

REVIEW

The History of the Teaching of Gross Anatomy - How we got to where we are!

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SUMMARY

Evidence primarily from historical considerations is gathered to compare a variety of approaches to the teaching and learning of gross (topographical) human anatomy. The historical approach adopted is not just a chronological approach to the development of pedagogy but is conceptually based to underline the changing culture of medicine and the ways in which normal and abnormal structure and function have been considered. Although there is often claimed to be an unbreachable divide between 'traditionalists' and 'modernists' amongst teachers of gross anatomy, and although the method of teaching gross anatomy by means of dissection by the students is frequently referred to as the 'traditional' method, historically this method only came into its heyday relatively recently when legislation permitted a sufficiency of bodies to dissect and with the advent of experiential learning and the development of the idea of students achieving competency skills. Paradoxically, the so-called 'modern' way (e.g. problem-based learning, computer-based learning) that relies more on library/book work and computer simulations harks back to the pre-Renaissance scholastic approach. Our findings suggest that, as anatomy teaching has moved away from dissection by students, the culture of medicine has become more inclined towards the disease-based

model and not towards the functionality (health) - based model. Overall, we conclude that the main focus of attention historically has been the rôle of dissection. Where in the past religious authorities were foremost in condemning dissection now it is academic and postmodernist strictures that denigrate historical perspectives.

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INTRODUCTION

There is a joke that imagines two men driving their car aimlessly in the countryside. They are lost. Seeing a local farmer, they stop the car and

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Fig. 1 (Left). William Hogarth: *The Reward of Cruelty*; plate 4 from the suite *The Four Stages of Cruelty* (1751 CE). Tom Nero, the fictional hero portrayed in Hogarth's suite of prints, is hung for murder and, as here depicted, he is being anatomized with the noose still around his neck and a dog licking his heart. The prints were intended to be a form of moral instruction, although it was only 1 year after he produced the print that the Murder Act of 1752 in Britain legally permitted public dissection of criminals. The image is clearly a pastiche of the frontispiece of Vesalius' *Fabrica* but here the students seem uninterested by the results of the dissection! (Public domain artwork).



Fig. 2 (Right). Thomas Rowlandson: *The Resurrection Men* (1775 CE). A vivid portrayal of the evil trade of body snatching (Burking). (Public domain artwork).

ask for directions to London. The farmer replies: "Well, sirs, if I were you I wouldn't be starting from here!" So, in terms of the teaching of anatomy, where is 'here' and how did we get 'here'? Where we are in the first decades of the 21st century is the easy question to answer. For the education of healthcare professionals, including anatomical education, we are in a phase of experimentation. A variety of educational ideologies abounds and what once was a global acceptance of the importance of anatomy, namely through dissection and a firm grounding in the biomedical sciences at the start of a healthcare course, no longer applies¹. How we got 'here' is the purpose of this article. In essence, we describe events in an historical context and show that the evolutionary path taken until the latter part of the 20th century has now given way to a more revolutionary phase. We do not see it as our business to spend much time asking why this has happened. That is a question for the reader to answer.

To pose a further question: what is anatomy? The name is derived from both the Greek (*anatemnein*) and the Latin (*anatomia*), meaning to cut up (dissect) parts. In today's terms, for all healthcare studies, anatomy is concerned with the structure (morphology) of the human body. For the purposes of this article, we will give an account of the historical development of the teaching and learning of only gross (or topographical) anatomy².

Furthermore, since medicine has had a longer provenance, with other healthcare professions (such as dentistry) appearing much later as separate professions, inevitably much of our focus is on anatomy in a medical context.

It appears to us that anatomy has had both a glorious and an inglorious history. Glorious because it laid the foundations for all the biomedical sciences, because it established the scientific and linguistic basis for medicine and other healthcare disciplines, and because it allowed the culture of medicine to shift from an overemphasis on disease and abnormalities to health and normality. Above all, its history is glorious because it was an essential feature of the Renaissance that allowed academia to abandon the scholastic approaches reliant on the study of long-established texts and ideas so that scientists moved towards observation, experiment and the questioning of prevailing dogma³. Inglorious because of the way in which anatomy historically was used as a punishment for criminals (Figure 1), because of the stigma that some societies placed upon the invasive nature of the discipline and its procedures, because of the immoral ways by which bodies were often obtained for anatomical examination (e.g. by Resurrectionists)⁴ (Figure 2), and because of what was thought to be a gory anatomical spectacle⁵. Most particularly, for the perception amongst many in the healthcare professions that it is an 'old-fashioned'

discipline where everything that needs to be known is known and where it is claimed that its practitioners tenaciously hold on to outmoded educational principles⁶. We will explore these notions mainly by an historical approach that is partly chronologically based and partly conceptually based. We will therefore follow the development of pedagogic philosophies, evaluate the reality behind the view that there are 'traditionalist' and 'modernist' approaches, and assess the relationship between anatomical research and teaching.

At this point it is necessary to momentarily digress by considering whether history is, in Henry Ford's terms, bunk! This belief implies that history should be ignored, that novelty is all, and that no lessons are to be learned from the past. One might also infer that historicism (a progressive direction for history as espoused by, for example, Hegel and Marx) is invalid⁷. Whatever one's view, it is clearly the case that medicine and other healthcare professions have moved from the occupation of, and for, the privileged few to that of, and for, the many and to a point where nowadays the 'mass' higher education systems present in many countries have had a significant effect on clinical and anatomical education⁸. This is an issue that needs to be borne in mind as we recount the history of anatomical education.

So what are our hypotheses or, more meaningfully for the approach we have adopted, from whence do we, the authors, come? Where are our initial biases and prejudices? In answer, we defy the notion that education shows no progress, there being flux or movement between elaborate and radical philosophies, ideologies and methodologies and movement back towards simple and obvious concepts. Perhaps in our postmodernist world one should not be surprised by those who advocate the belief in flux/movements⁹, particularly since there is ever a clash between normative educational theories that wish things to be as they are not and historical analyses that demonstrate exactly how things were/are! This tension is mirrored in other areas. For example, while Baconian and Popperian normative philosophies of science instruct individual scientists about their methods and attitudes, Kuhn observed that, whatever the prevailing instructions/methodologies, scientists and the scientific community just get along and do what seems appropriate at the time, with paradigm shifts occurring when crises arise in the existing paradigms¹⁰. In medical education, until recent times, an evolutionary, pragmatic approach was at play... what worked worked, what did not work was swiftly abandoned. Nowadays, it might appear that careers and academic esteem rule in a competitive environment that encourages the imposition of untested methodologies that, even in the face of contrary evidence, are tenaciously supported else reputations are destroyed. Thus, the very concept that educational changes are perforce experimental

and should be objectively and dispassionately evaluated has disappeared because of political necessities (or niceties) or because of a postmodernist narrative approach that sees equal validity for any analytical approach and/or takes an overtly social constructivist view. In our opinion, the result is the establishment of educational ideologies that seem to care little for subject concerns, for student learning, or even patient welfare. The history of anatomical education exemplifies such processes and gives concern about the learnedness, abilities, professionalism, and even safety, of present day recipients of medical/healthcare training¹¹. As learning and challenge have been removed, so has professional competency and, perhaps more damaging, the potential respect of the public and of society towards the healthcare professions¹². It is our belief that anatomy has been at the forefront in dealing with these changes, this should not surprise scholars of history... it was ever thus.

ANATOMICAL EDUCATION PRE-RENAISSANCE (UNTIL CIRCA 1450)¹³

The earliest anatomists

'The Dark Ages' and 'Lost in the mists of time' are expressions often used to describe our poor understanding of history prior to the Renaissance. Not all was 'dark' however¹⁴. We have some appreciation of the history of anatomy, particularly in relation to the growth of anatomical knowledge, but we have scant knowledge concerning the early history of the teaching and learning of anatomy. Indeed, what we have in this regard is mainly about the history of human dissection, whether undertaken for research or teaching purposes. This is therefore the main focus of what follows¹⁵.

Although primarily concerned with disease, the earliest document featuring anatomy (circa the 27th century BCE) is attributed to the Egyptian polymath, Imhotep¹⁶. Between 3000 and 2500 BCE, in Egypt, the techniques of embalming and mummification employed required at least a minimum knowledge of anatomy and consequently some kind of 'dissection' of corpses was likely to have been permitted. During the ancient Indo-Aryan civilization (± 1500 BCE), dissections were allowed and Susrata, a surgeon (6th century BCE), described a method to prepare the body for dissection. It seems that exchanges also took place between Greek and Indian scholars that influenced various branches of knowledge, including medicine and anatomy. During the early part of the 7th century BCE, Vagbhata published a summary of the 'eight branches of Hindu medicine'. At that time, however, religious laws prohibited dissections, although some dissections were probably conducted. Meanwhile, in China, medical knowledge was strongly influenced by Confucian beliefs. Such beliefs centred on achieving a balance between 'the Yin and the Yang', which determine the Tao (the

way). Accordingly, dissection was frowned upon and this prohibition persisted until the 18th century CE. Despite this prohibition, a dissection was undertaken by Tang Chiai (c1106-1140 CE) who recorded his findings by means of drawings. Much before that (c2600 BCE), Huang Ti, reputedly the 'Father of Chinese Medicine', reported that the blood is controlled by the heart, indicating a knowledge of anatomy. Later, Hua T'o (c208 CE) is credited with the production of anatomical charts that depicted various organs of the body (*Nei-Chao-T'u*). During the later Ming dynasty (1438-1517 CE), the body was regarded as so sacred that neither dissections nor even minor surgery were countenanced.

Around the Mediterranean, Alcmeon of Croton from Southern Italy dissected animals circa 500 BCE. It is also known that he studied human anatomy. In Sicily, Empedocles of Agrigento (493-433 BCE) held to the belief that four elements (Earth, Air, Fire, Water) provided the foundations of all things ('Theory of Humours')¹⁷. This theory influenced medical thinking for over 2000 years and until Robert Boyle in 1661 CE wrote the *Sceptical chemist* that resulted in the theory being discarded. At this epoch in Greece, Hippocrates (c 460-377 BCE; Figure 3) considered that "Anatomy is the foundation of medicine.. and should be based on the form of the human body". Despite such strong convictions, he refused to dissect and consequently his anatomical knowledge was erroneous (e.g. that the brain was a gland secreting mucous). Aristotle, born in 384 BCE in Macedonia, dissected animals. His books, *De partibus animalium* and *Historia animalium*, gave accounts of his anatomical enquiries. Like Plato, however, Aristotle firmly argued against experiment, believing that altering a system removed the important functional attributes that categorised all things. This view, sustained by religious thinking, undermined scientific enquiry for millennia. In Greek Alexandria, Herophilus (born 350 BCE) dissected 600 humans (including condemned criminals) and, according to Celsus and Saint August-

tine, indulged in vivisection! Nevertheless, historically he has been regarded as the 'Father of Anatomy'. His works on anatomy, although now lost, were commented upon by Celsus, Galen, Oribasius and many others pre-Renaissance figures. Another Alexandrian, Erasistratus (born 250 BCE) has been accused of vivisection and his works are also lost to history. Subsequently, the power and influence of Alexandria declined and rivalry amongst Greek scholars resulted in much persecution and the loss of freethinkers.

Dissections within the Roman Empire were usually prohibited. For example, Asclepiades of Bithynus (c.120-130 BCE) founded the Asclepiades sect that denounced human dissection. Camus Pliny Secundus (23-79 CE) who wrote 37 books that are collectively called *Historia Naturalis* also discouraged the study of human body. His influence remained strong even until the 17th century. Cornelius Celsus (c. 30 BCE to 45 CE) on the other hand, although not a physician, recognized the importance of anatomy and even advocated human dissection. His books (*De Re Medicina*) were rediscovered during the 14th century CE and provided a survey of the medical knowledge of that time. Marcus Tullius Cicero (106-43 BCE) considered that superstition and dependence on religion were obstacles for the establishment of institutions and, in terms of anatomy, this has often been a stumbling block for the development of the subject (both for research and teaching). In *De Natura Deorum*, Cicero presented a theoretical account of the structure and function of the human body. In later Roman times, during the reigns of Vespasian, Hadrian and Severus, some human dissection was undertaken; a practice that persisted until the beginning of the 2nd century CE.

The eras of Galen and Avicenna

The training of the Roman physician, Galen (c. 129 to 216 CE), provides a good example of how medicine and anatomy were taught in ancient times. Galen's works influenced our knowledge of anatomy until the publication of Vesalius, *Fabrica*, in 1543 CE. Galen (Figure 3) was Greek, born in Pergamum, but was based in Rome where, in addition to providing general medical care, he treated wounded gladiators¹⁸. Philosophers taught Galen medicine/anatomy. Indeed, the philosophical approach to medical education (contrasting with the scientific approach) persisted until well after the Renaissance. He thought himself to be a philosopher as well as a physician and he considered medicine to be a branch of philosophy. He held to



Fig. 3. Hippocrates and Galen debating the Material Nature of the World. From a mural of the 12th century CE at Cattedrale di Anagni (Italy). Perhaps it is a matter of irony that the portrayal of two pagans should be celebrated in a church that at that time decried the study of anatomy. (Photograph by Nina Aldin Thune – Creative Commons Attribution-Share Alike).

the belief that a physician should be learned and cultured (*pepaideumenos* in Greek). Unlike Roman physicians who came from the company of slaves, Greek physicians (*Iatroi*) underwent a traditional apprenticeship, sitting at the feet of a 'master'. Furthermore, at the patient's bedside there would be passionate discussions, involving both the 'master' and apprentices. However, Galen's training was mainly intellectual, with only a minor component involving practical demonstrations and clinical experience. Thus, medical education was a textual discipline and the trainee physician was expected to recite the texts in a similar manner to the way that many Moslems learn the Quran. In Galen's time, the medical literature was extensive but, to society at large, medicine was regarded as 'secret knowledge'. Galen believed that the best medical training came from listening to the words of his 'masters' and not from the study of books. He is reported as saying: "from a book neither the helmsman nor the practitioner of any craft can be trained. These books are memoranda for those who are already learned, not a complete education for the ignorant". Galen chose not to follow any particular school of medicine but was eclectic in his approach. It is claimed that he professed that the learning of methods only, without a variety of practices in them, was unable to produce well-trained physicians. He thus followed the 'rationalist/dogmatist' approach generally available in his time but, as shown in his writings where case histories can be found, he also adopted empirical methodologies. Although Galen was acquainted with the 'methodist' school of medicine, their rejection of anatomical knowledge was not to his liking. His anatomy teachers demonstrated the actions of muscles by using fellow students and living anatomy of this kind was required since dissection of corpses was considered taboo. He relied consequently upon dissection of animals, a practice followed throughout his life that had advantages relating to the development of comparative anatomy but that led to unfortunate errors in his understanding of human anatomy. One noteworthy feature of medical training in Galen's time was that, contrary to today's reverence for the new, the old and traditional were accorded great respect. From all of our understanding of Galen's training and opinions, in today's terms, he would be respectful of tradition, would not be tied to any particular educational ideology, would expect dialogue with those who were masters of their craft (not student-directed learning), would demand experiential learning (including dissection) and not a bookish education, and would expect the trainee to become cultured and philosophically learned.

It is perhaps to be regretted that, because of the tyrannical influence of the church in the medieval period, the 'Dark Ages' lasted in Europe until about c. 1000 CE. At this time, medical and anatomical knowledge and expertise passed from Europe to

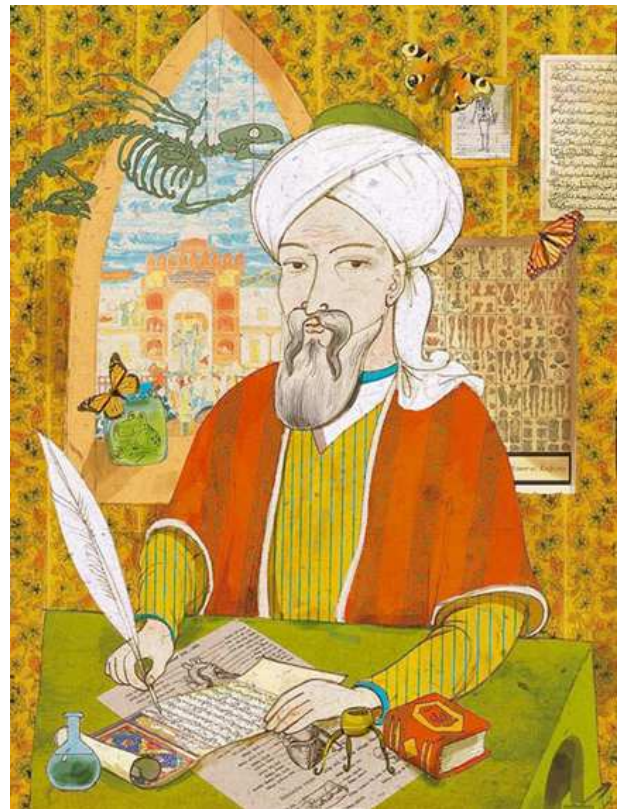


Fig. 4. Portrait of Avicenna (Abu Ali Sina) (date and attribution unknown – Free Art License).

Arabia and was particularly evident from c. 800 to 1100 CE¹⁹. Indeed, Arabic became as a result the most widely accepted language for medical scholars. Arabic scholars worked mostly by providing translations of Greek, Syrian, Persian, and Indian texts, but also they also delivered original contributions. It was because of liberal interpretations of the Quran by liberal rulers that discussions concerning anatomy were permitted, even when the practice of dissection was prohibited. One of the foremost Islamic scholars was the Persian, Avicenna (980-1037 CE) (Figure 4)²⁰ who wrote (c1000 CE) *Al-Qānūn fī aṭ-ṭibb* (translated as *Canon of Medicine* or *Law of medicine*). In this book, Avicenna gave a classification of human organs and their functions. Until Vesalius, Avicenna and Galen provided the only officially recognised sources of anatomical information. Other Islamic scholars who contributed significantly to anatomy include Hunain, Ishaq, Hubaysh al-As'am, Ibn Nafees, and Al-Hazen. Hunain, with the help of Ishaq and Hubaysh al-As'am, wrote treatises (c. 803-873 CE) that surveyed medical knowledge of that time. Ibn Nafees (1210-1288 CE) practised dissection and Al-Hazen (or Ibn-al-Haytham) (965-1040 CE), in his work *Kitāb al-Menazir*, departed from humoral and teleological traditions in order to formulate a theory of vision based on his understanding of the eye as an optical system. The modern development of medicine would subsequently shift back to Europe but the debt to the Islamic scholars for pre-

servicing medical knowledge that would otherwise have been lost is incalculable.

The European Era before the Renaissance

The birth of great universities and medical schools in Europe went alongside a renewal of interest in the anatomy of the human body. This was to be developed further by recognition of the contributions of the 'ancients' and by the printing process invented by Gutenberg (1454 CE). In addition, liberal and humanist views undermined the influence of religious objections and overcame the tendency to look upon the body, not in scientific terms, but in mystical terms. Indeed, before the rise of universities, a person's fate was often considered to be under influence of the planets. Consequently, the depiction of 'Zodiac Man' was popular (Figure 5). To highlight the authoritarian influence of the Church, in 1300 CE a papal edict from Pope Boniface XIII appeared against practice of boiling the remains of those who died far away from their homes (a custom of the Crusaders). His edict was interpreted by the Church, and by many anatomists, as a prohibition on dissection. Despite such views, Mediaeval and Renaissance humanism provided the cultural background for anatomy

to advance²¹. Papal and Venetian liberalism also began to remove restrictions on dissection so that Bologna (and eventually Padua) became the two main universities practising dissection. Furthermore, translations of anatomy texts from the Arabic spread around Europe through the monasteries. However, the scholastic philosophy employed in these institutions stultified the evolution of anatomy for two more centuries²².

The University of Salerno in Italy was the first recognised European university. There, Roger II of Sicily took the decision in 1140 CE that to practice medicine it was necessary to demonstrate competence and knowledge by passing appropriate examinations. Several important academics at the University of Salerno would affect the history of anatomy. For example, Constantinus Africanus (c. 1020-1087 CE), being multilingual, was able to translate many anatomical treatises especially *Al Maleki* (the royal book). In addition, Cophon wrote a standard work of reference for the learning of anatomy in the 12th century CE (*De Anatomia Porci*). Unusually for the period, the university opened its doors to female students (including for the study of medicine). The university was not however the first to undertake human dissection. This honour falls to the University of Bologna, the first dissection occurring in 1156 CE. Amongst the distinguished professors of anatomy at Bologna prior to the Renaissance were Bartolomeo da Varignana, Henri de Mondeville, Mondino de Luzzi, Taddeo Alderotti. All undertook dissection for the teaching of anatomy. In 1240 CE, an edict of Frederick II (the Holy Roman Emperor) stipulated that all surgeons should study anatomy for a year and demonstrate their competence in anatomy. One human dissection was allowed every five years. To be eligible to sit an examination, a surgeon had to prove legitimacy of birth, be aged 21 years, be trained for at least seven years in medicine, and have studied the works of Hippocrates, Galen, Avicenna, and Aristotle. On passing the examinations, the title of 'Magister' was conferred.

Mondino de Luzzi (1276-1326 CE) taught anatomy to medical students and members of the general public during one of the first dissections of the human body in 1315 CE at the university²³. He held the post of Professor of Anatomy for 20 years at the University of Bologna and wrote in 1316 CE *De Omnibus Humani Corporis Interioribus Membris Anathomia*, one of the first anatomy books. In this book, he provided instructions for dissecting (without illustrations). However, he only reiterated Galen's version of anatomy and inconsistently employed anatomical nomenclature derived from Arabic names. Despite these criticisms, Mondino de Luzzi's work influenced the way of teaching anatomy (and especially dissection) for a considerable time in many different European universities.

The University of Bologna officially approved the practice of human dissection in 1405 CE and this

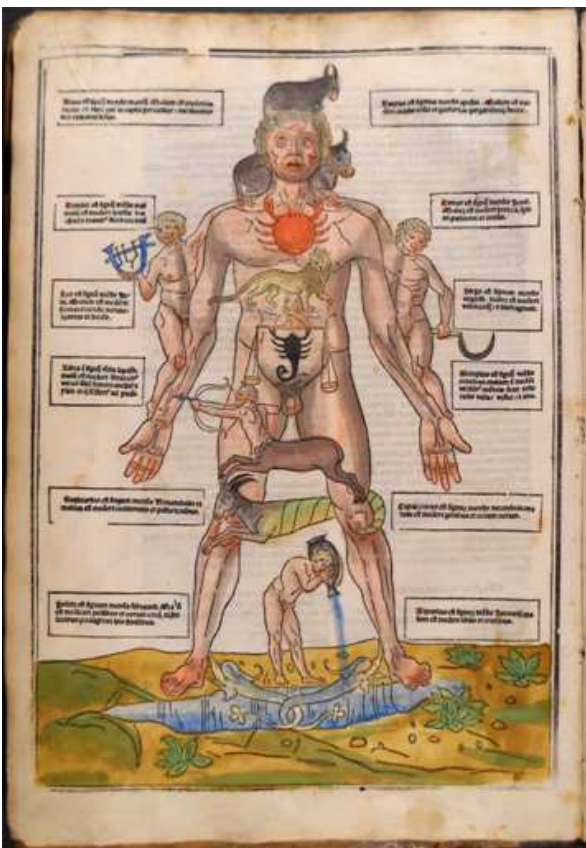


Fig. 5. Johannes de Ketham: Woodcut of Zodiac Man from *Fasciculus di medicina* (1495 CE). The text is thought to provide practical advice about the correct timing of medical procedures. For example, treatments for the head would not be advisable when the Sun is in Aries! (Public domain artwork).

came as a result of the work of Nicolo Bertuccio (c. 1300-1347 CE) who established dissection as the main means of teaching anatomy. As for Mondino de Luzzi, he taught anatomy by dissection from an elevated chair. Later, Alessandro Benedetti (c. 1450-1512 CE) wrote *Anatomice* (1497 CE) and also practised dissection. The mediaeval anatomists who were the successors of Mondino de Luzzi commented on his treatise *Anathomia*, which recognized anatomy as a distinct discipline and not as part of surgery. Antonio Benivieni (1443-1502 CE) followed by writing *De Abditis Nonnullis ac Mirandis et Sanationum Causis* and by practising autopsies. From his descriptions of the causes of symptoms and the determination of organs responsible for diseases emerged the discipline of pathological anatomy (1507 CE).

The dissecting room at Bologna had a major influence on the hierarchy of universities that pertains even today. The hierarchy within the dissecting room, instituted by Mondino de Luzzi, required that the Professor, on his Chair, oversaw proceedings, the Reader below the professor provided instructions from the recommended text (usually Galen or Avicenna), while Lecturers and Demonstrators performed the dissection at floor level (Figures 6,7). This hierarchy, together with the academic titles, remain in existence in many universities throughout the world, regardless of the subject

discipline.

The most important mind of that time after Mondino de Luzzi was probably Giacomo Berengario (1470-1550 CE). Working in Bologna (1502-1527 CE) and Rome, he made amendments to Mondino's book and produced 21 woodcut plates; illustrations not only produced for the benefit of medical students and practitioners but also for artists. He wrote two books, *Commentaria Super Anatomia Mundini* (1521 CE) and *Isagogae Breves* (1522 CE), based on more than 100 human dissections. Berengario also was accused of human vivisection (seemingly the last recorded incidence in history). Other notable anatomists at Bologna before Vesalius were Alessandro Achillini (1463-? 1512 CE) and Niccolo Massa (1485-1569 CE). Achillini wrote *Anatomice, Siue Historia Corporis Humani* in 1502 CE, in which are recorded his own observations and not just received wisdom! Niccolo Massa was a Venetian who wrote *Liber Introductorius Anatomiae Siue Dissectionis Corporis Humani* (1536 CE). Followed Mondino's principles, he incorporated in his works some of his own observations from human dissections and challenged the descriptions of Galen that prevailed at that time. Elsewhere, mention should be made of Giovanni Battista Canano (1515-1579 CE) who graduated from, and was professor at, Ferrara. He published a book *Musculorum Humani Corporis Picturata Dissectio* with 27 illustrations based on human dissections.

Beyond Italy, in France, two universities existed in this period. The oldest was in Montpellier, the other was the University of Paris. In 1000 CE, a 'magistri physici' existed at the University of Mont-



Fig. 6 (Left). Johannes de Ketham: Woodcut from *Fasciculus di medicina* (1495 CE). Ketham was a German physician who was not the author of the *Fasciculus* but was its owner. The book is the first illustrated medical text in print. (Public domain artwork)



Fig. 7 (Right). *The Dissecting Room at Bologna* (reconstructed after war damage in WWII). Note the "Chair" for the Professor and the lectern for the Reader in front of the dissecting table. (By kind permission of The Archiginnasio, Bologna)

pellier and there Arnold of Villa Nova (1235-1311 CE) translated Avicenna's works. After 1314 CE, dissections were opened to the public (on the payment of a fee) and from 1376 CE a body of an executed criminal was available for dissection annually. Guy de Chauliac (1300-1368 CE) established at Montpellier the Bologna tradition of teaching anatomy and wrote the *Cirurgia Magna* (1363 CE). Henri de Mondeville (1260-1320 CE), another professor at Montpellier, encouraged the study of anatomy and devised a test for anatomy. He published in 1314 CE a series of 13 anatomical miniatures that are well known in the history of anatomy and in the history of art. The University of Paris was opened towards the end of the 12th century CE. Gilles de Corbeil of Salernum, physician of King Philip, began in 1210 CE the teaching of medicine in Paris. In 1404 CE, a stone in the gallbladder was found in a body dissected in Paris. The method of teaching anatomy of Mondino de Luzzi was employed for the dissection of the Bishop of Arras. Guido de Vigevano (Gui de Pavie), physician of King Philip de Valois of France, wrote a book entitled *Anathomia, Liber Notabilium Philippo Septim* with 18 coloured drawings. It was the first time that the human body was divided into three parts, abdomen, thorax, and head, for the purposes of teaching anatomy. Jean Fernel (1497-1558 CE) at the University of Paris wrote the first chapter of *Universa Medicina* (1554 CE). This book served as an introduction to functional anatomy. Fernel was adamant that students should learn anatomy through dissection rather than by looking at books and pictures. Another notable French anatomist was Charles Estienne (?-1564 CE). He was assisted by Etienne Riviere who performed the dissections and drew the illustrations for Estienne's book *De dissectione Partium Corporis Humani* (1545 CE). The book contained 62 high-quality, full-page plates, but they lacked anatomical accuracy. Many personal observations made during dissections were however included in the book and it is one of the first books of dissection with illustrations.

In Britain, the Universities of Oxford and Cambridge opened in 1167 CE and 1217 CE respectively. There was no teaching of surgery and medical tuition was based upon that within the University of Paris. From Germany, Johannes Dryander (originally Eichmann; 1500-1560 CE) published works in anatomy, *Anatomia Mundini* (1541 CE), *Anatomia Capitis Humani* (1535 CE) and *Anatomiae, Hocest, Corporis Humani Dissectionis Pars* (1536 CE). He created his own illustrations of dissection and taught anatomy as a practical discipline (1536-1560 CE). Dryander undertook public dissections (amongst the first in Germany). Magnus Hundt (1449-1519 CE), a German philosopher, wrote *Antropologium de hominis dignitate, natura et proprietatibus, de elementis, partibus, et membris* (1501 CE), a book containing 120 pages

of anatomical woodcuts that was the most complete representation of the internal organs at this time.

Finally, mention should be made of Jacobus Sylvius (1478 -1555 CE) who, as Professor of Anatomy at Paris, wrote *Hippocrates et Galeni Physiologiae Partem Anatomicam Isagoge* (1555 CE). His work is essentially Galenic with some personal observations. Muscles were, until his work, only designated by numbers and instead he provided them with an anatomical nomenclature. He also practised colour injections and was known to be an excellent teacher who taught anatomy through human dissections. Sylvius was however quarrelsome and always maintained that Galen was right. Although he taught Vesalius the techniques of dissection, he fell out with him and the rift has diminished the contributions of Sylvius in the eyes of anatomists ever since.

In summary, it seems that before the Renaissance a tussle existed between anatomists who wished for research and teaching purposes to undertake human dissection and the authorities, both religious and secular, who wished to prohibit dissection. This tussle continues to this day with most anatomists still advocating the use of dissection for research and teaching and some educational authorities being dismissive of anatomical research from the cadaver (the "we know everything there needs to be known" attitude) and also of the use of the cadaver for teaching (the "teach it all with IT, models and MRIs" attitude). Furthermore, anatomists at this early period were keen to describe the healthy, functioning body to understand how disease might arise and this was a significant change to the culture of medicine that, nowadays, might be in reverse because of teaching that emphasises disease²⁴.

ANATOMICAL EDUCATION POST-RENAISSANCE²⁵

Often the names da Vinci and Michelangelo come to mind when thinking of the Renaissance. Both these great artists were also anatomists. Both learned their anatomy, considered by them to be essential for developing their craft as drawers, painters and sculptors of the human figure, initially by observing dissection and subsequently by undertaking their own dissections. For Michelangelo, anatomy was essentially a means to an end²⁶. For da Vinci, however, his anatomical studies became the end in itself²⁷. At first, the studies of da Vinci followed the misguided, hence incorrect, notions about anatomy promulgated by religious and secular authorities and the pre-Renaissance anatomists. In particular, his disdain for female anatomy and for the sexual act is evidenced by quite grotesque drawings that, for example, erroneously have a tract leading from the womb to the nipple (Figure 8). Furthermore, he drew connections be-



Fig. 8 (Left). Leonardo da Vinci: *Hemisected Man and Women in Coitus* (1492 CE). This illustration, showing a sexual act that was distasteful to da Vinci, is full of anatomically inaccurate information that relates not to observation but to prevailing medieval and mystical views. (Photograph by Luc Viatour – GNU Free Documentation License).

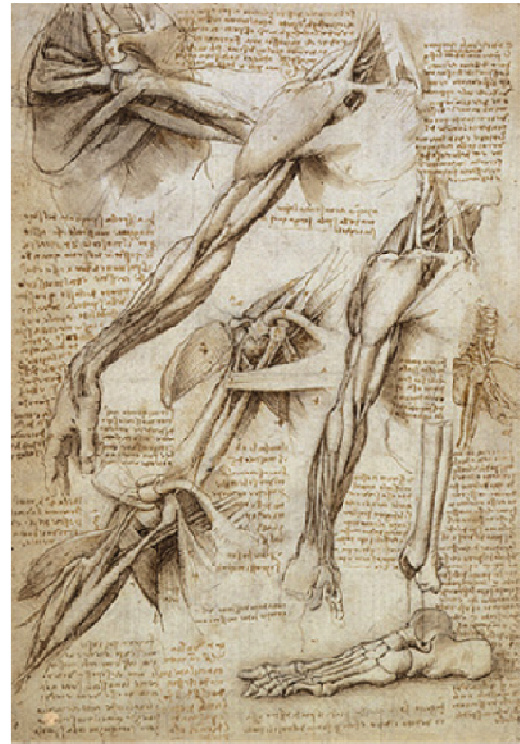


Fig. 9 (Right). Leonardo da Vinci: *Dissections of the Muscles of the Arm* (1510/11 CE). Casting aside mysticism and conventional “wisdoms”, da Vinci trusts his powers of observation to record the anatomy and functions of limb musculature. (By kind permission of the Royal Collection Trust/©Her Majesty Queen Elizabeth II 2014).

tween the brain, spinal cord and the circulatory system that have more in common with the theory of humours and with mystical considerations than with close observation and scientific investigation. Later, however, da Vinci followed his true nature and trusted his senses and powers of observation to produce anatomical drawings of great accuracy (and beauty) (Figure 9). In our opinion, it should be regarded as shameful that da Vinci's anatomical investigations remained hidden from public and scientific view and that his intended book was therefore never realised (as was unfortunately the case for too many of his projects). It was only in the last 150 years that historians and anatomists became aware of da Vinci's anatomical work; a situation that, if it were otherwise, would have given da Vinci, and not Vesalius, the title of 'Father of Modern Anatomy'.

The era of Vesalius

Andries van Wezel, more commonly known as Andreas Vesalius, was born in Belgium in 1514 CE²⁸. His influence on anatomy as a science and anatomy as an academic discipline is incalculable. He also had a profound effect on science in general, on the culture of medicine, and on principles of anatomical education that have been followed up to present times.

Vesalius began his medical education at the Uni-

versity of Louvain where initially he received a general education, graduating with an arts degree in 1532 CE. Louvain was well known at the time for its tolerance of progressive, and humanist, ideas. The education was based largely on lectures with occasional (private) lessons or tutorials. It is recorded that Vesalius showed considerable interest in philosophy while at the university and that he admired those who defied conventional wisdoms. In 1533 CE, after Louvain, Vesalius (aged 19) entered the medical school of the University at Paris. There he continued to associate with humanists and Nicolas Florenas (physician to Emperor Charles V) guided him by recommending a practical system for studying the 'Hippocratic arts'. In Year 1 of medical studies at Paris, students undertook courses in pharmacy/herbal medicine and what at the time stood for physiology. In Year 2, added to pharmacy/herbal medicine were pathology and surgery while in Year 3 *materia medica* entered the curriculum. Year 4 provided continuing study of physiology, surgery and pathology. Throughout, the student would be assigned to professors who taught them 'natural subjects', including botany and anatomy. The tuition was mainly delivered by lectures (2 per day) and the anatomy lectures were heavily based on the principles of Hippocrates, Galen and Avicenna. Indeed, the anatomy teaching (through the influence of Sylvi-

us) was deeply respectful of Galen. Most of the anatomy taught in the early part of the medical course was concerned with osteology, but there was an annual public demonstration of human anatomy on a cadaver. In addition to the 'natural subjects', other professors were assigned for the 'non-natural subjects' (hygiene) and 'subjects contrary to nature' (pathology and therapeutics). It is known that Vesalius had contempt for the teaching of anatomy at Paris. Firstly, he disliked the hierarchical system that meant that professors did not dirty their hands with the dissection²⁹ and he received huge criticism for carrying out dissections. Secondly, Vesalius insisted that dissection skills were self-taught. Many of the criticisms came from his assigned tutor, Jacobus Sylvius, who, in addition to being a 'died in the wool' follower of Galen, was renowned for having a very unpleasant personality. Like Sylvius, however, Vesalius learned much anatomy from animal dissections. He also studied bones that he stole from cemeteries. In the early years, Vesalius was himself a supporter of Galen and he assisted in the publication of books that promulgated Galenic views. In Vesalius' time, human dissection throughout Europe was usually deemed immoral, both in society and by the Church. Even in liberal institutions such as Louvain anatomy was not considered appropriate for medical education, astronomy being preferred! Despite such views, respect was shown to those who were dissected (even for criminals) since the dissections were often accompanied by the saying of Requiem Mass³⁰.

Vesalius claimed that, while at Paris, he alone undertook human dissection. There is no truth in this since Charles Estienne around the 1530s CE dissected and provided drawings that illustrated his findings. In 1536 CE, Vesalius was forced to leave Paris, without his medical degree, because war made him an 'enemy alien'. Back at Louvain, Vesalius took part in the vicious arguments concerning the efficacy of 'bloodletting'. Unusually for that university, Vesalius possessed a human skel-

eton that he claimed he brought with him from Paris... another untruth since it was found to belong to a local inhabitant. Furthermore, for the first time in 18 years Louvain witnessed an autopsy (of a young noblewoman) conducted by Vesalius and this event was a stimulus to further anatomical investigations. Indeed, Louvain awarded Vesalius the title of 'Anatomy Instructor'. This was not necessarily a blessing since there appeared to be much jealousy amongst his peers and teachers. In 1537 CE, Vesalius presented his baccalaureate thesis. This was concerned with medical terminology and involved the naming of anatomical structures using Arabic, Greek and Latin terms. Thus, in Vesalius' time it was expected that a student of medicine had a duty to add to medical knowledge and not just receive it... a notion that is nowadays mainly reserved for those undergraduates who, in addition to studying for a medical degree, opt also to take a science degree. Furthermore, as is obvious from our account so far, anatomical research and anatomical education were closely entwined in this early part of the history of the discipline. In today's universities, research and education have too frequently become disentangled and separated, despite frequent statements suggesting that universities provide research-led curricula. Thus, science degrees provide opportunities for medical (and other healthcare) students to conduct research in at least a research-aware curriculum³¹.

On receiving his medical degree, Vesalius relocated to the University of Padua (Figure 10). The school of medicine there was large for its time and was renowned for providing many medical publications. Unlike other schools, Padua emphasized anatomical studies and also clinical demonstrations at the patient's bedside. On completing his final examinations for his doctorate, involving *viva voce* examinations³², Vesalius was elevated to the status of professor of surgery and he immediately gave anatomical demonstrations, showing human specimens alongside dissections of dogs for comparison. Concerning the order of dissection, exam-

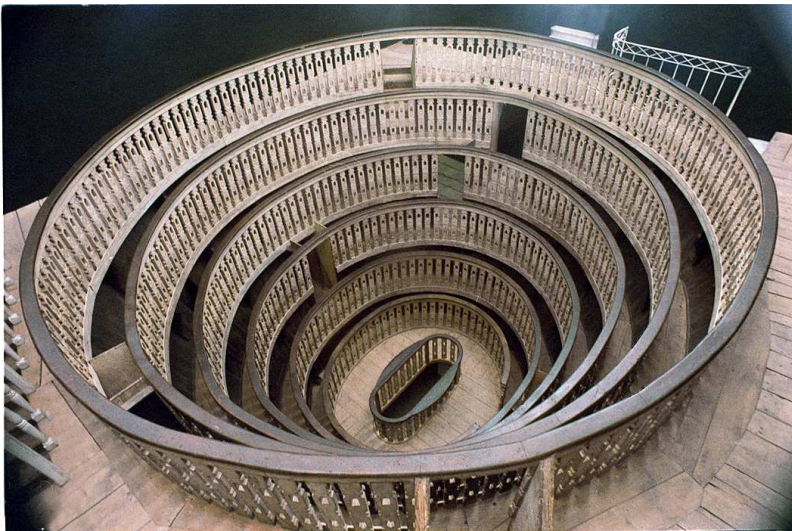


Fig. 10. The Dissecting Room at Padua University (inaugurated 1595 CE). The university, acceding to the wishes of anatomists and students, built this permanent anatomy theatre not just for the spectacle of human dissection but also for the consideration of natural philosophy and an understanding of the condition of Mankind. (By kind permission of Professor Raffaele de Caro, University of Padua).

ination of the abdomen was followed by the thorax, then the head, neck and brain, and finally the extremities. Remarkably for the age when the text was all and images were regarded as unnecessary, Vesalius produced pictorial charts that he distributed to his students. It is worth recording that not only was dissection deemed immoral but also the act of illustrating human anatomy was considered to be blasphemous! Vesalius' most productive period as an anatomist came during his stay in Italy. Here, he realized the errors of Galen and Avicenna and, taking courage, dared to contradict their principles and knowledge, leading to the publication of the greatest book in the history of anatomy, *De Humani Corporis Fabrica* (On the Fabric of the Human Body) (Figure 11)³³.

Vesalius is as significant to the history and culture of the Western World through science as Galileo, having more to offer than just the foundation of human anatomy on lines contrary to the views of Galen. He changed the culture of medicine from reliance on disease to an understanding of functionality and health, a notion highlighted by Michel Foucault in his book, *La Naissance*

de la Clinique (1963)³⁴. Vesalius also helped universities generate knowledge from experience and observation and not on scholastic principles that merely relied upon reading and reinterpreting existing texts. Educationally, he came down from his professorial chair onto the floor of the dissecting theatre to perform and demonstrate his anatomy²⁹. However, this method of teaching was an adaptation of the traditional, indeed semi-scholastic, approach that relied upon those learning anatomy to only observe the results of the 'master's work'. That said, students did play an important part in the development of anatomical pedagogy and this aspect has not been well documented, even though written records of their experiences exist. Cynthia Klestinec³⁵ has pointed out that the students were not passive consumers of their teachers' ideas but demanded that the medical pedagogy should reflect the recent discoveries emanating from human dissection. Indeed, by their insistence on "seeing for themselves", and by welcoming the rare opportunity to dissect for themselves, the students helped in establishing permanent anatomy theatres.

With the realisation that the works of Galen and Avicenna were flawed, anatomists cast off their inhibitions, became increasingly curious, and unafraid of religious and scholastic strictures. Following in the footsteps of Vesalius, anatomy became one of the most important and productive areas of research in the burgeoning European scientific community. Furthermore, the findings had to be demonstrated and passed on to medical trainees and consequently, for both research and educational purposes, more human cadavers needed to be obtained. Many important anatomists contributed to anatomical knowledge, although they largely persisted in the ways by which anatomy was taught, albeit now being less reliant on lectures alone but incorporating anatomical demonstrations/dissections. The next important step for anatomy occurred 50 years after the death of Vesalius with the work of William Harvey in England.

The era of William Harvey

Generally referred to by medical historians as the 'Father of Physiology', because of his investigations on the circulation of the blood, Harvey was a skilled anatomist (Figure 12)³⁶. Whether as an anatomist or as a physiologist, Harvey advocated only coming to conclusions about a scientific or medical problem after critical evaluation of existing knowledge against experimental findings. Thus, with Vesalius, he pushed medicine (and indeed medical education) from an observational to an experimental science. His studies at Padua over a 4-year period were necessitated by the lack of anatomy and dissection at Cambridge. Many of the European universities at this time were 'magistral' in that the professors governed and ruled on the educational and scholarly requirements, this pat-



Fig. 11. Skeleton in Contemplative Pose with Memento Mori from Andrei Vesalius' *De humani corporis fabrica librorum epitome* (1543 CE). An image from one of the first atlases of human anatomy showing osteology, not in the context of *postmortem* anatomy, but as if in life. (Public domain artwork; Special Collections University of Glasgow).

tern continuing worldwide until recent times. However, at Padua in Harvey's time the 'studia' made decisions and consequently the students had a considerable influence upon their own education (see comments above concerning the students' role in establishing permanent anatomy theatres). Indeed, there was a 'congregation' of students who, with an executive general, provided the governing body of the university. This is perhaps a lesson for today's universities that should recognise that the 'community of scholars' comprises just academics and students (not managers) and that curricula should have a component of student-centred education³⁷.

During the 16th and 17th centuries CE, to be the 'Lecturer of Anatomy' was to have considerable esteem. This was the case for Harvey whose notes for his anatomy lectures are still available for perusal. These notes not only showed that Harvey was well versed in contemporary views of anatomy, and was a researcher of considerable ability, but also demonstrated that he had firm views about how anatomy should be directed and about its importance in medical education. Amongst his directives are the following rules and observations³⁸:

"Cut up as much as may be in the view of all, that practical skill may be learned together with theoretical knowledge."

"The end of Anatomy is knowledge of the part, why it exists, for what purpose it is necessary and what is its use."

"For the physician it (anatomy) is to learn what is the natural constitution of the body."

"Do not speak of anything which, without the carcase, may be delivered or read at home for... I profess to learn and teach anatomy not from books but from dissections; not from the tenets of Philosophers but from the fabric of Nature".

What would such rules and observations imply for contemporary anatomy? Harvey would clearly have seen anatomy as central to medicine, would have required an understanding of matters relating to health before trying to understand disease, would have required the acquisition of professional skills and attitudes and not just facts, and would have insisted upon a non-scholastic approach that privileged experiential learning through dissection over book (or even web-based) work.

It is noteworthy that Harvey took 14 years to obtain his medical degree. This compares with today's 5 to 7 years, although it must be recognised that many years of postgraduate training and examinations are nowadays required to develop the competent practitioner. Furthermore, although Harvey was educated through a European university system, many healthcare practitioners learned their craft by apprenticeship or by private means and the university medical school is a relatively recent development.



Fig. 12. Robert Hannah: *William Harvey teaching Anatomy to his King* (1848 CE). A portrayal of the anatomist and physiologist instructing not just King Charles I of England and Scotland but also his son, the future King Charles II, who was so enamored of the new sciences that he founded the Royal Society (the first institution for the promulgation of science along the lines of the philosophies of Francis Bacon. (Royal College of Physicians, London).

The development of the medical school

Medical training was particularly well organised in Italy, France, the Netherlands and Germany, where curricula comprising compulsory lectures and practicals led to the requirement to pass formal examinations. In such institutions, anatomy and dissection were important components of their courses, although as we have already reported the teaching was most often based on the works of Galen and Avicenna. Nevertheless, until quite recent times many doctors received their training by attending private lectures and by a system of apprenticeship³⁹. There was little practical anatomical tuition and some surgical authorities (e.g. the Guild of Barber Surgeons in the UK) strictly forbade dissection by those under apprenticeship. One of the most famous of private medical schools, where anatomy was an important component of the tuition, was founded by William Hunter (c. 1740 CE)⁴⁰. Furthermore, he brought together a significant collection of anatomical specimens that, being designated an anatomy museum, was a major contributor to medical students attending Hunter's school. William's brother, John, joined his brother at the school and became one of the most famous teachers of anatomy in history⁴¹. His methods involved the study of comparative anatomy (having described the anatomy of over 500 species), a discipline that has Galenic overtones and that has now disappeared from most medical/healthcare curricula. He strongly believed that "... only by investigating the changes due to disease in the light of a knowledge of the functions of normal tissues and organs can surgery be properly applied"⁴²; a concept that is being diluted in many of today's healthcare curricula. John Hunter's museum, now

at the Royal College of Surgeons in London, was novel in that he did not restrict himself to the display and labelling of specimens but arranged them for didactic purposes so that various medical theories could be presented for analysis and discussion. He also had firm views about the training of surgeons, views that were flatly rejected in his day. Indeed, it was following a dispute that he had a heart attack and died. The schools of Hunter trained thousands of doctors, many of whom became prominent in the medical profession, in anatomy and in education on both sides of the Atlantic.

Private medical schools, sometimes governed by quacks with unscientific ideas, and apprenticeships persisted until relatively recently and until national governments passed legislation to ensure that medicine was taught and learned at university. For example, only in the late 1850s CE did the UK pass legislation to set up a General Medical Council that eventually led to university-based medical education. The pattern from apprenticeship to university education has spread to all other healthcare professions, first for dentistry but more recently for nursing, physiotherapy and occupational therapy, radiography and radiotherapy. Many disciplines that are complementary to medicine have also become incorporated into the university system.

Nowadays, we are used to the concept of each university of repute having its own school for the training of medicine, surgery and other healthcare professionals, recruiting students mainly within the locality of the university. However, this is a recent phenomenon since students in the past used to travel extensively to seek their medical and anatomical training. Notably, William Harvey, although ostensibly graduating from Cambridge, studied anatomy at the University of Padua. In the 16th century CE, in addition to the universities at Bologna and Louvain already mentioned, two important centres for medical education of international students existed in Europe, Padua in Italy and Leiden in the Netherlands. So many foreign students chose to study at Padua because of its liberalism and its reputation for anatomy that the students were grouped into colleges or 'studia' named according to the nation of origin. Furthermore, it has been reported that, in the early 18th century CE, half of the medical students at Leiden were foreign, mostly British⁴³. This came about because of the reputa-

tion of its academics (e.g. Desiderius Erasmus, Hermann Boerhaave, Alexander Monro, Antoni van Leeuwenhoek, Bernhard Siegfried Albinus, Frederik Ruysch) and also because it was considered a short cut for incorporation into their national medical professional associations. Hermann Boerhaave was a significant medical educator at Leiden in the late 17th, early 18th, centuries CE. Medical historians regard him as a great medical reformer, writing many textbooks and teaching at the bedside such that the progress of the patient was kept under surveillance until recovery (or death).



Fig. 13 (Top). Michael Jansz Van Mierevelt: *Anatomy Lesson of Doctor Willem von der Meer in Delft* (1617 CE). No longer afraid of religious or public odium, the anatomists of Reformist Netherlands proudly boast of their occupation. One can also hear the artist proclaim – “Say cheese!” (Public Domain).

Fig. 14 (Bottom). Rembrandt Harmenszoon van Rijn: *Anatomy Lesson of Dr Nicolaes Tulp* (1632 CE). This portrait, displaying inaccurate anatomy of the arm, is not just a painting of the artist and his students but also a proclamation of the very act of teaching, it being readily understood that to be learned one had to be an accomplished teacher. (Public Domain).

He was instrumental in demonstrating relationships between symptoms and pathology and was convinced that much of medicine relied upon a firm knowledge of anatomy. Indeed, the Dutch became renowned for their use of dissection in medical education in the 16th to the 18th centuries CE and many anatomists celebrated their fame by commissioning artists to paint group portraits and paintings of them teaching and dissecting (viz. Rembrandt's painting of the *Anatomy Lesson of Dr Tulp*) (Figures 13 and 14).

Today, although some movement of students occurs away from their home base, particularly for universities of great esteem and for overseas students paying for their own education (it is still the usual practice in the UK for students to study at a university that, although in the UK, is at a distance from their home), once recruited they tend to remain at the same school. However, the appropriately named Erasmus scheme in Europe, and such schemes as the Rhodes scholarships, have been established to encourage students to study for part of their course away from their graduating university. This is highly commendable, although the actual teaching experience may not easily be quality assured to the satisfaction of the home university!

It was not until relatively recent times that legislation concerning anatomical examination changed matters educationally by providing for many body donations that permitted students not just to observe but also to experience anatomy by their own dissection. Furthermore, this was made possible by the development of body preservatives that hitherto meant that bodies had to be dissected quickly, and by skilled practitioners, before the onset of putrefaction. The introduction of legislation to permit dissection of donated bodies, and to close off the supply of cadavers by Resurrectionists⁴⁴, had a profound effect on the development of hospital-based medical schools at the expense of private anatomy/medical schools. Richardson has pointed out that the private schools could now no longer compete for the supply of bodies since often the law would not have provision for a system to ensure 'fair distribution' of cadavers⁴⁵.

Commensurate with the development of dissection rooms for the use by students was the opportunity for teachers to add the attainment of skills and attitudes crucial to the professional development of the students to the acquisition of knowledge and understanding of human anatomy⁴⁶. Contemporarily, anatomy has changed radically with the development of new teaching technologies and, while many anatomists welcome these as adjuncts to the dissecting room experience, some have used technological change as a means of suggesting that teaching by dissection is an old-fashioned, traditional technique inappropriate for today's generation of students. And yet, many studies show that today's students fully ap-

preciate the clinical importance of anatomy and believe that dissection is the most effective teaching methodology⁴⁷. Furthermore, the overreliance of the new technologies risks the return to scholasticism where electronic texts and images are to be learned or accessed only when required, where they are critically unquestioned, and where learning become devoid of the opportunity for the acquisition of skills and professional attitudes. Thus, learning from books, texts and electronic media without direct experience of dissection is traditional while experiential learning through dissection is modern! However, it is not just a case of being modern in terms of the methods of delivering anatomy. Consideration should also be given to the attitudes, personal characteristics (including personality) and learning styles of today's student⁴⁸. Furthermore, the integration of the basic sciences with the clinic and the delivery of important skills (many related to professionalism) are becoming increasingly important⁴⁹.

Anatomical museums

The rise of anatomical museums affords us with a glimpse of the changing practices for teaching and learning anatomy from the Renaissance to present times. In early times, anatomical knowledge was for the educated elite and museums were not open for the general public. Indeed, they were often quite secret places, hidden within learned institutions. In Europe, the Barber Surgeons of Edinburgh set up one of the first anatomical museums in 1699 CE. This museum was considered at the time to be a 'cabinet of curiosities' and the suggestion of a 'Freak Show' has continued unabated throughout the history of museums of anatomy and pathology. The museum seems to have consisted of 'anatomical manikins' since it was then illegal to work on human cadavers. The first prepared dissected specimens for public view were housed in a dissection cabinet within the Neapolitan anatomical museum (17th century CE).

The University of Bologna, the oldest university in Europe with a medical school established in 1288 CE, did not create its famous museum until 1788 CE. This museum initially consisted of wood, clay and wax models as well as a substantial number of anatomical paintings. The use of wax (Figure 15) became increasingly a feature of anatomical museums, as evidenced by the museums at Bologna, Cagliari (founded in 1806 CE) and at Florence (the Specola Collection; founded in 1775 CE)⁵⁰. Later, and particularly in France with the modeller Louis Auzoux, anatomical models were produced using papier-mâché⁵¹. In addition to university-based museums, privately owned museums were sometimes created. As already mentioned, John Hunter ran a museum at his home in London between 1783 and 1793 CE and until the government purchased the museum in 1799 CE.

The museums have had their fair share of prob-

lems from an ethical perspective. Given the taboo associated with dissection of human cadavers, the use of models was often preferred and/or the prosections were secretly hidden from view. Those who prepared the models were not uncommonly antagonistic to human dissection since the sources of material were so suspect.

Leading through to today's situation, most anatomy departments within medical schools boast of an anatomical museum, often containing potted dissected specimens in addition to graphic materials, models and drawings and paintings. However, it seems that in many cases, due to neglect or the decrease in teaching of anatomy, the museums have disappeared or become museum pieces, more of cultural value than educational value. Furthermore, some dissection rooms have now become 'learning resource centres' where, because students are not expected to dissect, prosections are available on a need to know basis. Attempts have been made to make museums up-to-date by incorporating electronic media and Internet facili-

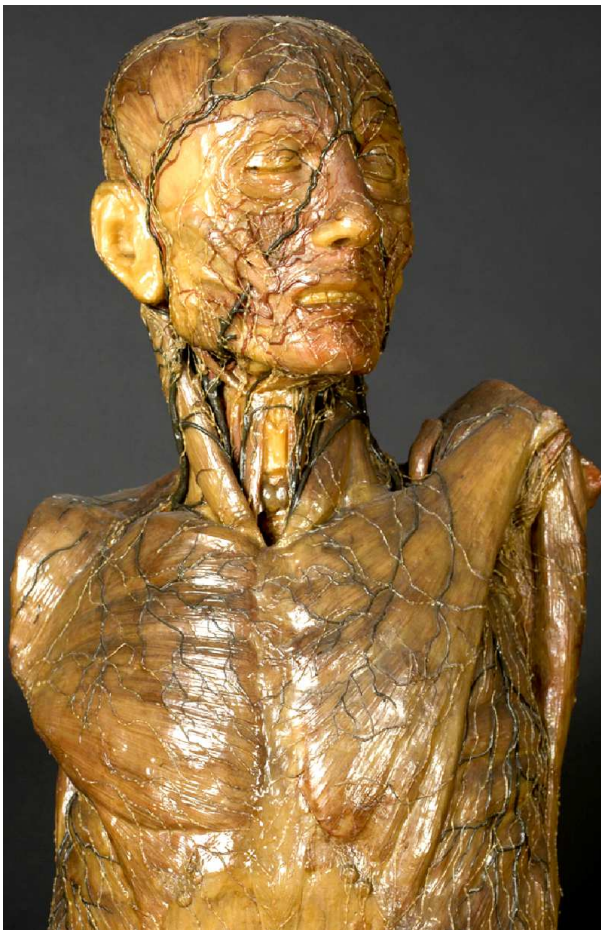


Fig. 15. Luigi Francheschi and Juan Chaez: *Lymphatic system of the torso* (late 18th century CE). The lack of availability of bodies, and occasionally ethical considerations, resulted in some artists specializing in the production of wax anatomical models. (By kind permission of Javier Puerta Museum, Complutense University of Madrid).

ties. However, the question about the educational value of museums has not yet been properly addressed. Although it is generally assumed that the anatomy museum is a valuable asset for educating both students studying healthcare professional courses and also for the general public. However, a hint that they may not be as valuable as once thought arises from the recent surveys of student and professional anatomists opinions⁵². These studies suggest that, in a variety of schools in the UK and at a medical school in France, students do not have positive attitudes towards the use of models and computer-based materials, preferring study by dissection and then by demonstrations using prosected material. As for public display, historical museums, such as those displaying wax models, have become popular public attractions and the Hunterian museum at the Royal College of Surgeons (London) is esteemed and well attended by members of the general public. The most recent example of a museum that features cadaveric material for public display is von Hagens's *Body Worlds*⁵³. Here, von Hagens displays human material that he produced using the technique of plastination where specimens can be preserved long-term by tissue polymer impregnation. Most attention is paid in *Body Worlds* to plastinated human material that is arranged in poses that von Hagens calls 'spectaculars' (for example, where couples are plastinated in the sexual act or as flayed athletes or as a group playing cards, or as a rider on horseback). The extent to which the public are educated about anatomy, matters relating to mortality, and/or cultural concerns associated with body art remains debatable.

Anatomical terminologies⁵⁴

Anatomical terminologies, for gross anatomy, histology, embryology and neuroscience, provide the basis for the languages of the healthcare disciplines. As already mentioned, Vesalius obtained his baccalaureate degree at Louvain on the theme of anatomical terminology. During the early Renaissance, anatomical terms often adopted an Aristotelian approach, using terminology that designates a structure's function. For example, Biceps brachii muscle (named by Albinus in 1734 CE) was previously termed by Vesalius the anterior cubitum flectentium musculus (the anterior muscle that flexes the arm) while the trapezius muscle Vesalius called the musculus scapulam moventium secundus (the muscle counted as the second of those that move the scapula)⁵⁵. That anatomical terminology has varied considerably over the course of history is highlighted by the fact that, until the first official anatomical terminology was produced (the *Basiliensia Nomina Anatomica* in 1895 CE), there were over 50,000 terms in general circulation. This has now been reduced to about 5,000 terms⁵⁶. Since the *Basiliensia Nomina Anatomica* in 1895 CE, noteworthy terminologies have been devised

such as the *Parisiensia Nomina Anatomica* (1955 CE) and, most recently, *Terminologia Anatomica* (1998 CE) under the auspices of the International Federation of Associations of Anatomists (IFAA). Such developments are important educationally and, adding to its remit, the IFAA has recently embarked on the development of core syllabuses for the anatomical sciences that is more democratically and internationally derived than previous attempts to formulate such syllabuses⁵⁷.

Art and anatomy and anatomical texts⁵⁸

In the pre-Vesalian era, anatomists provided their own anatomical drawings or artists themselves (such as Michelangelo and da Vinci) drew or painted the anatomised body for their own instruction or pleasure. Many of these images were scientifically and artistically crude, lacking detail and displaying inaccuracies (Figure 16). As mentioned previously, the anatomical drawings of da Vinci were of great artistic merit and, while some of the earliest drawing had inaccuracies owing to the artist strictly following the misconceptions and prejudices of the age (Figure 7), the later drawings would also have been of scientific merit if they had been published or publically available (Figure 8). In the pre-Vesalian period the human body was often depicted in mystical terms, in particular astrological themes being superimposed on parts of the body in images categorised as 'Zodiac Man' (Figure 4). The underpinning concept was that Man was a microcosm reflecting the macrocosm of the Ptolemaic universe. Accordingly, since the Earth was divided into regions influenced by the planets, so Man's body was divided into regions governed by signs of the Zodiac.

From the time of Vesalius until present times, when depicting the human body scientifically, artists have been employed to illustrate anatomy texts. Initially, at a time when the illustrations were meant to convey the results of anatomical research, artists were employed who, in today's

terms, would be classified as fine artists and not graphic artists (Figures 11, 17 and 18). As the anatomy text became less research-based and more teaching-based, the artists would often be just copyists of previous illustrations (plagiarism was/is rife) until we get to today's situation where clearly identifiable graphic artists are employed to illustrate textbooks and computer assisted learning tools. With the change from fine arts to graphic arts came a change in the nature of the illustration; from the early complex and very detailed and realistic illustrations related to research findings the images became increasingly simplified to further the didactic purposes of the textbook. This simplification was seen as providing a good learning device since students were able to reproduce the images. However, in the 20th and 21st centuries CE we have become bombarded with imagery and, in line with this cultural shift, the textbook illustrations have once more become complex, although not in the detailed and realistic form seen during Vesalius' time. One can only surmise the reason for this change; perhaps aesthetic quality has become privileged over the simple line drawings previously employed for teaching purposes. This trend has also been seen very clearly in computer-generated imagery where the technologies have become so advanced that the aim is to produce a good approximation to realism. However, at this time in our history, holography is not yet sufficiently advanced to approach the 3-dimensionality of the dissected cadaver. Whatever the artistic technique or purpose used in anatomical texts, it is particularly striking that, throughout the history of anatomy and anatomical education, anatomists have been iconophilic (in love with images). Indeed, such iconophilia has expanded beyond anatomy, and even beyond medicine, to be a major feature of the sciences in general. If Pythagoras, Galileo and Newton believed that to know something about anything one had to be able to express that thing mathematically, it seems that anatomists have taken

the empirical principle to the point that to see and perceive things through imagery is to know those things!

One issue that has gone largely unnoticed, but has baffled some, is why many anatomical images so often do not depict dead persons but instead living persons performing normal actions (thinking, reading, weeping

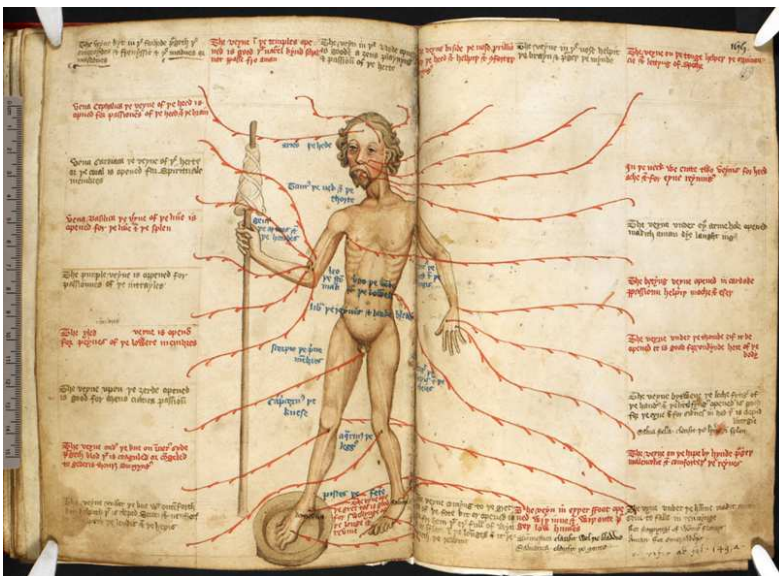


Fig. 16. Bloodletting Man with a Zodiac Man (15th century CE). The human body has been a vehicle throughout history for all manner of religious, mystical and psychological conjectures. Nowadays we see such images as "art", even though no artist can lay claim and no aesthetic purpose was originally intended. (By kind permission of the Wellcome Library, London).

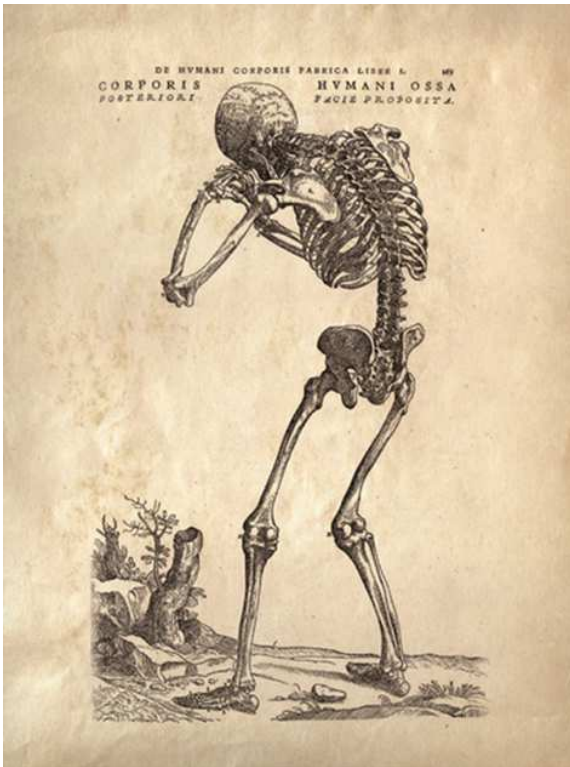


Fig. 17 (Left). Jan Stephen van Calar: *Weeping Skeleton (Hunched Skeleton)* from Vesalius' *Fabrica* (1543 CE). Another image of a skeleton seen as if in life. This justifiably famous print was the work of an artist collaborating with a scientist – an early form of Sci-Art (Public Domain).

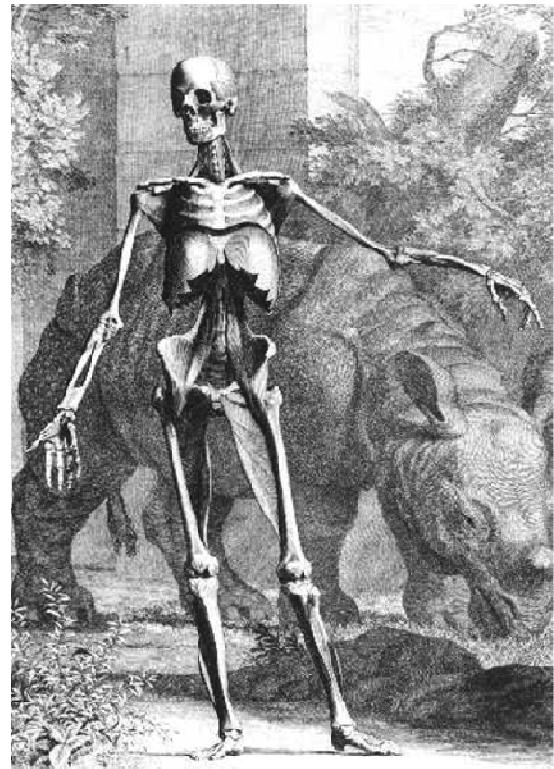


Fig. 18 (Right). Jan Wandelaar: *Clara Rhinoceros and Human Skeleton* from Bernhard Albinus' *Tabulae sceleti et musculorum corporis humani* (1749 CE). This image is another example of artist/scientist collaboration. But, is this a surrealist image before its time? Only to modern eyes! (Public Domain).

(Figure 17), even in the sex act (Figure 7). We speculate that, during times when a dualist philosophy pertained that suggested that body and mind (or soul) were separate entities, it was beneficial for anatomists to suggest that the anatomy they were describing was not an artefact after the soul had left the body but was a representation of real structures and organs that produced all functions associated with the living.

No anatomy book these days would be valued unless it was substantially illustrated but, until Vesalius' *Fabrica* and Eustachio's *Tabulae*, most works on anatomy relied upon the written word. Indeed, by his method of using Greek and Roman characters to identify structures, and then cross referencing them in the text, Vesalius invented the concept of labelling used to this day. Even after Vesalius, however, and until the publication of major works such as those from Bernhard Albinus (Figure 18)⁵⁹, texts were often wordy and without images.

Although fine artists generally lost interest in anatomical art (indeed life study classes at art school have all but disappeared), in recent times there has been a resurgence of interest in anatomy amongst contemporary artists⁶⁰. For example, major exhibitions have been organised and well received by both critics and the public (e.g. *Spectac-*

ular Bodies – The Art and Science of the Human Body from Leonardo to Now, Hayward Gallery, London, 2002 CE). However, compared with anatomical art in the past that was research or teaching based and had didactic purposes, anatomical art today is more conceptual and deals with issues such as death and the 'theatre' of anatomy (Figures 19 - 22).

Concerning anatomical texts, textbooks of anatomy have been the cornerstone of anatomical education, regardless of the teaching and learning methodologies and ideologies employed. Although texts of such kinds have probably existed forever, it was in the 16th century CE in Europe that these texts, whether for research or pedagogic purposes, emerged with revolutionary force. At this time, the works of Galen and Avicenna were gradually replaced by those of Colombo (*De re anatomica libri*, 1599 CE), Eustachio (*Tabulae anatomicae clarissimi*, c. 1552 CE), and Vesalius (*Fabrica*, 1543 CE). Notable books of the 17th century include those of Jessenius (*Anatomiae*, 1601 CE), Spigeli (*De humani corporis humani fabrica*, 1632 CE), and Verheyen (*Anatomiae corporis fabrica liber primus*, 1699 CE). In the 18th and 19th centuries appeared the works of Albinus (*Historia musculorum hominid*, 1734 CE) (Figure 18), Sommering (*De corporis humani fabrica*, 1796 CE), Winslow (*Exposito*



Fig. 19 (Left). Nick Cudworth: *The Reproductive System* (a large crayon and pastel drawing from the series *New Anatomy Lessons*) (1980 CE). Anatomical art fell out of fashion in the “modernist” period but is reappearing in the “postmodernist” era. Cudworth’s drawing teases a famous anatomical painting by D’Agoty into an improbable carpet (reminiscent of Marcel Duchamp’s reciprocal ready-made – make an ironing board from a Rembrandt). The Adam and Eve drawing within the picture is taken from van Eyck’s Ghent altarpiece and represents the original sin often interpreted as being lust. (By kind permission of the artist and Bernard Moxham).

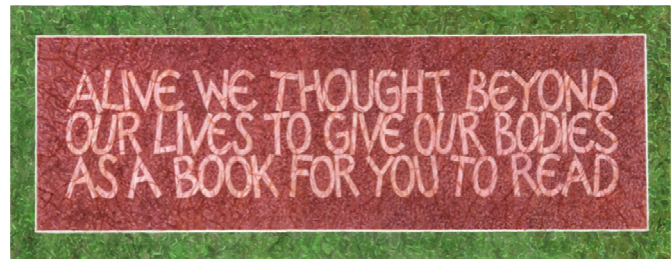


Fig. 20 (Above). Tom Phillips: *Watercolour Study for a Memorial Plaque for the Dissecting Room at Cardiff University* (2012 CE). Commemoration and celebration of the great gift of bequeathing a body for anatomical examination has been undertaken in various ways. The Tom Phillips watercolour is a study for a large marble plaque that is housed in the dissecting room at Cardiff University. It serves to remind students that their anatomical education is not only about the learning of anatomical facts but involves the acquisition of many other professional skills. (By kind permission of the artist and Bernard Moxham).



Fig. 21. Karen Ingham: *Death’s Witness* (2000 CE). Images of the artist and her husband superimposed on an 1898 CE photograph of the Turin Shroud. Karen Ingham shocks the unwary into consideration of the nature of mortality and of the depiction of the body in a state of unconsciousness, sleep or even death. Anatomists are clearly aware of Michel Foucault’s paradox that, while anatomy is concerned with the normal structure and function of the human body, its instrument is the dead body. (By kind permission of the artist).



Fig. 22. Marc Quinn: *Self 1991* (1991 CE). This work is composed of the refrigerated blood of the artist. Its novelty lies in not just providing a physical self-portrait but also a “physiological” (perhaps even “psychological”) portrait. (By kind permission of the artist).



Fig. 23 (Left). John Banister's *Dissecting Instruments* (c. 1580 CE). The tools of the trade are displayed here, echoing the modern artistic conceit of honouring the "process" as well as the "end result". However, all anatomists are aware that the skills of dissection are an integral part of our discipline. (Special Collections, University of Glasgow).



Fig. 24 (Right). Gerard de Laresse: *Drawing of Extensor compartment of the forearm for Govard Bidloo's Anatomia humani corporis* (1685 CE). This beautifully drawn, and accurate, anatomical image is the apotheosis of images that "instruct", but primarily through the eyes of the investigator. (Public Domain).

anatomica structurae corporis humani, 1758 CE), Henle (*Handbuch der systematischen Anatomie des Menschen*, 1871 CE) and Hyrtl (*Lehrbuch der Anatomie des Menschen*, 1846 CE). Thus, until the 19th century CE many anatomy texts were written in Latin whence German, and eventually English, became the main language of the discipline. Notable exceptions do however exist; for example, Valverde's Spanish book (*Historia de la composición del cuerpo humano*; 1556 CE) and Banister's English text (*The Historie of Man...*, Figure 23), both plagiarising Vesalius' images. That plagiarism has been widespread throughout the history of anatomy is also suggested by the copying of anatomical illustrations from Bidloo's book (*Anatomia humani corporis*; 1685 CE; Figure 24) by William Cowper in his *The Anatomy of Human Bodies* (1698 CE).

Although anatomical atlases are nowadays common, their importance as educational tools has been respected since Vesalius published his *Epitome*. The first anatomical atlas to be illustrated by lithography was published in 1821 CE (Cloquet's *Anatomie de l'homme*) and, during the 18th and 19th centuries CE, anatomical plates and charts were frequently produced to guide students in the learning of anatomy.

Today, anatomists and students are assailed by a great variety of anatomy texts, although *Gray's Anatomy* (first published in 1858 CE, now in its 40th edition, 2008 CE)⁶¹ and *Netter's Atlas of Human Anatomy* (first published in 1989 CE from

illustrations first undertaken in the 1930s) perhaps remain the most authoritative. Reviewing the titles of anatomy books reveals that, while initially the description of anatomy was sufficient in itself, increasingly in recent times the term 'clinical anatomy' has crept into vogue. Even *Gray's Anatomy* has the subtitle *The Anatomical Basis of Clinical Practice*. And yet, what could be more clinical than anatomy, even in its purest form, since, as introduced by Vesalius, medicine is as much about health as it is about disease⁶². Anatomy books these days are written for the benefit of students and not as research monographs. However, Vesalius himself took away from his research-based *Fabrica* a selection of illustrations that formed his *Epitome* (*De humani corporis fabrica epitome*)⁶³ that was intended to help readers/students understand his findings. As mentioned earlier, Vesalius even drew anatomical charts that he distributed to his students (collected as the *Tabulae Anatomicae*)... a very fine example of a student 'handout'⁶⁴! The illustrations he chose for the *Epitome* and for the *Tabulae* show that he had a keen understanding of how images are important in the acquisition of anatomical knowledge and his methods still work within modern concepts of anatomical education. Also in this era, Fabrici had printed a series of slim anatomical monographs and he stated that he wished to keep their cost low to encourage purchase by the students.

FINAL THOUGHTS AND CONCLUSIONS

Thomas Kuhn, a physicist and historian of science, advanced the notion that science progresses by 'revolutionary' paradigm shifts⁶⁵. The teaching of anatomy has certainly undergone numerous paradigm shifts. Perhaps initially it was the realisation that the inner structure of Man was not a mystery that could not be investigated, followed by the demonstration that *post mortem* anatomy related closely to that seen in life. With Vesalius, religious tenets, scholastic values and unscientific practices gave way to direct observation and a move away from reliance upon bookwork. With Harvey, structure was seen to be closely related to function and, following on from Vesalius, anatomy was considered to be the standard bearer for the development of the biomedical sciences where normality and health was the main focus of attention. More recently, moral and legislative developments, together with new ways of preserving anatomical specimens, enabled anatomical education to move away from a passive 'observation and demonstration' didactic approach so that students could gain anatomical knowledge experientially by dissection (with the added benefit of acquiring professional skills). Thus, in historical terms, dissection by students is a modern approach that has lasted for just over a century. Indeed, the pattern of medical education for most of the 20th century CE was, with few exceptions, consistent across the globe. The medical course, in common with many other healthcare courses, consisted of 5 to 7 years of study, with the early years being devoted to the basic biomedical sciences. After 2 or 3 years of scientific training, the students would begin their clinical training. However, politico-educational authorities within the healthcare professions (including deans and educationalists) have increasingly taken power and influence and as a result this consistency became tenuous so that nowadays healthcare courses display many different arrangements for the study of clinical and scientific material. We would argue, therefore, that this has resulted in an educational 'Tower of Babel' that is in danger of undermining the educational principles of 'consistency, reliability and transparency' that helps to convince the general public, and society at large, that there is quality medical (healthcare) education founded on firm principles (including anatomy). For those healthcare disciplines that award their graduates the title of 'Doctor', these are not frivolous matters but remain the hallmarks by which doctors are honoured by being considered 'learnèd'.

Anatomical education has, in historical terms, undergone an evolutionary process that led to 'dissection by the students'. However, this process has now been 'revolutionised' by largely untried educational methods and by claims that anatomy needs radical change because it is 'traditional'⁶⁶.

Paradoxically, there is evidence that contemporary anatomists who can be designated 'modernists' or 'traditionalists' do not differ in their views concerning the best way of teaching and learning gross anatomy... by dissection⁶⁷. It is also worrying that the evolution of anatomical education towards an experiential approach is being abandoned to the point that history is being put into reverse. As a consequence, and at best, the true 'traditional' approach is being reintroduced that involves 'dissection by the 'master anatomist' and observation by the student'. At worst, there is a trend towards downgrading anatomy (because it is deemed 'old-fashioned') and to reject the use of cadavers. This risks going back to pre-Vesalian scholasticism. This trend seems to fit with aspects of contemporary society that privileges individuality over collective (more 'disciplined') approaches but, as a further paradox, this is contrary to consumerist approaches where anatomical education is ultimately not really for the benefit of deans, educationalists, or even students but for laypersons (prospective patients) who, according to recent evidence⁶⁸, are concerned that anatomy may not be central to medical education. So, have we in medical education taken the postmodernist view that education shows no progress, that historicism is a fallacy and that there is flux or movement between philosophies, ideologies and methodologies?

Peter Abrahams, a Clinical Anatomist and writer of many anatomical textbooks, has described the main features of anatomical education today, as⁶⁹:

- emphasising integrated anatomy teaching, including vertical integration and clinical integrated (the concept of 'Clinical Anatomy');
- incorporating aspects of wider medical education; for example, focus on health care for the future, greater patient focus
- addressing students' concerns regarding curricular density;
- highlighting problem/team-based tuition;
- appreciating that the concept of the learner being a mere processor of information has been replaced by the image of a self-motivated, self-directed problem solver;
- understanding that anatomy teaching is more than just the acquisition of anatomical knowledge but incorporates professionalism / ethics/humanism/and appreciation of death.

It is not the purpose of this article to comment extensively on these matters; this will be done within other articles in this series. What can be stated here is that, in historical terms, many of these features were implicitly (occasionally explicitly) in place before the 'modern' era. Furthermore, notions relating to the ways in which a generation of students differs attitudinally and behaviourally from previous generations have often guided changes in the curriculum. In today's terms,

Strauss and Howe have coined the term 'The Millennial generation' or 'Generation Y' and Draves and Coates, authors of *Nine Shift: Work, Life and Education in the 21st Century*, claim that 'Millennials' have distinctly different behaviours, values and attitudes from previous generations as a response to the technological and economic implications of the Internet⁷⁰. Interesting as such speculations are, the evidence is that today's 'Millennial' medical students differ not at all from previous generations with respect to anatomical pedagogy, acknowledging that, in common with the beliefs of most professional anatomists, dissection by the students themselves is best⁷¹. To return to Henry Ford's notion that "History is more or less bunk"; perhaps being unaware of historical developments blinds us to what is good and best and so condemns us to waste time in reinventing the wheel at great cost and effort, but without great improvement. Consequently, rather than accept the scepticism of Henry Ford we prefer the perspicacity of Abraham Lincoln who said: "We cannot escape history"⁷².

So what might history have to teach us about anatomical education:

1. that the anatomical sciences were, until relatively recently, at the heart of healthcare curricula (regarded as core) but this has radically altered with the perception that curricula should be research-led;
2. that medicine and other healthcare disciplines are underpinned by knowledge conveyed by imagery and language that originated from anatomy;
3. that there has been evolution of teaching methodology from individuals pursuing their own interests and research, to dissection by the 'master and observation by the students' (the true 'traditional method'), to experiential learning by the students engaging in dissection with complementary outcomes related to the acquisition of skills and attitudes that relate to professionalism (the 'modern method');
4. that the evolution of anatomical education has given way in recent times to revolution, but risking a return to earlier scholastic methods by a reliance on bookwork, IT sources and the use of 'authoritative' resources;
5. that the opportunities to undertake dissection have changed from availability for the few to the many, but with a persistent critique emanating primarily from religious authorities but occasionally, and even today, from academic sources following fashion and/or educational misunderstandings;
6. that anatomy was central to shifting the culture of medicine and healthcare from a disease-based model to a functionality-based (health-based) model (although in recent times the disease-based model predominates and has led to the concept of 'Clinical Anatomy')⁷³;
7. that, despite all the changes and criticisms (justified or otherwise), anatomists remain enthusiastic about their discipline and are eager to participate in improving the training of healthcare professionals. In this respect, the division between so-called 'modernists' and 'traditionalists' is often artificial in educational terms and only meaningful in political terms;
8. that, in the recent development of the teaching of anatomy within healthcare curricula, little attention has been paid to historical events and concepts; with the result that we are in danger of losing what was good without really understanding why something was bad! To go further, those with politico-educational credentials appear presently to be in thrall to postmodernist concepts, which display an anti-historical trend. Accordingly, there is a denigration of the notion of progress which goes alongside the belief that structures and historical trends are mere social constructs, there being a disregard for being evidence-based because of the concept of 'equal validity' such that science is no better at pursuing truth than fortune-telling.

*Those who don't know history are destined to repeat it (Edmund Burke)*⁷⁴

*That men do not learn very much from the lessons of history is the most important of all the lessons of history (Aldous Huxley)*⁷⁵

*History repeats itself, first as tragedy, second as farce (Karl Marx)*⁷⁶

ENDNOTES

¹There is an extensive literature on this matter that can be accessed through virtually all the academic journals dealing with anatomy. Here is provided just a sample. W W Cottam: Adequacy of medical school gross anatomy education as perceived by certain postgraduate residency programs and anatomy courses (1999), *Clin. Anat.* 12, 55-65; Bernard Moxham & Siân Moxham: The relationships between attitudes, course aims and teaching methods for the teaching of gross anatomy in the medical curriculum (2007), *Eur. J. Anat.* 11, 19-30; General Medical Council (2009): *Tomorrow's Doctors. Recommendations on undergraduate medical education.* General Medical Council Publications, London; Richard Drake et al.: Medical education in the anatomical sciences: the winds of change continue to blow (2009), *Anat. Sci. Edu* 2, 253-259; R. Pabst: Anatomy curriculum for medical students – what can be learned for future curricula from evaluations and questionnaires completed by students, anatomists and clinicians in different countries? (2009), *Ann. Anat* 191, 541-546; Bernard Moxham et al.: The future of clinical anatomy (2011), *Eur. J. Anat.* 15, 29-46; Richard Drake: A retrospective and prospective look at medical education in the United States –

trends shaping anatomical sciences education (2014), *J. Anat.* 224, 256-260. Readers are also referred to issues of *Anatomical Sciences Education* and to a special educational issue of the *Journal of Anatomy* (2014, volume 224).

²The following references provide some books that are concerned generally with the history of anatomy. T V N Persaud: *Early History of Human Anatomy* (1984), Charles C Thomas, Springfield, Illinois; T V N Persaud: *A History of Anatomy – The Post-Vesalian Era* (1997), Charles C Thomas, Springfield, Illinois; Roy Porter: *Blood and Guts* (2002), Allen Lane, London; Roy Porter: *Flesh in the Age of Reason* (2003), Allen Lane, London; Rafael Mandressi: *Le regard de l'anatomiste - dissections et invention du corps en Occident* (2003), Seuil, Paris; Paul Strathern: *A Brief History of Medicine* (2005), Robinson, London; Roy Porter (editor): *The Cambridge History of Medicine* (2006), Cambridge University Press, Cambridge; Jean Claude Ameisen et al.: *Une histoire de la médecine* (2011), Éditions de la Martinière, Paris; Cynthia Klestinec: *Theaters of Anatomy* (2011), The Johns Hopkins University Press, Baltimore.

³The reader is referred to the following books for general information concerning the Renaissance - Margaret Aston: *The Renaissance Complete* (2009), Thames and Hudson, London; Walter Pater & Matthew Beaumont: *Studies in the History of the Renaissance* (Oxford World's Classics) (2010), Oxford University Press, Oxford

⁴Body snatching by Resurrectionists is a topic that has intrigued both historians and novelists. R Michael Gordon: *The Infamous Burke and Hare – Serial killers and Resurrectionists of nineteenth century Edinburgh* (2009), McFarland & Co Inc, Jefferson, N Carolina; Lisa Rosner: *The Anatomy Murders* (2010), University of Pennsylvania Press, Philadelphia; Michael Dowsett: *Body Snatchers* (2012), Kindle publication; Piers Mitchell: *Anatomical Dissection in Enlightenment England and Beyond* (The History of Medicine in Context) (2012), Ashgate, Farnham, Surrey.

⁵Rafael Mandressi (*Le regard de l'anatomiste* (2003), see note 2), while praising the rôle of the anatomy theatre in being “a place where one sees” rather than “a place to obtain book knowledge”, criticises the theatre as providing too visceral an experience, tending towards the ghoulish. He likens the experience to that of the shock of a *memento mori* and, taking a cue from Michel Foucault, invests the phrase ‘the anatomist’s gaze’ with negative connotations. Similarly, Giovanna Ferrari (*L’esperienza del passato: Alessandro Benedetti filologo e medico umanista* (1996), Olschki, Florence) has likened anatomical events to attending Carnival. On the other hand, Cynthia Klestinec (*Theatres of anatomy* (2011) see note 2) paints an altogether more positive picture with students professionally participating in the act of dissection and recording their philosophical reflections on the nature of Man.

⁶Comments abound that state that anatomy is old-fashioned. For example - Jonathan Sawday: *The Body Emblazoned – Dissection and the Human Body* (1995), Routledge, London; McLachlan JC et al.: *Teaching anatomy without cadavers* (2004), *Med. Ed.* 38, 418-424; McLachlan JC: *New path for teaching anatomy - living anatomy and medical imaging vs dissection* (2004), *Anat Rec B New Anat* 281, 4-5; McLachlan JC & Regan de Bere S: *How do we teach anatomy without cadavers?* (2004), *Clinical Teacher* 1, 49-52. However, the plethora

of contemporary journals devoted to discoveries in gross anatomy attest to the on-going importance of anatomical research. Indeed, the societal impact if the work is considerable when taking into account the influence on surgical procedures and medical imaging.

⁷There are many definitions and interpretations of the term “historicism”. It is used here to signify rules and principles discernible in history that suggest a line of progress or evolution to an ultimate goal (see Paul Hamilton: *Historicism (The New Critical Idiom)* (2003), Routledge, Oxford; Karl Popper: *The Poverty of Historicism* (2002), Routledge Classics, Oxford; Prasenjit Dura et al.: *A Companion to Global Historical Thought* (2014), Wiley Blackwell, Chichester.

⁸Peter Scott: *The Meanings of Mass Higher Education* (1995), Open University Press, Buckingham; Martin Trow: *Reflections on the transition from elite to mass universal access: Forms and phases of Higher Education in modern societies since WWII* (2007), *International Handbook of Higher Education* 18, 243-280.

⁹Postmodernism usually defines itself in opposition to the notions surrounding the ideals and the progress-orientated views and objectivity associated with Modernism. It is ill-defined but most advocates espouse relativistic views founded on the concepts of social constructivism and equal validity of all philosophies, epistemologies and historical perspectives for both time and place (see Linda Hutcheon: *The Politics of Postmodernism (New Accents)* (2002), Routledge, Oxford; Michael Drolet: *The Postmodernist Treader – Foundational Texts* (Routledge Readers of History) (2003), Routledge, Oxford; Richard Edwards & Robin Usher: *Postmodernism and education – Different Voices, Different Worlds* (1994), Routledge, Oxford.

¹⁰Thomas S Kuhn: *The Structure of Scientific Revolutions* (1962), University of Chicago Press, Chicago; Thomas S Kuhn: *The Road since Structure* (2000), University of Chicago Press, Chicago; Alexander Bird: *Thomas Kuhn* (2000), Acumen Publishing, Chesham.

¹¹See W S Monkhouse & TB Farrell: 1999. *Tomorrow's doctors: Today's mistakes?* (1999), *Clin. Anat.* 12, 131–134; H Goodwin: *Litigation and surgical practice in the UK* (2000), *Br. J. Surg.* 87, 977–979; S E Kahan et al.: *Urological medical malpractice* (2001), *J. Urol.* 165, 1638–1642; Harold Ellis: *Medico-legal litigation and its links with surgical anatomy* (2002), *Surgery* 20, i–ii; T M Kidder: *Malpractice considerations in endoscopic sinus surgery* (2002), *Curr. Opin. Otolaryngol. Head Neck Surg.* 10, 14–18; A G Lynn-Macrae et al.: *Medicolegal analysis of injury during endoscopic sinus surgery. Laryngoscope* (2004), 114, 1492–1495; K Ahmed et al.: *Is the structure of anatomy curriculum adequate for safe medical practice?* (2010), *Surgeon* 8, 318–324; K Ahmed et al.: *Specialist anatomy: Is the structure of teaching adequate?* (2011) *Surgeon* 9, 312–317.

¹²Bernard Moxham et al.: *The attitudes of laypersons towards the clinical importance of gross anatomy* (IFAA Beijing Congress Abstracts, 2014)

¹³For a reference book dealing with the history of anatomy before the Renaissance see T V N Persaud: *Early History of Human Anatomy* (1984), Charles C Thomas, Springfield, Illinois.

¹⁴Conventional wisdom espouses the view that the “Dark Ages” and the medieval era were not productive periods for science. This view is to some extent countered by the research of James Hannam: *God’s Philosophers – How the Medieval World Laid the Foundations*

of Modern Science (2009), Icon Books, London.

¹⁵For information relating specifically to human dissection, see Jonathan Sawday (1995; note 6); Helen MacDonald: *Human Remains – Dissection and its Histories* (2006), Yale University Press, London; D Gareth Jones & Maja I Whitaker: *Speaking for the Dead – The human body in biology and medicine* (2009). Ashgate, Aldershot; Cynthia Klestinec (2011; see note 6); Rafael Mandressi (2003; see note 6).

¹⁶C. P. Bryan: *The Papyrus Ebers* (1930), Geoffrey Bles, London.

¹⁷Humourism, or humoralism, is a now discredited theory of the makeup and workings of the human body that initially was adopted by Ancient Greek and Roman physicians and philosophers. According to the theory, a marked change of any of four distinct bodily fluids (the humours) would directly influence an individual's health and temperament. The four humours were thought to be phlegm (Gk. *phlegma*), black bile (Gk. *melan chole*), yellow bile (Gk. *chole*), and blood (Gk. *haima*). From the time of Hippocrates until the nineteenth century CE, the humoral theory was the most commonly held view of the human body among European physicians. See Faith Wallis: *Medieval Medicine – A Reader (Readings in Medieval Civilisations & Cultures)* (2010), University of Toronto Press, Toronto.

¹⁸Susan P Mattern: *The Prince of Medicine – Galen in the Roman Empire* (2013), Oxford University Press, Oxford.

¹⁹For information concerning Islamic scholars see Howard R Turner: *Science in Medieval Islam* (1995), University of Texas Press, Austin; Salim T S Al-Hassani (editor): *Muslim Heritage in Our World* (2007), Foundation for Science, Technology and Civilisation, Manchester; Bradley Steffens: *Ibn al-Haytham – First Scientist* (2007), Morgan Reynolds, Greensboro; Ehsan Masood: *Science & Islam* (2009), Icon Books, London; John Freely: *Aladdin's Lamp – How Greek science came to Europe through the Islamic World* (2009), Alfred A Knopf, New York; Jim Al-Khalili: *Pathfinders – The Golden Age of Arabic Science* (2010), Allen Lane, London.

²⁰Jon McGinnis: *Avicenna (Great Medieval Thinkers series)* (2010), Oxford University Press, Oxford; Mones Abu-Asab et al.: *Avicenna's Medicine* (2013), Healing Arts Press, Rochester, Vermont.

²¹R L Lind: *Studies in pre-Vesalian anatomy. Biography, translations, documents* (1975), The American Philosophical Society, Philadelphia.

²²For references regarding Scholasticism see Ian Maclean: *The Renaissance Notion of Women – A study in the fortunes of Scholasticism and medieval science in European intellectual life* (1980), Cambridge University Press, Cambridge; Josef Pieper et al.: *Scholasticism – Personalities and problems of medieval philosophy* (2001), St Augustine's Press, South Bend, US.

²³*Anatomies de Mondino dei Luzzi et de guiso de viganovano. facsimiles publies avec des notes* (Slatkin reprint, 1977)

²⁴The "disease-based model for medicine" is that most commonly employed for medical education. Alternatively, and to a great extent more appropriately for the biomedical sciences (including gross anatomy), there is a "functionality-based model". World Health Organization: *International classification of functioning, disability and health*. (2001), WHO, Geneva; Alexander R Green et al.: *Why the disease-based model of medicine fails our patients* (2002), *West. J. Med.* 178, 141-143; Derick Wade

& Peter Halligan: *Do biomedical models of illness make for good healthcare system?* (2004), *BMJ.* 329, 1398–1401.

²⁵For reference books concerned with the history of anatomy during and after the Renaissance see T V N Persaud: *A History of Anatomy – The Post-Vesalian Era* (1997), Charles C Thomas, Springfield, Illinois; Andrea Carlino: *Books of the Body – Anatomical Ritual and Renaissance Learning* (1999), The University of Chicago Press, Chicago.

²⁶Martin Gayford: *Michelangelo – His Epic Life* (2013), Penguin, London.

²⁷Martin Clayton & Ron Philo: *Leonardo da Vinci – The Anatomy of Man* (1992), Bulfinch Press, Boston; Kenneth Clark & Martin Kemp: *Leonardo da Vinci* (1993), Penguin, London; Michael White: *Leonardo The First Scientist* (2000), Abacus, London; Martin Kemp: *Leonardo da Vinci – Experience, Experiment and Design* (2006), V&A Publications, London; Martin Kemp: *Leonardo da Vinci – The Marvellous Works of Nature and Man* (2007), OUP, Oxford; Edward MacCurdy (translator): *The Notebooks of Leonardo da Vinci* (2009), Folio Society, London; Martin Clayton & Ron Philo: *Leonardo da Vinci – The Mechanics of Man* (2010). Royal Collection Publications, London; Martin Clayton & Ron Philo: *Leonardo da Vinci – Anatomist* (2012), Royal Collection Publications, London.

²⁸James Moores Ball: *Andreas Vesalius, The Reformer of Anatomy* (1910), Medical Science Press, Saint Louis; C D O'Malley: *Andreas Vesalius of Brussels* (1964), University of California Press, Berkeley; Stephen N. Joffe: *Andreas Vesalius – The Making, The Madman, and the Myth* (2009), Persona Publishing, Bloomington; *The Anatomical Drawings of Andreas Vesalius* (1982), Bonanza Books, New York.

²⁹Renaissance anatomists assumed that they could not be regarded as being truly learned unless they taught students and Vesalius scorned those who refused to engage in dissection and teaching, showing his contempt for those who pontificate about things that they have never done but who merely recite from the books of others.

³⁰It is now common for universities that receive body bequests for anatomical examination to hold "Thanksgiving Events" that might be either religious or secular see D Gareth Jones & Maja Whitaker (note 15); S L Bertman & S C Marks: *The Dissection Experience as a Laboratory for Self-Discovery about Death and Dying – Another side of clinical anatomy* (1989), *Clin. Anat.* 2, 103-113; and also Figure 20.

³¹It is commonplace nowadays for universities to claim that their course are research-led and this claim has arisen because of the emphasis placed upon research and the winning of grants, sometimes at the expense of teaching. It is generally recognised that it is difficult to precisely define a curriculum that is research-led and, in truth, most are at best research-aware. Nevertheless, it remains important for students to know the frontiers of knowledge and to be exposed, directly or indirectly, to research activity. Alan Jenkins et al.: *Reshaping Teaching in Higher Education: linking teaching with research* (2003), Kogan Page, London; Barbara Zamorski: *Research-led Teaching and Learning in Higher Education* (2010), *Teaching in Higher Education* 7, 411-427; Angela Brew: *Teaching and Research: New relationships and their implications for inquiry-based teaching and learning in Higher Education* (2010), *Higher Education Research*

& Development 22, 3-18.

³²Historically, most university examinations were conducted by *viva voce*. Increasingly, however, because of issues relating to reliability and consistency, vivas are becoming much less common. S Abrahamson: *The Oral Examination - The case for and the case against* (1983). In: *Evaluating the skills of medical specialists*. American Board of Medical Specialists, Chicago; Eva Andreasson: *Fairness and Flexibility in Oral Examinations* (2005). Thesis Umea Universitet; Muhammed Ashraf Memon et al.: *Oral Assessment and Postgraduate Medical Examinations* (2010), *Adv. in Health Sci. Educ. Theory Prac.* 15, 277-89.

³³Two recent translations of the *Fabrica* into English have been undertaken: Andreas Vesalius - the Fabric of the Human Body: An annotated translation of the 1543 and 1555 editions by Daniel H. Garrison and Malcolm H. Hast (2013), S Krager Publications, Basel; *On the Fabric of the Human Body*, illustrated editions (5 volumes) translated by William Frank Richardson in collaboration with John Burd Carman (1998-2009).

³⁴Michel Foucault: *Naissance de la Clinique: une archéologie du regard médical* (The Birth of the Clinic; a history of the medical gaze), Presses universitaires de France, Paris (1963). Foucault (1926-1984), a French postmodernist philosopher, was the son of an eminent surgeon and professor of Anatomy. Throughout his life he was concerned with the way society's structures, conventions and institutions limit the freedom of the individual. There are three major elements to Foucault's philosophy in *The Birth of the Clinic*. First, he continued to espouse the notion of institutions, including medical institutions (e.g. hospitals and medical schools), limiting human freedom (devising a concept he called 'the medical gaze'). Second, he reported that, because of the reorganisation of knowledge in the 18th century CE and the findings of anatomists, the culture of medicine had shifted markedly away from a disease-based model (as illustrated in many pre-Renaissance medical images) to a health-based model that had the greater potential for recognising, and potentiating, human freedom. At the same time as putting forward this notion, Foucault realised that he had constructed a paradox (Foucault's paradox) in that, while anatomical knowledge has focussed on the normal/healthy condition it had done so by examining, and dealing with, death. Medicine, however, concentrated on disease/abnormalities while dealing with life. Nevertheless, even anatomy, in his view, was not a privileged empirical science beyond its historical period. Third, and a persistent theme in all Foucault's work, was an obsession with death. In 1954, he wrote that "in the depths of his dream, what man encounters in his death is a welcome fulfilment of his existence... death is a constant companion to life... a white brightness in the black coffer of the body. It is in death that the individual becomes one with himself, escaping from monotonous life and its levelling effect... near death, the dull common life at last becomes an individuality... and this gives it the style of its truth".

³⁵Cynthia Klestinec: *Theatres of anatomy* (2011) see note 5.

³⁶Thomas Wright: *Circulation - William Harvey's Revolutionary Idea* (2012), Chatto & Windus, London; Thomas Wright: *William Harvey* (2012), Oxford University Press, Oxford.

³⁷Student-centred education, and its application to anatomy, is reviewed in - J L Scott et al.: Building an

Open Academic Environment - a new approach to empowering students in their learning of anatomy through 'Shadow Modules' (2014), *J. Anat.* 224, 286-295.

³⁸The citations from Harvey and his lectures can be obtained from: C D O'Malley et al.: *Letters on the Whole of Anatomy* (1962), University of California Press, Berkeley.

³⁹Charles Singer and SWF Holloway: *Early Medical Education in England in Relation to the Pre-History of London University* (1960), *Academic Medicine* 35, 719-720.

⁴⁰W F Bynum & Roy Porter: *William Hunter and the Eighteenth-Century Medical World* (2002), Cambridge University Press, Cambridge.

⁴¹Wendy Moore: *The Knife Man* (2005), The Bantam Press, London.

⁴²H Graham: *Surgeons All* (2nd ed) (1956), Rich & Cowen, London.

⁴³H Beukers: *Leiden's medical faculty during its first two centuries*. In: *The Anatomy Lesson - Art and Medicine* (1992), The National Gallery of Ireland, Dublin.

⁴⁴T V N Persaud: *Legislation of Human dissection*. In: *A History of Anatomy - The Post-Vesalian Era* (1997) Charles C Thomas, Springfield, Illinois; D Gareth Jones & Maja Whitaker: *Speaking for the Dead - Cadavers in biology and medicine* (2000). Ashgate, Aldershot

⁴⁵R Richardson: "Trading assassins" and the licensing of anatomy. In: *British Medicine in an Age of Reform* (1991), Routledge, London.

⁴⁶See note 52 and Wojciech Pawlina: *Professionalism and Anatomy - how do these terms define our role* (2006), *Clin. Anat.* 19, 391-392; Wojciech Pawlina et al.: *Leadership and Professionalism Curriculum in the Gross Anatomy Course* (2006), *Annals Edu. Sg.* 35, 609-614; Frederic W Hafferty et al.: *Professionalism, the invisible hand, and a necessary reconfiguration of medical education* (2011), *Academic Medicine - Journal of the Association of American Medical Colleges* 86, e5.

⁴⁷See note 52

⁴⁸Odile Plaisant et al.: *Medical students' attitudes toward the anatomy dissection room in relation to personality* (2011), *Anat. Sci. Edu.* 4, 305-310; Odile Plaisant et al.: *Medical students' attitudes towards science and gross anatomy, and the relationship to personality* (2014), *J. Anat.* 224, 261-269; Claire Smith et al.: *The context of learning anatomy - does it make a difference* (2014), *J. Anat.* 224, 270-278; Tracey Wilkinson et al.: *Does learning style influence academic performance in different forms of assessment?* (2014), *J. Anat.* 224, 304-308.

⁴⁹See note 52 and Bernard Moxham et al.: *The future of clinical anatomy* (2011), *Eur. J. Anat.* 15, 29-46; Richard Drake: *A retrospective and prospective look at medical education in the United States: trends shaping anatomical sciences education* (2014), *J. Anat.* 224, 256-260.

⁵⁰Alessandro Riva: *Flesh & Wax* (2007), University of Cagliari, Sardinia; Roberta Panzanelli (editor): *Ephemeral Bodies - Wax sculptures and the human figure* (2008), The Getty Research Institute, Los Angeles; Rebecca Messbarger: *The Lady Anatomist - The Life and work of Anna Morandi Manzolini* (2010), The University of Chicago Press, Chicago.

⁵¹Louis Auzoux: *Leçons élémentaires d'anatomie et de physiologie humaine et comparée* (1858) published 2013 by Hachette Livre, Paris.

⁵²Keval Patel & Bernard Moxham: *Attitudes of profes-*

sional anatomists to curricular change (2006), *Clin. Anat.* 19, 132-141; Bernard Moxham & Odile Plaisant: Perception of medical students towards the clinical relevance of anatomy (2007), *Clin. Anat.* 20, 560-564; Bernard Moxham & Siân Moxham: The relationships between attitudes, course aims and teaching methods for the teaching of gross anatomy in the medical curriculum (2007), *Eur. J. Anat.* 11, 19-30; Keval Patel & Bernard Moxham: The relationships between learning outcomes and methods of teaching anatomy as perceived by professional anatomists (2008), *Clin. Anat.* 21, 182-189; J. Kerby et al.: The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students (2011), *Clin. Anat.* 24, 489-497.

⁵³Angelina Whalley: Pushing the Limits – Encounters with Body Worlds (2005), Arts & Sciences, Heidelberg; T Christine Jespersen (editor): The Anatomy of Body Worlds – Critical Essays on the Plastinated Cadavers of Gunther von Hagens (2009), McFarland & Co., Jefferson North Carolina; John D Lantos (editor): Controversial Bodies (2011), John Hopkins University Press, Baltimore; Christophe Degueurce: Fragonard Museum – The Écorchés (2011), Blast Books, New York; Gunther von Hagens: Body Worlds – The original exhibition of real human bodies (2013), Arts & Sciences, Heidelberg; Beat Riederer: Plastination and its importance in teaching anatomy. Critical points for long-term preservation of human tissue (2014), *J. Anat.* 224, 309-315.

⁵⁴D Kachlik et al.: Anatomical terminology and nomenclature - past, present and future (2008), *Surg. Radiol. Anat.* 30, 459-466; Wojciech Pawlina & Richard Drake: Moving forward with Terminologia Anatomica (2009), *Anat. Sci. Edu.* 2, 93; Wayne Vogel: Awareness of, and access to, a unified terminology by anatomists (2009), *Anat. Sci. Edu.* 2, 139-140; Martin Bradford et al.: Contrast in usage of FCAT-approved anatomical terminology between members of two anatomy associations in North America (2010), *Anat. Sci. Edu.* 3, 25-32; James Pamphill & Andrew Petto: Familiarity with Latin and Greek Anatomical Terms and Course Performance in Undergraduates (2011), *Anat. Sci. Edu.* 4, 9-15; D Kachlik: Anatomical nomenclature and clinical anatomy (2013), *Rev. Arg. de Anat. Clin.* 5, 192-193.

⁵⁵Vladimir Musil et al.: The history of Latin terminology of human skeletal muscles (from Vesalius to the Present) (In press), *Surg. Radio. Anat.*

⁵⁶see D Kachlik et al. (2008) note 53.

⁵⁷Bernard Moxham et al.: An Approach towards the Development of Core Syllabuses in the Anatomical Sciences (In press), *Anat. Sci. Edu.*

⁵⁸There have been many books and articles written about art and anatomy/medicine and only a sample can be provided here. K B Roberts & J D W Tomlinson: The Fabric of the Body – European traditions of anatomical illustration (1992), Clarendon Press, London; Fiona Haslam: From Hogarth to Rowlandson – Medicine in Art in Eighteenth Century Britain (1996), Liverpool University Press, Liverpool; Julie V Hansen & Suzanne Porter: The Physician's Art – Representations of art and medicine (1999), Duke University Medical Centre, Durham, North Carolina; Alejandro Aris: Art et Médecine (2002), Éditions Mengès, Paris; Alan Emery & Marcia Emery: Medicine and Art (2003), Royal Society of Medicine Press, London; Marco Bussagli: Le Corps – anatomie et symboles (2006), Éditions Hazan, Paris; Benjamin A Rifkin et al.: Human Anatomy – Depicting the Body from the Renaissance to Today (2006), Thames & Hudson, Lon-

don; Philippe Comar: Figures du Corps (2009), Beaux-arts de Paris; Giorgio Bordin & Laura Polo D'Ambrosio: Medicine in Art (2010), The J Paul Getty Museum, Los Angeles; Andrea Carlino et al.: L'anatomia tra arte e medicina (2010), Silvana Editoriale, Milan; G Morriss-Kay & J Fraher (editors): The Art of Anatomy (2010), *Journal of Anatomy*, Volume 216, Issue 2; Julie Anderson et al.: The Art of Medicine (2011), The Ilex Press, Lewes; Andrea Carlino et al.: Visioni anatomiche (2011), Silvana Editoriale, Milan; Juan Bordes: Figura Humana (2012), Ediciones Cátedra, Madrid.

⁵⁹Robert Hale & Terence Coyle: Albinus on Anatomy (1989), Dover Books, New York.

⁶⁰Here is provided just a sample of work suggesting the contemporary resurgence of interest in art and anatomy - Nick Cudworth & Bernard Moxham: New Anatomy Lessons (1981), Nicholas Treadwell, London; Ian Breakwell & Bernard Moxham: Death's Dance Floor (1998), Ffotogallery Publications, Cardiff and Cornerhouse Publications, Manchester; Martin Kemp: Spectacular Bodies (1999), Hayward Gallery Publications, London; Karen Ingham: Anatomy Lessons (2004), Dewi Lewis Publishing, Stockport; Elisabeth Quin: Le Livre des Vanités (2008), Éditions du Regard, Paris; Maaik Bleeker (editor): Anatomy Live – Performance and the Operating Theatre (2008), Amsterdam University Press, Amsterdam; Patrizia Nutti (editor): C'est La Vie! Vanités de Pompéi à Damien Hirst (2010), Skira, Paris; Anne-Marie Charbonneaux: Les vanités dans l'art contemporain (2010), Flammarion, Paris.

⁶¹Ruth Richardson: The making of Mr. Gray's Anatomy (2008), Oxford University Press, Oxford; Bill Hayes: The Anatomist – The true story of Gray's Anatomy (2008), Ballantine Books, New York.

⁶²In the article "The future of clinical anatomy" (2011; see note 48), Bernard Moxham has argued that the term "Clinical Anatomy" is an oxymoron since Anatomy is clinical, by definition, since medicine as well-practised is as much about health as about disease.

⁶³L R Lind & C W Asling: The Epitome of Andreas Vesalius (1949), McMillan, New York.

⁶⁴A Prelude to Modern Science – being a discussion of the history, sources and circumstances of the Tabulae Anatomicae Sex of Vesalius (1946), Wellcome, London.

⁶⁵See note 10.

⁶⁶See note 6

⁶⁷Keval Patel & Bernard Moxham (2006), see note 51

⁶⁸See note 12

⁶⁹Kapil Sugand, Peter Abrahams & Ashish Khurana: The anatomy of anatomy: A review for its modernization. *Anat. Sci. Educ.* 3, 83–93.

⁷⁰William Strauss & Neil Howe: Generations (1991, revised 1998), William Morrow (Quill editions), New York; Neil Howe & William Strauss: Millennials Rising (2000), Vintage Books, New York; William A Draves & Julie Coates: Nine Shift: Work, Life and Education in the 21st Century (2003), Learning Resources Network, California; V L Venne & D Coleman: Training the Millennial learner through experiential evolutionary scaffolding: Implications for clinical supervision in graduate education programs (2010), *J. Genet. Couns.* 19, 554–569.

⁷¹See note 51

⁷²Abraham Lincoln's quote emanates from his concluding remarks at his Address to Congress (1862).

⁷³In these days when clinical relevance is all, it is worth remembering that anatomy began not instrumentally as a tool for medical practice but as a means of philosophi-

cal understanding (albeit from a teleological viewpoint since reflections were mainly based upon concerns for purpose and design).

⁷⁴Edmund Burke's quote is probably a misquote that is derived from his statement: "People will not look forward to prosperity who never look backward to their ancestors." From *Reflections on the Revolution in France* (1790).

⁷⁵Aldous Huxley's quote is taken from *Case of Voluntary Ignorance* in *Collected Essays* (1959).

⁷⁶Karl Marx's quote derives from a paraphrase of the opening sentences of *The Eighteenth Brumaire of Louis Bonaparte* (1852).