PROC (BAYL UNIV MED CENT)
2021;34(1):199–214
https://doi.org/10.1080/08998280.2020.1812366

Taylor & Francis
Taylor & Francis Group

The Texas Society of Pathologists: molded by the legacy of pathology and focused on excellence in medicine for 100 years and beyond

L. Maximilian Buja, MD

Department of Pathology and Laboratory Medicine, McGovern Medical School, The University of Texas Health Science Center at Houston, Houston, Texas

ABSTRACT

In 1921, 16 Texas pathologists gathered in Dallas, Texas, to found the Texas Society of Pathologists (TSP). The TSP is now the oldest state pathology society in the USA with continuity traced back to its founding 100 years ago. This article aims to both commemorate the TSP centennial and to provide context for the remarkable success of the society. The article takes a look back and a look forward from 1921. The look back focuses on the development of the field of pathology and the maturation of medicine and pathology in the USA and Texas. The look forward encompasses developments in science, technology, American health care policy, and medicine that have impacted Texas pathologists and influenced proactive initiatives of the TSP. The review of the life and times of the TSP highlights the importance of leaders and leadership in shaping outcomes. Complexities and uncertainties of the contemporary health care scene point to the need for continued strong leadership. The successful past century and hopeful future of the TSP are inextricably linked to the guiding principle of the TSP, which is a focus on continual striving for excellence in medicine.

KEYWORDS Health care policy; history; Texas society of pathologists

> *"I have great respect for the past. If you don't know where you've come from, you don't know where you are going."* —Maya Angelou (1928–2014)

> *"Of necessity an historical account must be largely biographical. Men and their books have built pathology. Yet without a point of view which takes account of the major social movements of general history, no real conception of the historical development of any subject is possible."* —Esmond R. Long, MD (1890–1979)

> *"If I have seen further than others, it is by standing upon the shoulders of giants."* —Isaac Newton (1642–1726)

In 2021, the Texas Society of Pathologists (TSP) is celebrating its 100th birthday. The centennial meeting of the TSP featuring a gala celebration of this milestone has been postponed because of the COVID-19 pandemic but will take place at a suitable time in the future. In 1921, 16 Texas pathologists gathered in Dallas, Texas, to found the TSP. The TSP is now the oldest state pathology society in the USA with continuity traced back to its founding 100 years ago.[1,2]

With a nod to the Roman god Janus, this article takes a look back and a look forward from 1921. The look back focuses on the development of the field of pathology and the maturation of medicine and pathology in the USA and Texas. The look forward encompasses developments in science, technology, American health care policy, and medicine that have impacted the membership and operations of the TSP and influenced proactive initiatives of the TSP. This article complements and extends previously published documentation of the history of the TSP, including a book coinciding with the 75th anniversary and an article coinciding with the 90th anniversary, as well as earlier brief reports and

Corresponding author: L. Maximilian Buja, MD, Department of Pathology and Laboratory Medicine, McGovern Medical School, The University of Texas Health Science Center at Houston, 6431 Fannin St., MSB 2.276, Houston, TX 77030 (e-mail: l.maximilian.buja@uth.tmc.edu)

The author reported no conflicts of interest.

Received June 20, 2020; Revised August 10, 2020; Accepted August 13, 2020.

Figure 1. Logos of the TSP Centennial: **(a)** TSP centennial meeting logo, **(b)** TSP Onward logo.

other reflections.[1–7] Other information is presented in the Legacy section of the TSP website.[8]

The major theme of the article is an exploration of the TSP as an organization molded by the legacy of pathology and focused on excellence in medicine *(Figure 1)*. Milestones for Texas medicine and pathology are shown in *Table 1*. The analysis and views expressed herein are those of the author and do not necessarily represent official positions of the TSP.

ESSENTIALS OF PATHOLOGY

Pathology is uniquely both a biomedical science and medical specialty based on a specific approach to the study of disease.[9] This approach progresses from etiology, or causes of disease, to pathophysiological mechanisms at the cellular, subcellular, molecular, and genetic levels, to disease expression, resulting in morphological and functional changes and clinical manifestations. The fundamental role of pathology is expressed in the analogy of the tree of medicine.[9] The trunk of the tree of medicine is general pathology, which elucidates basic features of cell injury and inflammation by utilizing the basic science roots of anatomy, chemistry, physiology, and other basic sciences. The general pathology trunk divides into the many branches of organ-based pathology, each one of which supports a specialized field of medicine.

A SHORT HISTORY OF PATHOLOGY

Pathology developed as a medical science along with physics, chemistry, anatomy, histology, physiology, biochemistry, and microbiology in Europe after the Renaissance.[10,11] In the 18th century, stalwarts, including Giovanni Battista Morgagni and Carl von Rokitansky, established the scientific investigation of causes of disease based on performance of numerous meticulous autopsies.[10–14] In the mid-19th century, the next great advance in pathology was led by Rudolf Virchow (1821–1902). Virchow is the quintessence of the prepared mind succeeding by being at the right place (Germany) at the right time (improved light microscope).[15] In 1858, Virchow established the scientific discipline of cellular pathology with his publication "Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebenlehre." The title, "Cellular pathology as based upon physiological and pathological histology," captures the essence of cytopathology, surgical pathology, and autopsy pathology as practiced today. The 19th century saw other major developments of relevance to pathology. Claude Bernard advanced the field of physiology and established the importance of biological experimentation in medicine.[16] Louis Pasteur and Robert Koch were instrumental in formulating the germ theory of disease and the science of microbiology. Élie Metchnikoff and Julius Cohnheim among others made important observations providing a foundation for cellular physiology and immunology.[17,18]

A SHORT HISTORY OF AMERICAN MEDICINE

In the 18th century, American medicine was in a primitive state and largely devoid of the advances being made in Europe.[19] In the 19th century, American medicine inched forward from this primitive state. In 1847, the American Medical Association (AMA) was established.

The early 20th century was dominated by two momentous global events: World War I and the 1918 influenza pandemic.[20] The same time period ushered in a major change in American medicine with a movement away from ad hoc training and practice to a more scientific approach. Two individuals were major contributors to this movement: Abraham Flexner, an educator, and William Osler, a physician whose career encompassed pathology and internal medicine.[21,22] Recognizing the poor training provided by the many proprietary medical schools, the AMA's Council on Medical Education engaged the Carnegie Foundation, and this organization obtained the services of Abraham Flexner to study medical schools in the nation. The resultant report was published in 1910.[23] Flexner recommended that medical schools should be university based, have minimum admission requirements, implement a rigorous curriculum with applied laboratory and clinical science content, and have faculty actively engaged in research. Osler championed bedside teaching, bringing medical students into direct contact with patients.

Flexner's report had a profound effect on medical education and the teaching of pathology as an important component of a 4-year undergraduate medical education comprising biomedical science courses in the preclinical years and clinical clerkships in the clinical years.[21–23] The newly established Johns Hopkins Medical School quickly became the model Flexnerian institution led by its first dean, the pathologist William Welch.[24] Educated in the leading laboratories in Europe, Welch became the most influential scientist in the world.[20]

Medical schools utilizing the Flexnerian two-pillar construct produced scientifically grounded physicians capable of a high level of clinical practice as well as a subset who pursued highly successful careers as physician-scientists and academicians. Kenneth Ludmerer has produced a comprehensive analysis of the origins and progression of undergraduate and graduate education in the USA.[25–27]

FURTHER DEVELOPMENT OF PATHOLOGY IN THE USA

During the 19th and early 20th century, pathology was essentially an academic discipline with a focus on

Table 1. Selected events relevant to Texas medicine and pathology

Year	Event
1836	Texas Revolution leads to independence.
1845	Texas becomes the 28th state of the USA.
1853	TMA is formed.
1881	Texas voters authorize establishment of UT in Austin and UTMB in Galveston (Texas' largest city).
1889–91	George Dock, MD, and Allen J. Smith, MD, are appointed as first full-time pathology professors in Texas.
1891	Texas Medical College closes and UT Medical Department is established.
1900	Hurricane devastates Galveston.
1900–04	Baylor University College of Medicine is established in Dallas.
1910	The Flexner Report leads to reform of medical education.
1919	George T. Caldwell, MD, commences position as professor and chairman of pathology at Baylor University College of Medicine in Dallas.
1921	Texas pathologists form the State Pathological Society of Texas (later the TSP) on May 9 during the meeting of the TMA in Dallas.
1941	Texas legislature authorizes UT to establish the state cancer hospital in Houston with the name of M. D. Anderson Cancer Center.
1943	Baylor College of Medicine moves to Houston and Southwestern Medical School is reconfigured in Dallas and becomes affiliated with UT.
1945	The Texas Medical Center is founded.
1949	Houston physicians form the Houston Society of Clinical Pathologists.
1962	Texas attorney general rules that pathology is the practice of medicine.
1963	On November 27, President Kennedy is assassinated, which leads to strengthening of the medical examiner system in Texas.
1965	Medicare and Medicaid programs are established by the federal government.
1970s	New medical schools are opened: UT Houston, UT San Antonio, Texas Tech, Texas A&M, University of North Texas.
1971	TSP celebrates its 50th anniversary.
1972	TSP declares the "year of pathology."
1996	TSP celebrates its 75th anniversary. Celebratory meeting marred by ice storm in Dallas.
1998	Houston Society of Clinical Pathologists celebrates 50th anniversary.
2003	TMA celebrates its 150th anniversary.
2003	Texas tort reform begins.
2004	North Texas Society of Pathology is formed.
2011	TSP celebrates its 90th anniversary.
2010s	More medical schools open.
2018	Goal achieved of 1000 active and junior members of TSP.
2021	TSP celebrates its centennial year.

TMA indicates Texas Medical Association; TSP, Texas Society of Pathologists; UT, University of Texas; UTMB, University of Texas Medical Branch.

experimental medicine.[10,11,20,28–30] In the United States, the autopsy and experimental study were the main legacies of 18th and 19th century European pathology. The discipline of surgical pathology for diagnosis was started in surgery departments and subsequently evolved as a component of academic pathology departments, but with tension between classical pathologists and diagnosticians.[31,32] Clinical pathology, i.e., laboratory medicine, was practiced only in medical schools and large hospitals, and formal training was available only in Europe.[20] Over the ensuing years, academic and hospital departments of pathology began to incorporate surgical pathology and cytology practice as well as components of clinical pathology (laboratory medicine).[7,31–34] The private practice of pathology also became more prevalent.

The development of American pathology is reflected by the chronology of the formation of pathology organizations: 1901, American Association of Pathologists and Bacteriologists; 1907, International Association of Medical Museums; 1913, American Society for Experimental Pathology; 1922, American Society of Clinical Pathologists

(now the American Society for Clinical Pathology); 1936, American Board of Pathology; 1946, College of American Pathologists (CAP); 1955, International Academy of Pathology (former International Association of Medical Museums) with the US and Canadian Academy of Pathology subsidiary; 1967, Association of Pathology Chairs; 1976, American Association of Pathologists, formed by the joining of the American Association of Pathologists and Bacteriologists and the American Society for Experimental Pathology; and 1992, American Society for Investigative Pathology, new name for the American Association of Pathologists.[35,36]

BEGINNINGS OF TEXAS MEDICINE AND PATHOLOGY

Seminal events for Texas were the Texas Revolution in 1835–1836 and statehood in 1845. These events are enshrined in the state flag and the designation of Texas as the Lone Star State. The advancement of medicine in America eventually reached Texas, as reflected by the establishment of the Texas Medical Association (TMA) in 1853. In 1881, Texas voters selected Austin as the site of their main university and Galveston as the site of their Medical Department, in recognition of Galveston as the largest city in the state at the time.[37,38] In 1891, the University of Texas (UT) Medical Department (now the UT Medical Branch, UTMB) opened, and Dr. George Dock and Dr. Allen J. Smith joined as full-time pathologists.[37,38] (Dr. George Dock, who had studied with William Osler at the University of Pennsylvania, had arrived in Galveston in 1889 to serve as chair of pathology at the Texas Medical College, the precursor to the UT Medical Department.) The arrival of Dr. Dock and Dr. Smith marked the true beginning of the specialty of pathology in Texas.[1–7] This was followed in 1892 by the first recorded autopsy at UTMB and in 1903 by the first recorded surgical pathology report at that institution, with continuous recording of autopsy and surgical pathology reports until the current time.

In 1900–1904, the Baylor University College of Medicine was established in Dallas, Texas.[7,39,40] In 1919, George T. Caldwell, MD, became professor and chairman of pathology at Baylor University College of Medicine in Dallas. He was the first scientifically trained and full-time pathologist to teach at the school.[1] His wife, Janet Caldwell, MD, also a pathologist, assisted him in the laboratory and became director of the laboratory at Baylor University Hospital.[7]

FORMATION AND EARLY YEARS OF THE TEXAS SOCIETY OF PATHOLOGY

In parallel with the national environment, organization of pathology also occurred in Texas. In 1921, 16 Texas pathologists formed the State Pathological Society of Texas (later the TSP) on May 9, 1921, during the meeting of the TMA in Dallas.[1–7] The society met separately, then met as the Section on Clinical Pathology of the TMA from 1928 to 1934, and once again resumed separate meetings. The original constitution stated that the "purpose of this Society shall be to federate and bring into one compact organization, the pathologists and bacteriologists of the State of Texas and to affiliate with similar associations of other states; to advance and to extend a knowledge of pathology and bacteriology; to promote friendly intercourse among pathologists and bacteriologists, and to guard and foster the material interests of its members and protect them against imposition."[1] The inaugural meeting took place on May 9, 1921, at the Oriental Hotel in downtown Dallas.

Three classes of membership were recognized: active, associate, and honorary.[1,2] After the constitution and bylaws of the society were adopted, the first officers were installed. Key issues discussed by the 16 founding members related to the need for agreed-upon standards for medical laboratories; appropriateness of advertising by pathologists; strategies to cope with intrusion into the practice of pathology by other physicians and nonphysician practitioners; considerations regarding licensure and/or certification for medical technologists; need for recognition of "pathology" as the practice of medicine; and systems of payment for pathologists. In varying forms and degrees, these concerns of the founding members have remained active and often difficult issues.[1,2]

In 1922, Texas physicians participated in the organization of the American Society of Clinical Pathologists in St. Louis (now the American Society for Clinical Pathology). This event marked the beginning of the organized discipline of clinical pathology, also known as laboratory medicine.[33,34] In 1940, the name of the State Pathological Society of Texas was changed officially in the constitution and bylaws to TSP.

ORGANIZATION, OPERATIONS, AND STALWARTS OF THE TSP

From the beginning, the TSP has operated in accord with the organization's constitution and bylaws.[1] Over the years, judicious changes have been made in these documents to reflect modifications in operations. Governance of the organization is entrusted to officers, a board of directors, and a house of delegates. The officers and board of directors consist of an elected president, president-elect, immediate past president, vice president, secretary, and treasurer and three at-large members. The house of delegates is composed of nine director districts, each with three delegates and three alternates. The current categories of membership are active members, junior members, honorary members, corresponding members, and retired members. Operations also involve committees, including Communications, Membership, Economic Affairs, Residents'/Fellows' Seminar, Advocacy Communication Subcommittee, and Digital Content Subcommittee, and Councils, including Caldwell, Education, Heritage, and Legislative. Clearly, the TSP is an organization totally dependent upon the volunteer activities of the members and a democratic organization with many opportunities for participation by the members. The

Table 2. Vision, mission, goals, and objectives of the Texas Society of Pathologists

Category	Statement
Vision	To promote optimal health and medical care of all Texans through the contributions of pathology to medical practice.
Mission	TSP advances the cause of Texas pathologists by providing proactive solutions to the challenges they encounter in the provision of pathology expertise for the physicians and patients they serve.
Goals and objectives	TSP is strongly committed to fulfilling its vision and mission by: • Educating members on current issues that impact the practice of pathology. • Advocating for members in the Texas legislature. • Providing a community of peers that enrich members' professional lives. • Preserving the history of the practice of pathology in Texas. • Giving back to the pathology community through the Educational Foundation. • Supporting future pathologists through the Young Pathologists' Section program.

activities of the TSP are responsive to the vision and mission of the organization and a set of goals and objectives *(Table 2)*.

The TSP came into existence a year after the 19th Amendment to the US Constitution was adopted giving women the right to vote. Beginning in 1930 with Dr. Violet H. Keiller, there have been 12 women presidents of the TSP (in 1930, 1946, 1973, 1982, 1989, 1990, 1995, 2003, 2005, 2006, 2012, and 2018).

For many years, the annual meetings have been held over 3 days in January and have featured high-quality scientific sessions with presentations by internationally recognized pathology experts coupled with meetings of the board of directors and committees and award presentations. The house of delegates met in person for many years until there was a switch to a teleconference format preceding the annual meeting.

In 1982, a summer seminar was started, and this became a precursor of the New Issues Forum in 1986. As a typical example, the theme of the 13th annual New Issues Forum was "Demonstrating Value in Pathology and Laboratory Services." By 2000, after a good run, this meeting series came to an end. In the late 1980s, a new initiative was started by Dr. Ibrahim Ramsey to more formally involve residents and fellows in the annual TSP meeting by inviting poster and platform presentations. This initiative has morphed into the Residents Forum and Scientific Sessions. Subsequently, in 1997, an Educational Foundation was established as a 501(c)3 organization to support educational activities of the residents. Dr. Vernie Stembridge of Dallas was instrumental in the formation of the foundation. In 1997, another important initiative of the TSP came to fruition with the formation of the Young Pathologists Section. Dr. Gary Rust was its architect and driver, and the section has continued as a major venue for the attraction into organized pathology of residents, fellows, and young pathologists just entering practice.

In 1972, the "year of pathology" was observed by Texas pathologists. During the previous year, the TSP had celebrated its 50th anniversary, with Dr. Vernie Stembridge serving as chairman of the event. In 1996, the TSP was poised to celebrate its 75th anniversary, with an elaborate planning effort led by Dr. Stembridge. Unfortunately, the celebratory meeting in Dallas was impacted by a severe ice storm, which limited participation. Nevertheless, the event was commemorated by a noteworthy publication building upon Dr. Stembridge's historical research and written by Marilyn Miller Baker, former longtime editor of *Texas Medicine*.[1]

The annual meetings have served as a venue for the TSP to recognize the special accomplishments of selected members through awards and named lectureships. In 1946, the TSP named its award for scientific distinction the George T. Caldwell Distinguished Service Award. In 1998, the TSP recognized Dr. John J. "Andy" Andujar by bestowing on him its recently established (1993) Citation of Merit Award, and naming it in his honor. Dr. Andujar was a stalwart Texas pathologist noted for his innovative scientific work, including creating a revolutionary blood test for syphilis,[41] as well as his accomplishments as a world leader in pathology, reflected by his election as the president of the American Board of Pathology and the first American president of the World Association of Societies of Pathologists. Dr. Andujar's wife, retired State Senator Betty R. Andujar, had previously received the Citation of Merit in 1996 for her contributions to medicine and pathology.

In 1997, the Vernie A. Stembridge, MD, Lectureship was established in recognition of the extraordinary and sustained contributions of Dr. Stembridge to pathology and the TSP. He was the recipient of the Legion of Merit, the nation's second highest peacetime award, in recognition of his contribution to military aircraft safety based on his early career work as senior pathologist and chief of the aviation pathology section of the Armed Forces Institute of Pathology (1956–1959).[42,43] Dr. Stembridge was an officer in almost every local and national association in which he held membership, including president of the American Board of Pathology and the American Society of Clinical Pathologists.[44,45] A festschrift has been published honoring Dr. Stembridge upon his retirement.[46] Dr. Stembridge's writings and memorabilia have been preserved in the McGovern Historical Collection and Historical Research Center of the Houston Academy of Medicine – Texas Medical Center Library in Houston.[47] The scholarship of these individuals is preserved or otherwise recognized in the

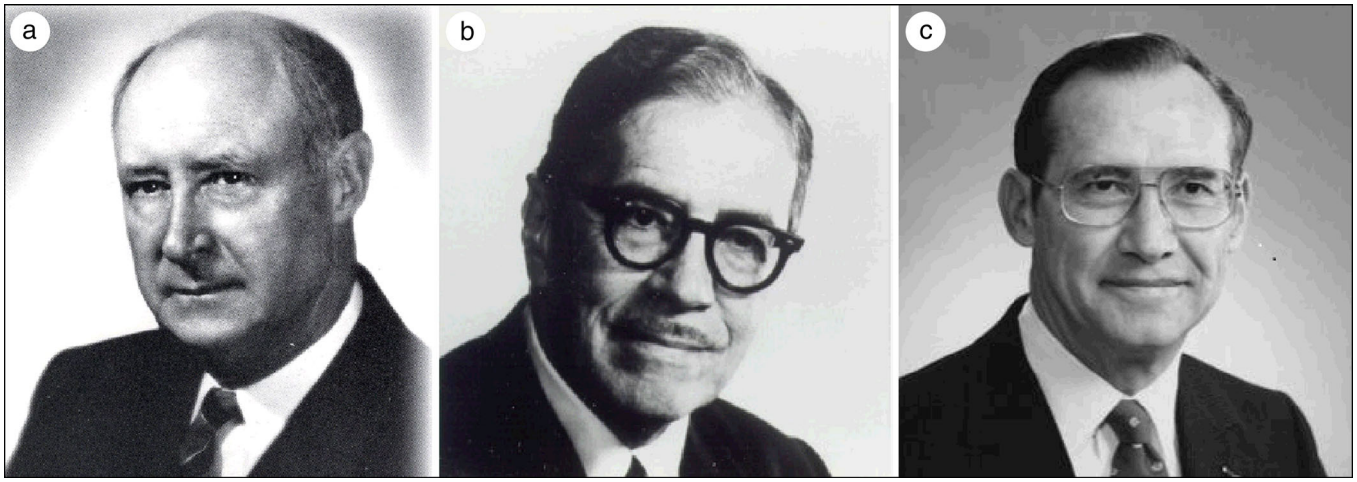

Figure 2. **(a)** George T. Caldwell, MD, **(b)** John J. Andujar, MD, and **(c)** Vernie A. Stembridge, MD.

scientific literature.[41–49] Dr. Caldwell, Dr. Andujar, and Dr. Stembridge *(Figure 2)* remain icons for Texas pathologists because of their outstanding qualities of integrity, professionalism, good judgment, and extraordinary and sustained contributions to the medical profession, pathology, and the TSP.

In 2013, recognizing that TSP membership had been stagnant for many years at around 700 to 750 members, the TSP president challenged the society to have 1000 members by its centennial. The board of directors agreed to institute a group membership for large private and academic groups, an idea that had been resisted by the board for many years. A major membership campaign drive ensued with enthusiastic and creative approaches from TSP leaders. Membership in the TSP has now passed the 1000 mark, including active members and junior members!

Medicine has always been influenced by social and scientific developments, and the TSP and its members are no exception. Therefore, an overview of major social and scientific developments is now presented in this narrative to place into context the history and future of the TSP.

INFLUENCE OF MAJOR AMERICAN BIOMEDICAL INSTITUTIONS

The federal government has been and continues to be a major force in the progress of biomedical science and clinical practice.[50] The National Institutes of Health (NIH) traces its beginnings to 1887, when a one-room laboratory was created in the Marine Hospital Service, founded in 1798 and the precursor agency to the US Public Health Service.[51] Following World War II, funding from the federal government, funneled primarily through the NIH and the Department of Defense, fueled a major expansion of biomedical research.[52,53] Also, the National Science Foundation (NSF) was established by the NSF Act of 1950 with the mission to promote the progress of science; to advance national health, prosperity, and welfare; and to secure the national defense.[54] Research in academic pathology departments has benefited greatly from federal funding supported by the NIH and NSF.

In 1836, the National Library of Medicine (NLM) had a modest beginning as the Library of the Surgeon General of the Army.[55–57] In 1879, the NLM started publishing Index Medicus. In 2004, the catalogue content converted to the freely accessible digital format of PubMed. The NLM also runs the National Center for Biotechnology Information, which houses PubMed and other biological databases that are freely accessible on the Internet. The revolutionary changes in dissemination of the scientific literature were led by Dr. Donald Lindberg, a pathologist who was the longtime director of the NLM and a pioneer in the introduction of computer technology into medicine.[58–60]

The National Academy of Sciences was founded in 1863, at the height of the Civil War.[61,62] Beginning with 50 charter members, the academy has included many of the nation's most distinguished scientists. The National Academy of Sciences established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970, which became the National Academy of Medicine in 2015.[63] These influential entities provide advice in the form of reports to the government. A relevant prime example is the series of reports on medical errors from the Institute/Academy of Medicine. Several pathologists have been elected to the National Academy of Sciences and/or National Academy of Medicine.

The Armed Forces Institute of Pathology (AFIP) was founded in 1862 as the Army Medical Museum in Washington, DC, on the grounds of the Walter Reed Army Medical Center.[64,65] The AFIP subsequently developed a unique character based on the expertise of a civilian and military staff of outstanding pathologists who provide diagnostic consultations for civilian and military referrals.[66] This development at the AFIP mirrored the progressive development of subspecialties in pathology research and practice. Unfortunately, the AFIP came afoul of the base realignment and closure process and closed in 2005.[66–70] Closure of the AFIP represents a major loss to pathology and medicine.

THE ADVANCE OF TECHNOLOGY

In 1959–1960, electronics technology was revolutionized when Jack Kilby (Texas Instruments) and Robert Noyce (Fairchild Semiconductor Corp) announced the invention of the microchip, and this was followed by the invention of the integrated circuit and microprocessor in the 1960s. In the 1970s, the personal computer was developed. These inventions ushered in the digital revolution.[71–74]

In 1982–1983, the Advanced Research Projects Agency Network of the Department of Defense was expanded when the NSF funded the Computer Science Network and then adopted the Internet protocol suite with the foundational transmission control protocol (TCP/IP) leading to the modern Internet. In 1990, Tim Berners-Lee invented the World Wide Web, ushering in the information age.[75–77] In medicine, technology continues to be a major driver of advances as well as costs. This has included, for better or worse, the implementation of the electronic medical record.[78,79]

THE EMERGENCE OF MOLECULAR BIOLOGY AND GENOMIC MEDICINE

In 1953, James Watson and Francis Crick announced the double-helix structure of DNA, the molecule determining genetic inheritance, a seminal discovery that would give rise to genomic medicine.[80,81] In 1990, the Human Genome Project was launched. Five years later, it reported completion of the first map of human DNA, and by the fall of 1995, 1% of the 3 billion DNA base pairs had been sequenced.[82–84] In 2001, publications announced the complete sequencing of the human genome by the International Human Sequencing Consortium and Celera, a private venture, ushering in the age of genomic medicine.[80–82] Further developments occurred rapidly, resulting from 2005 onward in capabilities for next-generation sequencing and genome-wide association studies.[85,86]

The Human Genome Project has had many ramifications, including the cloning of the entire human genome, computational biology for data mining, genetic profiling of individuals and populations, functional genomics and proteomics, molecular pharmacology, gene therapy, and stem cell therapy with genetically manipulated stem cells.[87–89]

ORGANIZATION OF INVESTIGATION AND CLINICAL PRACTICE IN PATHOLOGY DEPARTMENTS

Academic pathology departments came to be organized to operate pathology-specific programs linked to the classical academic tripartite mission of research, teaching, and service, including clinical service. Pathology departments incorporated surgical pathology and subsequently developed programs in multiple subspecialties. Components of laboratory medicine developed both within and outside of pathology departments, but laboratory medicine has now been incorporated into the pathology department at most institutions.

Pathology departments are now key components of the medical school and the health care system of contemporary academic health centers.[90,91] Operations of pathology departments have become increasingly complex to meet clinical demands and outside contingencies while striving to maintain an academic mission.[92,93] Academic departments have led the way in subspecialization in response to the subspecialization of clinical medicine, but subspecialization is also increasingly occurring in private practice as well.[94,95]

UNDERGRADUATE AND GRADUATE MEDICAL EDUCATION

The accrediting agency for US and Canadian undergraduate medical education programs, the Liaison Committee on Medical Education, was founded in 1942 by the Association of American Medical Colleges and the AMA. In the 1920s, organized postgraduate training of pathologists in the USA began.[96–98] In 1936, the American Board of Pathology was formed and began its certification program. In 1972, the Liaison Committee for Graduate Medical Education was founded by the AMA and the Association of American Medical Colleges and commenced its accreditation of graduate medical education programs. In 1981, the Accreditation Council for Graduate Medical Education (ACGME) was founded.

Since 2002, the ACGME and the American Board of Pathology have recognized a 4-year residency training program in anatomic pathology and clinical pathology.[96] In recent years, pathology programs have been busy adapting to current trends in graduate medical education, including competency-based education (six ACGME competencies), milestones, the rise of postresidency fellowships, and maintenance of certification.[97–100]

In undergraduate medical education, the pathology course encompassing general and systems pathology occupied a pivotal role in the Flexnerian two-pillar model of medical education.[21,22] Pathology education became strongly influenced by Stanley Robbins' textbook, first published in 1957, which linked anatomic pathology to pathophysiology and clinical correlation and had a vibrant writing style.[101] Regarding the importance of pathology in the education of a physician, Dr. Vernie Stembridge wrote:

> Pathology continues to be the subject which has the best ability to accomplish that oneness (i.e. the focus of medicine on the unity of the human being, R L Wilbur, 1927). The staunch position of pathology in the early curriculum is based on its uniqueness as the single medical science which spanned the gap between the basic and the clinical sciences, bringing together the normal and the abnormal through physiology, biochemistry, and morphology.[46]

Nevertheless, 20th century medical education has come under significant criticism, as reflected in the Second Carnegie Foundation Report, which has championed major curriculum change leading to implementation of integrated curricular models. Pathology courses have become casualties of the movement to a modular organ-based approach in the new "integrated" curriculum.[102,103] Pathology educators

have raised concern that the "disruptive innovation" may have unintended consequences on the education of scientifically grounded physicians and have adverse effects for pathology and physician-scientists.[22] Of all medical specialties, pathology now has the fewest number/percentage of US medical graduates entering training.[104] Nevertheless, pathology continues to attract quality American and international medical graduates.

US HEALTHCARE POLICY WITH IMPACT ON PATHOLOGY

Self-payment by patients was the norm for financing health care in this country for many years. Health insurance in the USA began as a private enterprise when, in 1929, the first employer-sponsored hospitalization plan was created by teachers in Dallas, Texas.[1] In the 1930s, Blue Cross organizations were begun with the goal of providing prepaid hospital services to individuals.[105] In 1935, as a major component of the Franklin D. Roosevelt administration's response to the Great Depression, Congress created the Social Security program, but health care funding was excluded from the program. The 1940s saw the rise of employer-sponsored health insurance plans as employers responded to salary freezes during World War II by offering health insurance as a benefit to attract workers that were in short supply.

In 1946, Congress passed the Hill-Burton Free and Reduced-Cost Health Care Act giving hospitals, nursing homes, and other health facilities grants and loans for construction and modernization. In 1960, the Kerr-Mills Act provided matching funds to states assisting patients with their medical bills. In 1965, as a key component of the Great Society, President Lyndon B. Johnson signed into law legislation that established the Medicare and Medicaid programs, which went into effect shortly thereafter.[105,106] Initially the AMA vigorously opposed the legislation, but subsequently it dropped opposition after successfully negotiating fee-for-service reimbursement mechanisms for physicians in Medicare.[105,106]

In 1967, amendments to Medicare law provided for 100% reimbursement in Part A of Medicare for inpatient services provided by hospital-based physicians for services to inpatients, while hospital outpatient diagnostic services were transferred to Part B. Thereafter, many requirements were imposed on pathologists, and over the years a variety of formulas and approaches for reimbursement for Medicare patients have been used.[107] More than 100 amendments to Medicare have been adopted, including establishment of fee schedules for routine laboratory work on the basis of the median in-network rate of private payors within a region; reimbursement for teaching physicians was transferred to Part A of Medicare, and, in 1972, Professional Standards Review Organizations were given responsibility for review of Medicare services.

In the 1960s, the American Society of Clinical Pathologists and others encouraged automation of pathology laboratories, regardless of size, initiating the establishment of the modern clinical pathology laboratory.[1,33,34] The Clinical Laboratory Improvement Act (CLIA) established minimum quality requirements for participation in Medicare for clinical laboratories engaged in interstate commerce. Also, several large commercial laboratories were founded, with continued expansion over the next three decades.

In 1973, President Richard Nixon signed into law the Health Maintenance Organization Act of 1973, in which medical insurance agencies, hospitals, clinics, and even doctors could begin functioning as for-profit business entities instead of the service organizations they were intended to be, leading to the growth of private insurance companies, managed care, and managed health care programs.[1] In 1977, Medicare-Medicaid Fraud and Abuse Amendments were adopted. One section called for disclosure of ownership of 5% or more in a facility, such as an independent laboratory, in order to participate in Medicare and Medicaid.

In 1982, the Tax Equity and Fiscal Responsibility Act brought hospital ancillary units, including laboratories, under reimbursement limits. The Health Care Financing Administration was given authority to limit reimbursement to pathologists under reasonable compensation equivalents. The Deficit Reduction Act of 1984 replaced a reasonable charge basis for outpatient laboratory testing with career-wide fee schedules. In 1985, the Gramm-Rudman-Hollings deficit-reduction legislation led to a court decision that in effect set the stage for cost-shifting of indirect laboratory charges for nonpatients in an amount equal to that applied for the hospital's own patients. Under the Omnibus Budget Reconciliation Act (OBRA) '87, the Secretary of Health and Human Services was authorized to impose sanctions on physicians who declined assignment of Medicare benefits on fee schedule testing. Also eliminated were previous allowances for return on equity of capital for hospital outpatient departments, including laboratories, and Medicare laboratory reimbursements were reduced.

Once enacted, CLIA '88 in principle would extend direct federal jurisdiction for the regulation of clinical laboratory quality to all US clinical laboratories. The act also provided for Medicare coverage of preventive laboratory services, including payment for screening of Pap smears every 3 years. OBRA '89 reduced laboratory fee schedules again and barred "self-referral" to laboratories owned by physicians; the act created the "shell lab" concept regarding laboratory-to-laboratory referrals. OBRA '90 again reduced laboratory fee schedules. The act changed the definition of shell laboratory to one that does not perform on site 70% of tests for which it has received requisitions. In 1992, the first regulations for CLIA '88 took effect. The final regulations on the Medicare and Medicaid Patient Program Protection Act, passed in 1987, were implemented, as was the Stark self-referral ban. In 2003–2005, the Health Insurance Portability and Accountability Act of 1996 went into effect.

In 2010, The Patient Protection and Affordable Care Act, also known as the Affordable Care Act or Obamacare, was enacted. Thereafter, Obamacare has taken considerable

battering (with some provisions dropped or modified as a result of legal challenges in the Supreme Court) but has continued to withstand assaults by forces favoring a laissez-faire approach to health care operations and financing.[108]

MEDICINE AND PATHOLOGY IN TEXAS SINCE 1921

During the 1940s, the Texas Medical Center was established in Houston and the Texas legislature passed a bill authorizing funding to establish a state cancer hospital, M. D. Anderson Hospital and Tumor Institute (later UT M. D. Anderson Cancer Center) in Houston.[109] In 1943, Baylor University College of Medicine moved from Dallas to Houston and the Southwestern Medical College of the Southwestern Medical Foundation (established 1939) opened in Dallas. In 1949, the Southwestern Medical College became the second medical school in the UT system. And in 1949, Houston physicians formed the Houston Society of Clinical Pathologists.[6]

In the 1970s, Texas added new medical schools and health institutions: UT Medical School at Houston, now part of the UT Health Science Center at Houston; the UT Medical School at San Antonio, now part of UT Health Science Center at San Antonio; Texas Tech University School of Medicine, now part of the Texas Tech Health Science Center; The University of North Texas College of Osteopathic Medicine, now part of the University of North Texas Health Science Center; and the Texas A&M Medical School, now part of Texas A&M University Health Science Center (Texas A&M Health). The Texas A&M medical school was founded in 1977 as one of five medical schools authorized by the federal Teague-Cranston Act, which created medical schools in conjunction with Veterans Affairs hospitals to meet the needs of the medically underserved of the country. Texas A&M Health has gone on to establish relationships with a number of institutions in the state, including Baylor University Medical Center at Dallas.[7]

The population of Texas cities has continued to grow (28.7 million in 2018), no more so than Houston (2.4 million in city and 6.2 million in the metropolitan area). The Texas Medical Center in Houston has become the largest multi-institutional medical center in the world. Houston has also experienced increasingly frequent "rain and water events." On June 15, 1976, the first catastrophic flood of the Texas Medical Center occurred. In June 9, 2001, Tropical Storm Allison led to another catastrophic flood, causing $4 billion in damages in Houston with $2 billion in the Texas Medical Center. And in August 2017, Hurricane Harvey also caused widespread flooding in Houston.

TSP ADVOCACY FOR PATHOLOGY AS THE PRACTICE OF MEDICINE

In the 1950s, Texas pathologists engaged Blue Cross-Blue Shield of Texas to recognize their fees under Blue Shield, which reimburses physicians, rather than under Blue Cross, which pays for hospital services.[1] To get legal clarity to issues related to the clinical practice of pathology, the Texas attorney general was petitioned. In 1957, Texas Attorney General Will Wilson rendered an opinion declaring that whenever a corporation employs a licensed physician to treat patients and receives the fee, the corporation is unlawfully engaged in the practice of medicine and the licensed physician so employed is violating the provisions of Texas state law and is subject to having his or her license to practice revoked.

In 1958, an inquiry regarding a trained but unlicensed physician working in a Texas laboratory brought forth the opinion from the secretary of the Texas State Board of Medical Examiners that 1) if individuals come to Texas and work in a laboratory and limit their work to diagnosis, they are practicing medicine and will have to have a license; 2) all those who do pathology and make a diagnosis are practicing medicine; and 3) no one can do pathology in Texas without a medical license.

In 1962, Texas Attorney General Wilson ruled that pathology is the practice of medicine.[1,2] In 1965, the CAP gave formal support to the concept of billing for the "professional component" of services. In follow-up, a mailing was sent to members of the TMA by the TMA Board of Councilors listing qualified Texas pathologists and the categories of laboratory tests offered.

MEDICAL EXAMINER SYSTEM IN TEXAS

As early as 1942, the TSP established a committee to investigate the activity of justices of the peace, coroners, and medical examiners. In 1955, the Texas legislature passed a bill allowing county commissioners in four Texas locations—Dallas, Fort Worth, Houston, and San Antonio—to set up a medical examiner's system. In June 1955, San Antonio became the first city to initiate a medical examiner's system in the state.[1]

On November 22, 1963, President John F. Kennedy was assassinated in Dallas. Texas physicians were thrust into history.[110] The Secret Service overruled Dr. Earl Rose, the Dallas chief medical examiner, and Texas law by having the body moved to Washington, where the autopsy was performed with erroneous conclusions contributing to conspiracy theories. Thereafter, through efforts led by Dr. Vernie Stembridge, the medical examiner system was strengthened by a requirement that the medical examiner in Dallas be a member of the faculty of UT Southwestern Medical Center. A similar policy has been adopted in other jurisdictions.

TSP AND TMA

TSP advocacy efforts have included engagement with Texas legislators on legislation affecting pathologists, other physicians and patients, and collaboration with the TMA and with national organizations, especially CAP and the American Society of Clinical Pathologists. Four TSP pathologists have served as presidents of the TMA: Truman Connor Terrell, MD, from Fort Worth, president of TSP, 1938, 1941, 1942, and president of TMA, 1952–1953; May

Owen, MD, from Fort Worth, president of TSP, 1946, and president of TMA, 1960–1961; Ladon V. Homer, MD, from Fort Worth, president of TSP, 1992, and president of TMA, 2006–2007; and William W. Hinchey, MD, from San Antonio, president of TMA, 2007–2008. In 2003, the TMA celebrated its sesquicentennial.[111]

TORT REFORM IN TEXAS

Advocacy by TMA, the Texas Alliance for Patient Access, the Texas Medical Liability Trust, and others, including the TSP, over many years resulted in a major legislative victory for medicine in 2003. On September 1, 2003, Texas House Bill 4, the Medical Malpractice and Tort Reform Act of 2003, went into effect. The same month, Texas voters approved Proposition 12, an amendment to the Texas Constitution that authorized the state legislature to cap noneconomic damages in health care liability cases, ensuring a $250,000 limit on noneconomic damages against individual physicians; a total "stacked" noneconomic cap of $750,000 if health care institutions were also found liable; and other crucial protections, such as providing personal immunity to physicians working for governmental entities, including state medical schools. No cap was imposed on economic damages.[112]

As a result, there has been a marked decrease in the number of malpractice lawsuits, creating a significantly more favorable environment for medical practice in Texas. In 2017, Texas set a record for new medical licenses issued by the Texas Medical Board, nearly doubling the number issued in 2003, the year tort reform went into effect. However, because of the ongoing growth of the population of Texas, the state still has a doctor shortage, particularly in rural areas, based on number of physicians per 100,000 population compared to some other states. In response to the current and projected doctor shortage in Texas, a surge of recent openings of medical schools (allopathic and osteopathic) is taking place in Texas, mirroring the national trend.[113–115] The legislature has also responded with increased funding for graduate medical education slots, but there is still a risk that an imbalance in Texas medical school graduates and first-year graduate medical education slots in Texas may lead to a continuing doctor shortage in Texas.

TSP MOVING TOWARD THE 2021 CENTENNIAL

The last 30 to 50 years have been marked by increasingly difficult relationships between pathologists and private insurance companies. In the 1990s, the TSP developed a strong interest in a suit brought against the insurance industry by the Pathology Laboratories of Arkansas.[1] In 1995, a court issued a ruling in this suit that was favorable and supportive of that group's separate billing for the professional component of its work to an insurance fund; however, the court ruling did not assure that an insurance company in the future would have to allow separate billing for the professional component.

In 1996, members of the TSP Pre-Paid Health Committee met with representatives of major insurance companies to discuss payment for clinical pathology professional services. Extensive data were collected and presented to decision-making executives to affirm the TSP position on this issue. To further reinforce this position, TSP submitted recommendations to the TMA through its Council on Socioeconomics. These recommendations were that 1) the TMA recognize that clinical pathology represents a medically necessary service from which patients directly benefit; 2) the TMA give support to the position that, in the absence of contractual arrangements that forbid balance billing, pathologists should be able to bill patients directly for clinical pathology services not covered by the patients' insurance, and 3) the TMA reaffirm its policy supporting the separation of physician and hospital payments.

In 2007, the TSP took on the issue of direct billing for pathology services. TSP advocated for SB 1832, which was eventually passed by the Texas legislature. The initial bill would have required that only the laboratory that provided anatomic pathology services could bill for them (direct billing). TMA and almost all specialty societies vigorously opposed the bill. TSP hired a lobbyist and was supported by CAP in this effort. The bill that ultimately passed required a person, physician, or entity that does not directly provide or supervise the anatomic pathology service to disclose on an itemized statement the name and address of the physician or lab that provided the service and the net amount paid to the physician for that service. Essentially, the bill provided for disclosure of the markup.

Another issue addressed in the 2011 legislative session involved legislative intent in HB 1009 to codify a Texas standardized informed consent for autopsy. The back story involved a Houston-area pathologist who was sued (along with the hospital) over an autopsy. He was accused of collusion with the hospital in covering up the cause of death and removing organs without consent from the family. The family believed the man died of a medication error. Several irregularities in procedure and inadequacies in the informed consent came to light. The Texas Medical Liability Trust initially refused to cover the pathologist's litigation expenses, stating that the person was deceased and therefore not a patient and thus no harm could be incurred. TSP leadership advocated on behalf of the pathologist to the top Texas Medical Liability Trust executive explaining the autopsy, its importance in detecting significant unexpected findings, and how it is recognized as the practice of medicine. As a result, Texas Medical Liability Trust rewrote its policies for pathology to specifically cover autopsies. TSP also advocated for the legislation that passed and became law.

Since 2000, the TSP Legislative and Economic Affairs Committees have taken on a number of other issues still operative including 1) advocacy for a balanced approach to medical technology licensure and 2) regulation of laboratory benefit management programs. TSP has not been successful

in obtaining passage of legislation to amend the Medical Examiner Reauthorization Act to empower medical examiners to release tissue for public health–related research. The TSP is currently trying to exert influence in the ongoing state and national debate regarding out-of-network balanced billing, so-called "surprise medical bills."[116,117]

For many years and in many contexts, as reflected in this narrative, the TSP has advocated to preserve the principle of fee-for-service billing and reimbursement for clinical pathology professional services along with anatomic pathology professional services. Over the last 25 years, this TSP advocacy has involved several skirmishes and battles with health insurance companies. TSP advocacy has had continuing success in achieving the major goal of the preservation of fee-for-service billing and reimbursement for clinical pathology as well as anatomic pathology services in Texas.

While TSP advocacy has been very successful in the past, the present and future of the TSP is inextricably intertwined with major current and future forces influencing the biomedical enterprise and the American health care scene.

CONTEMPORARY STATUS OF THE BIOMEDICAL ENTERPRISE

From a broad perspective, progress in medicine since the mid 20th century has been astounding.[118–121] Essential to this progress has been the unfettered pursuit of scientific discovery for its own sake.[122] Yet, the very success has spawned unintended consequences. A cogent analysis has found that two great projects of the last two decades, i.e., new genetics and the social theory of disease, have fallen short of delivering further tangible results, leading to societal discontent.[123] The discontent is manifest by several phenomena, including fear of illness and death among the general public, termed "the worried well"; disillusioned doctors; slowing of the development of new "wonder drugs" in spite of the undue influence of the pharmaceutical industry[124,125]; the soaring popularity of alternative medicine; the antivaccination movement[126]; and the spiraling cost of health care.[127] The American health care scene has developed characteristics of a "riddle, wrapped in a mystery, inside an enigma" (Winston Churchill's definition of Russia, 1939), with a conglomeration of multiple delivery systems and funding mechanisms linked to various sectors of society, a heavy reliance on for-profit private insurance plans, and a large number of uninsured Americans, coupled with ever-increasing costs.[127–131]

Thus, the current American biomedical enterprise presents some fundamental paradoxes and needs. First, while the future of biomedical research has never been brighter based on the advances to date and the continuing expectations regarding molecular and genomic medicine, American national priorities and economic realities are constraining ongoing funding of research.[132–135] During the decade prior to 2004, biomedical research funding from all sources in America increased at an annual rate of 6.3%, and the United States funded more than half of all biomedical research conducted throughout the world.[130] Since 2004, the growth rate for research funding has decreased to 0.8%, and the USA's share of the world's research investment has decreased to 44%.[132] In 2017, the US government share of basic research funding fell below 50% for the first time in the post–World War II era.[128] From 1996 to 2014, the percent of Nobel laureates in medicine or physiology who were at US institutions at the time of the award decreased from 80% to 45%.[132] From 2007 to 2009, the Texas government and the citizens of Texas, to their credit, sought to improve the situation through the passage of landmark legislation and funding of the Cancer Prevention and Research Initiative, providing $3 billion over 10 years, which has subsequently been renewed for another 10 years.

Second, while the pace of biomedical discovery and new knowledge has dramatically quickened, the pace of application of knowledge to effectively prevent disease and improve the health of the population lags behind.[123] Third, the effectiveness of the American health care delivery system is constrained because of increasing dysfunction of its socioeconomic foundation. Medical practice has undergone a fundamental transformation, dominated by a fixation on increasing efficiency in the delivery of care with quality of care a secondary consideration.[132] Fourth, the current situation has created tensions for physicians based on inherent conflicts of interest as physicians try to balance the financial realities with providing optimal care for their patients.[132] Fifth, societal forces are making increasingly clear that the current fragmented health care in America is ultimately nonsustainable and that fundamental change is needed to institute a more coherent and equitable health care system that is also uniquely American.[108,136,137]

IMPACT OF SCIENTIFIC ADVANCES ON PATHOLOGY

Pathology has always been an opportunistic and eclectic science, taking advantage of advances in basic sciences to conduct basic and translational research ultimately aimed at the elucidation of the etiology and pathogenesis of human diseases. In the 18th and 19th centuries, autopsy pathology was primarily responsible for the scientific elucidation of many human diseases. In the 20th and 21st centuries, autopsy pathology has continued to be primarily responsible for the discovery or elucidation of the pathogenesis of new diseases, such as acquired immunodeficiency syndrome due to human immunodeficiency virus, as well as documentation of effects of new therapies.[138–141] Both the discovery process as well as diagnostic pathology have been enhanced by the coupling of gross examination and light microscopy with new techniques, including electron microscopy, fluorescence microscopy, histochemistry, and immunohistochemistry. From the 1970s onward, immunocytochemistry has become a powerful and ubiquitous component of diagnostic pathology.[142]

Investigation in pathology departments has generally been innovative and of high quality. Seven pathologists have been awarded the Nobel Prize in Physiology or Medicine:

Johannes Fibiger, 1926, for experimental production of gastritis and gastric carcinoma; George H. Whipple, 1934, for discovery that a diet rich in liver cures pernicious anemia; Howard W. Florey, 1945, for testing and production of penicillin; F. Peyton Rous, 1966, for discovery of carcinogenic viruses made in 1911; Renato Dulbecco, 1975, for discovery of the interaction between DNA tumor viruses and the genetic material of the host cell; Baruj Benacerraf, 1980, for discovery of the immune response genes; J. Robin Warren, 2005, for co-discovery that stomach ulcers are an infectious disease caused by *Helicobacter pylori.*[143–149]

Pathologists also have made major contributions to the conjoined fields of cell biology and cell pathology.[10,30,35,36,144,150–155] These contributions have provided a foundation for fundamental insights by basic scientists recognized by the award of six Nobel Prizes in 1908, 1974, 2002, 2004, 2012, and 2019.[156–162] The contemporary field of cell injury research has sprung from the conceptualization of apoptosis as a fundamental pathobiological process by pathologists studying human material.[153–155] The major Nobel Prize–winning discovery of *H. pylori* infection as the treatable cause of gastric conditions, including ulcer disease, resulted from the collaborative work of a pathologist and gastroenterologist correlating findings in gastric biopsies with clinical observations.[148,149] Our contemporary understanding of the pathogenesis of atherosclerosis is due to the major contributions of innovative pathologists active in the later 20th century.[163]

Contemporary advances in biomedical sciences and technology are presenting challenges as well as opportunities for pathology.[164] In the 21st century, gene cloning and next-generation sequencing have come of age.[85,86] Genetic profiling and diagnostic testing from human blood samples are now technically and financially feasible. Application of next-generation sequencing to formalin-fixed paraffin-embedded tissues also has become feasible, with great potential for a renaissance of genomic research on human tissues, including an expanded role for the autopsy ("molecular autopsy").[139–141] Pathologists have taken on the key role of stewards of human tissue specimens for diagnosis and research into the future.[165]

Applications of health informatics technology are making increasingly prevalent telecommunications between physicians and scientists and between professionals and patients and subject participants.[166] Telepathology is being facilitated by advances in telecommunications coupled with advances in digital and quantitative morphology.[164–167] Digital microscopy also is being coupled with artificial intelligence and deep computer learning.[168,169] The latter is better termed *augmented intelligence,* representing a powerful adjunct for the human operator. The CAP has convened a series of Futurescape of Pathology Conferences to proactively address the challenges and opportunities for pathology provided by these scientific advances.[170,171]

The importance of pathology to medical practice and discovery continues as American medicine and society meet the challenges of dealing with new diseases, including EVALI (e-cigarette or vaping product use–associated acute lung injury)[172] and the COVID-19/SARS-CoV-2 virus pandemic.[173]

REFLECTIONS ON MEDICINE AS A PRIVILEGED PROFESSION AND PATHOLOGISTS AS PHYSICIANS

Thus, pathologists share with other physicians the challenges and opportunities of simultaneously dealing with the socioeconomics of health care as well as scientific advances while remaining true to the ideals of the medical profession. Characteristics of the ideal physician encompass personal life, professional life, and public life as well as a combination of humanistic and scientific attributes and capabilities. Texas pathologists such as Dr. Caldwell, Dr. Andujar, and Dr. Stembridge have been exemplars of these ideals. Seven key roles of the ideal physician have been identified—communicator, collaborator, manager, health advocate, scholar, professional, and integrator—with all the roles overlapping equally to create the "medical expert."[22] Professional expertise is required because of the complexities of practicing medicine, as succinctly and cogently stated by William Osler:[174] "Medicine is a science of uncertainty and an art of probability" and "the practice of medicine is an art, not a trade; a calling, not a business, a calling in which your heart will be exercised equally with your head."

The quintessence of the pathologist is medical expert, the doctor's doctor. Our core conviction that the practice of pathology is the practice of medicine brings with it professional privileges as well as responsibilities to patients and society reflected in medicine's code of ethics.[175] Maintenance of the social contract between the lay public and medicine, and pathology as part of medicine, is of paramount importance.

PATHOLOGY AND THE TSP ONWARD INTO THE FUTURE

This review of the life and times of the TSP highlights the importance of leaders and leadership in shaping outcomes. Complexities and uncertainties of the contemporary health care scene point to the need for continued strong leadership. The pathology profession faces four major challenges: 1) maintaining a pathology workforce by implementing multifaceted proactive approaches ensuring a pipeline of medical students choosing pathology as a career; 2) successfully incorporating scientific and technological advances into pathology practice; 3) successfully adapting to inevitable changes in the socioeconomics of the American health care system; and 4) embracing the unique role of pathology and pathologists as the supreme medical expert and consultant, as a key to survival and prosperity for the profession. Texas pathologists are providing leadership in addressing these issues.[116,176,177]

In his "Leaven of Science" address of 1894, William Osler eloquently stated that past achievement is a major source of inspiration for individuals and nations, but he

warned that undue focus on parochial and selfish interests, while superficially attractive, can lead to a loss of continuity with previous accomplishment that sustains the broader good. "In the continual remembrance of a glorious past, individuals and nations find their noblest inspiration, and if today this inspiration, so valuable for its own sake, so important in its associations, is weakened, is it not because, in the strong dominance of the individual so characteristic of a democracy, we have lost the sense of continuity?"[174]

The challenge for pathology and the TSP is to remain true to a glorious past while adapting to the future. As reflected by its glorious past, the TSP has exhibited features of a long-term successful organization and aspires to continue as such into the future. A roadmap for continual success has been identified.[178,179] The enduringly successful organization *preserves* core values and core purpose and opportunistically *changes* cultural and operating practices and specific goals and strategies to meet prevailing circumstances. The enduringly successful organization also *adheres to the hedgehog concept* by identifying and focusing on what the organization can be the best at doing and, to that end, *develops BHAGs* (big, hairy, audacious goals)—addressing what you are deeply passionate about (which includes your core values and purpose), what you can be the best in the world at doing, and what drives your resource and/or economic engine.[178,179]

The TSP has ended a century of accomplishment and is now entering a new century with incumbent challenges and opportunities and with the goal of maintaining continuing relevance and success. The successful past century and hopeful future of the TSP are inextricably linked to the guiding principle of the TSP, which is a focus on continual striving for excellence in medicine. Fortunately, Texas pathologists are providing the leadership to proactively, optimistically, and creatively embrace the future.

1. Baker MM. *The History of Pathology in Texas*. Austin, TX: Texas Society of Pathologists; 1996.
2. Laucirica R, Buja LM, Milam JD, Hausner RJ. The Texas Society of Pathologists: a historical perspective of the first 90 years. *Arch Pathol Lab Med*. 2011;135(1):12–18. doi:10.1043/2010-0415-ED.1.
3. Stout BF. Early experiences in clinical pathology in Texas. *Texas State J Med*. 1948;44:500–503.
4. Stout BF. One hundred years of progress in pathology in Texas. *Texas State J Med*. 1953;49:312–315.
5. Andujar JJ. Pathology. *Tex Med*. 1967;63(3):90–92.
6. Koch E. *Reflections: Historical Perspectives on Pathology in Houston and Galveston*. Houston, TX: The Houston Society of Clinical Pathologists; 1998.
7. Race GJ, Tillery GW, Dysert PA 2nd. A history of pathology and laboratory medicine at Baylor University Medical Center. *Proc (Bayl Univ Med Cent)*. 2004;17(1):42–55. doi:10.1080/08998280.2004.11927956.
8. Texas Society of Pathologists. Legacy: Publications. https://www.texpath.org/amsimis/TSPI/Legacy/Publications/TSPI/Legacy/Publications.aspx?hkey=e7d343b6-f09a-42ba-8af3-a22b9258ae39. Published 2010. Accessed August 22, 2020.
9. Majno G, Joris I. Preface and introduction. In: *Cells, Tissues, and Disease*. 2nd ed. New York: Oxford University Press; 2004:vii–ix, 1–8.
10. Long ER. *A History of Pathology*. New York: Dover; 1965.
11. Nezelof C, Seemayer TA. The history of pathology: an overview. In: Damjanov I, Linder J, eds. *Anderson's Pathology*. St. Louis: Mosby; 1996:1–11.
12. Zampieri F, Zanatta A, Basso C, Thiene G, eds. Andreas Vesalius 500 years later. *Proceedings of the 2nd International Meeting on Medicine and Pathology, Working Group of History of Pathology of the European Society of Pathology, Padua 2015*. Padua, Italy: CLEUP; 2019.
13. McManus BM, Babul S. The autopsy. In: Damjanov I, Linder J, eds. *Anderson's Pathology*. St. Louis: Mosby; 1996:15–32.
14. van den Tweel JG, Taylor CR. The age of the autopsy. In: van den Tweel JG, Taylor CR, eds. *From Magic to Molecules: An Illustrated History of Disease*. Beijing, China: Peking University Medical Press; 2016:65–80.
15. Brown TM, Fee E. Rudolf Carl Virchow: medical scientist, social reformer, role model. *Am J Public Health*. 2006;96(12):2104–2105. doi:10.2105/AJPH.2005.078436.
16. Bernard C. *An Introduction to the Study of Experimental Medicine*. New York: Dover Publications; 2017:226.
17. Medzhitov R. Inflammation 2010: new adventures of an old flame. *Cell*. 2010;140(6):771–776. doi:10.1016/j.cell.2010.03.006.
18. Wallach D, Kang TB, Kovalenko A. Concepts of tissue injury and cell death in inflammation: a historical perspective. *Nat Rev Immunol*. 2014;14(1):51–59. doi:10.1038/nri3561.
19. National Constitution Center. The mysterious death of George Washington. https://constitutioncenter.org/blog/the-mysterious-death-of-george-washington/. Published December 14, 2018. Accessed August 22, 2020.
20. Barry JM. *The Great Influenza. The Story of the Deadliest Pandemic in History*. New York: Penguin; 2004:546.
21. Norman G. Medical education: past, present and future. *Perspect Med Educ*. 2012;1(1):6–14. doi:10.1007/s40037-012-0002-7.
22. Buja LM. Medical education today: all that glitters is not gold. *BMC Med Educ*. 2019;19(1):110. doi:10.1186/s12909-019-1535-9.
23. Flexner A. *Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching*. New York: Carnegie Foundation for the Advancement of Teaching; 2010.
24. Roberts CHL. H. L. Mencken and the four doctors: Osler, Halsted, Welch, and Kelly. *Proc (Bayl Univ Med Cent)*. 2010;23(4):377–388. doi:10.1080/08998280.2010.11928657.
25. Ludmerer KM. *Learning to Heal. The Development of American Medical Education*. New York: Basic Books; 1985.
26. Ludmerer KM. *Time to Heal. American Medical Education from the Turn of the Century to the Era of Managed Care*. New York: Oxford University Press; 1999.
27. Ludmerer KM. *Let Me Heal. The Opportunity to Preserve Excellence in American Medicine*. New York: Oxford University Press; 2015.
28. Starr CL. The age of the microscope: from whole body to tissue: America. In: van den Tweel JG, Taylor CR, eds. *From Magic to Molecules: An Illustrated History of Disease*. Beijing, China: Peking University Medical Press; 2016:149–168.
29. Starr C, Gardner WA. Philadelphia: cradle of American pathology. *Virchows Arch*. 2011;458(1):31–38. doi:10.1007/s00428-010-0989-2.
30. Long ER. *A History of American Pathology*. Springfield, IL: Charles C. Thomas; 1962.
31. Rosai J, ed. *Guiding the Surgeon's Hand: The History of American Surgical Pathology*. Washington, DC: American Registry of Pathology; 1997.
32. Louis DN, Young RH. *Keen Minds to Explore the Dark Continents of Disease. A History of the Pathology Services at the Massachusetts General Hospital*. Boston, MA: Massachusetts General Hospital; 2011.
33. Kotlarz VR. Tracing our roots: the beginnings of a profession. *Clin Lab Sci*. 1998;3:161–166.

34. Adeli K. Laboratory medicine—a hidden treasure in healthcare. *Clin Biochem*. 2017;50(12):645–647. doi:10.1016/j.clinbiochem.2017.03.022.
35. Long ER. *History of the American Society for Experimental Pathology (1913–1970)*. Bethesda, MD: The American Society for Experimental Pathology; 1972.
36. Sobel ME, ed. *History of the American Society for Investigative Pathology 1976–2013. Commemorating the Centennial Anniversary of the American Society for Experimental Pathology 1913–2013*. Rockville, MD: American Society for Investigative Pathology; 2013.
37. Burns CR. The University of Texas Medical Branch at Galveston. Origins and beginnings. *JAMA*. 1991;266(10):1400–1402.
38. Watts L. The University of Texas Medical Branch: a century of service. *Tex Med*. 1991;87(4):61–65.
39. Butler WT. *Arming for Battle against Disease. Through Education, Research and Patient Care at Baylor College of Medicine. Books I, II, III, IV, and V*. Houston: Baylor College of Medicine; 2011.
40. Chapman JS. *The University of Texas Southwestern Medical School. Medical Education in Dallas 1900–1975*. Dallas: Southern Methodist University Press; 1976.
41. Andujar JJ, Anderson MM, Mazurek EE. Cardiolipin blood tests in syphilis. *Am J Clin Pathol*. 1948;18(3):199–211. doi:10.1093/ajcp/18.3.199.
42. Stembridge VA, Crafft WM, Townsend FM. Medical investigation of aircraft accidents with multiple casualties. *J Aviat Med*. 1958;29(9):668–675.
43. Berry FB, Stembridge VA. The human element in aircraft accidents. *Ann Surg*. 1958;147(5):590–593, discussion 594–595. doi:10.1097/00000658-195805000-00002.
44. Stembridge VA. Preservation of the species-pathologist. *Am J Clin Pathol*. 1982;78(6):797–805. doi:10.1093/ajcp/78.6.797.
45. McKenna R, Buja M, Milam J. Vernie A. Stembridge, MD (1924–2000). *Am J Clin Pathol*. 2001;116:150–151.
46. A festschrift honoring the retirement of Vernie A. Stembridge, MD. *Arch Pathol Lab Med*. 1993;117(12):1205–1239.
47. Vernie Stembridge, MD papers, 1945–2000. MS 143. McGovern Archives, Texas Medical Center Library. https://legacy.lib.utexas.edu/taro/hamtmc/00014/tmc-00014.html. Published 2010. Accessed August 22, 2020.
48. Gill AJ, Caldwell GT, Goforth JL. Choriocarcinoma of the testicle. *Am J Med Sci*. 1945;210:745–751. doi:10.1097/00000441-194512000-00006.
49. Deter RL, Caldwell GT, Folsom AI. A clinical and pathological study of the posterior female urethra. *J Urol*. 1946;55:651–662. doi:10.1016/S0022-5347(17)69961-0.
50. Federal funding of scientific research—a timeline. http://www.sciencecoalition.org/downloads/1392650023researchfundingtimeline.pdf. Published 2010. Accessed August 16, 2020.
51. Morens DM, Fauci AS. The forgotten forefather: Joseph James Kinyoun and the founding of the National Institutes of Health. *mBio*. 2012;3(4):1–10. doi:10.1128/mBio.00139-12.
52. Shannon JA. The National Institutes of Health: some critical years, 1955–1957. *Science*. 1987;237(4817):865–868. doi:10.1126/science.3303330.
53. Wyngaarden JB. The National Institutes of Health in its centennial year. *Science*. 1987;237(4817):869–874. doi:10.1126/science.3303331.
54. Bronk DW. The National Science Foundation: origins, hopes, and aspirations. *Science*. 1975;188(4187):409–414. doi:10.1126/science.1091972.
55. Lindberg DAB, Humphreys BL. 2015—the future of medical libraries. *N Engl J Med*. 2005;352(11):1067–1070. doi:10.1056/NEJMp048190.
56. Lindberg DAB. The National Library of Medicine. *World Neurosurg*. 2010;74(1):46–48. doi:10.1016/j.wneu.2010.04.014.
57. Fee E. Information on a global scale: the National Library of Medicine. *Lancet*. 2014;384(9937):21–22. doi:10.1016/s0140-6736(14)61118-1.
58. Lindberg DAB, Humphreys BL. "You have to be there": twenty-five years of SCAMC/AMIA symposia. *J Am Med Inform Assoc*. 2002;9(4):332–345. doi:10.1197/jamia.m1076.
59. Lindberg DAB. Biomedical informatics: precious scientific resource and public policy dilemma. *Trans Am Clin Climatol Assoc*. 2003;114:113–121.
60. Seelye KQ. Dr. Donald Lindberg, 85, dies; opened medical research to the world. *New York Times,* September 2, 2019. https://www.nytimes.com/2019/09/02/obituaries/dr-donald-lindberg-dead.html.
61. Cicerone RJ. Celebrating the 150th anniversary of the National Academy of Sciences. *PNAS*. 2013;110(12):4433–4434. doi:10.1073/pnas.1303065110.
62. Olson S. The National Academy of Sciences at 150. *PNAS*. 2014;111(Supplement_2):9327–9364. doi:10.1073/pnas.1406109111.
63. Fallon HJ. The Institute of Medicine and its quality of healthcare in America reports. *Trans Am Clin Climatol Assoc*. 2002;113:119–125.
64. Townsend FM. A century of pathology. The Armed Forces Institute of Pathology: 1862–1962. *Mil Med*. 1963;128:273–289. doi:10.1093/milmed/128.4.273.
65. Henry RS. *The Armed Forces Institute of Pathology. Its First Century 1862–1962*. Washington, DC: Office of the Surgeon General, Department of the Army; 1964.
66. Mullick FG, Fontelo P, Pemble C. Telemedicine and telepathology at the Armed Forces Institute of Pathology: history and current mission. *Telemed J*. 1996;2(3):187–193. doi:10.1089/tmj.1.1996.2.187.
67. Gorstein F, Mostofi FK. Armed Forces Institute of Pathology in jeopardy—who should care? *Hum Pathol*. 2003;34(3):203–205. doi:10.1053/hupa.2003.108.
68. Spencer WH, Albert DM. The Armed Forces Institute of Pathology: an appreciation. *Arch Ophthalmol*. 2006;124(9):1332–1334. doi:10.1001/archopht.124.9.1332.
69. Butler DA, Baker TP. The DoD Joint Pathology Center as a resource for researchers. *Mil Med*. 2015;180(10 Suppl):85–89. doi:10.7205/MILMED-D-14-00738.
70. DeLellis RA, Caton M. The AFIP/ARP Atlases of Pathology past, present, and future. *Am J Surg Pathol*. 2018;42(3):e28–e32. doi:10.1097/PAS.0000000000001012.
71. Wikipedia. Computer. https://en.wikipedia.org/wiki/computer. Published 2010. Accessed August 16, 2020.
72. Wikipedia. Integrated circuit. https://en.wikipedia.org/wiki/Integrated_circuit. Published 2010. Accessed August 16, 2020.
73. van Lunteren F. Clocks to computers: a machine-based "big picture" of the history of modern science. *ISIS*. 2016;107(4):762–776. doi:10.1086/689764.
74. Zimmermann KA. History of computers: a brief timeline. *Live Science*, September 7, 2017.
75. Wikipedia. History of the Internet. https://en.wikipedia.org/wiki/History_of_the_Internet. Published 2010. Accessed August 16, 2020.
76. Leiner BM, Cerf VG, Clark DD, et al. A brief history of the internet. *ACM SIGCOMM Comp Comm Rev*. 2009;39(5):22–31. doi:10.1145/1629607.1629613.
77. Wikipedia. Information age. https://en.wikipedia.org/wiki/Information_Age. Accessed August 16, 2020.
78. Alkureishi MA, Lee WW, Lyons M, et al. Impact of electronic medical record use on the patient-doctor relationship and communication: a systematic review. *J Gen Intern Med*. 2016;31(5):548–560. doi:10.1007/s11606-015-3582-1.
79. Gawande A. Why doctors hate their computers. *The New Yorker,* November 5, 2018.
80. Watson JD, Crick FHC. Molecular structure of nucleic acids: a structure for deoxyribose nucleic acid. *Nature*. 1953;171(4356):737–738. doi:10.1038/171737a0.
81. Portin P. The birth and development of the DNA theory of inheritance: sixty years since the discovery of the structure of DNA. *J Genet*. 2014;93(1):293–302. doi:10.1007/s12041-014-0337-4.

82. International Human Sequencing Consortium. Initial sequencing and analysis of the human genome. *Nature.* 2001;409:860–921.
83. International Human Sequencing Consortium. Finishing the euchromatic sequence of the human genome. *Nature.* 2004;431:931–945.
84. Venter JC, Adams MD, Myers EW, et al. The sequence of the human genome [published correction appears in Science 2001 Jun 5;292(5523):1838]. *Science*. 2001;291(5507):1304–1351. doi:10.1126/science.1058040.
85. LeGallo M, Lozy F, Bell DW. Next-generation sequencing. *Adv Exp Med Biol.* 2017;943:119–148.
86. Yohe S, Thyagarajan B. Review of clinical next-generation sequencing. *Arch Pathol Lab Med*. 2017;141(11):1544–1557. doi:10.5858/arpa.2016-0501-RA.
87. Mao AS, Mooney DJ. Regenerative medicine: current therapies and future directions. *PNAS*. 2015;112(47):14452–14459. doi:10.1073/pnas.1508520112.
88. Buja LM. Cardiac repair and the putative role of stem cells. *J Mol Cell Cardiol*. 2019;128:96–104. doi:10.1016/j.yjmcc.2019.01.022.
89. Chien KR, Frisén J, Fritsche-Danielson R, Melton DA, Murry CE, Weissman IL. Regenerating the field of cardiovascular cell therapy. *Nat Biotechnol*. 2019;37(3):232–237. doi:10.1038/s41587-019-0042-1.
90. Lee TH. Discovering strategy: a key challenge for academic health centers. *Trans Am Clin Climatol Assn.* 2016;127:300–312.
91. Wood JP. Opportunities for academic pathology: the thoughts and perspective of a legal observer. *Acad Pathol.* 2016;3:1–7.
92. Sanfilippo F, Burns KH, Borowitz MJ, Jackson JB, Hruban RH. The Johns Hopkins Department of Pathology novel organizational model: a 25-year-old ongoing experiment. *Acad Pathol.* 2018;5:1–14.
93. Balfour E, Stallone R, Castagnaro J, et al. Strengths of the Northwell Health laboratory service line: maintaining performance during threatened interruptions in service. *Acad Pathol.* 2016;3:1–13.
94. Mrak RE, Parslow TG, Ducatman BS. Benchmarking subspecialty practice in academic anatomic pathology: the 2017 Association of Pathology Chairs survey. *Acad Pathol.* 2018;5:1–9.
95. Sarewitz SJ. Subspecialization in community pathology practice. *Arch Pathol Lab Med*. 2014;138(7):871–872. doi:10.5858/arpa.2014-0084-ED.
96. Bennett BD. Certification from the American Board of Pathology: getting it and keeping it. *Hum Pathol*. 2006;37(8):978–981. doi:10.1016/j.humpath.2006.02.023.
97. Alexander CB. Pathology graduate medical education (overview from 1926 to 2005). *Hum Pathol*. 2006;37(8):923–928. doi:10.1016/j.humpath.2006.02.025.
98. Alexander CB. Pathology graduate medical education (overview from 2006–2010). *Hum Pathol*. 2011;42(6):763–769. doi:10.1016/j.humpath.2010.11.008.
99. Naritoku WY, Alexander CB. Pathology milestones. *J Grad Med Educ*. 2014;6(1 Suppl 1):180–181. doi:10.4300/JGME-06-01s1-10.
100. Byrne LM, Miller RS, Philibert I, et al. Program performance in the next accreditation system (NAS): results of the 2015–2016 annual data review. *J Grad Med Educ*. 2017;9(3):406–410. doi:10.4300/JGME-D-17-00320.1.
101. Robbins SL. The birth and rearing of a textbook on pathology. *Arch Pathol Lab Med*. 1996;120(9):887–891.
102. Cooke M, Irby DM, Sullivan W, Ludmerer KM. American medical education 100 years after the Flexner report. *N Engl J Med*. 2006;355(13):1339–1344. doi:10.1056/NEJMra055445.
103. Irby DM, Cooke M, O'Brien BC. Calls for reform of medical education by the Carnegie Foundation for the Advancement of Teaching: 1910 and 2010. *Acad Med*. 2010;85(2):220–227. doi:10.1097/ACM.0b013e3181c88449.
104. Jajosky RP, Jajosky AN, Kleven DT, Singh G. Fewer seniors from United States allopathic medical schools are filling pathology residency positions in the main residency match, 2008–2017. *Hum Pathol.* 2018;73:26–32. doi:10.1016/j.humpath.2017.11.014.
105. Preskitt JT. Health care reimbursement: Clemens to Clinton. *Proc (Bayl Univ Med Cent)*. 2008;21(1):40–44. doi:10.1080/08998280.2008.11928358.
106. Zelizer JE. How Medicare was made. *The New Yorker*, February 15, 2015.
107. Langwell KM, Hadley JP. Capitation and the Medicare program: history, issues, and evidence. *Health Care Financ Rev*. 1986;1986(Spec No):9–20.
108. Ho V. Refinement of the Affordable Care Act. *Annu Rev Med*. 2018;69:19–28. doi:10.1146/annurev-med-052616-044854.
109. Kellar WH. *Enduring Legacy. The M.D. Anderson Foundation and the Texas Medical Center*. College Station: Texas A&M Press; 2014.
110. Baker M. Nov. 22, 1963. Texas physicians are thrust into history. *Tex Med*. 2003;99(1):45–52.
111. Texas medical association 150 years. *Texas Med*. 2003;99:1–176.
112. Berlin J, Berlin J. Coming of age: Celebrating 15 years of Texas tort reform. *Tex Med*. 2018;114(9):14–21. https://www.texmed.org/Template.aspx?id=48427
113. Whitcomb ME. The development of new MD-granting medical schools in the United States in the 21st century. *Acad Med*. 2020;95(3):340–343. doi:10.1097/ACM.0000000000003048.
114. Shannon SC, Teitelbaum HS. The status and future of osteopathic medical education in the United States. *Acad Med*. 2009;84(6):707–711. doi:10.1097/ACM.0b013e3181a43be8.
115. American Association of Colleges of Osteopathic Medicine. U.S. osteopathic medical schools. https://www.aacom.org/docs/default-source/data-and-trends/u-s-osteopathic-medical-schools-by-year-of-inaugural-class.pdf?sfvrsn=dc9e2997_4. Published 2019. Accessed August 22, 2020.
116. Allen TC. Twenty-first century pathologists' advocacy. *Arch Pathol Lab Med*. 2017;141(7):940–943. doi:10.5858/arpa.2017-0105-SA.
117. Berlin J. Swinging for fairness: law creates new ballgame for surprise billing. *Tex Med*. 2019;115(8):30–31.
118. Looking back on the millennium in medicine. *N Engl J Med.* 2000;342:42–49.
119. Acierno LJ. *The History of Cardiology*. London: Parthenon, 1994.
120. Braunwald E. The rise of cardiovascular medicine. *Eur Heart J*. 2012;33(7):838–846. doi:10.1093/eurheartj/ehr452.
121. Mukherjee S. *The Emperor of All Maladies. A Biography of Cancer*. New York: Scribner; 2010.
122. Comroe JH Jr. *Retrospectoscope. Insights into Medical Discovery*. Menlo Park, CA: Von Gehr Press; 1977.
123. Le Fanu J. *The Rise and Fall of Modern Medicine*. Revised ed. New York: Carroll & Graf; 1999.
124. Relman AS, Angell M. America's other drug problem: how the drug industry distorts medicine and politics. *New Republic.* 2002;227:27–41.
125. DeAngelis CD. Big pharma profits and the public loses. *Milbank Q.* 2016;94(1):30–33. doi:10.1111/1468-0009.12171.
126. Hotez PJ. *Vaccines Did Not Cause Rachel's Autism. My Journey as a Vaccine Scientist, Pediatrician, and Autism Dad*. Baltimore: Johns Hopkins Press; 2018.
127. McIntosh MAE. The cost of healthcare to Americans. *JONA's Healthcare Law Ethics Regul*. 2002;4:78–89.
128. Richmond JB, Fein R. *The Health Care Mess: How We Got into It and What It Will Take to Get Out*. Cambridge, MA: Harvard University Press; 2005.
129. Clifton GL. *Flatlined. Resuscitating American Medicine*. New Brunswick, NJ: Rutgers University Press; 2009.
130. Relman AS. *A Second Opinion: Rescuing America's Health Care*. Cambridge, MA: The Century Foundation; 2007.
131. Reid TR. *The Healing of America. A Global Quest for Better, Cheaper, and Fairer Health Care*. New York: Penguin; 2009.
132. Brigham K, Johns MME. Good enough medicine: are we "averaging excellence out"? *The Pharos.* 2018;(80):32–34.

133. Mervis J. Data check: U.S. government share of basic research funding falls below 50%. *Science*, March 9, 2017. https://www.sciencemag.org/news/2017/03/data-check-us-government-share-basic-research-funding-falls-below-50.
134. Tessier-Lavigne M. In defense of basic science funding: today's scientific discovery is tomorrow's medical advance. *Cold Spring Harb Perspect Med*. 2013;3(6):a019554–a019554. doi:10.1101/cshperspect.a019554.
135. Science in the age of Trump. *Nat Cell Biol*. 2017;19(5):409. doi:10.1038/ncb3526.
136. Dzau VJ, McClellan MB, McGinnis JM, et al. Vital directions for health and health care: priorities from a National Academy of Medicine Initiative. *JAMA*. 2017;317(14):1461–1470. doi:10.1001/jama.2017.1964.
137. Jones G, Kantarjian H. The many roads to universal health care in the USA. *Lancet Oncol*. 2019;20(10):e601–e605. doi:10.1016/S1470-2045(19)30517-0.
138. Buja LM, Butany J. *Cardiovascular Pathology*. 4th ed. New York: Academic Press/Elsevier; 2016.
139. Buja LM, Barth RF, Krueger GR, Brodsky SV, Hunter RL. The importance of the autopsy in medicine: perspectives of pathology colleagues. *Acad Pathol*. 2019;6:2374289519834041. doi:10.1177/2374289519834041.
140. Buja LM, Ottaviani G, Mitchell RN. Pathobiology of cardiovascular diseases: an update. *Cardiovasc Pathol*. 2019;42:44–53. doi:10.1016/j.carpath.2019.06.002.
141. Hooper JE, Williamson AK, eds. *Autopsy in the 21st Century. Best Practices and Future Directions*. Cham, Switzerland: Springer Nature; 2019.
142. Teruya-Feldstein J. The immunohistochemistry laboratory: looking at molecules and preparing for tomorrow. *Arch Pathol Lab Med*. 2010;134(11):1659–1665. doi:10.1043/2009-0582-RAR1.1.
143. Hajdu SI. A note from history: Nobel Laureate pathologists. *Ann Clin Lab Sci*. 2009;39:196–198.
144. Sternberg SS. The Nobel Prize and pathology. *Am J Surg Pathol*. 2003;27(6):846–847. doi:10.1097/00000478-200306000-00019.
145. Ligon BL. Sir Howard Walter Florey—the force behind the development of penicillin. *Sem Pediatric Inf Dis*. 2004;15:109–114.
146. Kumar P, Murphy FA. Francis Peyton Rous. *Emerg Infect Dis*. 2013;19(4):660–663. doi:10.3201/eid1904.130049.
147. Weiss RA, Vogt PK. 100 years of Rous sarcoma virus. *J Exp Med*. 2011;208(12):2351–2355. doi:10.1084/jem.20112160.
148. Warren JR, Marshall B. Unidentified curved bacilli on gastric epithelium in active chronic gastritis. *Lancet*. 1983;1(8336):1273–1275.
149. Pincock S. Profile: Nobel Prize winners Robin Warren and Barry Marshall. *Lancet*. 2005;366(9495):1429. doi:10.1016/S0140-6736(05)67587-3.
150. Virchow R. *Cellular Pathology: As Based upon Physiological and Pathological Histology*. Trans. F. Chance. New York: Dover; 1971.
151. Heidland A. Beginning of modern concept of inflammation: the work of Fredrich Daniel von Recklinghaus and Julius Friedrich Cohnheim. *J Nephrol*. 2009;22(Suppl 14):71–79.
152. Kerr JRF. History of the events leading to the formulation of the apoptosis concept. *Toxicology*. 2002;181–182, 471–474. doi:10.1016/S0300-483X(02)00457-2.
153. Kerr JF, Wyllie AH, Currie AR. Apoptosis: a basic biological phenomenon with wide-ranging implications in tissue kinetics. *Br J Cancer*. 1972;26(4):239–257. doi:10.1038/bjc.1972.33.
154. Buja LM, Eigenbrodt ML, Eigenbrodt EH. Apoptosis and necrosis. Basic types and mechanisms of cell death. *Arch Pathol Lab Med*. 1993;117(12):1208–1214.
155. Majno G, Joris I. Apoptosis, oncosis, and necrosis. An overview of cell death. *Am J Pathol*. 1995;146(1):3–15.
156. Brown H. Ilya Mechnikov and his studies on comparative inflammation. *Proc Soc Exp Biol Med*. 1995;209(2):99–101. doi:10.3181/00379727-209-43884a.
157. The 1974 Nobel Prize for Physiology or Medicine. *Science*. 1974;186:516–520.
158. Barbour V. Celebrating death—the 2002 Nobel prize in physiology or medicine. *Lancet*. 2002;360(9340):1117. doi:10.1016/S0140-6736(02)11240-2.
159. Nandi D, Tahiliani P, Kumar A, Chandu D. The ubiquitin-proteasome system. *J Biosci*. 2006;31(1):137–155. doi:10.1007/BF02705243.
160. Tooze SA, Dikic I. Autophagy captures the Nobel prize. *Cell*. 2016;167(6):1433–1435. doi:10.1016/j.cell.2016.11.023.
161. Lilienbaum A. Relationship between the proteasomal system and autophagy. *Int J Biochem Mol Biol*. 2013;4(1):1–26.
162. Prabhakar NR. 2019 Nobel Prize in Physiology or Medicine. *Physiology (Bethesda)*. 2020;35(2):81–83. doi:10.1152/physiol.00001.2020.
163. Buja LM. Innovators in atherosclerosis research: a historical review. *Int J Cardiol*. 2020; 307:8–14. doi:10.1016/j.ijcard.2020.02.016.
164. Goldman DP, Shekelle PG, Bhattacharya J. Prospects for medical advances in the 21st century. In: *Health Status and Medical Treatment of the Future Elderly: Final Report*. Santa Monica, CA: RAND Corporation; 2004:3–16. https://www.jstor.org/stable/10.7249/tr169cms.7
165. Kapila SN, Boaz K, Natarajan S. The post-analytical phase of histopathology practice: Storage, retention and use of human tissue specimens. *Int J Appl Basic Med Res*. 2016;6(1):3–7. doi:10.4103/2229-516X.173982.
166. Henricks WH, Karcher DS, Harrison JH Jr, et al. Pathology informatics essentials for residents: A flexible informatics curriculum linked to Accreditation Council for Graduate Medical Education milestones. *Arch Pathol Lab Med*. 2017;141(1):113–124. doi:10.5858/arpa.2016-0199-OA.
167. Morrison AO, Gardner JM. Microscopic image photography techniques of the past, present, and future. *Arch Pathol Lab Med*. 2015;139(12):1558–1564. doi:10.5858/arpa.2014-0315-RA.
168. Tizhoosh HR, Pantanowitz L. Artificial intelligence and digital pathology: challenges and opportunities. *J Pathol Inform*. 2018;9:38. doi:10.4103/jpi.jpi_53_18.
169. Volynskaya Z, Chow H, Evans A, Wolff A, Lagmay-Traya C, Asa SL. Integrated pathology informatics enables high-quality personalized and precision medicine: digital pathology and beyond. *Arch Pathol Lab Med*. 2018;142(3):369–382. doi:10.5858/arpa.2017-0139-OA.
170. CAP Foundation. Past conference. https://webapps.cap.org/apps/docs/futurescape/past_conferences.html. Published 2011. Accessed August 16, 2020.
171. Kass ME. Futurescape of pathology 2008 conference of the College of American Pathologists. Rosedale, Ill., June 7–8, 2008. *Arch Pathol Lab Med*. 2009;133:512–610.
172. Saqi A, Mukhopadhyay S, Butt Y. E-cigarette or vaping product use-associated lung injury: what is the role of cytologic assessment? *Cancer Cytopathol*. 2020;128(6):371–380. doi:10.1002/cncy.22237.
173. Jones DS. History in a crisis—lessons for Covid-19. *N Engl J Med*. 2020;382(18):1681–1683. doi:10.1056/NEJMp2004361.
174. Osler W. *Aequanimitas. With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*. 3rd ed. New York: McGraw Hill; 1932.
175. Riddick FA Jr. The code of ethics of the American Medical Association. *Oschner J*. 2003;5:6–10.
176. Saad AJ. The future of pathology is now. *Arch Pathol Lab Med*. 2014;138(1):9–10. doi:10.5858/arpa.2013-0205-ED.
177. Uthman EO. Getting out from behind the paraffin curtain. *Arch Pathol Lab Med*. 2014;138(1):12–13. doi:10.5858/arpa.2013-0194-ED.
178. Collins JC, Porras JI. *Built to Last. Successful Habits of Visionary Companies*. New York: Harper Business; 1994.
179. Collins J. *Good to Great. Why Some Companies Make the Leap…and Others Don't*. New York: Harper Business; 2001.