

Lessons to be Learned From the History of Anatomical Teaching in the United States: The Example of the University of Michigan

Sabine Hildebrandt*

Division of Anatomical Sciences, Office of Medical Education, University of Michigan Medical School, Ann Arbor, Michigan

Although traditional departments of anatomy are vanishing from medical school rosters, anatomical education still remains an important part of the professional training of physicians. It is of some interest to examine whether history can teach us anything about how to reform modern anatomy. Are there lessons to be learned from the history of anatomical teaching in the United States that can help in the formulation of contents and purposes of a new anatomy? This question is explored by a review of US anatomical teaching with special reference to Franklin Paine Mall and the University of Michigan Medical School. An historical perspective reveals that there is a tradition of US anatomical teaching and research that is characterized by a zeal for reform and innovation, scientific endeavor, and active, student-driven learning. Further, there is a tradition of high standards in anatomical teaching through the teachers' engagement in scientific anatomy and of adaptability to new requirements. These traditional strengths can inform the innovation of modern anatomy in terms of its two duties—its duty to anatomy as a science and its duty toward anatomical education. *Anat Sci Educ* 3:202–212, 2010 © 2010 American Association of Anatomists.

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INTRODUCTION

It is a curious fact that anatomy, the subject that served as a leading science in the founding of medical schools, is today frequently missing from departmental rosters of medical teaching institutions in the United States. Classical departments of anatomy have been replaced by departments of cell biology, subsumed into clinical departments like surgery, or transformed into smaller units of medical education departments. Nevertheless, most medical schools still offer anatomy

courses that include formal anatomical training and the classic learning tool of student dissection of the human body (Drake et al., 2009). Even where dissection is no longer performed, the teaching of the structure of the human body by other means is central to the education of future medical doctors (McLachlan and Patten, 2006). Whether viewed as a research or teaching endeavor, academic anatomy has changed considerably and questions must be raised concerning the contents and purposes of a new anatomy. The aim of this article is to investigate this problem by reviewing the history of anatomical education in the United States, with the University of Michigan as an example, to formulate suggestions for the future duties of anatomy.

*Correspondence to: Dr. Sabine Hildebrandt, Division of Anatomical Sciences, Office of Medical Education, University of Michigan Medical School, 3767 Medical Science Building II, Catherine Street, Ann Arbor, MI 48109-0608, USA. E-mail: shilde@umich.edu

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THE BEGINNINGS OF ANATOMY IN THE UNITED STATES

In her biography of the anatomist Franklin Paine Mall, his pupil Florence Sabin, the first woman to become a full professor of anatomy in the United States, quotes Dixon Ryan Fox

in stating that the history of medical education in the United States is a cultural transfer from Europe that occurred in four stages (Sabin, 1934). In the beginning, a few physicians trained in the old country served pioneer communities. Then native youth interested in the medical profession traveled to the mother country for training, until medical schools were established in the new country by foreign-trained teachers. Finally, the schools in the new country became adequate. While all these stages can be observed in the history of US medical schools, they did not occur strictly chronologically but coexisted over long stretches of time.

In the 17th and early 18th century, foreign-trained physicians served their communities in the new North American colonies (Sabin, 1934). William Shippen Jr. of Philadelphia was among the young men who went to London to study anatomy with John and William Hunter. In 1746, William Hunter had newly introduced the “Paris manner of dissection,” which was anatomical dissection by students themselves as opposed to teaching anatomy by demonstrations only (Gelfand, 1972). After his return from Europe, Shippen started the first North American medical school at the College of Philadelphia in 1765 and made anatomy the foundation of his medical teaching. He offered courses in anatomical dissection accompanied by didactic lectures (Blake, 1955). So, from the beginning of systematic medical education in the United States, the most modern European method of anatomical teaching, dissection by medical students, was employed in some North American medical schools, thus promoting active learning by students. Many other private physicians and educational institutions adopted Shippen’s example in the following decades and founded their own medical schools, among them Harvard, Dartmouth, New York, and William and Mary College by 1800 (Hartwell, 1881b).

Throughout the 19th century, there existed three different basic systems of medical education: first, the apprenticeship with a physician; second, the proprietary school providing theoretical and clinical training by the physician-owner; third, the university associated medical school (Halperin et al., 2010). At the beginning of the Civil War, 85 mostly proprietary medical schools existed (Bardeen, 1905), by 1905 there were 160 (Michels, 1987). By 1830, nearly half of all medical schools were located in small towns of rural America, an arrangement that had no equivalent in Europe but served the education of a significant number of physicians in the new country (Bonner, 1995). In all the three types of medical education, the teachers were practicing physicians and surgeons, who trained their students clinically in their private practices. Their teaching was accompanied by short courses of formal lectures, mostly on clinically relevant anatomy. During this early period of US medical education, teaching methods relied in great part on rote memorization of detail (Papa and Harasym, 1999; Markel, 2000). Practical hands-on learning was afforded through work in the anatomical dissection laboratory and through the apprenticeship with a clinical teacher. However, many students complained about an imbalance in the heavy emphasis on learning through lectures and a lack of active training through anatomical dissection and contact with patients (Bonner, 1995). Anatomical teaching was supported by the use of textbooks (Papa and Harasym, 1999) and the specimen and model collections in anatomical departments. These museums usually originated from personal teaching and research collections of anatomists. John Collins Warren, one of the founders and later Dean of Harvard Medical School, donated his collection of anatomi-

cal and pathological specimen to the university at his retirement from his position of full professor of anatomy in 1847 (Warren Anatomical Museum, 2010). Likewise, Thomas Dent Mütter, a surgeon at Jefferson Medical College, presented his collection to The College of Physicians of Philadelphia in 1858, thus founding the Mütter Museum (Worden, 2002). Indeed, a well-stocked museum was frequently seen as an “indispensable supplement to the dissection of cadavers” and used as a selling point in circular advertisements for medical educational institutions (Sappol, 2002).

The three different systems of medical education existed concurrently throughout the 19th century and the development of adequate medical schools that trained competent physicians in the new country only began in the 1890s. What were the reasons for this delay? First, quality standards for medical schools were lacking. By the middle of the 19th century, a general decline of the quality of medical education was noted (Bardeen, 1905). Hartwell traced this development back to the lack of influence of the state on the many (mostly privately owned) medical schools, thus making quality control impossible (Hartwell, 1881b). Second, Hartwell criticized the insufficient legislation concerning the provision of human bodies for anatomical dissection. In his opinion, US legislation compared unfavorably to European legislation, where individual states made liberal provision for anatomical institutions by allowing them the use of unclaimed bodies of persons who had died in public institutions such as hospitals and prisons. Third, anatomy remained the main subject of most medical schools, but the teaching was often focused on lectures instead of dissections by students. The teachers were physicians who taught anatomy exclusively as a clinically applied discipline and they had little time for their students and less time for innovations in the field of scientific anatomy. A fourth reason may have been the continued expansion of the United States into the Western territories and the accompanying pioneer mentality. Fox stated: “civilization [...] declines when it strikes the frontier” (Fox, 1927) and observed a relaxation of legal standards for the practice of medicine and of medical standards in general far into the 19th century. Medical educators were not unaware of these problems and early attempts at reform were made. In 1859, the Medical Department of Lind University in Chicago, a forerunner of Northwestern University Medical School introduced a graded curriculum, and in 1857, New Orleans School of Medicine decided on a thorough reform of clinical teaching that included active participation of students in care for patients (Ludmerer, 1985). However, these reforms were isolated and other endeavors failed due to a lack of insight into the importance of experimental medicine by many clinicians (Bonner, 1995) and the fact that a “modern philosophy of medical education had not yet emerged” (Ludmerer, 1985).

By the end of the 19th century, most US medical schools presented the unsatisfactory picture that Flexner described in his 1910 report on “Medical education in the United States and Canada.” He noted that the teaching of anatomy clung to “thoroughly conventional lines” and that embryology was “practically unknown.” The dissecting rooms he found to be “rarely clean, always unattractive, and not infrequently unpleasant” and he judged the typical professor to be “a busy physician or surgeon,” who “lectures to ill-prepared students for one hour a few times weekly.” Most of the teaching was “done by quiz-masters, who drill hundreds of students in memorizing minute details, which they would be unable to recognize if the subject were before them” (Flexner, 1910).

However, Flexner cited exceptions to this commonly low status of teaching in US medical schools, among them are Harvard, Johns Hopkins, and the University of Michigan.

In recognition of the need for quality standards in medical training, the American Medical Association was formed in 1847 and it soon formulated recommendations for medical training (Michels, 1987). These recommendations served as guidelines in the planning of the University of Michigan Medical School (UMMS) in 1848, one of the first public medical schools (Hinsdale, 1906). UMMS opened the first laboratories for medical instruction in the United States for chemistry and anatomy in the 1850s. Laboratories for histology and physiology followed in 1877 and for bacteriology and hygiene in 1888 (Bardeen, 1905). While the first anatomist at UMMS, Moses Gunn (1850–1854), was the typical anatomist–surgeon of the early medical schools, he soon realized the need for a teacher who focused only on anatomical education. He saw such a teacher as a necessity to maintain the quality of medical education, as anatomy made up half of the basic science education of the medical students. Corydon Ford was called to UMMS in 1854 and held what was at the time the rare position of a professor solely responsible for the teaching of anatomy without any clinical duties until 1894. This arrangement was possible because UMMS, unlike all other medical colleges at the time, provided salaries for its professors that made them independent from other sources of income (Markel, 2000). Ford gave lectures and supervised student dissections, greatly aided from 1889 on by the acquisition of the first anatomy laboratory building in the United States that was exclusively dedicated to the teaching of anatomy. Much of his time was spent in preparing specimens for the anatomical collection. Since 1870, he also oversaw the anatomical education of women, as UMMS was one of the first US medical schools to admit women. Anatomical dissection took place in gender-separated dissection rooms until 1907 (McCotter, 1947; Huelke, 1961, 1963; Markel, 2000). In 1877, the first student course in microscopy in the United States was taught at UMMS by the physiologist Charles Stowell (Shaw, 1920). Ford’s teaching of anatomy was heavily lecture-oriented and, while he was beloved by most of his students (Michels, 1987), his method was considered antiquated by a younger generation of students, e.g., Franklin P. Mall (Sabin, 1934). The end of Ford’s tenure in 1894 coincided with revolutionary changes in medical education and the teaching of anatomy in the United States. New basic science subjects had entered the curriculum and new methods of teaching were proposed. At this time, anatomical education had not fulfilled its potential of active, student-driven learning, in that much of the course time was still taken up by lectures instead of active knowledge acquisition in the dissection laboratory.

THE REFORM OF MEDICAL EDUCATION IN THE 1870S

By the year 1870, it had become evident to some leaders of US educational institutions that thorough innovations would be needed to transform the provincial character of their colleges to a scientifically competent academic one that could compete with European institutions of the highest quality. Charles William Eliot proposed new admission standards and curricula for scientific universities (Eliot, 1869a,b) and introduced them in his position as President of Harvard University

in the early 1870s. This first educational reform was soon followed by similar efforts at the University of Pennsylvania and the University of Michigan (Markel, 2000). At Michigan, President James A. Angell and Victor Vaughan (later dean of UMMS; Vaughan, 1926) adopted measures similar to those at Harvard, with the introduction of a three-year medical curriculum in 1880 and a four-year curriculum in 1890 (Ludmerer, 1993). Angell saw the basis of this reform in the German ideals of education, with a broader view of university life than most of the Eastern colleges (Sabin, 1934). While Eliot had criticized UMMS for its lack of hospitals available for the education of medical students (Eliot, 1869a), the first university-owned training hospital in the United States was founded in Ann Arbor in 1869 (Markel, 2000). “Indeed, at Michigan University, science had taken root somewhat earlier than in the older Eastern colleges” (Sabin, 1934).

THE REFORM OF ANATOMICAL TEACHING, FRANKLIN PAINE MALL

The changes in the general organization of medical schools from the apprenticeship model to a discipline-based curriculum (Papa and Harasym, 1999) finally led to the creation of the first adequate and internationally competitive medical schools in the United States. The reform was reinforced in individual medical disciplines by men who had trained in Europe and brought back the idea of scientific research and innovative teaching to US facilities (Ludmerer, 1993). Foremost among them was the anatomist Franklin Paine Mall, whose mind Sabin called “the most potent force in our recent reform of medical education” (Sabin, 1934). Unfulfilled by his medical education at UMMS, Mall sought further instruction in Germany and studied from 1883–1886 with the embryologist Wilhelm His and the physiologist Carl Ludwig. There he learned to appreciate the academic principles of the German university of the 19th century: freedom of teaching, freedom of learning, and the pursuit of science for science’s sake. In addition, he experienced the value of “learning by doing,” i.e., the gaining of knowledge through active work in the laboratory rather than through passive listening to lectures. This principle had been the leading method of knowledge acquisition in anatomy from the first human dissections in Alexandria as practiced by Erasistratus and Herophilus (von Staden, 1989) to animal dissection by Galen and again since the beginnings of scientific anatomy in Renaissance France and Italy into the 19th century (Swick, 2006). It was taken up again in the early 19th century by the anatomist, Ignaz Doellinger, who answered his pupil Karl Ernst von Baer’s request for lectures with: “Why indeed lectures? Get yourself some animal, dissect it here with me- and bring then some others.” von Baer found this to be an ideal learning method and said later: “As a rule, a lecture provides little more than a stimulus, while ripe fruits are attainable only by studying on one’s own” (von Baer, 1886). Mall fully subscribed to this method of knowledge acquisition promoted by Doellinger, von Baer, and Thomas Henry Huxley (Mall, 1908). He saw the anatomy professor’s place in the laboratory together with the dissecting students (Mall, 1908) and reported his experience in the following terms: “I have learned to teach anatomy with few lectures. It is not difficult at all and the success is great” (Sabin, 1934). Another insight gained from his German studies was the importance of anatomy as a science in its own right, not just as a clinical appli-

cation. In his collaboration with His and Ludwig, he had experienced the most stringent practices of quality of research. He had come to see anatomy as a renewed science through the study of embryology and histology (Mall, 1896).

On his return to the United States, Mall spearheaded the reform of anatomical teaching, first in transitional positions including the foundational year of the University of Chicago Medical School in 1892, and from 1893 on as chairman of anatomy at Johns Hopkins Medical School. There he developed a new program of anatomy that addressed the science itself as well as the teaching in promoting active learning by dissection with teachers who were productive researchers and who strove for the highest standards in their own scientific work (Mall 1896, 1899, 1908). He criticized medical education, commenting that until the 1870s, US medical students “heard much, saw little, and did nothing” (Mall, 1899) and found that “analyzing the object itself [the human body] is infinitely more valuable than to watch the results exposed by others” (Mall, 1896). He proposed an anatomical curriculum that offered elementary foundational knowledge to all medical students, in which “only the essential and part of the useful become required work” (Mall, 1908) and additional elective courses for students with a desire for more profound knowledge. The concept of a basic training for all medical students enhanced by electives for in depth anatomical studies for interested students had earlier been formulated by Wilhelm Waldeyer. Waldeyer had also recommended peer teaching as an effective means for private study (Waldeyer, 1884).

Mall expected that these new arrangements in teaching would result in more time for the professor to spend on his scientific research, which he considered “absolutely necessary to him [the anatomist] if he wishes to exert a vitalizing influence upon his students” (Mall, 1908). He realized anatomy could not be the main focus of medical training for most of the future clinical physicians, but that it was only one of the foundational sciences among others in their education. He insisted on anatomy being taught well to all students, those who needed basic knowledge as well as advanced learners: “The best efforts of the anatomical staff should be devoted to teaching. The professors should teach in the dissection room. They should live there with their students and not delegate this important work to untried assistants” (Mall, 1908). The crucial point for him was in teaching anatomy as a science, that is exact and detailed in its ramifications, and not only as an application for clinical purposes: “The department of a university should be truly a university department and not one that limits itself to instruction which meets the bare needs of medicine and surgery” (Mall, 1908). Of the anatomist, he expected that “the university teacher must have more than literary command of the subject; he must also be an investigator and go back to nature for information” (Mall, 1908). His school of anatomical thought and teaching at Johns Hopkins Medical School was highly successful and influential. It produced 25 future chairmen of anatomy in US medical schools (Sabin, 1934).

DEVELOPMENT OF ANATOMY AND ANATOMICAL TEACHING SINCE MALL

Mall and his colleagues entered the field of scientific anatomy at a time when most discoveries in gross anatomy had already been made. Many anatomists turned to embryology and histology as their fields of scientific endeavor. In doing

so, they became international leaders in these areas and elevated anatomy and anatomical education in the United States to a role of global significance. US departments of anatomy retained this leadership role when the focus of research moved from the tissue level to the cell, to the subcellular level, and finally to molecular structure and function of the human body during the second half of the 20th century (Pauly, 1987). By that time, the explosion of knowledge in the newly developed biological and medical disciplines, as well as the concern for the integration of this knowledge from the molecular to the physiological and the clinical manifestations led to the next wave of reforms of the medical curriculum. The discipline-based curriculum that had been initiated by Eliot was no longer seen as suitable for the education of physicians, who needed not only a scientific training but also the opportunity to develop humane values like empathy and compassion, as well as problem-solving strategies (Ludmerer, 2005). In the organ-system-based curricula that emerged since the 1950s, it was not the faculty or departments of an individual discipline that decided on the respective curricular content of a discipline, but newly created topic committees. This concept was adopted by later modifications of this model, the problem-based and clinical-presentation-based curricula, which continued to work on the integration of scientific knowledge and clinical problems by utilizing insights gained from the cognitive sciences (Papa and Harasym, 1999).

The effect of these curricular reforms on anatomy was a significant reduction in content and teaching time of all classical anatomical disciplines: gross anatomy, neuroanatomy, histology, and embryology. While in 1955 about 335 hours of curricular time were spent with the teaching of gross anatomy, this number was reduced to 195 hours by 1973 and is now at 149 hours on a national average (Drake et al., 2009). The numbers at UMMS are slightly lower, with 250 hours in the mid-1940s (McCotter, 1947) and currently 136 hours for the first year dissection course. Accordingly, a new focus in anatomy had to become efficiency in the teaching of a reduced but essential anatomical curriculum aimed at the clinical relevance of anatomical knowledge and at the maintenance of a standard of quality in education (Louw et al., 2009). New methods were required to increase the efficiency of content delivery and to provide flexibility for students with new and differing learning approaches. These innovations comprised the integrated use of radiological imaging, including virtual-reality imaging, three- and four-dimensional ultrasound and animation; the use of interactive multimedia learning modules and anatomy of clinical procedures (Gest, 2002a; McLachlan et al, 2004; Sugand et al, 2010). Older approaches to anatomical teaching including the use of life models and the study of surface anatomy were reactivated (McLachlan et al., 2004; Collins, 2008). These modes of learning are frequently combined with dissection courses or the study of prosections. The common denominator of the various methods is the support of active, self-motivated student learning. Many claims have been made about the advantages or disadvantages of the various approaches to the teaching and learning of anatomy. These claims are usually made from empirical evidence, but the rare systematic studies on the effectiveness of certain methods reaffirm a certain lack of clear evidence at this point in time (e.g. Winkelmann et al., 2007).

The reduction of anatomical teaching programs and the decline in traditional gross anatomical research led to a

decrease in the number of active anatomists by the 1980s (Oxnard, 1987) and this situation is ongoing. “The anatomical sciences were seen as distinct from molecular biology and the result has been a significant decline in classically trained anatomists and declining numbers of anatomical educators” (Jones, 2010). However, the morphological science of anatomy is actually bound to the people who know and teach anatomy. While the accumulated research results of centuries of anatomy are contained in books and today in computerized databases, this knowledge will be forgotten without daily application and confirmation in the dissection laboratory. An example is the development of modern atlases: while older atlases that derived their illustrations directly from dissections show the details of the run of the thoracic splanchnic nerves through the diaphragm toward their ganglia, some newer illustrations only show a rare pattern of this anatomical detail and not the most common one (Gest and Hildebrandt, 2009). This correction, which might have implications for surgical procedures, can only be made by persons who dissect on a regular basis. Anatomy exists only in the active dissector, and it is only this active dissector who can teach anatomy in an informed manner. Indeed, this is a time in which the science of anatomy, that is, the knowledge of anatomy and the art of dissection may become endangered by disuse. This possible loss of anatomical knowledge has the potential to ultimately harm anatomical education and has to be taken into account in the reform of modern anatomy.

REFORMS OF ANATOMICAL TEACHING AT UMMS IN THE 20TH CENTURY

Besides Johns Hopkins Medical School, UMMS was one of the first schools to integrate the new concepts of anatomical teaching in their curriculum, beginning with Corydon Ford’s successor James Playfair McMurrich in 1894. McMurrich was a biologist, not a physician, and was the first PhD to head a department of anatomy in a US medical school. His work focused on scientific research and the reform of anatomical teaching. He introduced embryological studies into the department and expanded the teaching to neuroanatomy (Huelke, 1962). His educational program defined three duties for a department of anatomy; first, a special purpose: to provide the means for students to obtain first hand knowledge of the structure and function of the human body; second, a general purpose: train students in the habits of observation and deduction; and third, an increase in the knowledge of the structure of the human body through research. However, McMurrich’s reform of anatomical teaching focused more on new contents than on methodology: he still subscribed to a strongly lecture-based course and the educational results of his endeavor are not documented (McCotter, 1951). He took an active part in the shaping of anatomy as a science by becoming an early member and leading figure of the Association of American Anatomists, which had been founded in 1888 with the express purpose of advancement of anatomy as a scientific subject (Basmajian, 1987).

George Linius Streeter succeeded McMurrich in 1907. He was an embryologist who had studied in Germany and who promoted active scientific investigation in US anatomy. He continued the educational reform begun by McMurrich and implemented the teaching method of independent studies as

proposed by Mall more firmly at UMMS. He reduced the number of lectures, increased the hours of dissection, and made “bone boxes” available for each medical student to facilitate active, student-driven self study (Davenport, 1999). Like Mall, “He believed that a medical student, given good material, good light and the best books, will master the subject with a minimum of lecture and guidance” (McCotter, 1947). So by the time of Flexner’s visit to medical schools for his report on US medical education in 1910, UMMS had already introduced innovative teaching approaches and scientific anatomy, e.g., research in embryology and neuroanatomy, and Flexner came to view UMMS’ anatomical program positively.

In 1914, Streeter left Michigan to organize the embryological department of the newly founded Carnegie Institution at Johns Hopkins medical school and ultimately succeeded Mall. The new chairman of anatomy at UMMS, Gotthelf Carl Huber, had been instructor of histology at Michigan since 1887, with the exception of the years 1891/1892, when he had studied with Waldeyer in Berlin, Germany. Huber shared Mall’s belief in active learning in medical education, “the student does the greater portion of work himself, under the instructor’s direction” (Huber, 1898) and the belief in the need of scientific scholarship in the teacher: “If a person really knows a subject, others can learn from him.” (Guild, 1935). During his 20-year tenure, he combined the departments of anatomy and histology, supported a research group in comparative neuroanatomy under the leadership of Elizabeth Crosby and developed a training program for doctoral students of anatomy. He was an active researcher with interests in the autonomic nervous system, the embryology of the kidney and nerve regeneration, and delegated much of his teaching to Rollo McCotter. McCotter was instrumental in expanding the teaching programs of gross anatomy to students of physical education, the Departments of Speech and of Fine Arts as well as to the Nursing School and School of Dentistry (Huelke, 1962; Davenport, 1999). He lamented the steadily declining time allotment for gross anatomy in the curriculum, as this led to a cut in course content and, as he thought, an insufficient knowledge of the human body in medical students. By the mid-1940s, the course time had been cut by half from 500 hours (including 300 hours of dissection) under McMurrich (McCotter, 1947). This reduction had been the result of the expanded teaching of specialties like neuroanatomy, embryology, histology, and the addition of new basic medical sciences to the medical curriculum.

When Bradley Merrill Patten succeeded Huber in 1934 he modernized the department of anatomy within the three divisions created by Huber: the division of embryology and histology, the laboratory of comparative neurology, and the division of gross anatomy (McCotter, 1951). Elizabeth Crosby, a gifted researcher, continued her dedicated teaching of neuroanatomy, and McCotter remained in charge of the extensive gross anatomical teaching programs. During the chairmanships of Russell T. Woodburne, 1958–1973, and Johannes Rhodin, 1973–1977, the division of tasks between research and teaching that had started under Huber and Patten became more apparent with the further specialization of anatomy from embryology and histology to cell biology and molecular biology throughout the middle and late 20th century. Basic research had become more time intensive than ever, while medical curricula and courses for other medical sciences were continuously extending the teaching requirements expected from anatomical faculty. As in so many other ana-

tomical institutions at the time, the department was renamed as Department of Anatomy and Cell Biology in 1981 during the chairmanship of A. Kent Christensen, 1978–1981. Ludmerer describes very aptly the tension that built within basic science departments at that time, “where the research interests of most faculty no longer directly related to much of the subject matter still taught to medical students” (Ludmerer, 2005). This tension existed also at UMMS and led to the final step in the division of tasks in 2000, when the more basic scientific research oriented group became an independent Department of Cell and Developmental Biology, while the faculty members who taught gross anatomy were united within a newly founded Division of Anatomical Sciences in the Office of Medical Education.

THE DIVISION OF ANATOMICAL SCIENCES UMMS IN THE 21ST CENTURY

A major factor in the separation of main duties was the need to focus on the development and implementation of new educational methods in the teaching of gross anatomy, including reflection and evaluation of these methods in terms of efficiency (Krupinski, 2002). The most important innovation in anatomical education at UMMS was the introduction of the use of the Internet for communication between faculty and students via a main anatomical website created by Thomas Gest (Medical Gross Anatomy Resources UMMS, 2010). The website is a comprehensive resource for all the required course materials and includes the course manual, dissection videos, anatomical tables, clinical cases, cadaver medical histories, practice tests, radiology, and surface anatomy (Gest et al., 2002a). It also provides links to external websites that include 3D modeling of the human body. The fundamental idea behind this and other new approaches is a further promotion and modernization of the concept of active learning as envisioned by Mall over a hundred years earlier, which today integrates insights gained from the cognitive science perspective (Papa and Harasym, 1999). Thus the dissection course is supported by the web-based laboratory manual and only occasional lectures on specific subjects to facilitate self-reliant and self-paced studies. The website offers interactive teaching modules that cover conceptually complex topics of systemic and functional anatomy. It is constantly under review and modified according to suggestions from students and faculty. It has also proven to be flexible enough for the change from a regions-based dissection course to the systems-based new medical curriculum at UMMS introduced in 2003. In addition, the peer-teaching concept proposed by Waldeyer in 1882, but not integrated in a systematic fashion into anatomical teaching since then, had been reintroduced by William Burkel in the 1990s, a time of great technological advances in anatomical teaching under the chairmanship of Bruce Carlson, and was integrated into the reformed dissection course (Raouf et al., 2001; Krupinski, 2002). Course accompanying evaluations have shown that the new methods are successful in terms of their acceptance by the students and in terms of academic outcome (Gest et al., 2002b; Bryner et al., 2008). At the same time, the website is freely accessible (with the exception of patient histories and atlas-images) and is used globally in anatomical teaching. It should be mentioned that despite the reduction in lectures and the use of

the Internet for communication, the teaching of gross anatomy is still labor intensive and requires adequate numbers of teaching faculty.

The model proposed by Mall of teaching basic anatomy to all first year students and specific anatomy in specialized electives for advanced students has been successfully implemented at UMMS (Stein et al., 2002). Currently, these senior electives are being expanded and websites for the individual courses have been initiated. As Mall predicted, these advanced medical students are highly motivated to learn anatomy in more detail.

Another new educational method is the use of plastinated materials as adjuvant tools in courses for medical students and undergraduates. The plastination laboratory at UMMS was among the first to produce plastinated human tissue specimens in the United States in 1989 and is currently the largest of its kind in the country. It is a cost-for-service facility that provides the Division of Anatomical Sciences UMMS and other local educational institutions with human specimens that include individual organs and whole body plastinates (Plastination UMMS, 2010). One of the ongoing work areas of the plastination facility is the exploration of the potential of new plastination methods and specimens in preservation of material and teaching (Raouf, 2001; Aultman et al., 2003). The use of plastinated specimens in a large undergraduate course has been shown to enhance students’ learning and interest in anatomy (Raouf et al., 2003).

In accordance with its new focus of duties, the research in the Division of Anatomical Sciences has diversified from basic morphological research and clinical applications (e.g., Hiller et al., 2010; Majkrzak et al., 2010) to research in anatomical education, studies evaluating course content and outcome (e.g., Raouf et al., 2003; Bryner et al. 2008), and questions of history and ethics of anatomy (e.g. Hildebrandt, 2008, 2009a,b,c).

FROM BODY SNATCHING TO DONATION PROGRAMS AND THE TEACHING OF PROFESSIONALISM AND ETHICS

The science and teaching of anatomy has always been dependent on the availability of human bodies for dissection. The legal organization of anatomical body acquisition developed over three stages in Europe and the United States, generally through pleas and advice from anatomical institutions to their local governments. During the first stage, starting in the 13th century in Europe and the 17th century in the United States, there were only sporadic and insufficient laws in existence that addressed the subject by making the bodies of executed felons available for anatomical dissection (Sappol, 2002; Hildebrandt, 2008). However, these bodies were usually not sufficient in number and additional bodies were mostly procured by illegal means like grave robbing. The second stage brought liberal legislation that allowed the use of bodies of those who died in public institutions like prisons, hospitals, and psychiatric wards and were unclaimed for burial by their friends or relatives. The final stage can be seen in the development of anatomical donation programs with the accompanying Anatomical Gift Acts (Sappol, 2002; Hildebrandt, 2008).

Traditionally, the demand for bodies always outpaced the legally available supply, especially in countries with a lack of regulations, among them the United States in the 19th century. The result was the development of an illegal trade in bodies obtained by “bodysnatching,” the theft of bodies of the recently deceased from graveyards, and the use of bodies of disenfranchised members of society, i.e., criminals, the executed, the poor, the black, and the immigrants (Humphrey, 1973; Savitt, 1982; Halperin, 2007). Body procurement lay either in the hands of anatomy staff and medical students, including staff and students at UMMS, or professional “body-snatchers” (Huelke, 1961; Kaufman and Hanawalt, 1971; Blakely and Harrington, 1997). These practices deepened the popular prejudice against anatomical dissection and its practitioners, a public opinion described by Hartwell in 1881 as a “strange compound of pagan superstition, Christian materialism, and an innate aversion to the morals, aims, and manners of the average American student” (Hartwell, 1881b).

Sporadic early legislation in individual US states like Massachusetts in 1784 and Connecticut in 1824 (Blake, 1955) did not address the problem sufficiently. Massachusetts ratified a first comprehensive Anatomy Act in 1831 that allowed the use of unclaimed bodies from public hospitals and prisons for anatomical dissection. An early 1844 “Statute concerning unclaimed bodies” in Michigan lasted only until 1851, followed by the first Michigan Anatomy Act in 1867 that led to a final “Michigan amended Anatomy Act” in 1881. The demonstrators of anatomy at UMMS, George E. Frothingham and William J. Herdman, had been instrumental in the formulation of the new act which was considered by Hartwell to be the “the most advanced and liberal of all American Anatomy Acts” of its time (Huelke, 1961; Kaufman and Hanawalt, 1971; Hartwell, 1881b). Of the 38 US states existing in 1881, 24 states allowed dissection. Of these, only 15 had liberal laws providing unclaimed bodies for anatomical institutions (Hartwell, 1881a). By the end of the 19th century, state anatomical boards were introduced to regulate the distribution of bodies (Blake, 1955). While most US states had Anatomy Acts in place by the beginning of the twentieth century, sporadic grave robbing was reported as late as the 1920s in Tennessee (Humphrey, 1973). By 1913, more than half of all medical schools reported a sufficient body supply (Jenkins, 1913), but the fact remained that those whose bodies were used for dissection were members of “a voiceless, widely scorned segment of society” (Humphrey, 1973). The Anatomy Acts “reaffirmed the association between dissection and destitution in America” (Garment et al., 2007). This situation only changed when programs of voluntary body donation were introduced in the middle of the 20th century and became fully functional during the following decades (Humphrey, 1973).

Two driving forces can be identified behind the establishment of body donation programs: the decreased availability of unclaimed bodies and the change in public opinion concerning modern medicine. The combination of an improvement in general health of the population as well as better burial benefits led to a decrease of unclaimed bodies from public institutions by the middle of the 20th century (Garment et al., 2007; Warner, 2009). While sporadic body donations had been known to occur in Europe and the United States in the 18th and 19th century, these were usually individual donations from anatomists, doctors and prominent individuals, e.g., the English philosopher Jeremy Bentham in 1832 or the

English religious prophetess Joanna Southcott (Marshall, 1995). With the rise of better education of the public as well as the increasing success of modern medicine, especially in transplantation medicine, the general opinion towards scientific medicine including anatomy changed in the middle of the 20th century, so that the concept of individual body donation started to find wide acceptance. In 1954, 10 US states had provided statutes for legal body donation. The state of Michigan, with Russell Woodburne and his colleagues from UMMS as advisors, ratified a comprehensive “Anatomical Gift Act” in 1958 that regulated “gifts of the human anatomy or parts thereof” (Woodburne, 1962). In 1963, Jessica Mitford published a scathing criticism of the US funeral industry and pointed out alternatives to commercial burials. Among them she mentioned anatomical body donation and included the first list of US medical schools that accepted such donations (Mitford, 1963). Her book was widely received and may have been one of the factors helping to popularize body donation as an alternative to traditional burial. In 1968, “The Uniform Anatomical Gift Act” was formulated by the National conference of the Commissioners on Uniform State Laws; it established the human body as property and that a donor’s wishes for its disposal superseded those of his or her next of kin. By February 1972, 48 US states had accepted the act and today all states in the United States have adopted it (Garment et al., 2007). All US medical schools accept body donations, but some still have to supplement their supply of donated bodies by the use of unclaimed bodies. UMMS is among those that use the bodies of donors exclusively for their anatomical teaching programs.

Warner identifies the Uniform Anatomical Gift Act of 1968 as the cause for a “watershed in the social origin of the cadavers” in anatomical dissection. He sees the use of donated bodies as transforming the subjective experience of human dissection and the relationship between dissector and dissected (Warner, 2009). The dissected is no longer one of the disenfranchised of society but a voluntary true donor of knowledge and recognized by the dissector as such. This has been an important step in the change of the anatomical dissection course as not only a tool for the acquisition of knowledge about the structure and function of the human body but also as a “vehicle for moral and ethical education” (Dyer and Thorndike, 2000; Goddard, 2003). In this respect, it is a desideratum for the future to have sufficient body donation programs for all anatomical teaching institutions. In his paper on the Michigan “Anatomical Gift Act” of 1958, Woodburne expressly mentioned that “The bodies are treated with respect and are studied carefully” (Woodburne, 1962). He and his colleagues introduced a memorial service for the donors and their families, an event nowadays conducted by the medical students of UMMS and in many other anatomical departments around the world.

Indeed, respect for the dissected and the reflection on death and dying are frequent topics in modern introductions to dissection courses and belong to the core humanistic values of medical professionalism (Marks et al., 1997; Rizzolo, 2002; Swick, 2006). Anatomy and the dissection course play an important role in the development of professionalism in medical students (Pawlina, 2006), given the initiation of professional growth during the first year of the medical curriculum (Lachman and Pawlina, 2006). Swick identifies anatomy as uniquely suited to help develop the professional values of the ability to subordinate one’s own interest to that of others, of high ethical and moral standards, of accountability, of a

commitment to excellence and scholarship, and of self-reflection. Anatomists can serve as potential role models for these values, and the students' interaction with the donor's body and their teammates promotes active learning of professional behavior and attitude (Bourget et al., 1997; Swick, 2006). As anatomy brings students into contact with the dead so early on in their studies, this encounter can be used as a foundation for the education about death and dying and the exploration of humanistic goals in medical education (Marks et al., 1997; Rizzolo, 2002). In their introduction to the dissection course at UMMS, first year medical students are asked to express and share their expectations and fears about the course with their colleagues and hear from letters of the donors to their future dissectors. Many students respond to this invitation and show a wide variety of reactions expressed in various artistic media, including letters, poems, paintings, and music.

Anatomical dissection can be a means for the development of the important professional competencies of clinical detachment and empathy. While empathy is one of the initial skills brought by students to the course (Böckers et al., 2010), clinical detachment usually develops throughout the dissection course. This phenomenon was early recognized by anatomists and has been described as "a certain inhumanity" by William Hunter in the 18th century (Richardson, 1987) or, as John Ware, dean of the Massachusetts Medical College put it to his students in 1851, a "difference between us and other men in the feelings with which we regard the remains of the dead" (Ware, 1851). The experience of the dissection course can help students find their individual balance of clinical detachment and empathy, an important professional skill set for physicians to be fully functional and yet retain their humanity (Montross, 2007; Hildebrandt, 2009c). This balance of clinical detachment and empathy is sometimes also referred to as "detached concern" (Warner and Rizzolo, 2006; Böckers et al., 2010). Through the dissection course students can learn to interrogate rather than "tough out" or suppress their subjective experience (Warner, 2009). Historically, medical students have been known to develop coping mechanisms that exhibited a clear imbalance between detachment and empathy by abusing anatomical material to play so-called "pranks" that led to public riots in the worst cases (Sappol, 2002). Modern medical students still report a loss of empathy throughout the dissection course (Böckers et al., 2010), which may be due to an increase in clinical detachment (Hildebrandt, 2010). Emotional reactions have been shown to diminish over the course of the dissection experience (Arráez-Aybar et al., 2008). Further analysis of these factors is necessary. While the development of these professional skills may not be easily verifiable, "Dissection provides an opportunity for faculty to guide students in learning how to use effectively their affective responses, rather than to ignore or isolate them" (Swick, 2006).

Furthermore, the history of anatomy can serve as an object lesson in medical ethics (Hildebrandt, 2008). In his essay "Medical professionalism: Lessons from the Holocaust" John H. Cohen, president emeritus of the Association of American Medical Colleges, has called for the incorporation of relevant humanities in the medical curriculum to depict both professional and unprofessional conduct (Cohen, 2010). The history of German anatomy in the Third Reich is an example of unprofessional conduct in its abuse of the human body, and discussions of this history lead to questions about possible unethical practices in modern anatomy. The Division

of Anatomical Sciences UMMS has been researching and teaching courses on the subject since 2006, with great interest shown by the students (Hildebrandt, 2006, 2008, 2009a,b,c).

CONCLUSION: LESSONS FROM THE PAST FOR THE FUTURE

At a point where traditional departments of anatomy are vanishing but anatomical education remains an important part of the professional training of physicians, what can history teach us for the necessary reform of modern anatomy? The first lesson is that US anatomy has a tradition of reform. In the discipline-based reform of the medical curriculum, anatomy was one of the driving forces, while later curricula required reactions to the new requirements in medical education. Anatomy is currently going through another reform in a long history of innovation and adaptation but this latest one may be its most decisive yet. Anatomical departments of the future will have to develop new comprehensive concepts that involve their two main duties, the duty to anatomy as a science and the duty to anatomical education. The duty toward anatomy as a science demands the continuance of the knowledge of anatomy through adequate training programs for anatomists. This includes maintaining the skills to investigate questions of morphology, as "The explosion in imaging technology and imaging-based research demonstrates the continued need for understanding tissue morphology at macroscopic and microscopic levels" (Jones, 2010). With respect to anatomy's duties to anatomical education, the reform will include an increased reorientation of anatomists toward clinical anatomy (Louw et al., 2009).

The second lesson is that US anatomy has a tradition of scientific endeavor and scholarship to uphold. Gross anatomical research will continue its expansion from studies of human variation to investigations of morphology in their clinical application. Other active areas of research include organismal, functional, and evolutionary morphology (Oxnard, 1987). In addition, cell and developmental research will increasingly lead to questions of morphology. In terms of anatomy's duty to teaching, research in anatomical education will continue to grow as one of the main fields of anatomical investigation. This includes course-accompanying studies for the evaluation of teaching and learning, the introduction of innovative teaching tools and techniques, and the exploration of related fields like history and ethics of anatomy.

The third lesson is that US anatomy has a tradition of active, student-driven learning of anatomy that started with the early adoption of the European tradition of student dissection and was followed by a continuous reduction of lecture time in favor of more active forms of knowledge acquisition. The concepts of 'active learning' and peer-teaching have their roots in the 19th century and will be further developed in anatomical education, enriched by innovative technology (Sugand et al., 2010). Active learning is closely linked to motivation, thus a modern anatomical education has to be recognized as relevant to the work of physicians by students and teachers and integrate cognitive science perspectives (Papa and Harasym, 1999). Current efforts focus on formulating a core curriculum that could become a national and international standard (Louw et al., 2009; Sugand et al., 2010). Mall's model of a basic anatomical education for all medical students followed by further specialized anatomy for

advanced students has proven to be a viable one that will be enhanced by an increasing focus on clinically relevant anatomy that integrates living and surface anatomy (McLachlan et al., 2004; Sugand et al., 2010). This approach allows the advanced student an insight into the relevance of detailed anatomical study and research. The techniques of knowledge acquisition are undergoing a lively discussion, including questions about the value of student dissection in times of economic constraints (McLachlan et al., 2004; McLachlan and Patten 2006). As long as students appreciate anatomical dissection and patient care requires physicians to be well trained in anatomy, student dissection will exist (Rizzolo and Stewart, 2006; Winkelmann, 2007; Louw et al., 2009; Böckers et al., 2010). Currently, the sentiment is still with Karl Ernst von Baer, who noted in his autobiography: “I seriously doubt that a reasonable understanding of the human body is attainable without putting a hand to it, so to speak” (von Baer, 1886).

The fourth lesson is that US anatomy has a tradition of high standards in anatomical teaching through the teachers’ engagement in scientific anatomy maintained within anatomical departments. Ultimately, the two main duties of anatomy, the duty to anatomy as a science and its duty to anatomical education, are intimately bound together and inform each other. Mall formulated the consequences of ignoring this phenomenon succinctly over a hundred years ago: “It must never be forgotten that departments are unable to grow and perform their duty best when their ideals are no higher than those of compulsory education” (Mall, 1899). He emphasized the need for the science of anatomy to grow and saw this growth only possible under the banner of academic liberty. He believed in L. C. Miall’s maxim that “the spirit of enquiry is only communicated by those who have it, who habitually enquire themselves.” To teach by example, an instructor has to be a student, too, and can thus inspire students to want to learn (Sabin, 1934). Anatomical education is uniquely suited to teach the great excitement of learning, in addition to teaching knowledge about the structure and function of the human body. Apart from these latter overt goals of anatomical education, there are hidden objectives that have been increasingly referred to by instructors over the last decade and need further exploration. These include the anatomical course as addressing questions about the scientific method, ethical education, of death and dying and the balance between clinical detachment and empathy (Korf et al., 2007; Böckers et al., 2010).

Last, US anatomy has a tradition of adaptability to new requirements brought on by general changes in medical education and the needs of society and science. There is every reason to believe that this latest reform of anatomy and teaching of anatomy will be productive and contribute to the best medical education possible. This is not only a national but also an international goal.

NOTES ON CONTRIBUTOR

SABINE HILDEBRANDT, MD, is a lecturer in the Division of Anatomical Sciences, Office of Medical Education, at the University of Michigan Medical School, Ann Arbor, Michigan. She teaches graduate and undergraduate courses of anatomy. Her research interest is in the history and ethics of anatomy.

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