

LEONARDO DA VINCI
AND PRINTED ANCIENT MEDICAL TEXTS:
HISTORY AND INFLUENCE

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Abstract

From the so-called "Library" of Leonardo da Vinci, reconstructed by scholars based on literary works mentioned in his writings, we learn much about his interest in the printed ancient medical texts available in his time. In addition to traditional sources, Plato and Aristotle, we also find Arelus Celsius' *De Medicina*, *Pliny's* Natural History, Soranus' work on obstetrics and diseases of women, and the voluminous written work of the Greek Physician Galen, who had relied heavily on the *Corpus Hippocrates*. Human dissection was no longer practiced, and Galen gained his own knowledge of human anatomical details through the study of injuries or abandoned corpses. In the Renaissance these printed texts served as medical textbooks. Anatomy was still taught through the written word and seldom by direct observation. Here Leonardo da Vinci achieved his major scientific accomplishment in the realm of medicine. He began to practice dissections and planned to publish a treatise on anatomy, including his drawings of anatomical dissections. Far in advance of the modern technique of MRI and the interest in the structure of females and the process of giving birth, Leonardo's drawings are of a revolutionary nature and of exceptional skill and beauty. After his death his incomplete and unpublished sketchbooks remained largely unknown for almost 300 years. But he had set a new standard in his portrayals of the human figure through direct observation.

It is said that one can tell much about a person by looking over the books that he or she has collected, for books are like friends – a person only keeps those that are liked or give pleasure or from which knowledge can be gained. In a hypothetical visit to Leonardo da Vinci's so-called "Library," we would encounter a library reconstructed by scholars based on the list of thirty-seven books, titles, and authors' names indicated in his *Codex Atlanticus*, and his own list of one hundred sixteen books that he left in Florence, in 1504, to go to Piombino. That list was brought to light in the rediscovery of the *Madrid Codex II*.¹ In addition are those

books frequently quoted in his notebooks and the editions available at this time.

Despite Leonardo's attempts to present himself as unlearned, (*omo senza lettere*), this is quite untrue, although he had not received a formal "humanistic" education as a youth. This term referred to the essence of humanity consisting in the cultivation of the "noble" or "good" arts in the field of the so-called "humanitarian sciences" (*humaniora*), primarily classical philology.² His selections suggest an erudite person with a wide-range of interests. He was well aware of the fruits of the movable printing press invented in 1438-45 by Gutenberg in Germany. Leonardo's references cover all areas of knowledge: history, natural sciences, philosophy, the classics, contemporary literature, health and medicine. Within this last category, we are able to learn much about his concern for the printed medical texts that were becoming available in his time, and for their provenance and intended use.

We first take down a copy of Plato's *Opera*, published in Venice on August 3, 1491, including the important *Timaeus*, his only dialogue dealing with natural science. Reflections of this work are visible in Leonardo's belief that man, in a microcosmic way, is fashioned in the same order as that shared by the body of the world. This order was believed to reside in a delicate balance of the four elements, earth, air, fire and water and any imbalance would result in the appearance of illnesses that beset man. These illnesses were believed reflective of a specific element in the composition of the four humors of man which Leonardo named the "four universal states of man."³ This *Opera* by Plato does not surprise us here as Leonardo often quoted from the work of this contemporary of Hippocrates, whose interest in the human soul and medical concerns exerted a continuing influence on medical practices for centuries. However, Plato's method of instruction was from a distance to the patient or a cadaver, without direct experimentation, which led to many incorrect conclusions in regard to the human body. Plato's followers were called *Dogmatists*, for whom reasoning superseded observation and experience was equated with the proving of their own conclusions and teaching.⁴

Next to Plato we see the *Opera* of Aristotle (384-322 B.C.) including his *De generatione animalium* (1:7) in which he speaks of the teaching of anatomy through "paradigms, schemata and diagrams." His methods constituted a cautious investigation of both animals and humans. His influence was represented in the continuation of employment of this

type of illustrative material by other anatomists. Perhaps Aristotle's embryologic identification of the *punctum salien* (the first sign of the embryo) and his earliest identification of the beating of the embryo's heart,⁵ exerted a profound influence on Leonardo's later studies of the fetus in the uterus studies. Later Alexandrian anatomists continued the use of this type of illustrative material in their teaching. Aristotle, the son of a physician, also had a profound influence on later medicine, especially among the Arabic writers. Throughout Leonardo's anatomical works, we find the use of Arabic terms, so that we can deduce his knowledge of these early works on anatomy.⁶

In addition to these traditional ancient sources of studies of the human body and the principles of anatomy, we see that he had a copy of Aulus Cornelius Celsus' *De Medicina* which was one of the first medical books printed in movable type in 1478.⁷ The edition that we find in Leonardo's "Library" was published on May 6, 1497 in Venice. Celsus, a patrician layman (first century AD) wrote works summarizing, to the best of his ability, most of the knowledge available at that time, including one on the history of medicine as well as current medical diseases and practices. Only the eight books comprising *De Medicina* survived together. The first four described diseases that could be treated with strict diet and activity and the last four described the four classical signs of inflammation: rubor (redness), dolor (pain), calor (heat), and tumor (swelling). Several fragments of his writings also survived. He wrote in Latin, which seems to explain its obscurity during the Middle Ages when medical works in Greek were considered the only worthwhile ones. However, with a revival of interest in ancient texts during the Renaissance in Italy, *De Medicina* was rediscovered by Pope Nicholas V (1397-1455). While not a physician, Celsus' detailed and understanding descriptions of surgical procedures indicate that he was indeed familiar with medicine. Although his work was partly based on the Hippocratic canon and ancient classical writers, it was also based on his own personal experiences.⁸

Another book that we see in Leonardo's "Library" is Pliny's *Natural History* (Plinius, *Historia Naturalis*) published in Venice in 1476. Not as selective of his vast collection of information as had been Celsus, Pliny (A.D. 23-79) sought knowledge, some of it fanciful, on a wide variety of subjects such as physics, history, biology, chemistry, folklore, geography and medicine. In regard to the medical problems of women, of which he had little interest, it is significant that he had a horror of menstruation. He reported that dogs went mad at the taste of

the fluid and that ants even discarded their food if a menstruating woman were present. These negative opinions concerning the health of women became firmly entrenched in later periods. Despite the wide variety of facts and opinions that he included in his exhaustive *Natural History*, it was very popular during the Middle Ages and provided a valuable source of historical information on many subjects. Leonardo refers to this work many times in his notebooks.⁹

Medicine during the second century A.D. in Rome produced many outstanding practitioners whose writings on diseases and injuries became textbooks during the Middle Ages. Such was the case of Soranus from Ephesus (A.D. 98-138), whose principal medical interest was in the field of obstetrics and diseases of women, including difficult menstruation. This fact definitely sets him apart from other medical practitioners of the time. He exhibited an understanding of conception, parturition and the difficulties encountered in the delivery with the improper presentation of the baby. His instructions were sound in regard to the various problems encountered in the delicate and dangerous process of giving birth. He appears to have dissected the human subject, which seems to explain his clear understanding of the various parts of the uterus, the placenta, the bladder and vagina. I believe that Leonardo's intense interest in the same problems confronted by Soranus indicate that he was cognizant of the Roman's groundbreaking research on women.¹⁰

It is likely that Leonardo studied the Greek physician Galen (A.D. c. 129-216?), the most influential medical writer of all time. Born in Pergamum, the great cultural center of Roman Asia minor, of a very wealthy, prominent and highly educated family, as a young man, he was trained in philosophy, mathematics and the natural sciences. It is reported that his father guided him in the direction of medicine after receiving advice on the matter in a dream from Asclepius. Galen traveled extensively to centers such as Alexandria and Corinth, where he came under the influence of important physicians who placed their emphasis on the study of anatomy and all types of illness and treatment. It is of importance that after his return to Pergamum, he was appointed the physician to the gladiatorial games with the task of keeping the gladiators healthy despite times of illness and severe injury. It was partly through this strenuous duty that he was

able to gain valuable first-hand observation and experience of the human anatomy.

When once again he left Pergamum, this time for Rome, he was a skillful and prominent physician. When he initially departed from Rome, the Emperor Marcus Aurelius himself recalled him and appointed him as his personal physician.¹¹ Within the circle in which he found himself, he became a part of those who looked to classic texts on the importance of anatomy and empiricism found in the *Corpus Hippocraticum*. This important and very influential series of medical treatises had been traditionally considered a collection of works constituting one corpus by Hippocrates, of the Guild of Physicians of Asclepiadae. There is much information, including fables and myth, about this so-called “Father of Medicine”. However, the fact that Plato mentions him in his *Death of Socrates*, leads modern scholars to believe that he was a living person and that he headed a school of medicine. His pupils were traditionally believed to have been obligated to recite the “Hippocratic Oath”, still used today.¹²

Throughout his lifetime, Galen continued to travel, studying, practicing and absorbing all of the medical knowledge of the time. He wrote voluminously in Greek, his native tongue, with a concentration on the anatomical details of the human body. Since human dissection was no longer practiced, he sought information through injuries or abandoned corpses. Of importance to Leonardo, the texts of Galen were considered as the supreme authority. During the first third of the fifteenth century, Florence was the recipient of over two hundred original ancient manuscripts. Included with this group were medical writings by Hippocrates and Galen (notably the latter’s *Spiritus Animalis*) which had found their way from the great library of Alexandria.¹³ No less than five hundred editions of Galen were printed between 1490 and 1538.¹⁴

Leonardo probably owned a copy of the 1493 Italian *Fascicolo di Medicina* by the Renaissance writer and physician Johannes de Ketham, originally published in Venice in 1491 under the title *Fasciculus medicinae*. This second edition was quite different from the original. Its longest tract was an Italian translation of the *Anothomia* of Mondino de’ Luzzi rather than a varied assemblage of well-known Latin medical texts. This was the first illustrated medical text to be

printed but the illustrations were simplistic, child-like, and intended only to be used as a teaching aid. Obviously, they exerted no influence on the drawings of Leonardo.¹⁵

All of these printed texts provide us with a valuable estimation of the growing importance of the study of anatomy in the Renaissance, not only as a teaching subject but also as a research field. There were no medical textbooks on hand and these printed texts served the purpose. Thus, at this time, anatomy was continuing to be taught through the written word, that is, the classical authors, and seldom by direct observation. However, we do have several illustrations that suggest some type of dissection was carried out.

In a medieval manuscript illustration Emperor Nero is depicted observing the autopsy of his mother Agrippina, whom he had put to death in A. D. 59. An autopsy was ordered to determine cause of death in suspicious cases. c. 1410, fig. 1. An engraving shows the great anatomist Mondino de' Luzzi lecturing, while his assistant dissects a cadaver and students watch, 1493, fig 2. It is of interest that this engraving was selected for the frontispiece of the Italian edition of the *Fascicolo di Medicina* of 1493. Another fifteenth century manuscript portrays a professor himself teaching at the dissection table, fig. 3. An especially interesting Renaissance manuscript illustration depicts a student caught doing an illegal dissection with various body parts extracted, including the heart, lungs, kidneys, intestines, liver, and gallbladder, fig. 4. This is explicit evidence of the criminal status of the procedure at this time. In regard to Leonardo, it should be understood that he had continued his dissections in Florence and in Milan with relatively little opposition. However, when he was summoned to Rome in 1513, his anatomical activities exposed him to "slanderous denunciations addressed to the Pope and to the hospital which provided him with bodies for dissection. Eventually the director refused him cadavers and forbade dissection."¹⁶

It is on this point that I consider Leonardo achieved his major scientific accomplishment within the realm of medicine, the integration of observation and direct anatomical dissections.¹⁷ In 1510 Leonardo began to practice dissections in cooperation with Marcantonio della Torre (1481-1511), a young professor of anatomy at the University of Pavia, and they planned to publish a treatise of

anatomy together: the drawings by Leonardo and the text by Marcantonio. However, it should be understood that Leonardo had been involved in extensive anatomical studies twenty years earlier and thus was fully capable of writing the text.¹⁸ The young physician succumbed suddenly in an epidemic of the plague in 1511 and Leonardo's interest in the proposed joint project waned although he continued on with his dissections. That Leonardo had planned to publish the results of his studies in a *Treatise on Anatomy* is verified by the artist himself when he wrote:

The ancient authors and those of the present time have only achieved this [revealing parts of the human form} in tortuously ponderous, long-winded and confused written reports. . . . and that this, my gift to mankind, is not lost, I shall teach the method of reproducing the same in print; and you, O my successors, I beseech thee, do not be led by miserliness to make [wood engravings of them].¹⁹

There is evidence that Leonardo preferred the more expensive and precise process of copper engraving.

Far in advance of the modern medical radiology technique of magnetic resonance imaging, (MRI), Leonardo wrote concerning his planned approach to the illustration of human anatomy:

This my configuration of the human body will be demonstrated to you just as if you had the natural man before you. The reason is that if you want to know thoroughly the anatomical parts of man you must either turn him or your eye in order to examine him from different aspects, from below, from above, and from the sides, turning him round and investigating the origin of each part; and by this method your knowledge of natural anatomy is satisfied.²⁰

He discovered that the spatial complexity of anatomical forms could only be shown by still pictures of motion in a succession of studies. Here we see his theory expressed in these sequential views of the foot, fig. 5, (W 19011r) and the hand, fig. 6, (W 19009v) both of about 1508-1510. In his studies of the foot, he depicts six views of the left foot and ankle, showing the articulation of the bones and two

drawings of the leg and foot. Of these studies of the hand, he has shown the skeleton of a right hand seen from the back and then from the palm. Above these are two anatomical studies of fingers and below a clenched fist.

The investigation of the anatomy and function of the hand became a major concern of his after 1508. We find in his writings reference to his intended method of exhibiting the motion of the hand. His so-called “cinematographic” theory of the motion of parts of the body is clearly stated in his description of the hand: “The principal movements of the hand are ten; that is, forward, backward, to right and to left, in a circular motion, up or down, to close and to open, and to spread.”²¹ Beside a small diagram in the text, he writes in regard to the impossibility of anyone being able to memorize all the aspects or changes of the parts of the body, explaining his theory:

This we shall demonstrate by analyzing the movement of the hand. Because every continuous quantity is infinitely divisible, the motion of the eye which looks at the hand as it moves from A to B moves through the space A B which is also a continuous quantity and consequently infinitely divisible, and in each part of its motion changes the aspect and shape of the hand as it is seen, and thus moves through the whole circle. The hand which rises in its motion does likewise; that is, it will pass through space, which is a continuous quantity.²²

Equally impressive are these studies of a man’s shoulder, neck and torso muscles as the subject is rotated in seven different angles in order to display them in action, fig. 7 (W 19001v). Above are two studies of the head, neck and thorax of a man facing to the right, right arm out-stretched. In the center is a three-quarters view of the head, neck, thorax and arm of a man looking down, depicting chest and neck muscles with two studies of the shoulder. At the bottom of the page are two studies of a right shoulder from the right. The extremely detailed study of an arm, (W 19008v), fig. 8, is shown above three studies of muscles, seen from the back. Below are four studies of the neck, chest and right arm in profile to right and turning to the front displaying superficial muscles. In the lower right hand corner of the sheet, Leonardo has provided us with a geometrical diagram in the

star-like form of the eight points of view that he intended to use to illustrate the arm above.

Throughout the history of medical illustration, the depiction of the human skeleton has been of special interest. It is significant to compare Leonardo's accurate drawings, (W 19012r), fig. 9, with an illustration of the *Skeletal System* from Persian MS, No. 2296, about 1400, in the India Office, London, fig. 10. While the latter is schematic and entirely void of any scientific information, Leonardo has provided a very complete and accurate medical illustration. Above are two studies of the bony structure of the thorax, spinal column and upper arm; below, left, the front view of the bones from the neck to the pelvis; in the center, the skeleton of the pelvis and legs from the front and left, with bones of the right leg.

In the hundreds of anatomical drawings by Leonardo, those illustrating the structure of the female form and the process of giving birth are of a singularly revolutionary nature, of exceptional skill and rarity within his works. On the order of his intended *Book on Anatomy*, Leonardo writes:

This work should begin with the conception of man and describe the form of the womb, and how the child lives in it, and to what stage it resides in it, and in what way it is given life and food. Also its growth and what interval there is between one degree of growth and another, and what it is that pushes it out from the body of the mother, and for what reasons it sometimes comes out of the mother's belly before its due time.²³

From 1492-1494, Leonardo did studies of coition with the genital organs involved in reproduction in rather traditional drawings, based on theories dating back to Platonic theories but not grounded on direct experience, (W 19096r and W 19097v), fig. 11. He represents the coitus figures of a man and a woman depicting the idea of the spinal cord as the source of semen; that is, indicating that there are "nerves" to the penis which originate in the spinal cord and carry the sperm to be ejected in coitus. At the same time, the female has similar "nerves" to the uterus to carry her seed. Following this earlier belief, the male has two channels, one for the seed and one for urine.²⁴ In

regard to coition, Leonardo's words reflect a respectful and metaphysical admiration for this biological function:

The man who accomplished intercourse with reluctance and distain, sires children who are irritable and unworthy of confidence, but if intercourse is entered into with great love and desire on both sides, the children will be of great intelligence, full of wit, liveliness, and grace.²⁵

During 1508-1512, Leonardo produced drawings which were based on his own observation and show a higher degree of accuracy. Due to the scarcity of female bodies for dissection, he demonstrates an unusual understanding of the female body as illustrated in W 12281r, fig. 12, of an anatomical cross section of a woman in pen and ink with wash over black chalk.²⁶ In a profile drawing of the uterus of a woman in the early stages of pregnancy, (W 19095v), he has surrounded it by smaller views of the genito-urinary system and six small and inaccurate views of the left side of the male and female genitalia.²⁷ On the recto of the above, Leonardo has presented one of his most astonishing depictions of the female anatomy, fig. 13. He has given the viewer a very close-up image of a woman's external genitalia and vagina. Beneath are notes and diagrams on the anal sphincter explaining its function.

Between the years 1510-1512, Leonardo presents his finest drawings of his embryological series in which he illustrates the female genitalia and a fetus in the womb depicted in various positions (W 19101v), fig. 14, and (W 19191r), fig. 15.²⁸ In the latter large drawing of a *fetus in utero* the organs are clearly delineated as to position and purpose within the human uterus, but with a cow's placenta. Among numerous descriptive notes are other small drawings.

The tradition of depicting a woman giving birth goes back to antiquity. One of the earliest, of a seated woman delivering, dates back to about 6500-5700 B. C., found in the excavations of Çatal Hüyük in central Turkey, now in the Archaeological Museum, Ankara.²⁹

To fully understand the extent to which Leonardo had the extraordinary ability not only to dissect but also the talent to reproduce that which he saw, it should be of interest to compare his drawing of the *Cross-section of the Fetus in the Womb* with several others: "The

Arterial System of a Pregnant Woman” from a Persian MS, No. 2296, in the India Office, London, fig. 16; *Gravida*, from the Miniature painted about 1400 A. D. in the Leipzig MS Codex 1122, fig. 17; and a 12th Century MS based on work of Soranus, 1st c. AD forefather of obstetrics showing various fetal presentations- including twins – and warning of complications. (Codex 1653, Det Kongelige Bibliotek, Copenhagen), fig. 18.

During the eighteenth century terracotta models of dissected *fetus in utero* at the time of birth were made for use in the education of mid-wives. A large collection of these models is in the Museum of History of Science in Florence, fig. 19.³⁰ Three hundred years before, Leonardo was drawing dissected fetuses for the same educational purpose of safe childbirth.

As we leave Leonardo’s “Library,” we notice Luca Pacioli’s translation of *Euclid*, published in 1509 in Venice as a companion piece to the *Divina Proportione*. Knowing Leonardo’s great love for mathematics, we are not surprised to find this book by the famous classical founder of mathematics. Leonardo considered mathematics as the basis of all observations and that knowledge as well as ability to represent things is based on vision – in his words: “*saper vedere*” – to know how to see. Therefore, Leonardo’s particular appreciation of mathematics is based on the importance he attaches to the discipline of the visual processes in science.

Leonardo da Vinci’s incomplete and unpublished sketchbooks were disbanded after his death and remained largely unknown for almost three hundred years. It is impossible to speculate on their effect on medicine and anatomical texts had they been known, making clear that Leonardo had set a new standard in his portrayals of the human figure through direct observation and accurate illustration.

NOTES

¹ *The Unknown Leonardo*, Ladislao Reti, ed. (New York: McGraw-Hill Book Co., 1974), p. 58. On this list, Leonardo has carefully noted several books that he had lent to friends. It is very valuable in helping us to identify some of his own notebooks.

² V. P. Zubov, *Leonardo da Vinci*, David H. Kraus, trans. (Cambridge: Harvard University Press, 1968; reprint, Barnes & Noble, 2002), p. 9.

³ See Martin Kemp, *Leonardo da Vinci: the Marvellous Works of Nature and Man* (Cambridge, MA: Harvard University Press, 1981), pp. 114-117.

⁴ Albert S. Lyons and R. Joseph Petrucelli, II, *Medicine: An Illustrated History* (Harry N. Abrams, Abradale Press: New York, 1987), p. 219.

⁵ *Idem.*

⁶ *Ibid.*, pp. 219-223. Arabic culture was a stimulating force during the Middle Ages as it filtered across the Pyrenees from Spain. The influence of the Arabs in medicine was deep and long lasting. See E. G. Browne, *Arabian Medicine* (London: Cambridge University Press, 1921). Cf. Logan Clendening, *Source Book On Medical History* (New York: Dover and Henry Schuman, 1942, 1960), pp. 65-75. For another important source with numerous original illustrations, see Lyons and Petrucelli, *op. cit.*, pp. 294-317.

⁷ For an English translation of this work, see Celsus, *De Re Medicinæ*, trans. W. G. Spencer (Cambridge: Harvard University Press, Loeb Classical Library, 1935) 3 vols.

⁸ Clendening, *op. cit.* pp. 58-61.

⁹ Lyons and Petrucelli, *op. cit.*, pp. 248-249.

¹⁰ *Idem.*, p. 249.

¹¹ For this important time in his career, see J. Walsh, *Galen's Second Sojourn in Italy and His Treatment of the Family of Marcus Aurelius in Medical Life, Vol. 37, no. 9, New Series No. 120, September, 1930.*

¹² There is much information written, including fables and myth, about this so-called "Father of medicine." However, the fact that Plato mentions him in his *Death of Socrates*, leads modern scholarship to believe that he was a living person and that he headed a school of medicine. His pupils were traditionally believed to have been obligated to recite the "Hippocratic Oath", still used today. See W. H. S. Jones, *The Doctor's Oath* (Cambridge: Cambridge University Press, 1924).

¹³ On this exciting period during which the Florentines now possessed the greatest works of human thought, see Michael White, *Leonardo: the First Scientist* (London: Little, Brown and Co., 2000; reprint, Abacus 2001-2003), pp. 30-54.

¹⁴ For an English translation of Galen's important *De usu Partium*, see Galen, *On the Usefulness of the Parts of the Body*, Margaret Tallmadge May, trans., intro., and com. (Ithaca, NY: Cornell University Press, 1968), 2 vols. This work is a fundamental classic for an understanding of both Galen and the anatomy and physiology of his time.

¹⁵ *Ibid.*, pp. 265-266. For the early printed anatomical texts and a list of the editions of anatomical texts in the fifteenth century, see Ludwig Choulant, *History and Bibliography of Anatomic Illustration*, ed. and trans., Mortimer Frank (Chicago: University of Chicago Press, 1920), pp. 21N-21P.

¹⁶ Zubov, *op. cit.*, p. 35.

¹⁷ There is a vast amount of literature on Leonardo as an anatomist. However, the following sources are recommended: Charles D. O'Malley and J. B. de C. M. Saunders, *Leonardo on the Human Body*, Translations, Text and Introduction (New York: Dover Publications, 1983), reprint of Henry Schuman, *Leonardo da Vinci: The Anatomical, Physiological, and Embryological Drawings of Leonardo da Vinci* (New York, 1952); Kenneth Clark, with Carlo Pedretti, *The Drawings of Leonardo da Vinci in the Collection of Her Majesty the Queen at Windsor Castle* (London: Phaidon Press, 1935, 2nd ed. 1969), vol. 3; Kemp, *op. cit.*, pp. 37-349, *infra.*; Kenneth D. Keele and Carlo Pedretti, *Leonardo da Vinci, Corpus of Anatomical Studies at Windsor Castle* (London and New York: 1979-80), 3 vols.; and Kenneth D. Keele, *Leonardo da Vinci's Elements*

of the *Science of Man* (New York and London: Academic Press, Harcourt, Brace Jovanovich, 1983).

¹⁸ See Zubov, *op. cit.*, p. 34.

¹⁹ W An A and B: Folios A and B on Anatomy at the Royal Library, Windsor Castle.

²⁰ W. 19096r. Manuscripts at the Royal Library, Windsor Castle. The numbers listed after the abbreviation indicate the inventory number. Cf. Clark and Pedretti, *op. cit.*, p. 5.

²¹ W 19061r, quoted in Keele, *Elements of the Science of Man*, *op. cit.*, p. 196. Cf. Carlo Pedretti, *Leonardo da Vinci on Painting, A Lost Book: Reassembled from the Codex Vaticanus Urbinas 1270 and from the Codex Leicester* (London: Peter Owen, . 1965), p. 71.

²² Pedretti, *idem.* pp. 71-72.

²³ W 19061r. Quoted in Keele, *op. cit.*, pp. 196-197.

²⁴ *Idem.*, p. 244.

²⁵ Quoted in White, *op. cit.*, p. 275.

²⁶ For an excellent color photograph of this remarkable image, see *Leonardo da Vinci: Scientist, Inventor, Artist*, Catalogue, Otto Letze and Thomas Buchsteiner, eds. Tübingen: Institut für Kulturaustausch, 1997, and English translation, 1997), p. 91.

²⁷ See Clark and Pedretti, *Leonardo da Vinci's Anatomical Drawings at Windsor Castle*, *op. cit.*, p. 37, W 19095v.

²⁸ For color reproductions, see Letze and Buchsteiner, *op. cit.*, pp. 96-97.

²⁹ See Lyons and Petrucelli, *op. cit.*, figure 4, p. 19.

³⁰ For these exceptional models in color, see Mara Miniati, *Catalogo-Museo di Storia della Scienza* (Florence: Litografia Aurora, 1991), pp. 518-529.

FIGURES:

- 1- Miniature from *Le Cas des Nobles et Femmes* (c. 1410) by Boccaccio. *Nero at the Autopsy of his Mother Agrippina*. Bibliothèque Nationale, Paris.
- 2- *Mondino de' Luzzi Lecturing while a Student Dissects a Cadaver*, engraving from *Fasciculus Medicinae* (1493). Collection Putti, Istituto Rizzoli, Bologna.
- 3- *Teaching at the Dissection Table*, 15th c. Manuscript. Ms.fr. 218, fol. 56, Bibliothèque Nationale, Paris.
- 4- *Student Caught Doing an Illegal Dissection*, Manuscript illustration, Ms. Ashmole 399, fol. 34, Bodleian Library, Oxford.
- 5- Leonardo da Vinci. Sequential views of the Foot, W 19011 *recto*, Royal Library, Windsor Castle. (Clark-Pedretti).
- 6- Leonardo da Vinci. Sequential views of the Hand, W 19009 *verso*, Royal Library, Windsor Castle. (Clark-Pedretti).
- 7- Leonardo da Vinci. Sequential views of the Shoulder, Neck and Torso, W 19001 *verso*, Royal Library, Windsor Castle. (Clark and Pedretti).

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- 8- Leonardo da Vinci. Sequential views of the Arm, W 19008 *verso*. Royal Library, Windsor Castle. (Clark and Pedretti).
 - 9- Leonardo da Vinci, Skeletal Studies of the thorax, spinal column, upper arm; bones from neck to pelvis; skeleton of pelvis and legs, W 19012 *recto*. Royal Library, Windsor Castle. (Clark and Pedretti).
 - 10- Illustration of the *Skeletal System* from Persian MS. No. 2296, about 1400, in the India Office, London.
 - 11- Leonardo da Vinci. Studies of Coition, W 19097 *verso*. Royal Library, Windsor Castle. From 1492-1494. (Clark and Pedretti).
 - 12- Leonardo da Vinci. Anatomical Cross Section of a Woman, W 12281 *recto*, Royal Library, Windsor Castle. (Clark and Pedretti).
 - 13- Leonardo da Vinci. Profile of the Uterus in the Early Stages of Pregnancy, W 19095 *verso*. Female Genitalia, W 19095 *recto*. Royal Library, Windsor Castle. (Clark and Pedretti).
 - 14- Leonardo da Vinci. Female Genitalia and Embryological Series of the fetus in the Uterus, W 19101 *verso*. Royal Library, Windsor Castle. (Clark and Pedretti).
 - 15- Leonardo da Vinci. Large drawing of a Fetus in the Uterus, W 19191 *recto*. Royal Library, Windsor Castle. (Clark and Pedretti).
 - 16- “Arterial System of a Pregnant Woman”, from Persian MS, No. 2296, in the India Office, London.
 - 17- *Gravida* from the Miniature painted about 1400 A. D. in the Leipzig MS Codex 1122.
 - 18- A 12th century illustration based on the work of Soranus, 1st c. A.D. forefather of obstetrics showing various fetal presentations.
 - 19- Eighteenth century Terracotta Model of Dissected *fetus in utero*. *Catalogo-Museo di Storia della Scienza*. Florence: Litografia Aurora and Giunti, 1991, p. 521, #9.