from information obtained from several chairs of pathology departments attending a meeting of the Universities Associated for Research and Education in Pathology (UAREP), hosted by the Federation of American Societies for Experimental Biology (FASEB).¹

The number of pathology residency positions at a GME teaching institution is determined by the caseload of the pathology department. The Graduate Medical Education Directory stipulates that programs should have a sufficient number of cases to ensure that residents have a broad exposure to both common and unusual conditions and that the number of resident positions requested by an institution not exceed the educational resources available in a program (American Medical Association, 1997). The actual number of GME programs and residency positions in 1995–1996, and the number of programs and proposed residency positions for 1997–1998 are shown in Table 6.1. Table 6.2 shows the recommended number and types of cases/specimens residents should examine during their training in anatomic and clinical pathology, dermatopathology, forensic pathology, neuropathology, or pediatric pathology.

¹Medical schools represented at the UAREP meeting included those at the University of Pittsburgh, Johns Hopkins University, University of Minnesota, Robert Wood Johnson Medical School, University of Kansas, Case Western Reserve University, University of Pennsylvania, University of Iowa, Northwestern University, Thomas Jefferson University, and Memorial Sloan-Kettering.

This information was not available for the specialties of cytopathology, chemical pathology, hematology, immunopathology, or microbiology.

An analysis was performed to estimate the total number of cases accessioned per year at all GME teaching institutions in the pathology specialties of anatomic and clinical pathology, dermatopathology, forensic pathology, neuropathology, and pediatric pathology. This calculation was based on several criteria: the number of GME pathology programs in each specialty; the number of resident positions open in these programs for the academic year; the recommended number of cases per program to meet the training requirements of the residents; and the duration of the program in years. Table 6.3 contains data for the academic year 1995–1996, and Table 6.4 contains data for 1997–1998. Information on the recommended number of cases per resident was not available for all pathology specialties. However, an effort was made to obtain information on the average number of cases/specimens accessioned per institution each year for cytopathology and hematopathology, the two other pathology specialties in Table 6.1 with large numbers of residency positions.

Of the pathologic specialties, anatomic and clinical pathology, cytopathology and hematopathology specimens probably account for the largest collection of tissues. For the academic year 1996–1997, there were 180 anatomic and clinical pathology programs with 2,675 residents (see Table 6.1). To have enough cases to fulfill the educational needs of their residents, institutions would have had to

Table 6.1
GME Pathology Programs and Residency Positions

Pathology Specialty	1996–1997 ^a		1997–1998 ^b	
	Number of Programs	Number of Residents	Number of Programs	Number of Residents
Anatomic and Clinical	180	2,675	180	2,656
Cytopathology	68	74	68	101
Chemical Pathology	7	4	7	6
Dermatopathology	41	54	41	72
Forensic Pathology	39	47	39	73
Hematopathology	54	51	54	119
Immunopathology	9	6	9	12
Microbiology	9	5	9	9
Neuropathology	47	37	47	66
Pediatric Pathology	20	12	20	28
Total	474	2,965	474	3,142

^aGraduate Medical Education, 1997.

^bAmerican Medical Association, 1997.

accession more than five million total cases/specimens, an average of 28,050 cases/specimens per program (Table 6.3). Similarly, in 1997–1998, the 180 anatomic and clinical pathology programs with 2,656 residency positions would have to accession more than five million total cases/specimens, an average of 27,851 cases/specimens per program (Table 6.4). Some of the specimens collected by anatomic and clinical pathology may be referred to in another specialty, such as dermatopathology, neuropathology, or immunopathology, and given a separate accession number within that specialty. Therefore, some specimens listed in Tables 6.3 and 6.4, especially for dermatopathology and neuropathology, may also have been accounted for as anatomic and clinical pathology cases. Forensic pathology cases are accessioned separately from the other specialties. It is recommended that forensic pathology programs conduct approximately 500 medicolegal autopsies per year and approximately 300 additional autopsies for each additional residency position. Therefore, forensic pathology programs would have had to conduct 21,900 autopsies² in 1996–1997, and 29,700 in 1997–1998 to provide enough cases for resident training.

Table 6.2
Recommended Specimens for Pathology
Residency Programs

Pathology Specialty	Recommended Cases/Specimens per Resident
Anatomic and Clinical	≥75 autopsies ≥2,000 surgical pathology specimens ≥1,500 cytologic specimens ≥200 intraoperative consultations (frozen sections)
Dermatopathology	≥5,000 new accessions
Forensic Pathology ^a	250–350 autopsies
Neuropathology ^b	≥50 neuromuscular biopsy specimens
Pediatric Pathology	≥40 pediatric autopsies ≥2,000 pediatric surgical pathology specimens ≥50 intraoperative consultations (frozen sections/smears)

SOURCE: American Medical Association, 1997.

^aIn addition to the 250–350 autopsies recommended for residents in Forensic Pathology, it is recommended that forensic pathology programs conduct approximately 500 medicolegal autopsies per year and approximately 300 additional autopsies for each additional residency position requested.

^bIn addition to the minimum of 50 neuromuscular biopsy specimens recommended for residents in neuropathology, it is recommended that neuropathology programs conduct at least 200 necropsies and examine at least 100 neurosurgical specimens per year.

²A single autopsy case may generate several slides and paraffin blocks.

Table 6.3
Specimens and Autopsy Cases Accessioned in 1996–1997

Pathology Specialty	Number of Specimens ^a per Year	Number of Programs	Number of Specimens ^a per Program per Year
Anatomic and Clinical ^b	5,049,063	180	28,050
Dermatopathology	270,000	41	6,585
Forensic Pathology	21,900	39	562
Neuropathology	14,100	47	300
Pediatric Pathology	25,080	20	1,254

^aIncludes autopsy cases.

^bAnatomic and Clinical Pathology programs range in length from 18–24 months. Therefore, the number of specimens per year represents the number of programs multiplied by the number of residents (Table 6.2) divided by two years (24 months) as a minimum estimate.

Table 6.4
Specimens and Autopsy Cases Accessioned in 1997–1998

Pathology Specialty	Number of Specimens ^a per Year	Number of Programs	Number of Specimens ^a per Program per Year
Anatomic and Clinical ^b	5,013,200	180	27,851
Dermatopathology	360,000	41	8,780
Forensic Pathology	29,700	39	762
Neuropathology	14,100	47	300
Pediatric Pathology	58,520	20	2,926

^aIncludes autopsy cases.

^bAnatomic and Clinical Pathology programs range in length from 18–24 months. Therefore, the number of specimens per year represents the number of programs multiplied by the number of residents (Table 6.2) divided by two years (24 months) as a minimum estimate.

In some institutions, pediatric pathology cases may go directly to the pediatric pathology department. However, in some institutions, they may first be accessioned in anatomic and clinical pathology. The 12 residents in pediatric pathology programs in 1996–1997 would have conducted 480 pediatric autopsies and examined 24,000 pediatric surgical pathology specimens and 600 intraoperative consultations (frozen sections, smears). To support 28 pediatric pathology resident positions in 1997–1998, a total of 58,520 specimens and autopsy cases would have to be accessioned. A conservative estimate is that an average of approximately 30,000 anatomic and clinical, forensic, and pediatric pathology and autopsy cases are seen per GME teaching institution each year.

An estimate of the number of cases/specimens accessioned in cytopathology and hematopathology programs was obtained by averaging the number of

cases/specimens reported on various GME teaching institutions' Web sites. Table 6.5 shows information obtained for cytopathology, and Table 6.6 shows information about hematopathology. Cytopathology programs accession an average of approximately 50,000 cytology specimens per year (range of 14,000 to 100,000 cases/specimens). Hematopathology programs accession an average of 750 bone marrow aspirations and biopsies and resections of lymph nodes and related tissue.

As an independent method to estimate the average number of pathology cases accessioned per institution each year, chairs of pathology departments attending the UAREP meeting were asked several questions about the pathology

Table 6.5
Cytopathology Programs

Program	Specimens per Year
University of North Carolina	>24,000
Emory University	65,500
University of Wisconsin	100,000
University of Michigan	47,500
Georgetown University	14,000
Total	251,000
Average	50,200

Table 6.6
Hematopathology Programs

Program	Specimens per Year ^a
NYU Medical Center	750
Emory University	1,000
University of Michigan	500
Total	2,250
Average	750

^aThe College of American Pathologists Minimum Guidelines for the Retention of Laboratory Records and Materials recommends a retention time of 10 years for bone marrow specimens but only 24 hours for serum, cerebral spinal fluid, and other body fluids and seven days for peripheral blood and body fluid smears (<http://www.cap.org>). Therefore, specimens recorded here represent the number of bone marrow aspirations and biopsies and resections of lymph nodes and related tissue accessioned at each institution listed.

departments at their institutions. Information was obtained about the size of their institution, the number of cases accessioned per year, the age of the oldest tissues archived, how long the tissue samples are stored, what identifying information is kept with the tissues, and who has access to the samples. The medical schools represented had facilities that ranged from 250 beds to approximately 2,000 beds and accessioned from approximately 10,000 to approximately 60,000 cases per year. The medical schools accessioned an average of 40 cases per bed with a range of 20–60 cases per bed. Most of the pathology departments stored tissue samples indefinitely, with the oldest tissues archived anywhere from 20 years old to more than 100 years old. Stored specimens are either labeled with a pathology accession number linked to the patient's medical record or labeled directly with the patient's name and medical record number. People who have access to the specimens include the pathologists, researchers, other physicians, and anyone with a court order. Each institution accessions an average of approximately 30,000 cases per year, with approximately 3.8 million total cases accessioned per year at all 125 medical schools in the United States.

DNA DIAGNOSTIC LABORATORIES

GeneTests

GeneTests is an online national directory of DNA diagnostic laboratories. GeneTests seeks to promote the appropriate use of genetic counseling and testing in patient care. GeneTests maintains a comprehensive list of clinical service and research laboratories performing inherited disease-specific clinical molecular genetic testing for single-gene and contiguous-gene disorders. GeneTests is funded by the National Library of Medicine and the Maternal and Child Health Bureau and administered through the Children's Hospital Regional Center in Seattle, Washington. In January 1994, 148 laboratories were listed in GeneTests—131 in the United States, 16 in Canada, and one in Mexico (McEwen and Reilly, 1995). One hundred and thirty-seven of the labs were academically based or within government agencies, and 11 were commercial laboratories (McEwen and Reilly, 1995).

In a 1994 survey of GeneTests (formerly known as HELIX) DNA diagnostic laboratories, 90 percent of the respondents (93 of 148 (63 percent) laboratories surveyed responded) stated that they banked DNA (McEwen and Reilly, 1995). DNA banks ranged in size from fewer than 100 to more than 1,000 samples in storage (McEwen and Reilly, 1995). Most laboratories banked DNA as a service to referring physicians or for individuals and families at risk for a particular genetic disorder, for such research purposes as gene mapping, and as a service to clinical, forensic, or research laboratories (McEwen and Reilly, 1995). More

than half of the respondents stated that their laboratories had released samples to researchers after stripping the samples of identifiers (McEwen and Reilly, 1995).

CLINICAL SERVICE AND DIAGNOSTIC LABORATORIES

The majority of clinical service and diagnostic laboratories are not associated with GME teaching institutions. These include laboratories within physicians' offices or community hospitals and independent laboratories. In 1991, approximately 640,000 clinical laboratories and other facilities performed laboratory tests on human specimens (Department of Health and Human Services, 1991). The number of tissues stored at these laboratories varies greatly, but the minimum storage time is determined by CLIA and state regulations and College of American Pathologists guidelines.

CENTERS FOR DISEASE CONTROL AND PREVENTION INSTITUTES

The Centers for Disease Control and Prevention (CDC), in Atlanta, Georgia, is an agency of the Department of Health and Human Services. The CDC's mission is to promote health and quality of life by preventing and controlling disease, injury, and disability. The CDC is made up of six centers, one institute, and four offices.³ Several centers have stored tissue samples, including the National Center for Environmental Health and the National Center for Infectious Disease.

National Center for Environmental Health

The National Center for Environmental Health (NCEH) is involved in several areas of research, including biomonitoring, breast cancer-related projects, and genetic research. The NCEH has also prepared DNA specimens from approximately 8,000 NHANES (describe in Chapter Five) participants to be used by researchers around the country. In 1996, eight breast cancer-related projects collected more than 3,500 serum samples for analysis in such studies as "Breast Cancer Among Women Exposed to Polybrominated Biphenyl" and "Breast Cancer Among Native Alaskan Women Exposed to Organochlorines."

³The institute, offices, and centers within the CDC are the National Center for Chronic Disease Prevention and Health Promotion, the National Center for Environmental Health, the National Center for Health Statistics, the National Center for HIV, STD, and TB Prevention, the National Center for Infectious Diseases, the National Center for Injury Prevention and Control, the National Institute for Occupational Safety and Health, the Epidemiology Program Office, the Office of Global Health, the Public Health Practice Program Office, and the office of Genetics and Disease Prevention.

National Center for Infectious Diseases

The National Center for Infectious Diseases (NCID) plans, directs, and coordinates a national program to improve the identification, investigation, diagnosis, prevention, and control of infectious diseases. The NCID also maintains several tissue banks. The NCID's Scientific Resources Program maintains a bank of serum specimens of epidemiological and special significance to CDC's research and diagnostic activities. The NCID is also responsible for the integrity, security, and maintenance of a computer inventoried serum bank consisting of 250,000 aliquots of serum from 100,000 Alaskan Natives.