

VESALIUS AND DE FABRICA

If one were to choose a list of books that have had a profound and lasting influence on our civilization there are two titles that would undoubtedly appear high on this list which were published just one week apart in the year 1543. Both books were written by men who had studied at the University of Padua. The first to appear was On the Revolution of the Celestial Spheres by Nicholas Copernicus which changed the conception of the solar system that had been held for over 1,000 years; the second was De Humani Corporis Fabrica (the Fabric of the Human Body) by Andreas Vesalius, which challenged a concept of medicine that had been followed for about 1,300 years. Let us look at this period in world history that produced two such revolutionary volumes.

This period known in history as the Renaissance was one of great accomplishment in art, music, literature and science and it also witnessed profound changes in the structure of society and the organization of states. The three centuries that built a bridge between the medieval and modern worlds produced an age of superb artistry, awakening minds, decaying morals and great advances in the realm of scientific thought. With the disappearance of empires, nationalities began to spring up. In Spain, the Catholic kings had created the modern concept of the state as a nation. Gunpowder destroyed castles and with them the feudal system. The invention of printing facilitated human intercommunication. The discovery of the compass stimulated daring transoceanic explorations which culminated in the discovery of America. The

rediscovery of the beauty of the naked human body aroused interest not only in its form but in its structure and internal machinery, stimulating progress in anatomy and medicine. This was the glorious period in which the subject of this paper was born and grew to manhood.

Andreas Vesalius was born in Brussels on December 31, 1514, the second son of an apothecary to Emperor Maximilian. His father was originally named Witing and came from the Hanseatic town of Wesel on the Rhine but changed his name to Van Wesele after the town. Wesel means weasel in Flemish and we find three weasels on the coat of arms of Vesalius. The name went through many variations and finally emerged as Vesalius, a latinized and adjectival form of Wesel. For generations his family had been outstanding in medicine and both his grandfather and great grandfather had been court physicians.

As a boy he became interested in anatomy and dissected mice, rats, dogs and cats. Some men are born artists or scientists. Vesalius was a born anatomist. At the age of 15 he matriculated at the century-old University of Louvain where his great grandfather had held a chair of medicine. He expected to become a pharmacist although it is believed he wished to become a physician but probably could not aspire to that profession because his father had been an illegitimate child. However, in 1531 the Emperor legitimized his father so that now he was able to follow the family tradition.

The medical school in Louvain was not considered outstanding so he enrolled at the University of Paris in 1533 at the age of 18. The University was extremely conservative and its medical faculty lectured from the texts of Galen,

the renowned Greek physician whose teachings had been followed for over 1,300 years. In the anatomy classes the professor sat on an elevated platform while his two assistants stood by the corpse if one were available. One of the assistants, often a barber-surgeon, dissected the body, the other pointed to the parts exposed, while the professor read about them from Galen's texts. Sometimes the professor would tell the students "I have reached a part so difficult that you would never understand it, so we shall skip it completely." When human bodies were not available, it was not uncommon to use the remains of a dog. The advantages of this method is that it saved the student's fingers from contact with cadaveric material and the disadvantage is that the student did not learn any anatomy.

Vesalius was not satisfied with this method of studying anatomy so he and fellow students would rob the graves in the cemeteries or steal the corpses of criminals right off the gibbets in order to see first hand the parts of the body. Because of the early onset of putrefaction in the unpreserved corpses the dissection had to be done rapidly, usually within four days. In this manner, Vesalius became a skilled dissector and it is reported that one day while he was listening to a lecture and watching the dissection, he became irritated at the awkwardness of the barber-surgeon so he impetuously pushed him aside and performed the dissection himself to the amazement of the professor. Because of his brilliant talents one of his professors asked him to assist in the preparation of an epitome of anatomy based on Galen. As the professor was primarily a scholar rather than an anatomist, there is little doubt that most of this work, particularly the dissection, was done by Vesalius.

In 1536 a war between the French and Charles V forced Vesalius as an enemy alien to leave Paris and return to the University of Louvain. Here he wrote his dissertation and received his bachelor's degree. Vesalius continued his interest in anatomy but still had great difficulty in obtaining bodies to examine. Here again he had to resort to stealing corpses from the public gibbet or sometimes skeletons if the birds had gotten there first. While he was here he translated one of the books of Rhazes, the famous Arab physician.

In 1537 he went to the University of Padua where he continued his studies in medicine. Padua was the center of the scientific Renaissance and was then at the peak of its glory. While religious wars raged all over Europe, hundreds of foreign students came here to this haven of learning and friendship. In the second half of the 16th century there were 977 German students including the Flemish who were enrolled in the medical school.

It was here on December 5, 1537 in the great hall of the Bishop of Padua that a solemn assembly came together to witness the granting of Laureate Doctor of Medicine to Andreas Vesalius. He had shown such proficiency in his examination that his professors knew well that the young man was destined to go far in his profession. It was for that reason that on the very next day the Senate of Venice nominated him as Professor of Surgical Anatomy. Obviously the Senate and the faculty had observed with admiration the abilities of this young man of 23 or they would not have given him such a post of distinction.

Vesalius' duties also included lectures on surgery but anatomy was the chief object of his lectures. For obvious reasons, the course in anatomy was held during the cold of winter. His success was beyond all expectations. More

than 500 students crowded his classes. The university documents record a 500% increase in his salary between 1537 and 1542 and refer to his enthusiastic endorsement by the students as a major reason for this increase.

He would begin his teaching by summarizing Galen's description of the part he was going to show and then proceed to the demonstration, which was a departure from the usual procedure, dissecting the part by himself. The young teacher introduced another novelty in the form of very large charts on which he depicted in minute detail the anatomy and physiology of the body. The novelty and attraction of these charts was such that they were immediately and, in some cases, skillfully plagiarized so that Vesalius, to protect himself, caused them to be published in 1538. An examination of these plates shows that his physiological views were still those of Galen and Aristotle.

All the evidence points to the fact that Vesalius' masterpiece, the Fabrica, had its elementary origins around the beginning of 1539. Its composition and the construction of its illustrations occupied perhaps four years--an immense accomplishment for so short a time. During this interval Vesalius was lecturing at Bologna and Pisa as well as Padua. In the meantime Vesalius engaged in the typical pursuits of a medical humanist by intensively studying and editing certain of the anatomical works of Galen which were to be included in a large edition of Galen's works that was published in 1541.

The year 1540 is perhaps the most critical in the intellectual growth of Vesalius and in the development of the Fabrica. It is evident from his writings that up to 1540 he had growing suspicions as to the validity of the Galenical anatomy. In 1540 these suspicions hardened into certainty. The errors which

struck him with the greatest force were those on the bones, a system which he knew best from his earliest studies while at Louvain. It was while working with the skeleton of an ape that he saw clearly what Galen had attributed to a human skeleton. Six years later he was to write to a friend, "I can, indeed, draw a conclusion from my own experience, for I had lectured fully three times to my students on Galen's book De Ossibus before I dared comment upon any error of his. Now, however, I cannot marvel enough at my stupidity in having so little comprehension of what was written, especially when I myself was holding the text before my eyes."

It is interesting to see what some of these discoveries are that were made by Vesalius. Galen described the human breastbone as being segmented as is found in the ape, the liver as being divided into many lobes as is found in the hog; the hip bones as being flared as is found in the ox. When Vesalius demonstrated that Galen's description of the hip bones was wrong, the reply of the Galenists was that man had changed his shape by wearing tight trousers. Galen said the blood passed from the right side of the heart directly to the left side through pores in the walls between the ventricles. Vesalius could not find the pores but in deference to church opinion he said, "We are driven to wonder at the handiwork of the Almighty, by means of which the blood sweats from the right to the left ventricle through passages that escape the human vision." Vesalius' discretion was well founded for Servetus, a contemporary distinguished scientist in Spain, was less cautious. He maintained that the blood passes from one side of the heart to the other through the lungs, as in fact it does. In consequence of this heresy, his books were confiscated and he was burned at the stake.

also go to There were also numerous beliefs that had been handed down from generation to generation that were not strictly a part of the medical literature which Vesalius was able to disprove. At this time the bones of the bodies were numbered from 248 to 252 depending on how they were counted. It was believed that one of these was the bone of Luz, which was referred to in the Talmud, and was purportedly located in the lower part of the spinal column. From this bone the body was supposed to be restored at the resurrection. Another belief dated back to Biblical times and related to the missing rib of Adam. It was Vesalius that demonstrated that both men and women had the same number of ribs.

anatomic By the time Vesalius came to recognize clearly the nature of the Galenical anatomy the preparation of the book was well advanced. Many of the drawings had been completed and considering their number, many of the woodcuts would already have been made by 1540 and much of the text written. Consequently in the space of two years innumerable changes would be required or none at all. Thus the skilled anatomist finds a curious mixture of Galenical, animal and human anatomy. There were also serious contradictions between texts and illustrations--the older illustrations exhibiting animal findings and the text discussing the anatomy of men. It is, therefore, quite clear why a second edition so extensively revised was needed so soon. *uments of dissection can be seen on*

the table The draftsmen for the illustrations came from Titian's studio in Venice and it is believed the main artist was Johannes Stephanus from Calcar in the Netherlands. The finest Venetian block cutters were employed. The illustrations not only showed greater accuracy than ever before but they were also artistically superb and superior to any that appeared before or since. Great credit must

also go to Johannes Oporinus, the scholar and printer of Basel who was responsible for consummating the work of the anatomist and the artist in this magnificent medical book. The selection of a printer in Basel meant a dangerous trans-Alpine shipment of the precious wood blocks and Vesalius' own journey there to oversee the proof-reading and any final changes. It was during this sojourn in Basel, as the result of a bigamous husband's efforts to solve his problem by killing his first wife, then being caught and executed, that Vesalius was enabled to dissect the criminal's body and articulate the skeleton, which is still preserved in the Anatomical Institute of the University as its most noteworthy anatomical relic. Printing of the great work, as the colophon informs us, was finished in June 1543. The title page to the book besides being a very fine example of the woodcut, tells us much about Vesalius and his methods. It is designed to show Vesalius dissecting a female subject at Padua about 1540. It is believed that the idealized anatomical theater never existed but the attentive crowd which fills the foreground may have been drawn from life. The bearded Vesalius is seen standing by the subject's right hand. Beyond the body there is an upright articulated skeleton presumably to indicate the emphasis which Vesalius placed on osteology. By his hand the various instruments of dissection can be seen on the table. A naked model, looking at the scene from the pillar on the left, indicates the importance which Vesalius attached to the surface markings which indicate the position of the underlying structures. The two assistants, who would in earlier times have been carrying out the dissection, are now engaged in such tasks as the sharpening of instruments. Left and right two other attendants lead

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in an ape and a dog, thus symbolizing the fact that, while Vesalius laid the main emphasis on human dissection, he did not hesitate to dissect animals when there was a shortage of human subjects. The spectators seem to be divided into two groups. Beyond the bar, or we might say in the gallery, are members of the lay public, among whom may be seen gallants, elderly scholars, a monk and a young man reading a book. The onlookers around Vesalius himself appear to be students and professional men. Though the setting may be idealized, the interest and enthusiasm of the students shown in the woodcut certainly typify Vesalius' aspirations for Padua as a teaching school.

In his text Vesalius described the tools and techniques of dissection, also his manner of suspending a cadaver by a rope passed under the lower jaw so that it could be readily turned for dorsal or ventral approach. In the plates he gave the earthy Renaissance sense of humor full rein: one skeleton leans on a spade, another philosophically contemplates a skull. The plates that show progressive landscape, which can be reassembled by placing them side by side to form a continuous panorama. The completed Fabrica was folio size (16 by 11 inches pages) bound in vellum according to 16th century custom. It had 663 pages and 227 plates of full page and smaller sizes, sometimes two or three on a page, with a large illuminated initial at the beginning of each book and smaller ones for the many chapters.

The large historiated initials are evidence of Vesalius' excess of vitality: for example, the first page of the text opens with an O, within which we find cupids engaged in the forbidden practice of boiling a skull; behind an I the cupids, with the aid of a lighted torch, are disinterring a dead body. The initial letters alone are sufficient for a monograph on medical satire.

The Fabrica was not a book for the student still in medical school because of its bulk and price it could not be taken into the dissecting room. Rather it was meant for the established physician who might be attracted to a study of anatomy or members of medical faculties who taught anatomy.

For medical students and those with limited anatomical knowledge, Vesalius composed a briefer work called the Epitome of the Fabrica which was less bulky and less expensive. It apparently was used much more than the Fabrica and, therefore, much rarer today than the larger volume.

With the publication of his book, a storm broke over his head so shattering that its reverberations reached centers of learning all over Europe. The scholarly world was affronted and even his former teacher, Jacobus Sylvius, now turned against him and abused him roundly as a careerist and an upstart. The reason for all this noise was that Vesalius had been guilty of doing what no man had hitherto dared to do--he had contradicted the great Galen and had gone so far as to suggest that instead of only reading his books, students of medicine should go back to Nature and learn from her actual works.

Vesalius was an impulsive man, unequipped with the patience demanded of the martyr so he decided to abandon his career as an anatomist. There was a long tradition of imperial service in his family so he applied for a position with the Holy Roman Emperor Charles V, to whom he had dedicated his book. He received an appointment as a physician at the imperial court. Before he left he burned all of his unpublished manuscripts and vowed never again to undertake research or publication. Actually, Vesalius brought out a second edition of De Fabrica in 1555 in which he corrected some of the errors in the first edition but he was never to return to active teaching.

Shortly after he arrived at the Emperor's court, he was married and settled down to an inglorious career of attending an imperial patient who was a sufferer from gout, an insomniac, a gluttonous eater and addicted to self-medication.

However, despite renunciation of anatomical studies, he was able occasionally to return to his first interest. In fact, in January 1544 he travelled to Pisa for a series of demonstrations at the invitation of the Duke of Tuscany, and thereafter never failed to visit any near-by medical school, to participate in post-mortem examinations, and to take advantage of whatever opportunities offered while acting as a military surgeon during the emperor's numerous wars.

It was during such service with the army that Vesalius was able to apply his unrivalled anatomical knowledge to surgery. He learned the correct treatment of gunshot wounds from the Italians, and although at first his surgery had an academic quality not desirable on the battlefield for such things as amputations, he quickly learned surgical techniques and devised new ones. Such became Vesalius' reputation in surgery that when in 1559 Henry II of France was injured in a tournament and received what turned out to be a fatal head wound, despite the presence of Ambroise Pare, the most famous surgeon of the century, it was Vesalius, summoned from Brussels, who was placed in charge of the case and who wrote the report of it after the fatal termination.

The very qualities of mind which had been responsible for the Fabrica were in time to make Vesalius one of the great physicians of his age so that his opinion was widely sought in grave medical problems. He was referred to by some as "the best physician in the world." The great effort that the king was able to save him on condition that he would make a pilgrimage to the Holy City.

With the abdication of Charles V in 1556, Vesalius, for what reason is unknown, took service with his son Philip II, King of Spain, as physician to the Netherlands at the Spanish court, but it appears, from time to time serving the king himself. This required a transfer to Spain, whither Vesalius went with his wife and daughter in 1559 and promptly found himself with a large practice among the foreign embassies in Madrid.

As it had been a mistake to take service with the emperor so it was even more of a mistake to have gone to Spain with his son.

There was no opportunity for further investigation as Vesalius himself wrote long afterwards, the Church forbade the study of human anatomy so that he "could not lay his hand so much as on a dried skull, and much less have the chance of making a dissection." The Inquisition smothered all intellectual activity so for a man who was still in the prime of life and with a career behind him of intense activity this must have been difficult to endure. We get a glimpse of his true feelings from one of his letters written many years after his arrival in Spain when he said "I still live in hope that at some time or other, by some good fortune, I may once more be able to study that true bible as we count it, of the human body and of the nature of man."

But it was not to be. In 1564 he suddenly determined to make a pilgrimage to Jerusalem. There are various legends as to the reasons which led him to this step. The most dramatic but probably untrue relates to a post-mortem examination that he was supposed to have made on a nobleman. When he opened the chest the heart was still beating. The man's relatives accused him of murder and denounced him before the Inquisition. It was only with great effort that the king was able to save him on condition that he would make a pilgrimage to the Holy City.

The more probable reason is that he had received much opposition from the conservative medical element and had become quite weary of the court. According to another account he became quite ill and upon his recovery he vowed to make the trip to show his gratitude. This could also have been an excuse to leave Spain.

He first went to Venice where it is reported he was reappointed professor of anatomy at the University of Padua. He continued on to the Holy Land but on his return the ship was forced to stop at the bleak Ionian island of Zante where he died, possibly of the plague.

With the passing centuries, the work of Vesalius has received wide acclaim. William Osler, the great physician, scholar and humanist called De Fabrica "the greatest medical books ever written, from which modern medicine starts."

In order to get a better understanding of this statement, we must see what transpired between the death of Galen around 200 A. D. and the time of Vesalius. In the times of the Greeks, mankind had made a fair start in the quest of natural knowledge, both of things not alive and of things living. As Galen passed away, inquiry, that is to say inquiry into natural knowledge, stood still. For a thousand years or more the great Christian Church was fulfilling its high mission by the aid of authority; but at the same time it also used it to sterilize original research in natural knowledge.

As spiritual truths were learned by the study of the revealed word, so anatomical and medical truths were to be sought for, not by looking directly into the body of man, not by observing and thinking over the phenomena of disease, but by studying what had been revealed in the writings of Hippocrates and Galen. As

the Holy Scriptures were the Bible for all men, so the works of the Greek and Latin writers became the bible for the anatomist and the doctor. Truth and science came to mean simply that which was written, and inquiry became mere interpretation. Vesalius' work was the first application in modern scientific history of the method of accurate and independent observations. Tradition, untested beliefs were discarded and the systematic objective investigation of natural phenomena was instituted. The value of independent observations was first demonstrated by Vesalius' study of the human body and soon it was applied to other fields in biology and the physical sciences. In these studies careful observation was supplemented by new techniques for accurate measurement and by the development of experimental procedures. In this way our modern scientific method was conceived.

These things seem very commonplace today so that it is difficult for us to understand the tremendous furore which they aroused 400 years ago when Vesalius first proposed them as a consistent procedure and if anyone doubts that they were Vesalius' contributions let it be recalled that he and no one else was the target of the conservative attack. The fact that his principles of investigation have become commonplace is, of course, the greatest possible praise. The great message of De Fabrica is contained in the words he uttered at one of his last demonstrations: "You yourselves touch with your own hands and trust in them."