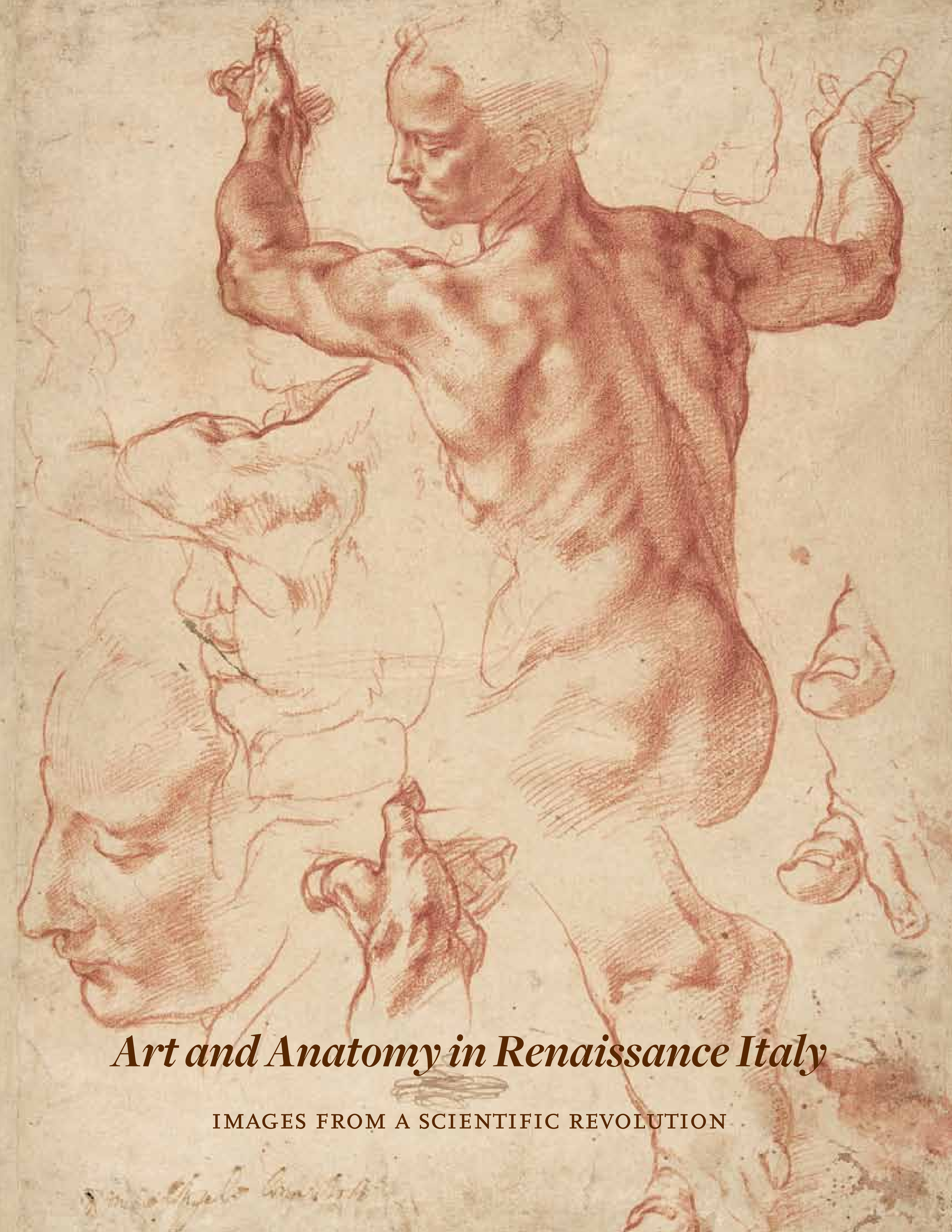
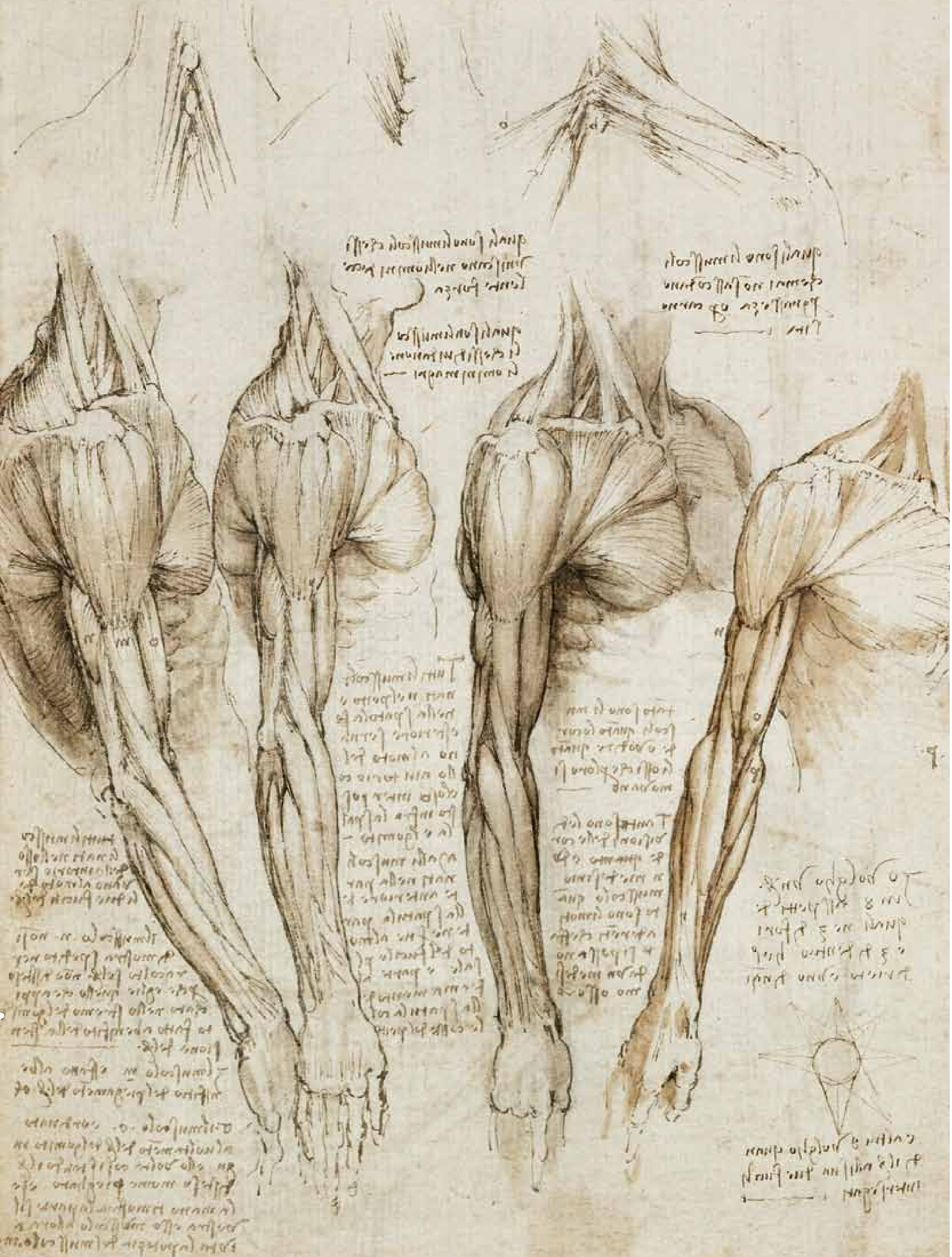


Art and Anatomy in Renaissance Italy

IMAGES FROM A SCIENTIFIC REVOLUTION



Art and Anatomy in Renaissance Italy

IMAGES FROM A SCIENTIFIC REVOLUTION

Domenico Laurenza

THE METROPOLITAN MUSEUM OF ART, NEW YORK

Distributed by Yale University Press, New Haven and London

Reprint of *The Metropolitan Museum of Art Bulletin* (Winter 2012)

This publication is made possible through the generosity of the Lila Acheson Wallace Fund for The Metropolitan Museum of Art, established by the cofounder of *Reader's Digest*.

Published by The Metropolitan Museum of Art, New York
Publisher and Editor in Chief: Mark Polizzotti
Associate Publisher and General Manager of Publications: Gwen Roginsky
Editor of the *Bulletin*: Sue Potter
Production Manager: Christopher Zichello
Designer: Makiko Katoh

Translated from the Italian by Frank Dabell

Front cover: Michelangelo Buonarroti, Studies for the Libyan Sibyl, ca. 1510–11 (see fig. 15). Back cover: Peter Paul Rubens, Anatomy of the left arm drawn from two points of view, ca. 1600–1602 (see fig. 59). Inside front cover: Leonardo da Vinci, Muscles of the arm, shoulder, and chest, ca. 1509–10 (see fig. 13). Inside back cover: Raphael, A lifeless body held up by cords, ca. 1505–6 (see fig. 19).

Cataloging-in-Publication data is available from the Library of Congress
ISBN: 978-1-58839-456-9 (The Metropolitan Museum of Art)
ISBN: 978-0-300-17957-6 (Yale University Press)

Printed and bound in the United States of America.

The Metropolitan Museum of Art
1000 Fifth Avenue
New York, NY 10028
metmuseum.org

Distributed by
Yale University Press, New Haven and London
yalebooks.com/art
yalebooks.co.uk

AUTHOR'S ACKNOWLEDGMENTS

This text grew out of the research I carried out between 2006 and 2010 in the Department of Drawings and Prints of The Metropolitan Museum of Art and in other American collections, funded by an Andrew W. Mellon Fellowship at the Metropolitan Museum and by the Italian Academy for Advanced Studies in America at Columbia University, New York. I would like to thank Thomas P. Campbell, Director of The Metropolitan Museum of Art, George R. Goldner, Drue Heinz Chairman of the Department of Drawings and Prints, and David Freedberg, Director of the Italian Academy. My special gratitude goes to Carmen Bambach, James David Draper, Geoffrey Taylor, and all the others who generously assisted me, largely in New York: Stijn Alsteens, Ellen Baird, Kit Basquin, Andrea Bayer, Evelyn Cohen, David del Gaizo, Rhoda Eitel-Porter, Barbara Faedda, Claire Farago, Robyn Fleming, Howard Fox, Laura M. Giles, Lisa M. Harms, Colta Ives, Allison Jeffrey, Catherine Jenkins, Laurence B. Kanter, Marcie J. Karp, Anne Varick Lauder, Ricky Luna, Michael McAuliffe, John P. O'Neill, Nadine M. Orenstein, Katharine Park, Sue Potter, David Rosand, Linda Seckelson, Marjorie Shelley, Nancy G. Siraisi, Wendy Thompson, Linda Wolk-Simon, Elizabeth Zanis, and Mary Zuber. Special thanks go to Frank Dabell for his impeccable translation and invaluable suggestions.

DIRECTOR'S NOTE

In Italy in the sixteenth century an unprecedented and widespread interest in anatomy gave rise to a unique collaboration between science and art. Anatomists published illustrated educational treatises, and artists not only helped illustrate those volumes but also studied anatomy for their own inspiration and understanding. Their research was often the impetus for remarkable drawings and sculptures.

This issue of the *Bulletin* presents a succinct history of art and anatomy in Italy during the Renaissance. The author, Domenico Laurenza, is a science historian with a strong interest in art who spent 2006–7 and 2009 at the Metropolitan Museum as an Andrew W. Mellon Fellow and is now affiliated with the Museo Galileo – Istituto e Museo di Storia della Scienza in Florence. At the Met, he was able to conduct his research with ideal resources: the Museum's collection is rare in that it contains not only scores of drawings by the greatest artist-anatomists of the Renaissance—most prominently Leonardo, Michelangelo, and Raphael—but also anatomical manuscripts and books that are most often found in libraries rather than museums.

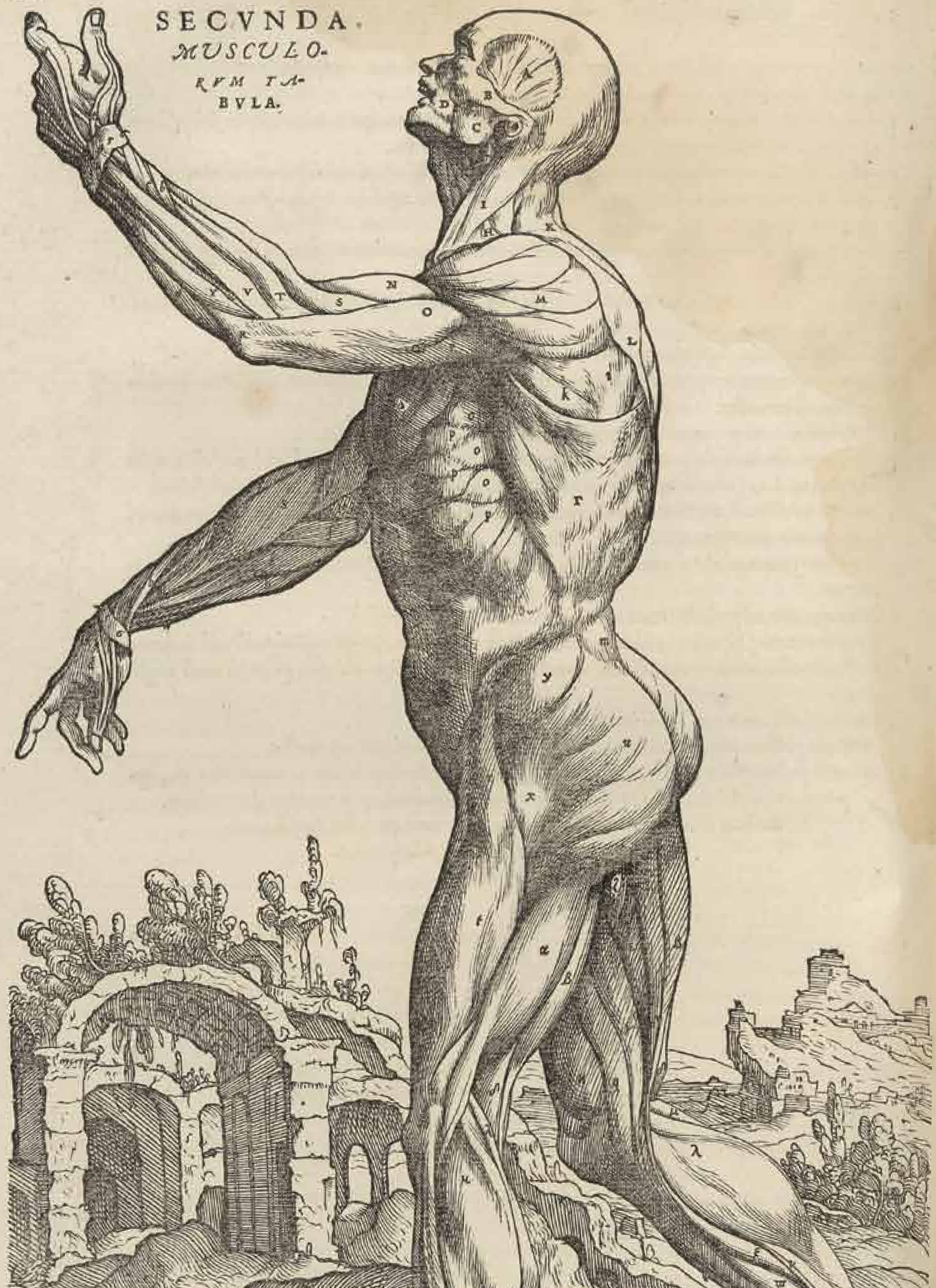
The opportunity to look at both kinds of documents simultaneously enabled Dr. Laurenza to understand the artists' anatomical drawings in the context of the history of science. For example, while he was studying a well-known anatomical drawing by Raphael (fig. 19) he discovered that another, related drawing of Raphael's (fig. 22) was almost certainly the direct source for a plate (fig. 23) in an anatomical treatise by Berengario da Carpi, a milestone in the history of anatomy. And through its printed version in Berengario's treatise, that drawing had a bearing on one of the plates (fig. 29) in Andreas Vesalius's *De humani corporis fabrica*, the masterpiece of Renaissance scientific anatomy.

Berengario da Carpi was a doctor, but he was also a collector of works of art. He had a special preference for drawings, particularly Raphael's, and that penchant certainly played a role in his choice of illustrations. Similarly, the gifts of a number of other doctors who were also collectors have significantly enriched our holdings of both books and drawings.

The Metropolitan's exceptional collection inspired a 1984 study, *Artists & Anatomists* by A. Hyatt Mayor, Curator of Prints here from 1946 to 1966. The essay in this *Bulletin* complements that earlier work, as it presents many of the same drawings and documents from a scientific perspective. We are sure to benefit from Dr. Laurenza's fresh approach to this material. Indeed, it seems the very essence of an encyclopedic museum to embrace such a breadth of interpretations.

Thomas P. Campbell
Director, The Metropolitan Museum of Art

SECVNDA MVSCVLORVM TABVLA.



Art and Anatomy in Renaissance Italy

IMAGES FROM A SCIENTIFIC REVOLUTION

The sixteenth century was "the century of anatomy"—never before or since was anatomy so important. It became something of a popular science, and public dissections of executed criminals were must-see events. This phenomenon had its epicenter in Italy, for it was there that anatomy and anatomical dissections were practiced with a greater freedom and intensity than elsewhere, and it was Italy that saw the emergence of the artist-anatomist. But nations are not monadic, devoid of doors and windows. Just as northern artists were drawn to its art, many anatomists from northern Europe spent a substantial part of their careers in Italy, attracted by greater opportunities for study on the peninsula.

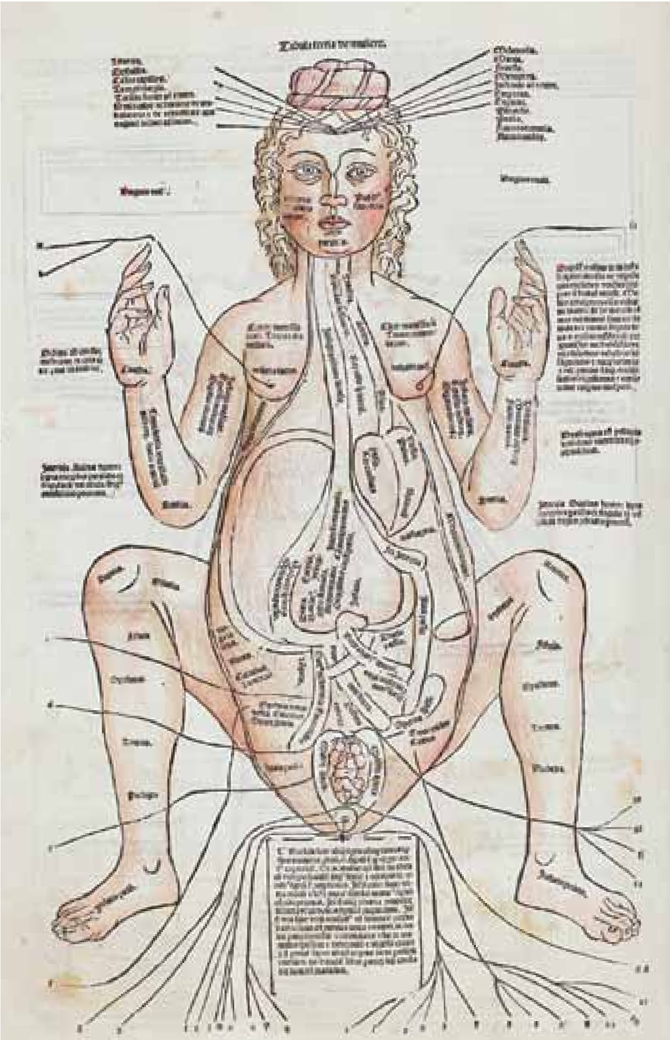
The rediscovery of anatomy during the Renaissance involved a number of breakthroughs that contributed to the shift from "humorism" to modern organ pathology. For centuries, physicians had considered illness above all an imbalance of the four humors that constituted the ensemble of the body: blood, phlegm, choler, and melancholy. In this sort of medicine anatomy played a limited role. Starting in the fourteenth and especially during the sixteenth century, interest in anatomy helped introduce a new type of healing, which slowly asserted itself during the subsequent centuries and is now prevalent in modern medicine: if an organ—the liver, for example—becomes sick, then treatment is applied to that individual organ, rather than to the entire body as a complex of humors.

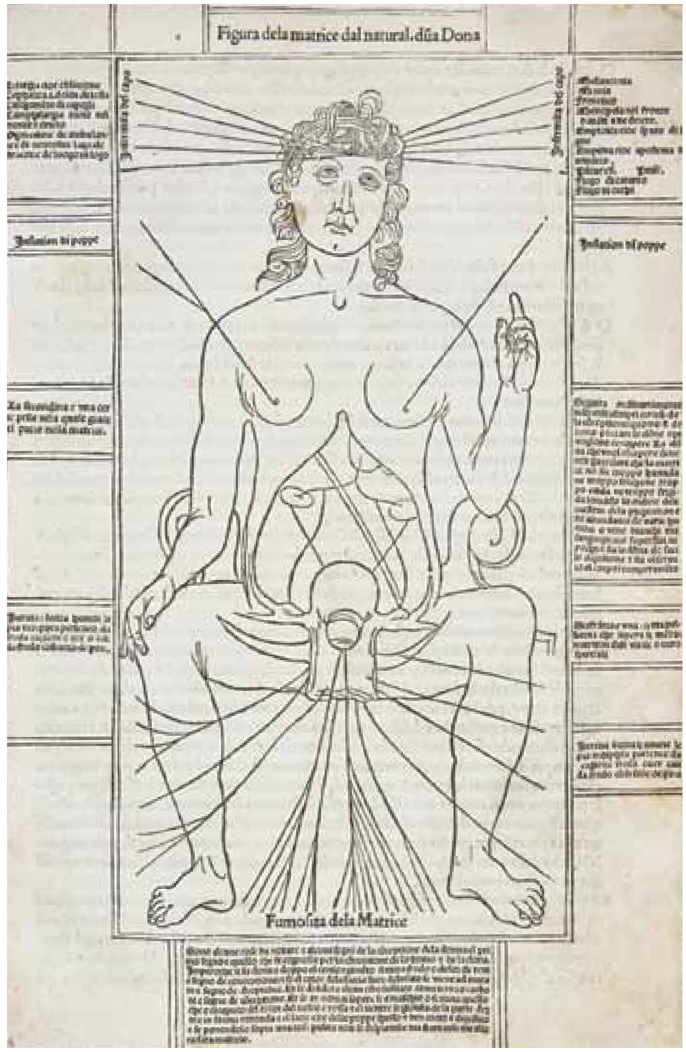
The change was also, and perhaps above all, a revolution in visual language, which took place within the context of the broader transformation represented by the shift from manuscript to print, an epoch-making metamorphosis in the history of Western culture. As a science that entailed the description of forms, anatomy required images, especially images—given the expanding cultural horizon—that could be reproduced in print. This is one of the reasons artists became involved, and it led to the nexus between art and science that assumed such unique forms in this period.

Printers, draftsmen, and engravers were all part of this story. During an initial phase, printers played a dominant role, yet what perhaps seems most surprising today is what happened in the phase that followed, when some artists became anatomists themselves, creating independent images that, at least for a time, were more advanced than those of professional anatomists. Only during a third phase, a little before the middle of the sixteenth century, did anatomists acquire direct control over anatomical illustrations.

For a good part of the Renaissance, scientists and artists continued to share the tendency to explain anatomy, and to a large extent nature, basically according to how it appeared to the eyes, in its macroscopic forms. Then, after the middle of the sixteenth century, scientists—and scientists alone—began to probe further, toward the finer structure of organs, and subsequently they used the microscope to investigate the true causes of natural forms. While the first attitude underlay the profound connection between art and anatomy during the Renaissance, the other dictated its end. The sixteenth century

Opposite: The lateral muscles of the body (detail). Woodcut in Andreas Vesalius's *De humani corporis fabrica* (see fig. 29)





1. A pregnant woman. Woodcut in *Fasciculus medicinae*, published by Giovanni and Gregorio de Gregori in Venice in 1491, p. a5v. Cushing/Whitney Medical Historical Library, Yale University, New Haven (Incunabula ++ K-13 [Goff])

2. A pregnant woman. Woodcut in *Fasiculo de medicina in volgare*, published by Giovanni and Gregorio de Gregori in Venice in 1494 (1493 Venetian style), p. d1r. Book: 12½ x 8½ in. (31.6 x 21.5 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1938 (38.52)

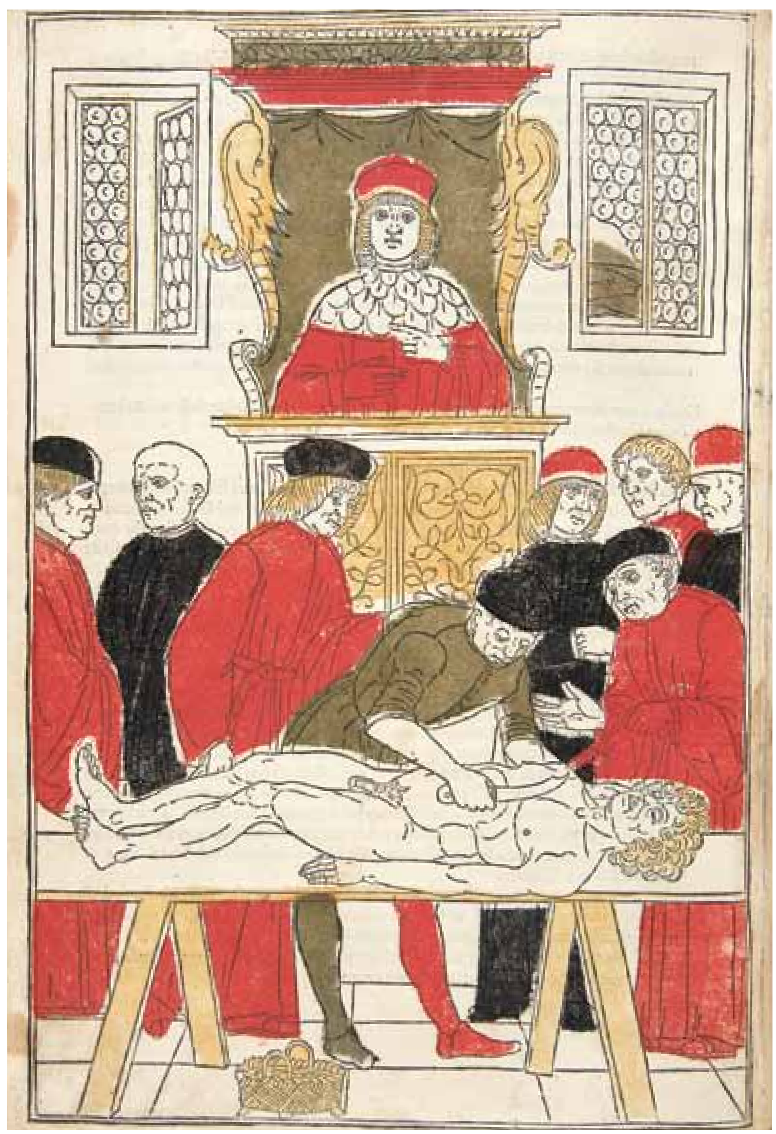
thus saw not only the high point of this relationship between anatomy and art, but also the beginning of its demise.

At first the concern was to translate into print anatomical images from the handwritten treatises that had been circulating in schools of medicine within universities. Anatomical illustrations were valued during the Middle Ages as teaching tools. In fourteenth-century France, for example, the surgeon Henri de Mondeville used painted panels with anatomical representations to supplement his lectures.[1] But what passed into manuscripts were either simplified versions of these didactic images or images that schematized a given text, facilitating its memorization and complying with the taste of scholastic philosophy for distinctions and enumerations. Often they had been added to a manuscript by the doctor or aspiring doctor who was studying the text and needed to summarize it following a preestablished scheme. Some of the images had extremely old origins, as in the case of what medical historian Karl Sudhoff named the “Five-Figure Series,” rather simple outlines of the five major anatomical systems of the human body—bones, nerves, arteries, muscles, and veins—as taught by Galen, the Greek physician, philosopher, and anatomist who lived and worked in Rome in the second century A.D. and whose writings had a profound and far-reaching effect on the practice and study of medicine. Handed down over the course of several generations, these kinds of images often constituted canons, or fixed iconographic models to be studied, memorized, and copied, and they also served as a basis for possible improvement or the addition of new ideas.

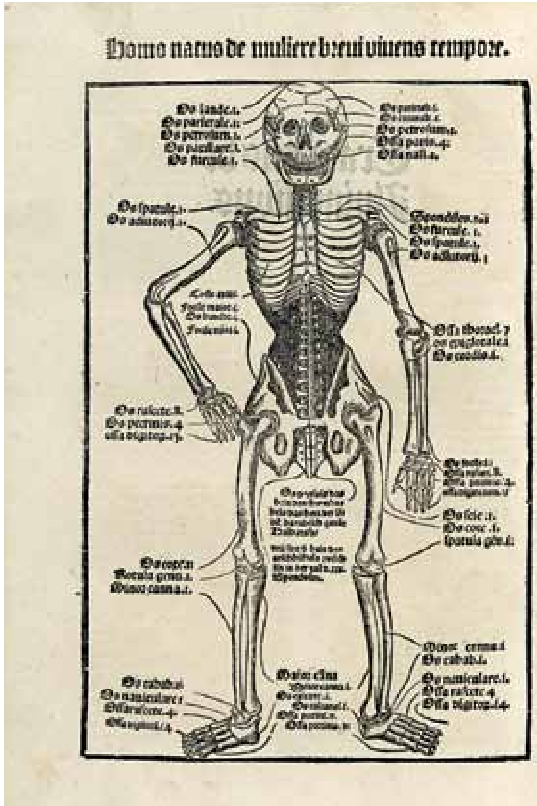
When in 1491 the brothers Giovanni and Gregorio de Gregori, owners of a well-established Venetian printing press, decided to venture into medical publishing, they did nothing more than put into print a collection of illustrated medical manuscripts, in Latin, that had formerly circulated in medical schools. They asked a doctor, Giorgio Ferrari dal Monferrato, to "correct" the texts, but they directed the project. Their *Fasciculus medicinae* was the first printed medical book accompanied by illustrations (see fig. 1). The book was as large as its manuscript source, about 17 by 11½ inches, and the printed images had the schematic combination of text and figures typical of manuscript illustrations. But this was only the first step. A short while later the De Gregori brothers prepared a new edition of the *Fasciculus medicinae*, translated into Italian and with smaller dimensions (about 12½ by 8½ inches). They added a new text, the *Anathomia* written in about 1316 by Mondino de' Liuzzi, and asked an artist to reformulate the printed images in the previous edition, including the illustration of the organs of the female anatomy (fig. 2), and also to create new images (see fig. 3). The new anatomical image, freed from the text (now arranged in neat horizontal lines along the margins), is less schematic than the one printed in 1491.

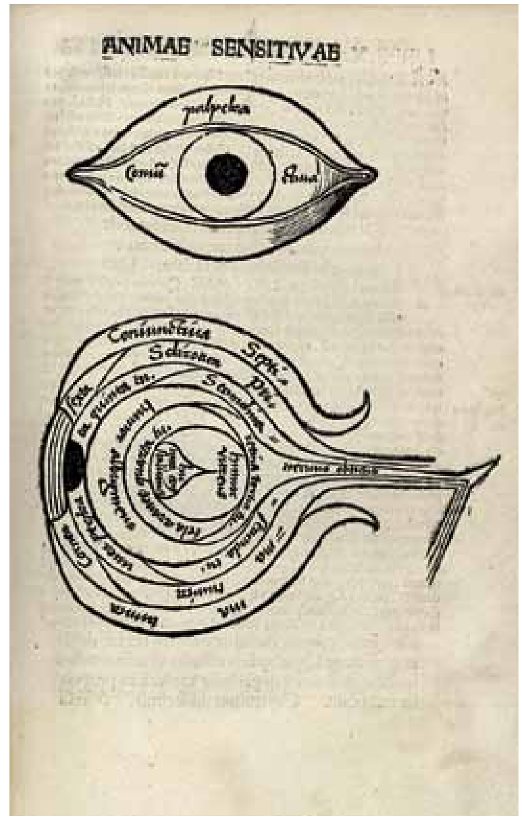
Something similar happened a few years later, in a less sophisticated manner, in northern Europe, where the art of typography was blossoming. In Nuremberg in 1493 the physician Richard Helain printed, with few modifications and as a single large-scale sheet, an image of the human skeleton, surrounded by scrolls containing the names of the bones, that had until then existed only in manuscripts.[2] Some four years later the same image, in a reduced format and with the text organized in a way more appropriate to a printed book, appeared in three books printed in Strasbourg: *Cirurgia* and *Anatomia* (Surgery and Anatomy) by the surgeon Hyeronymus Brunschwig, both printed by Grüninger, and [*H*]*ortus sanitatis*, an encyclopedia of natural history printed by Johann Prüss the Elder (see fig. 4). Similarly, a schematic scholastic representation of the eye and its layers provided the basis for the printed image published in the scientific encyclopedia of Gregor Reisch, a Carthusian monk from Freiburg (fig. 5).[3]

Most of the printed treatises published during this first phase, the era of the printer, repeat notions that were already known. They were innovative not for their content but for their visual language. In fact, they adapted works and illustrations belonging to the manuscript tradition to the new technology of printing, and in the course of this passage they freed the image from



3. Anatomy lecture with the dissection of a corpse. Woodcut (subsequently colored) introducing the *Anathomia* by Mondino de' Liuzzi (ca. 1316), published in *Fasiculo de medicina in volgare* by Giovanni and Gregorio de Gregori in Venice in 1494 (1493 Venetian style), p. f2v. Book: 12½ x 8½ in. (31.6 x 21.5 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1938 (38.52)





4. Skeleton. Woodcut in [*H*]*ortus sanitatis*, printed by Johann Prüss the Elder in Strasbourg in about 1497, p. 203v. Book: 11⅞ x 8¼ in. (30 x 21 cm). The Metropolitan Museum of Art, The Elisha Whittelsey Collection, The Elisha Whittelsey Fund, 1944 (44.7.36)

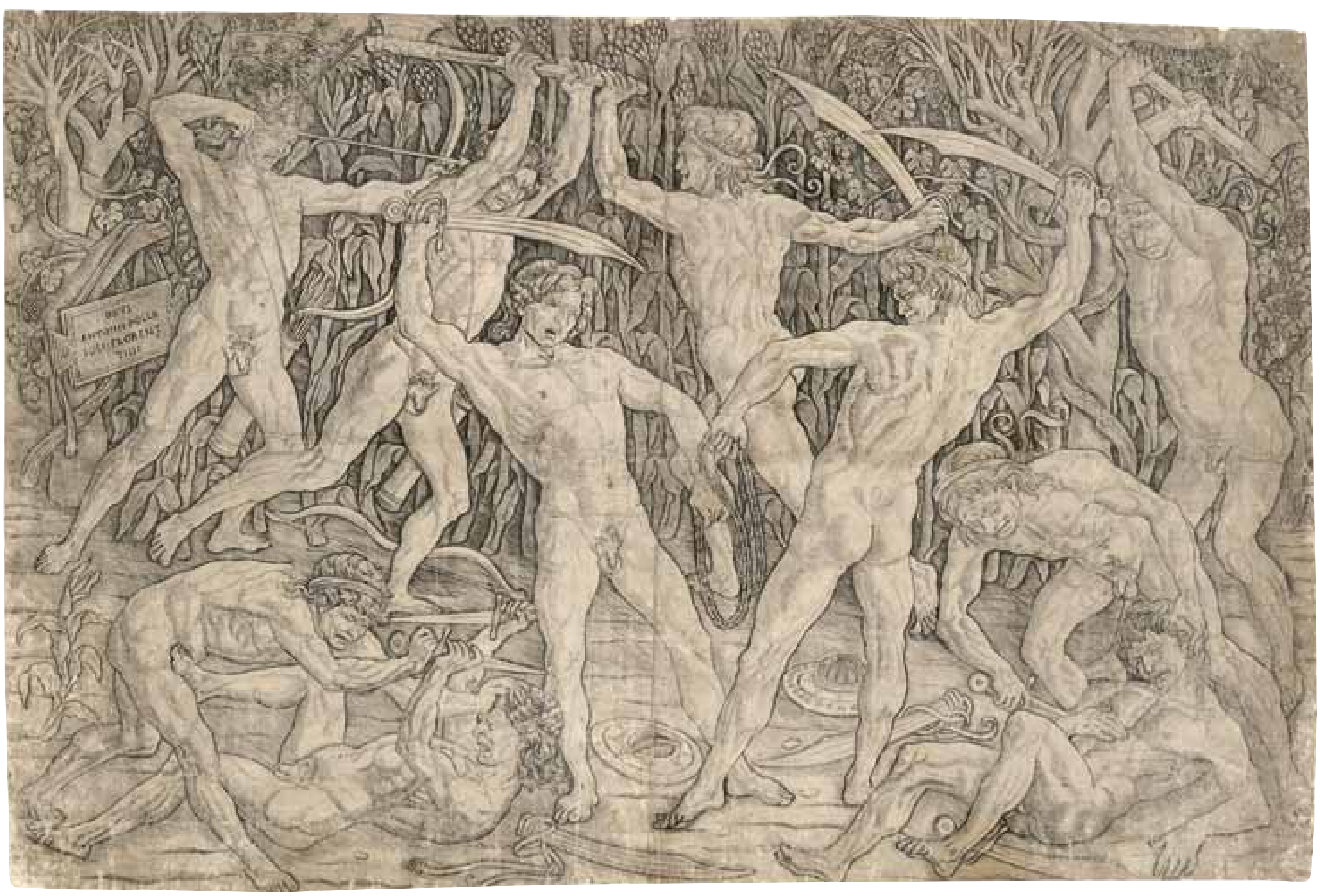
5. Urs Graf (Swiss, Solothurn ca. 1485–1529/30 Basel). Schematic illustrations of the eye. Woodcut in Gregor Reisch, *Margarita Philosophica*, printed by Johann Schott in Freiburg in 1504. Book: 8⅞ x 6⅛ in. (22.5 x 15.5 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1937 (37.39.5)

the encroachment of the text that typified the schematic and predominantly private manuscript images. Artists played an important role in the first printed anatomical books, but purely as implements, as it were, redrawing already established manuscript images and transferring them to woodblocks for printing.

Something very different occurred in Florence. In about 1470, two decades before the De Gregori brothers issued their *Fasciculus medicinae*, a Florentine artist, Antonio Pollaiuolo, made an original engraving depicting a battle of nude men (fig. 6) that, notwithstanding its artistic nature, has many points of interest for the history of anatomical illustration. In Pollaiuolo's print the episode of combat seems to have been but a pretext for the representation of muscles in a nude body in motion. Indeed, the image soon became a model for Florentine artists who had for years been studying muscles and bones as part of their artistic process. Mimesis, or the imitation of nature in art, implied the careful study not only of the superficial appearances of reality (in which Flemish painters excelled but to which they limited themselves) but also its internal causes. In the case of the human figure this meant understanding the bones and muscles as the foundation of the external form of the body and its movements.

Pollaiuolo was motivated by personal cognitive needs and thus did not limit himself to adapting an earlier image for printing. Instead, he created an original illustration in which he sought to set down what he understood about muscles. The engraving was innovative precisely because it showed muscles, which were seldom represented in scholastic manuscripts (the "Five-Figure Series" being one of the few examples) and completely absent from the first printed scientific publications. Obviously Pollaiuolo's depiction of muscles is strictly "anatomical-artistic"—that is, related to the appearance of the muscles through the skin, in a live body and in motion. Yet this is not a generic or free depiction. Independently of its anatomical correctness, the system of modeling indicating the various muscles is very precise, and for every area of the body Pollaiuolo established a specific morphology that was to have a widespread legacy, becoming a canonical reference for subsequent artist-anatomists. Pollaiuolo's intent was to show each muscle from various aspects as the body moved. In this sort of study a small sculpture would have been of considerable assistance, and it has been hypothesized that the ten nudes in the engraving were in fact drawn from one or perhaps as many as five sculptures made of a malleable material such as wax. In his *Lives of the Most Excellent Painters, Sculptors, and Architects*, first published in 1550, Giorgio Vasari wrote that Pollaiuolo "dissected many bodies in order to study their anatomy."[4] More likely Pollaiuolo's anatomical knowledge was a laborious synthesis of painstaking observation of living bodies and ancient statuary combined with anatomical notions grasped from watching physicians perform dissections or simply conversing with them.

Nevertheless, Pollaiuolo's print was more advanced than the woodcuts made in a medical milieu, not only in its anatomical content but also, and perhaps especially, in its figurative language, an innovation that has been more the focus of art historians than of historians of anatomical illustration.[5] Facilitated by his expertise as a goldsmith, his anatomical-artistic image was in fact a print of considerable size (about 15 by 23 inches), and above all, as Vasari emphasized, it was a copperplate engraving, not a woodcut. An engraving is usually produced by cutting into a copperplate with a pointed instrument known as a burin. Compared to the coarser woodcut technique, engraving is more flexible, and more capable of subtly rendering the chiaroscuro variations of anatomical forms and details.



6. Antonio Pollaiuolo (Italian, Florence ca. 1432–1498 Rome). *Battle of Nude Men*, ca. 1470. Engraving, sheet 15⅛ x 23¼ in. (38.4 x 58.9 cm). The Metropolitan Museum of Art, Purchase, Joseph Pulitzer Bequest, 1917 (17.50.99)

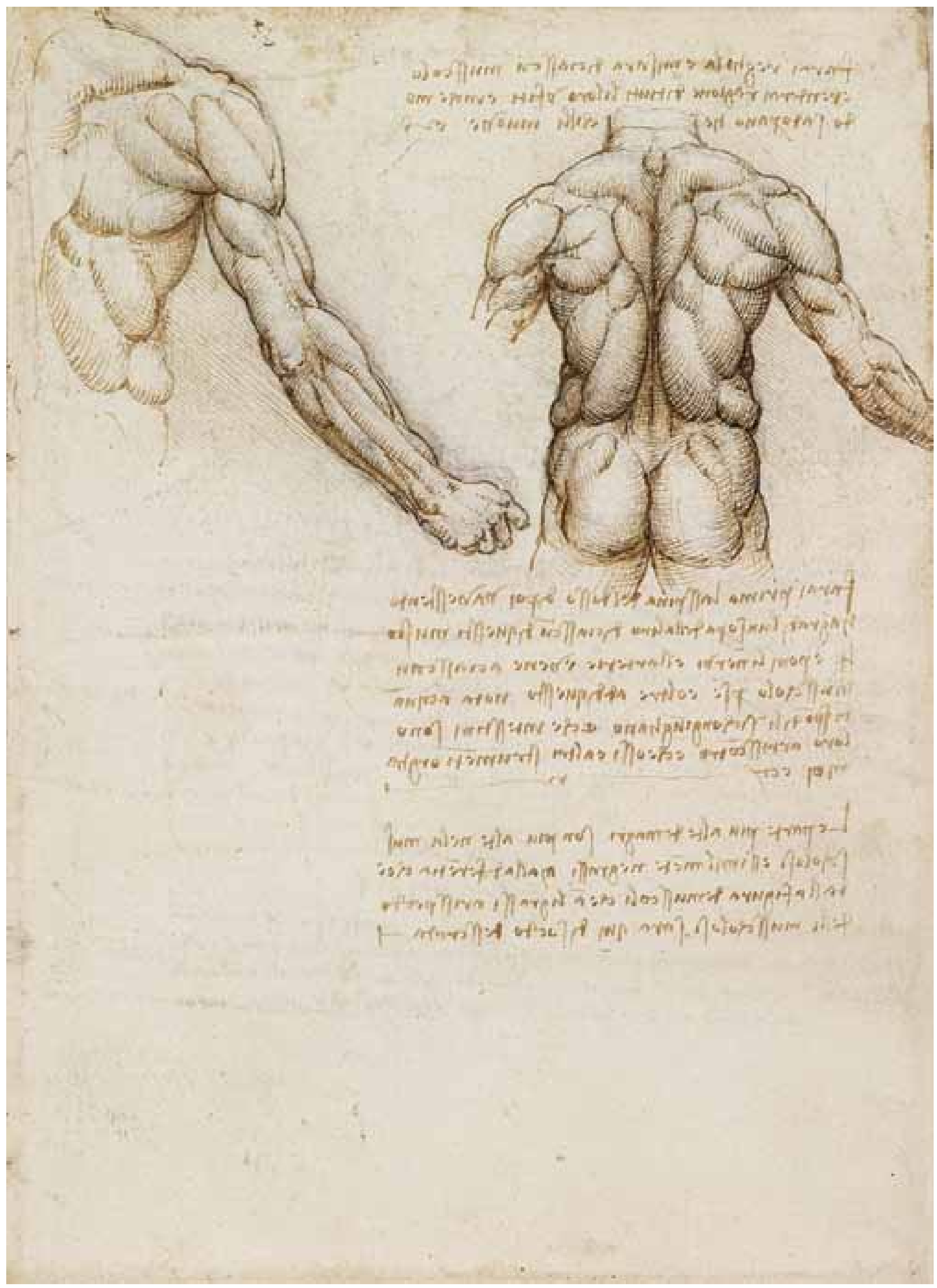
7. Leonardo da Vinci (Italian, Vinci 1452–1519 Clos-Lucé). *A Bear*, ca. 1480–90. Metalpoint on light buff prepared paper, 4 x 5¼ in. (10.3 x 13.3 cm). The Metropolitan Museum of Art, Robert Lehman Collection, 1975 (1975.1.369)

8. Leonardo da Vinci. The anatomy of a bear's foot, ca. 1485–90. Pen and ink with white heightening, over metalpoint, on pale blue prepared paper; 6⅜ x 5⅜ in. (16.1 x 13.7 cm). The Royal Collection, Royal Library, Windsor Castle (RL 12372)

Scientists would not use anatomical engravings until the middle of the sixteenth century, almost a century after Pollaiuolo made his print. For many years the creation of sophisticated engravings with representations of muscles was a prerogative of artists. Even *De humani corporis fabrica* (On the Structure of the Human Body) by the scientist Andreas Vesalius, printed in Basel in 1543 and considered the masterpiece of Renaissance anatomical publishing, used woodcuts. This primacy was partly inherent, since the refined engravings made by artists were free of any connection with text, which was more easily adaptable to woodcut images. Nevertheless, none of the great artist-anatomists of the sixteenth century succeeded in publishing an illustrated anatomical treatise in print. After Pollaiuolo, however, in the period dominated by giants such as Leonardo and Michelangelo, the preeminence of the artist became more general, directly relating to the content and practice of anatomy as science.

Leonardo da Vinci, who had been trained in the Florence of Pollaiuolo, studied anatomy both as part of his artistic process and with the aim of reviving it as a science. His stance toward the great anatomists of the past—from Hippocrates to Galen, Avicenna, and Mondino—was polemic, not only as regarded anatomical-artistic topics having to do with muscles and the skeleton but on every other aspect of anatomy and physiology: he was both an artist and a scientist, in the fullest sense. He performed dissections, made important discoveries (the frontal sinus of the cranium, the four cavities of the heart and its muscular nature, the true form of the cerebral ventricles, and degenerative arteriosclerosis of the vessels, among others), and extended the study of anatomy, proportions, and psychology to the animal realm, radicalizing the Aristotelian tradition of study *de animalibus*, which corresponds only in part to modern comparative anatomy. When he drew a bear, Leonardo's attention was focused on the anatomy of the legs, from which he selected a detail he later dissected (figs. 7, 8).

With Leonardo, artists' interest in anatomy reached its zenith, yet at the same time artistic anatomy became something completely different from what it had been earlier in the Renaissance—that is, substantially the study of the muscles and skeleton as part of the process of representing the nude in art. Leonardo made a few studies of this kind. In the first years of the sixteenth century, for example, when he returned from Milan to Florence after an absence of almost twenty years, he drew nudes with clearly evidenced muscles, as had Pollaiuolo and Michelangelo (see fig. 9). But he soon distanced himself from the "pittori notomisti" who through excessive depiction of muscles in their nudes represented more "sacks of walnuts" than human bodies.[6] At the same time the male heroic nude became for Leonardo part of a complex study of anatomy, physiognomy, and art. Performing autopsies at the hospital of Santa Maria Nuova, he discovered that the heart is a muscle and deduced that life was a question of force. This discovery was coupled with the physiognomic study of the human leonine type, characterized by attributes like a head of hair as full and strong as a mane, a courageous temperament, and a strong, ruddy complexion. The artistic manifestation of Leonardo's research on anatomy and physiognomy is represented by his studies for two projects: a figure of Hercules, the hero who symbolized physical and moral strength (see fig. 10), and *The Battle of Anghiari,* the fresco he painted in the Palazzo Vecchio about 1505 (and now lost), in which strength becomes raging fury—the passion that unites men and animals in wartime, turning man

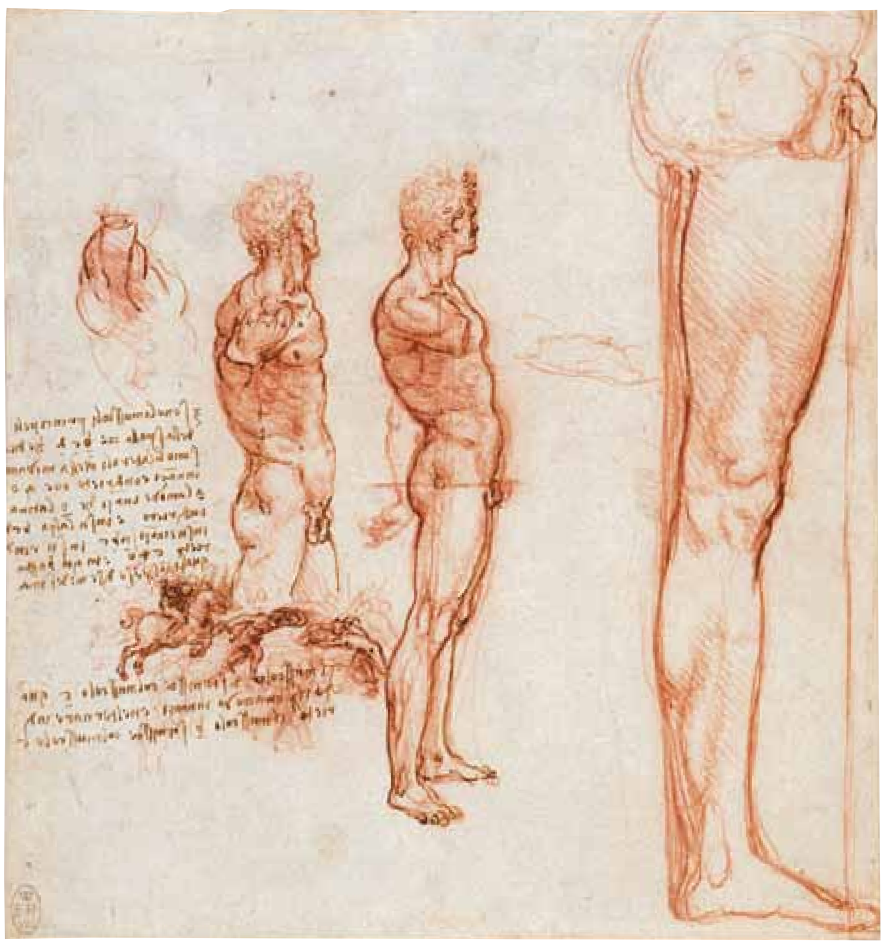


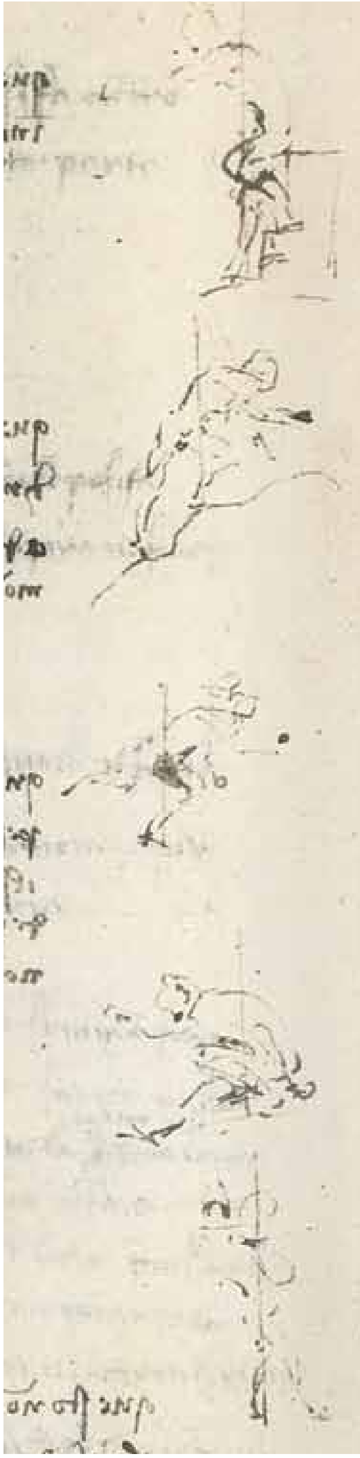
9. Leonardo da Vinci. The superficial muscles of the torso and arm, ca. 1508–9. Pen and ink and black chalk, 7½ x 5⅜ in. (18.9 x 13.7 cm). The Royal Collection, Royal Library, Windsor Castle (RL 19044r)

10. Leonardo da Vinci. Study for Hercules holding a club seen in rear view (detail), ca. 1506–8. Soft black chalk or charcoal, sheet 5⅜ x 5½ in. (13.7 x 14 cm). The Metropolitan Museum of Art, Purchase, Florence B. Selden Bequest and Rogers Fund, and Promised Gift of Leon D. and Debra R. Black, 2000 (2000.328b)

11. Leonardo da Vinci. Heroic nudes (anatomy and static and dynamic equilibrium) and a battle scene, ca. 1503–6. Red chalk and pen and ink, 6¼ x 6 in. (16 x 15.3 cm). The Royal Collection, Royal Library, Windsor Castle (RL 12640)

12 (opposite). Leonardo da Vinci. Studies of how the body generates movement by shifting its center of gravity in running and other movements, ca. 1490–92. Pen and ink, page 8⅜ x 5¾ in. (21.2 x 14.5 cm). Manuscript A, fol. 28v (detail). Bibliothèque de l'Institut de France, Paris (2172)





into a beast, according to Leonardo's conception of war as "pazzia bestialissima" (the most bestial madness).[7]

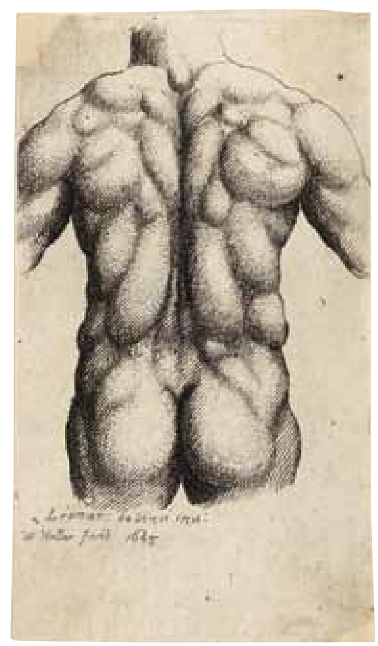
Leonardo connected yet another typically anatomical-artistic area, the study of the human body's static and dynamic equilibrium, with *scientia de ponderibus*, which at the time encompassed statics, dynamics, and kinematics. In a drawing from about 1503–6 (fig. 11), two lines thinly drawn in red chalk, one vertical, the other horizontal, meet at the hip, which is marked with a small circle. The thin vertical axis passing through the hip is the plumb line, and when the body departs from it, movement is generated. According to Leonardo, movement is the result of shifting the body in a desired direction—moving forward, jumping, or running (see fig. 12). He analyzed the body as if it were a scale. For the first time the ancient, abstract science *de ponderibus* was applied to actual bodies and situations.[8]

From the point of view of visual language, Leonardo produced the most complex and sophisticated anatomical representations of all time. That this perfection contained its own limits, however, is exemplified by a set of drawings of strictly scientific scope, with no artificial poses or indeed even landscape, that Leonardo made in about 1509 or 1510 (see fig. 13), when he was in Milan and performing dissections with the young anatomist Marcantonio della Torre, who was a professor at the nearby University of Pavia. The extremely fine hatching and extensive use of wash seem too complex to be reproduced in prints, unless perhaps with the sophisticated engraving techniques Leonardo mentioned in an obscure passage on a sheet in this same series but seems never to have put into practice. Because he continued to proceed within a solely manuscript culture, his discoveries, never published in print, had no influence on subsequent anatomists. His drawings had to wait nearly a century and a half to be put into print—without texts—by Wenceslaus Hollar, who used the malleable technique of etching, whereby lines are incised in the metal plate with acid (see fig. 14).[9]

Unlike Leonardo, Michelangelo studied anatomy exclusively as a function of his art, showing himself, according to his pupil Ascanio Condivi, to be basically uninterested in the production of a scientific treatise. Early sources agree that his greatest interest lay in "anatomia esteriore," or external anatomy.[10] His drawings of

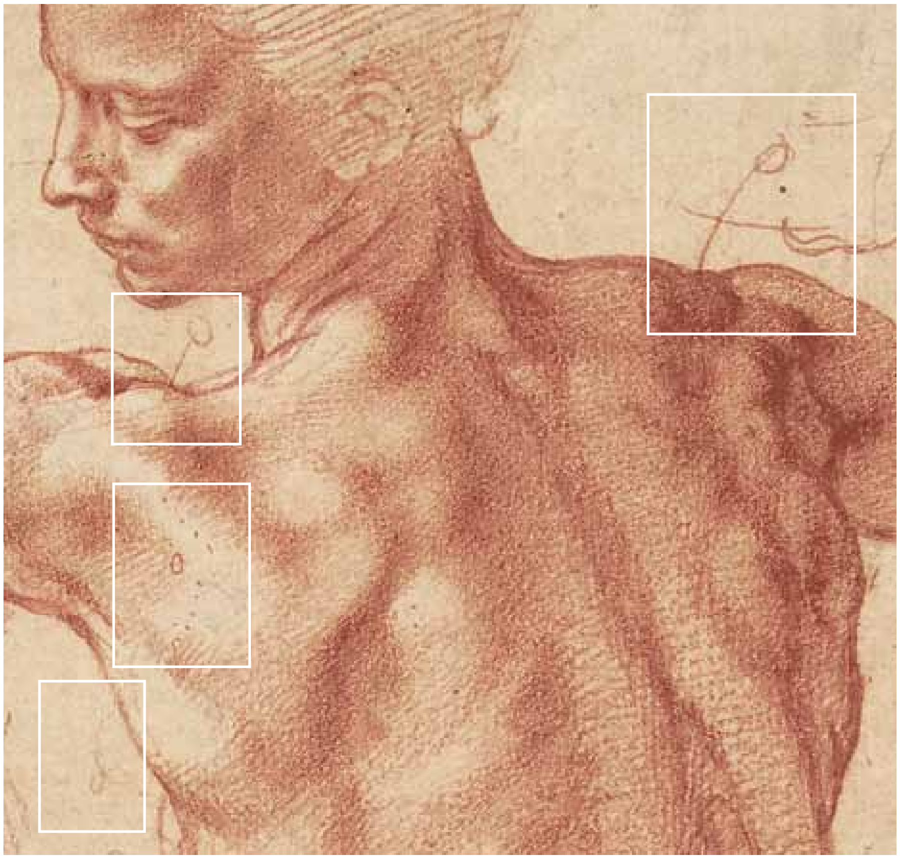
13. Leonardo da Vinci. Muscles of the arm, shoulder, and chest, ca. 1509–10. Pen, ink, and wash, with traces of red and black chalk; 11⅜ x 8 in. (28.8 x 20.2 cm). The Royal Collection, Royal Library, Windsor Castle (RL 19008v). This drawing is one of eighteen sheets (RL 19000–19017) called Anatomical Manuscript A. See also inside front cover.

14. Wenceslaus (Wenzel or Vaclav) Hollar (Bohemian, Prague 1607–1677 London), after Leonardo da Vinci (see fig. 9). Superficial muscles of the torso, 1645. Etching, sheet 3⅝ x 2 in. (9.1 x 5.2 cm). The Metropolitan Museum of Art, Purchase, Joseph Pulitzer Bequest, 1917 (17.50.18-239)



15. Michelangelo Buonarroti (Italian, Caprese 1475–1564 Rome). Studies for the Libyan Sibyl, ca. 1510–11. Red chalk, 11⅜ x 8⅜ in. (28.9 x 21.4 cm). The Metropolitan Museum of Art, Purchase, Joseph Pulitzer Bequest, 1924 (24.197.2)

nudes, sometimes in preparation for specific works of art (see figs. 15–17), were thus the principal outcome of his interest in anatomy, and the reason behind it. The surface of the body changes as it moves: the parts in relief rise and flatten in one motion, their appearance shifting according to the point of view of the beholder. Anatomy for Michelangelo consisted above all of the careful study of these metamorphoses of form, which to his eyes constituted a precise formal syntax composed of continuously changing contours. It was in order to understand these variations in the surface of the body that he studied the underlying muscles and bones, and when he made studies and drawings of dissected bodies what was foremost in his mind was always the nude: the body clothed in skin, alive and in motion.



16. Detail of fig. 15, showing the anatomical symbols on the main figure

17. Michelangelo Buonarroti. The Libyan Sibyl, 1511–12. Detail of the fresco in the vault of the Sistine Chapel, Vatican Palace

Unlike Pollaiuolo, Michelangelo actually performed dissections. In fact his strictly anatomical drawings, at least of certain muscles (especially those of the limbs), reveal precise, personal knowledge. Even though they are generally similar, Michelangelo's renderings of the forms of muscles correspond with neither Leonardo's nor Vesalius's. Like those other two anatomists, Michelangelo defined his own formal canon and in doing so established a trend. The form of the muscles behind the knee in the anatomical engraving by Domenico Fiorentino (fig. 31), for instance, was derived from the example set by Michelangelo (see fig. 32). Early sources mention at least three locations where Michelangelo performed dissections. These are unusual places, distinct from the world of hospitals and universities seemingly frequented (even as an outsider) by Leonardo, and they fall into the still elusive and mysterious category of "private dissections."

According to Michelangelo's student Condivi, at least some of these dissections occurred in the convent of Santo Spirito in Florence in about 1494: "Michelangelo, to oblige the prior of Santo Spirito . . . , made a wooden Crucifix . . . . He was very intimate with the prior . . . , who provided him with a room and with corpses for the study of anatomy."[11] A dissection that took place a few years later, between 1501 and 1506 (when Leonardo was also in Florence), involved a member of the powerful Corsini family. A biography probably written in the 1540s reports that "in connection with bloodshed in the Lippi family, Michelangelo entered a vault where many dead bodies were stored, and there dissected many of them. When he randomly chose the body of a Corsini, it caused a great uproar among that family, and an appeal was made to Piero Soderini, who was flagbearer of civic justice at that time, but he laughed it off, seeing that Michelangelo had done it to improve his art."[12] Condivi also reported that much later, sometime between 1547 and 1553, in Rome, Michelangelo "began to

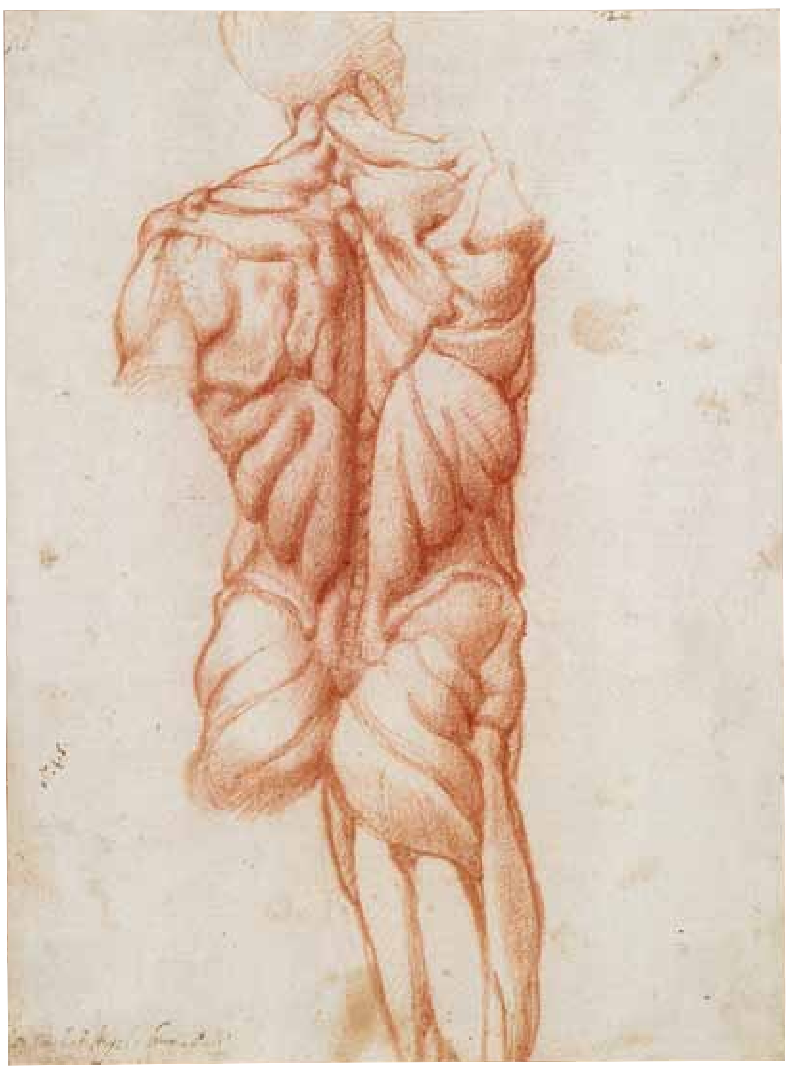
18. Michelangelo Buonarroti, or copy after. Muscles of the torso and thigh seen from behind, ca. 1518. Red chalk, 11⅛ x 8⅛ in. (28.2 x 20.6 cm). The Royal Collection, Royal Library, Windsor Castle (RL 0802)

19–20. Raphael (Raffaello Sanzio or Santi; Italian, Urbino 1483–1520 Rome). A lifeless body held up by cords, with a graphic reconstruction of the preparatory lines and perforations made by Raphael to study the static and dynamic equilibrium of the figure, ca. 1505–6. Pen and ink, 8⅞ x 6¼ in. (22.4 x 15.8 cm). The Metropolitan Museum of Art, Rogers Fund, 1964 (64.47, verso)

discuss [dissection] with Messer R[e]aldo Colombo, a very superior anatomist and surgeon and a particular friend of Michelangelo's and mine, who sent him for this purpose the corpse of a Moor [*moro*, which could also mean simply "dark-haired"], a most handsome young man and, insofar as one could say, most suitable; and it was placed in S. Agata where I was and still am living, because of its being a remote place. On this corpse Michelangelo showed me many rare and recondite things."[13]

There is a close connection between two types of drawings made by Michelangelo: drawings of nudes and strictly anatomical drawings of muscles and bones.[14] In one of the anatomical drawings (fig. 18) the muscles of the left shoulder form a sort of quadrangular plate with the bone of the shoulder blade. Michelangelo developed a canon established by Pollaiuolo: a sort of upside-down L surrounding two other points of relief that is also recognizable in the engraving by Domenico Fiorentino (see figs. 6 and 31). These anatomical formations can also be recognized "under the skin" in Michelangelo's drawings of nudes. In his study for the Libyan Sibyl on the ceiling of the Sistine Chapel, for example (fig. 15), though the forms are distorted by the movement of the shoulder, they are unified by chiaroscuro transitions that are further enhanced in the fresco (fig. 17).

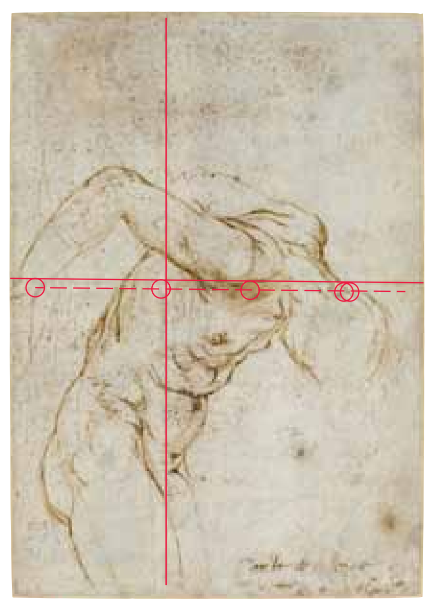
In the drawing of the Libyan Sibyl two well-known marks appear on the shoulders, each a straight stroke (on the right shoulder crossed with a horizontal line) topped by a small circle (see fig. 16). In fact at least two other marks can be made out: one, similar in form to the first two, relates to the left armpit, and the other, within the left shoulder, is a circle partly surrounded by a series of dots. The same symbols recur in connection with corresponding or different parts of the anatomy in other Michelangelo drawings, both nudes and anatomical studies, and further symbols occur on other sheets. What is the meaning of these marks? First, they appear to lend the drawings a more scientific air, as they recall the symbolic lines or letters on anatomical illustrations made for a specialized audience. Michelangelo's symbols do not seem to refer to texts, however, as do the letters Leonardo inserted in some of his anatomical drawings (see fig. 13), nor are they specific indications of certain muscles or anatomical parts (see fig. 29). In general their meaning is limited to the sheet on which they appear. Sometimes they serve to indicate a part of the anatomy that is shown from different points of view or in two states of movement, in either the same figure or an adjacent one. In the Libyan Sibyl drawing (figs. 15, 16), for example, the lines topped with circles underscore the relationship between two corresponding parts of the left and right shoulders. In some cases



the symbols seem to have had a personal meaning for Michelangelo that was related to the act of drawing itself, and in yet others the sense was didactic and explicative, meant for students. Because they are clearly not part of a formal system for indicating muscles, these marks are an integral component of the strictly anatomical-artistic syntax to which, in Michelangelo's hands, anatomy belonged.

When Raphael arrived in Florence in 1504 or 1505, he was immediately presented with an opportunity to compare his own work with two opposing models for understanding artistic anatomy: the more comprehensive, scientific approach of Leonardo and the more strictly artistic, anthropocentric one of Michelangelo and, before him, Pollaiuolo. For a number of reasons Raphael's anatomical drawings have never attracted much scholarly attention. Yet it is precisely through a consideration of these works, stimulated by the study of a drawing in the Metropolitan Museum (fig. 19), that I have been able to clarify, at least in part, a question of great importance: the origin of a plate in one of the two treatises by Berengario da Carpi, which are milestones in the history of anatomical illustration (see figs. 22 and 23).

In Florence, and later in Rome, Raphael learned from Leonardo and Michelangelo. Indeed, Vasari's description of Raphael's anatomical studies could as easily be applied to Michelangelo: "He then devoted himself to studying the nude and to comparing the muscles of anatomical subjects and of flayed human bodies with those of the living . . . ; and going on to observe in what way they acquire the softness of flesh in the proper places, and how certain graceful flexures are produced by changing the point of view, and also the effect of inflating, lowering, or raising either a limb or the whole person, . . . he became excellent in all the points that are looked for in a painter of eminence."[15]



Raphael's concept of anatomy was personal and highly sophisticated. He applied research on anatomy and the equilibrium of the body in an original way to his studies for paintings of the Crucifixion or the Deposition of Christ, including the drawings related to the celebrated *Deposition* of about 1507 in the Galleria Borghese in Rome. These scenes entailed the representation of corpses either held up by nails or cords or supported by other human

21. Raphael. The Virgin supported by the Holy Women (anatomical study for the Borghese *Deposition*), ca. 1506–7. Pen and brown ink, over black chalk; 12 x 8 in. (30.5 x 20.2 cm). British Museum, London (1895,0915.617)

bodies whose actions must counter their dead weight. This subtle play of weights and counterweights, of static release and dynamic action, was a key component of the invention of harmonic figure composition that was one of the principal features of Raphael's art.

The drawing in the Metropolitan Museum (fig. 19), perhaps a study for the bad thief in a *Crucifixion* on which Raphael was working in about 1506, represents and analyzes just such a lifeless body held up by the arms with cords. Studying the original reveals that Raphael executed this analysis of the anatomy and statics of the human body as a dead weight with the aid of preparatory marks: a horizontal line passing through the shoulder, a series of horizontally aligned perforations directly below this line, and a vertical line through the groin (see fig. 20). Even under a microscope no traces of stylus or metalpoint marks or black chalk are visible along these lines. They were therefore obtained by the less invasive method of folding the paper. (In a drawing either by or after Raphael in the Pierpont Morgan Library, New York, horizontal lines marking anatomical points significant for the equilibrium of the figure also appear to have been obtained by folding the sheet.)[16] The way the two lines relate to the equilibrium of the figure (and comparing them with other drawings by Raphael) suggests that their conception was not casual. The horizontal line and the holes aligned directly below it pass through three joints of the body: the wrist, the shoulder, and the articulation between the neck and the head. Raphael appears to have used these marks to define the reciprocal height of hand, shoulder, and head. This is a body burdened by its own dead weight, supported from above by cords (which are barely sketched in). Raphael studied the situation as if it involved a pair of scales, which he arranged so that the hand and the head are on the same level, perfectly balanced.

The vertical line passing between the point where the two arms meet and through the groin marks the point of departure for the figure in a vertical position: if the figure were to raise itself, its head, shoulder, and hip would lie along this line. The purpose of this vertical line is thus to provide a visual measure of how far the hip (and, in general, the lower part of the body) has moved away from a vertical position as a result of the body's weight. As in Leonardo's studies (and, later on, those of Rubens), it is weight that generates movement in the human body.

A similar situation arises with a famous drawing from the same years for the Borghese *Deposition* (fig. 21) in which there are also preparatory lines for studying the figures' equilibrium.[17] The unconscious figure of the Virgin, represented as a skeleton, is a dead weight supported by a pious woman, just as the body in the Metropolitan Museum's drawing is held up by cords. The seeming inexactness of the skeleton in this and other sheets by Raphael has certainly contributed to the underrating of his anatomical drawings, but this can be explained by the fact that they were made above all in order to study the static and dynamic equilibrium of the body.[18]

During the same years in Florence, Leonardo was studying anatomy and equilibrium and using linear markings as part of his technique (see fig. 11). It is thus likely that Raphael took his cue from Leonardo. That he was studying Leonardo's compositions in this period is confirmed by a small sketch of Leonardo's lost fresco *The Battle of Anghiari* in the corner of a sheet of studies (now in the Ashmolean Museum, Oxford) Raphael made for the *Trinity* he painted in about 1505 in the Chapel of San

Severo in Perugia and by a copy he made in about 1507 of a now lost drawing by Leonardo for his *Leda and the Swan* (Royal Library, Windsor Castle).[19] From both Pollaiuolo and Michelangelo Raphael inherited a propensity for studying muscles in the context of nudes, but he then elaborated a personal morphology, his own anatomical canon, with schematic representations of muscles as plates enclosed by lines, mostly in pen drawings like some of Michelangelo's anatomical studies.[20]

One of these drawings by Raphael (fig. 22), created in the same period as the drawing in the Metropolitan Museum, was the basis for a plate published, with minimal alterations and the addition of a landscape, in the *Isagoge breves* of the physician and anatomist Jacopo Berengario da Carpi (fig. 23). Berengario's *Commentaria*, published in Bologna in 1521, and the abbreviated but more successful edition entitled *Isagoge breves* he brought out in 1522 were the first printed anatomical treatises to contain original illustrations not based on precedents from medieval manuscripts. According to the sculptor Benvenuto Cellini, Berengario "was a great connoisseur in the arts of design."[21] He had a special penchant for Raphael's work. Vasari recounts that "for Cardinal Colonna [Raphael] painted a S. John on canvas, for which, on account of its beauty, that Cardinal had an extraordinary love; but happening to be attacked by illness, he was asked by Messer Jacopo da Carpi, the physician who cured him, to give it to him as a present; and because of this desire of Messer Jacopo, to whom he felt himself very deeply indebted, he gave it up."[22]

22. Raphael, or copy after. The lateral muscles of the body and other anatomical studies, ca. 1507–8. Pen and ink and black chalk, 16⅜ x 10⅜ in. (41.6 x 26.2 cm). Palais des Beaux-Arts, Lille (Pl. 490)

23. The lateral muscles of the body. Woodcut in Jacopo Berengario da Carpi (ca. 1465–1530), *Isagoge breves* . . . , printed in Bologna by Benedetto di Ettore Faelli in 1522, p. 69. Biblioteca Estense Universitaria, Modena (alfa.K.10.7)

What is significant here is the fact that a leading anatomist composed his treatise using, nearly verbatim, an anatomical illustration created by an artist-anatomist. (In fact only a few of the images in Berengario's treatises, the coarser ones relating, for instance, to the skeleton and the vessels of the limbs, seem not to have been artistic in origin.) Raphael's drawing may also have been an indirect source, through the printed version in Berengario's treatise, for a plate in Vesalius's *De humani corporis fabrica* (fig. 29), and the image became canonical for artist-anatomists, as copies of it appear in a sixteenth-century album of models for artists.[23] Drawings by Michelangelo were also widely reproduced (see figs. 24, 25). These copies (or copies of copies) of lost originals have been little studied because of their artistic inferiority, yet they are of great importance, especially in the case of Michelangelo, for reconstructing the history of the anatomical-artistic models that were also available for scientists to adopt for their treatises. They also provide clear evidence of the authoritative quality of the anatomical investigations carried out by Renaissance artists.

It would not be long, however, before scientists finally assumed a dominant role in the genesis of anatomical illustrations. In 1545 the French anatomist Charles Estienne finally succeeded, after a series of editorial misadventures that included a lawsuit brought by a fellow medical student who accused him of plagiarism, in publishing an anatomical treatise: *De dissectione partium corporis humani*.[24] Estienne belonged to a famous family of Paris printers connected with the French court. His book was already complete, and even partly set in type, in 1539, the year before he finished his medical training. The Latin edition was finally printed in 1545, after the lawsuit was settled, and a French edition was published the next year. Estienne's stepfather, Simon de Colines, supervised the work at the Estienne Press.

Estienne had studied in Italy, in Padua, between 1530 and 1534, and once back in Paris he worked in Italianate surroundings that must have prompted him to seek an artistic framework for his anatomical images. For the illustrations in book 3 of his treatise he adapted the prints from a series entitled *Gli amori degli dei* (The Loves of the Gods) engraved in 1527 by Giovanni Jacopo Caraglio after drawings by Perino del Vaga and Rosso Fiorentino (see figs. 26, 27). Once again an anatomist was appropriating images produced by an artist, although Estienne used the figures in the prints only as a frame for the anatomical details, which had been separately engraved and were completely new. (In many cases one can make out the edges of the insertion.) Others of Estienne's anatomical plates seem entirely original (see fig. 28).

Estienne was certainly a step ahead of Berengario da Carpi. As author, he had control over the decisions regarding the anatomical content of the images in his treatise, whereas in Berengario's treatises this was so with only a few quite simple images. Yet the illustrations tinge Estienne's book with schizophrenia: the figures made by artists (fig. 27) are elegant; those executed from the very beginning by an anatomist (fig. 28) are, from an artistic point of view, coarse. The decisive stride came with *De humani corporis fabrica* by Andreas Vesalius, who had studied medicine alongside Estienne in Paris in the 1530s.[25] In Vesalius's treatise, which was prepared in Padua, where he taught between 1537 and 1543, and printed in Basel in 1543, the anatomist controlled the content of the illustrations, but this time with no loss of artistic quality or classical style. Just twenty

24. Italy, 16th century. Anatomical studies of a leg in the style of Michelangelo. Pen and brown ink and red chalk, 6¾ x 5⅛ in. (17.2 x 13.1 cm). The Metropolitan Museum of Art, Gift of Herbert N. Straus, 1921 (21.15.1)

25. Italy, 16th century. Anatomical study of a leg in the style of Michelangelo. Pen and brown ink, 4½ x 3½ in. (11.4 x 8.8 cm). The Metropolitan Museum of Art, Gift of Herbert N. Straus, 1921 (21.15.2). Figs. 24 and 25 both refer to various copies in the style of Michelangelo's pen and ink anatomical drawings.

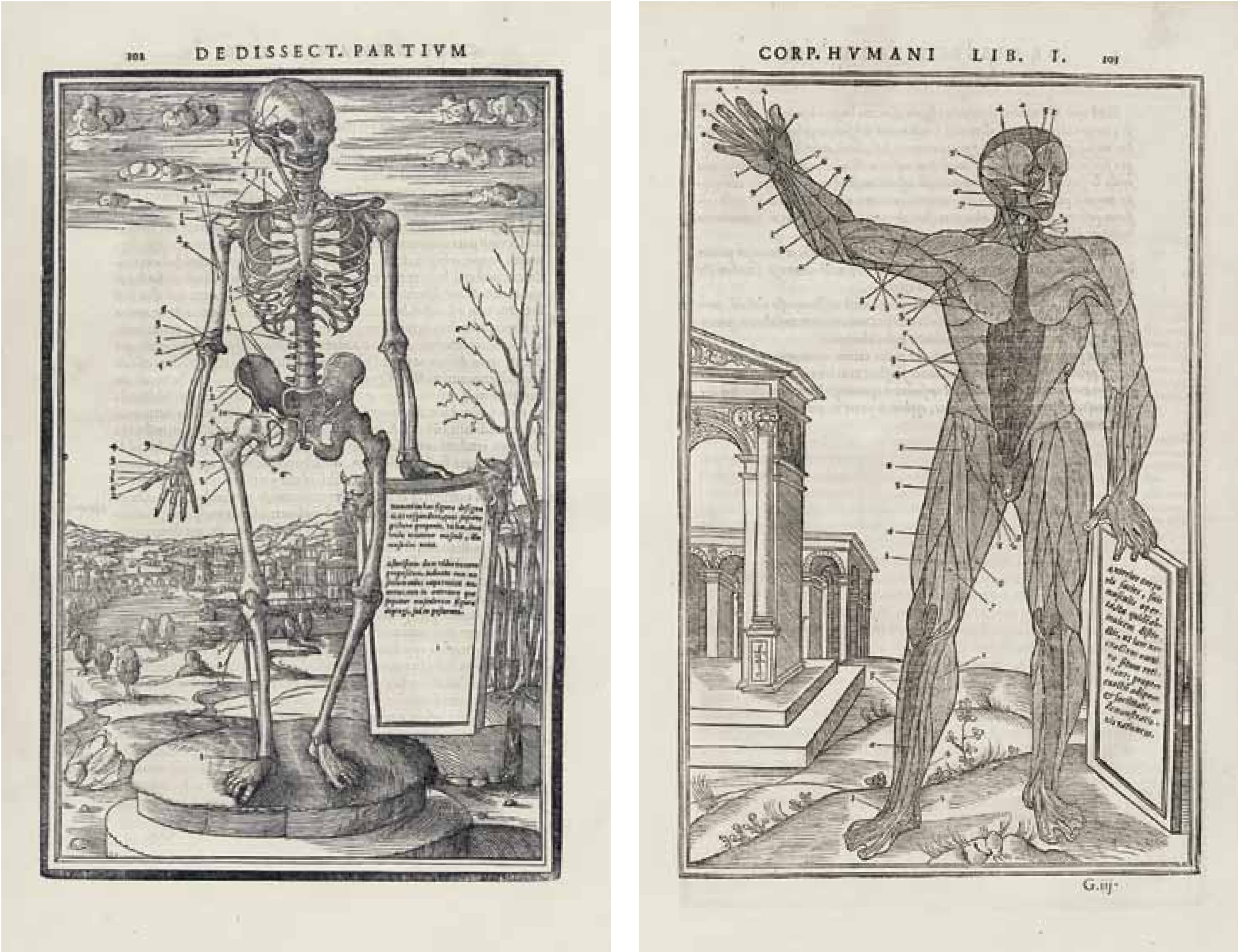
years after Berengario published his treatises, the qualitative leap seems enormous: like the first edition of the *Fasciculus medicinae* and Pollaiuolo's engraving, Vesalius's book is large; it contains hundreds of images; and, unlike Berengario's illustrations, which have no direct link to the text, the images are related to the text through cross-reference symbols in the margins and in the images (see fig. 29).

The ball seems to have passed entirely into the court of the scientist-anatomists. They were not artists and thus did not know how to reproduce reality, except in a most approximate way. But Vesalius, like other scientists of the prephotographic era, had acquired a certain skill as a draftsman, and it was probably he who drew the simplest illustrations for his treatise, such as those of the vessels. In order to illustrate the principal images, however, he must have turned to artists working in the Veneto, and then made sure that their drawings were cut into woodblocks and printed. In the age of what was truly a revolution, in which the publication of new discoveries entailed the use of novelty in both technique (printing) and visual language (realistic images), anatomists were forced to transform themselves into entrepreneurs. Alongside their activity as researchers, they now had to supervise and organize the results of their research. (During these same years, in Rome, the physician Ippolito Salviani opened a printing press in his own home.) Vesalius's organizational skills distinguished him from Leonardo and other anatomists who either failed to publish their work or were less successful at it.

As regards the artist (or, more likely, artists) responsible for the plates in Vesalius's treatise, scholars have often proposed the names of John Stephen Calcar, the

26. Giovanni Jacopo Caraglio (Italian, Parma or Verona ca. 1500/1505–1565 Kraków?), after Rosso Fiorentino. *Pluto and Proserpina*, 1527. Engraving. Albertina, Vienna (It I 25, fol. 23 [Bartsch 22])

27. Female figure with abdominal organs. Woodcut in Charles Estienne (ca. 1505–1564), *De dissectione partium corporis humani*, printed in Paris by Simon de Colines in 1545, p. 281. Book: 14⅛ x 9¼ in. (35.9 x 23.4 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund 1942 (42.138)



28. Skeleton and muscles. Woodcuts in Charles Estienne, *De dissectione partium corporis humani*, printed in Paris by Simon de Colines in 1545, pp. 102–3. Book: 14⅛ x 9¼ in. (35.9 x 23.4 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1942 (42.138)

sculptor Jacopo Sansovino, and even Titian, but their suggestions are not backed by any concrete evidence. In fact the artistic authorship of the plates of this true masterpiece of scientific publishing remains unknown. But this is understandable: the protagonist's role was played by the scientist-entrepreneur, and the artist, in this instance, had a strictly supporting part.

Vesalius's main contribution to the study of anatomy was his demonstration of the many errors made by Galen. He pointed out that Galen based a number of his conclusions on his dissection of animals. The rete mirabile, or network of vessels, exists at the base of the brain only in hoofed creatures, for example, and not in humans, as Galen had claimed. Vesalius also cast doubt on Galen's supposition that there were holes in the interventricular septum of the heart to allow the arteries to carry blood to the "higher" organs while the veins carry it to the "lesser" ones—an assumption that hindered anatomists' understanding of the circulation of the blood for the next fourteen centuries (although Vesalius challenged only the existence of the holes, and not the remainder of Galen's theory). The success of Vesalius's work was due above all to the extraordinary orchestration of images in his treatise. The *Fabrica* was republished in 1555 with a partly revised text and in a larger typeface. The author had himself portrayed in the frontispiece with his right hand resting on a cadaver (fig. 30), quite different from the scene depicted in the *Fasiculo de medicina* *in volgare* (fig. 3), where one professor of anatomy occupies the lecturer's chair while another uses a rod to indicate the parts of the body being sliced away by a surgeon or barber.

If Vesalius was ahead of Estienne in his ability to unite the scientific and artistic aspects of his plates, one profoundly important facet—the woodcut technique—makes Estienne's treatise more advanced. In both the plates that were entirely original and the separately carved anatomical details inserted into preexisting woodblocks, the artists working under Estienne's direction used an extremely refined system of thin and above all minutely varied strokes—parallel, curved, or with broad, medium, or fine cross-hatching. The system served to give volume to the forms, for example in the skeleton or internal organs, but first and foremost it allowed the artists to represent the directions of the muscular fasciculi, or fibers, which differ from muscle to muscle. (In his captions Estienne emphasized that the illustrations represented not only the locations of the muscles but above all the "filamentorum genera.") The exquisitely scientific aim of Estienne's illustrations has been practically ignored by historians, but it was of great significance for subsequent anatomists. When one compares Estienne's and Vesalius's plates relating to muscles (figs. 28, 29) the difference is clear. Vesalius's images, in which hatching serves chiefly to convey volume, are artistically very successful; Estienne's, where hatching is used to render the varied texture of the muscles, are flat and less aesthetically appealing but more complete from a strictly scientific point of view, because apart from distinguishing the various muscles they also represent their differing textures. In producing these technically sophisticated illustrations Estienne was certainly aided by his family's progressive printing expertise, which had also produced woodcuts such as those of the famed humanist Geoffroy Tory, some of them so detailed they could be mistaken for engravings.

The great challenge for anatomists in the next generation lay precisely in the adoption of engraving rather than woodcut to describe anatomical details such as the fascicular structure of muscles. Anatomical engraving was for many years the prerogative of artists, following Pollaiuolo (see fig. 6). It was very likely in France, in the same period that Estienne published his treatise, that Domenico Fiorentino published an engraving of an anatomical subject (fig. 31). Domenico Ricoveri del Barbiere, known as Domenico Fiorentino, was a Florentine artist who together with Rosso Fiorentino, another artist-anatomist to whom the drawing for this print is sometimes attributed, had left Italy to work at the court of Francis I in Paris and at Fontainebleau. The engraving presents

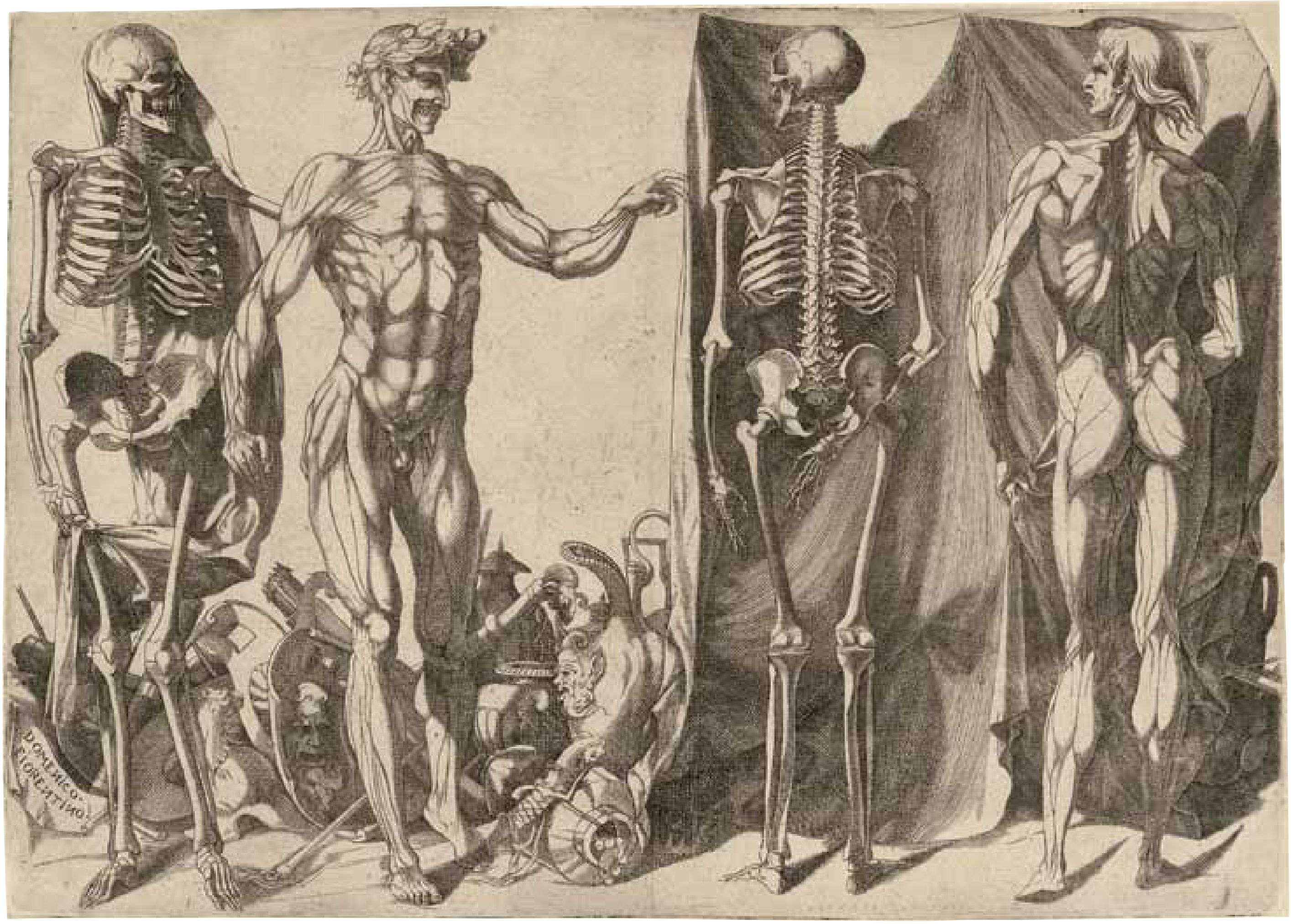
29. The lateral muscles of the body. Woodcut in Andreas Vesalius (1514–1564), *De humani corporis fabrica* (1st ed. 1543), printed in Basel by Johannes Oporinus in 1555, p. 214. Book: 15½ x 10½ in. (39.5 x 26.7 cm). The Metropolitan Museum of Art, Gift of Dr. Alfred E. Cohn, in honor of William M. Ivins Jr., 1953 (53.682). It is possible that Raphael's anatomical image (fig. 22), through its printed version in the treatise by Berengario da Carpi (fig. 23), had some influence on this plate, but only in relation to general posture, not anatomical detail. See also frontispiece, page 4.

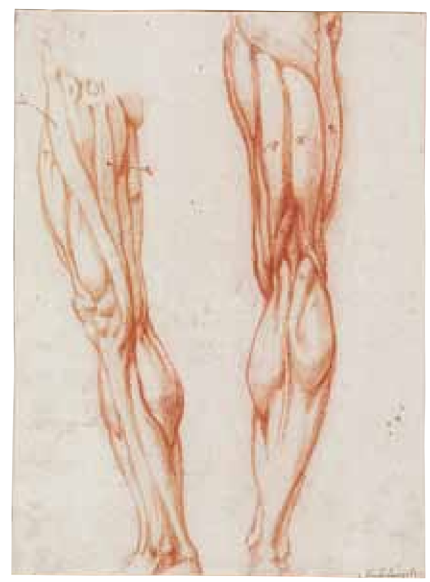
30. Andreas Vesalius dissecting the body of a woman. Woodcut in Andreas Vesalius, *De humani corporis fabrica* (1st ed. 1543), printed in Basel by Johannes Oporinus in 1555, frontispiece. Book: 15½ x 10½ in. (39.5 x 26.7 cm). The Metropolitan Museum of Art, Gift of Dr. Alfred E. Cohn, in honor of William M. Ivins Jr., 1953 (53.682)

31. Domenico del Barbiere, called Domenico Fiorentino (Italian, Florence? 1506–1565 Paris). Two flayed men and their skeletons, ca. 1540–45. Engraving, 9½ x 13¼ in. (24.1 x 33.6 cm). The Metropolitan Museum of Art, The Elisha Whittelsey Collection, The Elisha Whittelsey Fund, 1949 (49.95.181)

32. Michelangelo Buonarroti, or copy after. The muscles of a male leg, ca. 1518. Red chalk, 11⅛ x 8⅛ in. (28.2 x 20.7 cm). The Royal Collection, Royal Library, Windsor Castle (RL 0803)

views of the muscles and skeleton side by side, as in Estienne's book, and the graphic technique is painstaking and delicate, like the technique Estienne developed for the muscular fascicles. While the scientist Estienne continued, however, to use woodcut, as in earlier anatomical books, the artist Domenico made masterly use of engraving. Nevertheless, as an artist, Domenico was uninterested in the scientific potential of engraving, which in his hands served to describe muscles in relief (as Michelangelo



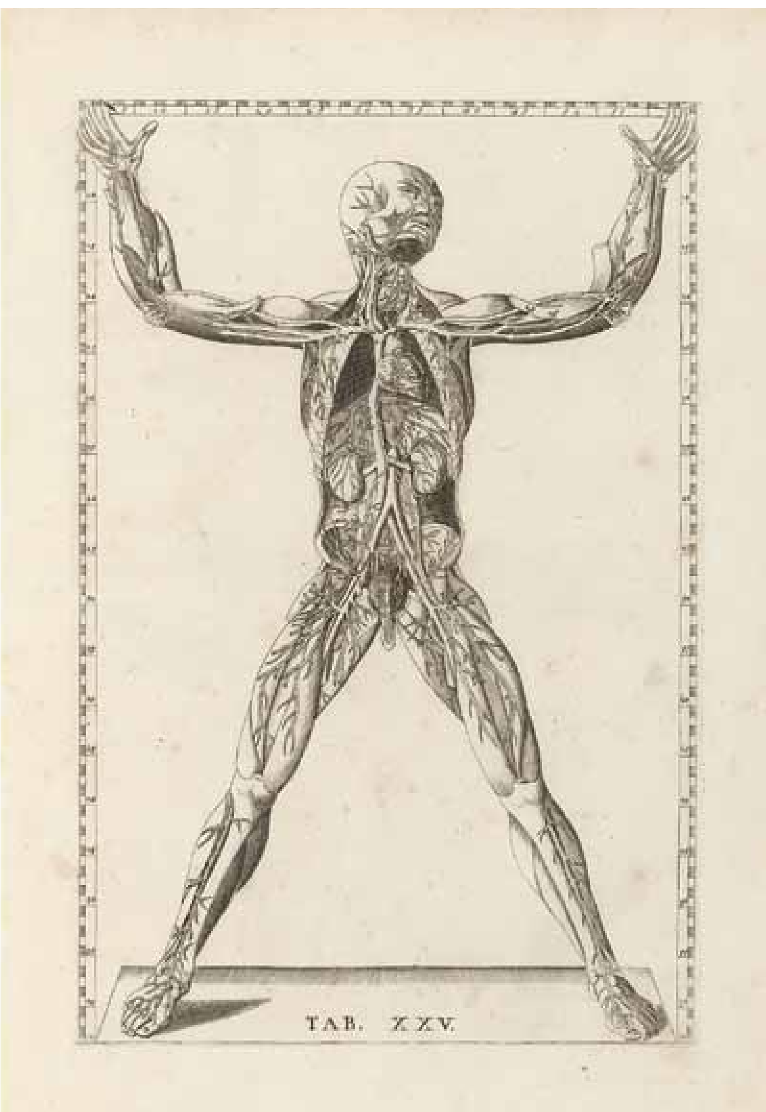


had done some twenty-five years earlier; see fig. 32), not to indicate the varied progression of their component filaments. A scientist's request for anatomical detail and a response expressed through a language mastered only by an artist (engraving) would not coincide until a few years later, in Rome, where the epicenter of anatomical research seems to have moved during the mid-sixteenth century, not only for scientific reasons but also in conjunction with dramatic events in the history of religion.

Rome was, for obvious reasons, the center of Catholic reaction to the Lutheran schism that threatened the papacy from Germany and other areas of northern Europe. In late 1545 the Roman Church gathered in a great council at Trent, in the north of Italy and thus geographically close to the disaffected territories to the north. Yet though the council was convened with the aim of unification, it only made the divisions more inflexible—for the Protestants, for the Greek Church, and for philosophical and scientific culture. The papal *Index librorum prohibitorum* (Index of Prohibited Books), first published under Paul IV in 1559 and then revised by a commission established by the Council of Trent and reissued in 1564, banned such fundamental scientific texts as Copernicus's astronomical treatise. In this atmosphere of tension, Rome saw the emergence of a sort of "Catholic anatomy" in opposition to the Vesalian, northern European view. The protestations of the Fleming Vesalius against the authority of Galen were in essence comparable to the resistance of the German Martin Luther against the authority of the Church fathers.[26] Progress in anatomy nonetheless moved on both fronts.

Many of the "Catholic anatomists" contributed, like Vesalius, to the renewal of the discipline with innovations in both content and visual language. In Rome Bartolomeus Eustachius (ca. 1500/1510–1574) promoted dissection as the method for identifying the cause of death (pathological anatomy) and wrote anatomical works whose hallmark was a focus on individual organs, for instance, the kidneys. Anatomists were increasingly drawn to observing single organs in close detail, and Eustachius's anatomy was defined by his successors as *anatomia artificiosa et subtilis* (sophisticated and minute anatomy). The demands of science called for a new vocabulary and new techniques capable of expressing the fine structure of anatomical forms through printed images. Thus there ensued a shift from the woodcut (the method used in anatomical treatises up to this point) to engraving, almost always on copperplates. The move was not painless and caused many failures or near failures in the publishing world.

Eustachius was among the first to have the images for his treatises engraved on copper, but he succeeded in publishing, in *Opuscula anatomica*, printed in Venice in 1564, only the plates relating to single organs and small parts of the body. The larger, more ambitious plates destined for a more general anatomical treatise (*De dissensionibus ac controversiis anatomicis*, or On the Disagreements and Controversies of the Anatomists, the text of which was lost after Eustachius's death), which as Eustachius declared in *Opuscula anatomica* had been ready as early as 1552, were printed in 1714 by the chief papal physician Giovanni Maria Lancisi and in subsequent editions (see fig. 33). The illustrations Eustachius published in 1564 were included as plates I–VIII in the posthumous *Tabulae anatomicae* of 1714. Their author remains unknown, although Battista Franco has been proposed.[27]



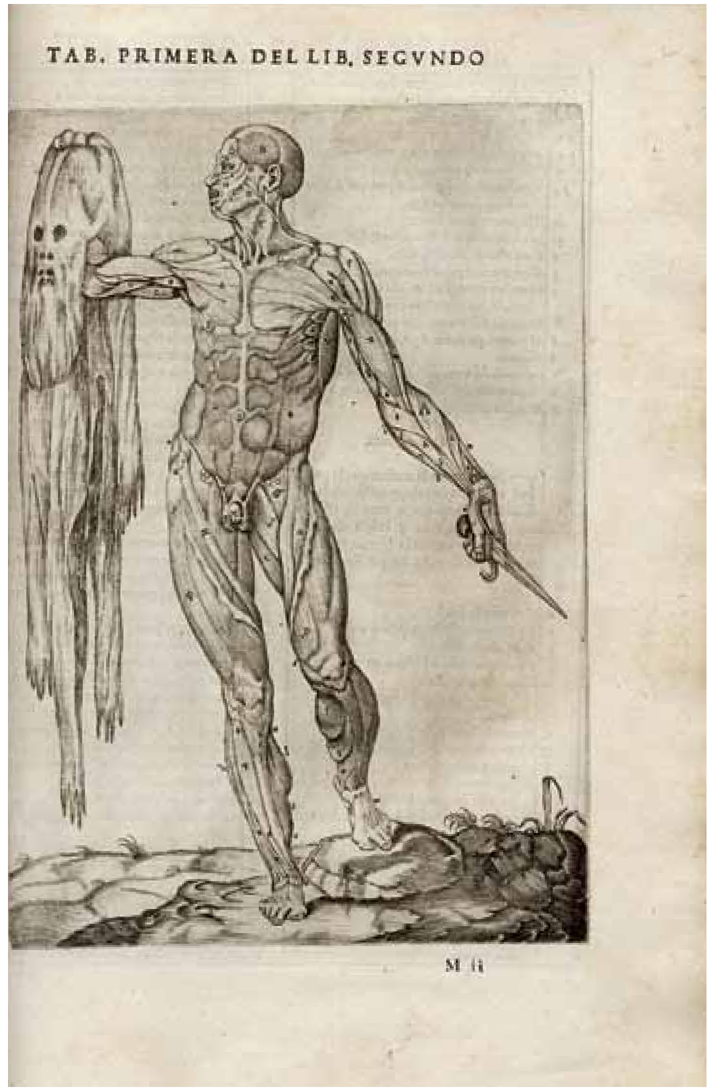
33. Arteries, veins, heart, and other organs. Engraving in G. M. Lancisi, ed., *Tabulae anatomicae clarissimi viri Bartholomaei Eustachii . . .* , printed in Rome by Lorenzo and Tommaso Pagliarini in 1728, pl. XXV. Book: 14½ x 10½ in. (36.8 x 26.7 cm). The Metropolitan Museum of Art, Gift of Lincoln Kirstein, 1952 (52.546.2)

Like a cartographer, Eustachius plotted the human body as if it were Earth, following the ancient analogy between microcosm and macrocosm. An innovative graduated frame enclosed each image, allowing every detail of the figure to be cited in the text. This system, which had a sparse following, answered the ever-growing demand for images unobscured by numbers or letters. In his comments on the first two plates in his treatise illustrating the structure of muscles (see fig. 29), Vesalius was already proud of having used as few labels as possible.

Engraving was also the preferred medium of the Ferrarese anatomist Giovanni Battista

Canano for his treatise *Musculorum humani corporis picturata dissectio* (An Illustrated Dissection of the Muscles of the Human Body), the plates for which were designed by Girolamo da Carpi.[28] During the time he spent in Rome after being appointed chief papal physician in 1552, Canano may have influenced Eustachius, but his work was another case of near failure, for he managed to publish only the first of seven projected volumes. His book, which carried no place or date of publication, is thought to have been printed in Ferrara in 1541, in a very small run (copies of it are extremely rare) and with unsuitable materials that allow the figures and text to show through the paper.

Also in Rome, in 1556, the Spanish anatomist Juan Valverde de Hamusco published a complete treatise, *Historia de la composición del cuerpo humano*, accompanied by excellent copper engravings.[29] Finally, success was at hand, in terms of sales as well, as attested by the number of subsequent editions. Valverde used many of Vesalius's figures, and plagiarism was suspected, but in reality the repetition confirms that by then a new visual canon—not anatomical-artistic in origin but scientific—had asserted itself. Eustachius and Valverde made thorough use of the capabilities of copper engraving, and they succeeded in representing the varied directions of muscular fasciculi without losing the qualities of relief and volume. From then on, images in anatomical treatises were often engraved, either with a burin or by etching.



34. Nicolas Beatrizet (French, Lunéville 1515–ca. 1566 Rome?), after a drawing traditionally attributed to Gaspar Becerra. Écorché holding his own skin. Engraving in Juan Valverde de Hamusco (ca. 1525–ca. 1588), *Historia de la composición del cuerpo humano*, printed in Rome by Antonio Salamanca and Antonio Lafrerij in 1556, book 2, pl. I. Biblioteca Casanatense, Rome (N.IV.50)

Valverde was in part sincere when he said in a letter to King Philip II of Spain that he reused Vesalian figures to show how his anatomical content differed from Vesalius's, and to emphasize the technical limitations of woodblock printing as compared with engraving. Commenting on one of his plates, he wrote, "And it should be known that this one [fig. 34] is different in this respect from those of Vesalius, since here the shading demonstrates the progression of the filaments of flesh, according to how they run individually through each muscle." The success of Valverde's work can also be attributed to his choice of an expert engraver, Nicolas Beatrizet, an artist from Lorraine who worked in Rome and in 1554 had also engraved plates for *Aquatilium animalium historiae,* a treatise on fish by the physician Ippolito Salviani. The drawings themselves have for centuries been attributed to the Spanish artist Gaspar Becerra, who may have been a pupil of Michelangelo's.

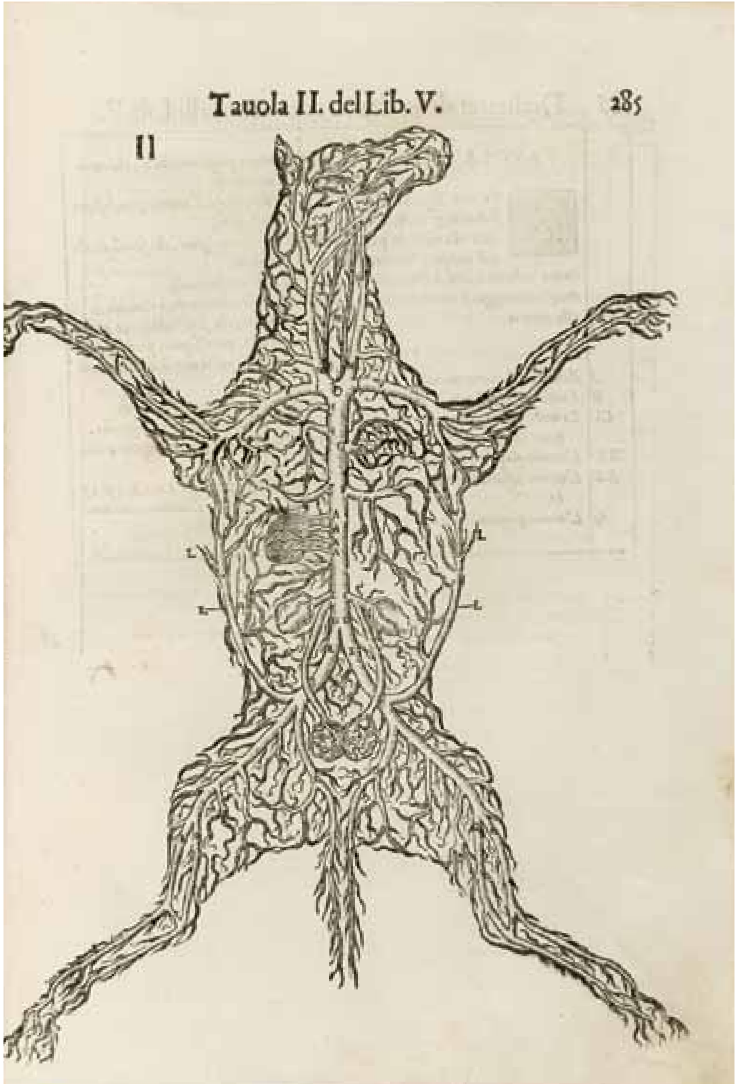
Realdo Colombo, another anatomist living in Rome in the 1550s, aimed very high when it came to selecting an artist to design the plates for his treatise, if indeed Michelangelo was "the premier painter in the world" Colombo was referring to when he wrote to Duke Cosimo I de' Medici to ask whether he might be exempted from teaching in Pisa so as to remain in Rome to work on his treatise. In 1548 Colombo took a position at the Sapienza University of Rome, where he remained until he died in 1559. Colombo is credited with several important anatomical discoveries; he made considerable progress, for example, toward an understanding of the circulation of the blood, yet without fully explaining it. His book, however, *De re anatomica*, completed in 1557 but printed in 1559 in Venice just before his death, appeared without anatomical plates—yet another failure in the feverish publishing climate that was the common lot of anatomists during these years.

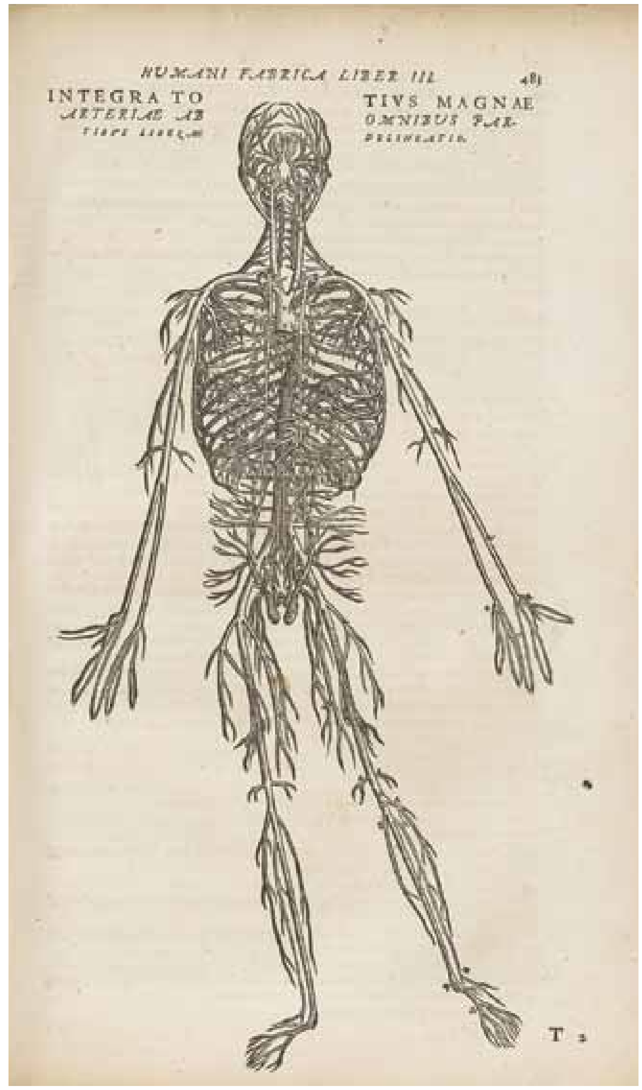
All the anatomical treatises considered thus far, from Berengario's to Colombo's, related to human anatomy. Vesalius represented the most radical form of this anthropocentric view, which in his case formed part of his anti-Galen polemic. The great classical anatomist Galen had the merit of placing dissection at center stage (and in this respect Vesalius followed his example), but he dissected animals (especially apes) rather than humans, improperly attributing certain details of animal anatomy to the human body and thus perpetuating errors. A woodcut published in Venice in the mid-sixteenth century that represents the figures of the celebrated classical group *The Laocoön* as apes (fig. 35) is perhaps a reflection of this Vesalian controversy.[30]

While during the classical era Galen used animal anatomy to reconstruct that of humans, Aristotle, some five hundred years earlier, dissected animals in order to give general definition to the anatomy of "animals," including human beings. This Aristotelian concept was revived toward the end of the sixteenth century by many anatomists who abandoned the anthropocentric formulation of Vesalius in favor of what is now called "comparative anatomy" and during the Renaissance was defined as *de animalibus*.

In his *Anatomia del cavallo, infermità et suoi rimedii* (Anatomy of the Horse, Sickness and Its Remedies), first published in Bologna in 1598, Carlo Ruini applied to the horse the visual formulas Vesalius had established for human anatomy (see figs. 36, 37).[31] Like Vesalius, he used woodcuts instead of engravings. This confirms that scientists had by now created their own independent visual canons, and that the most important among these was that of Vesalius. Nevertheless, in an indirect way, Ruini succeeded in creating a comparison between a horse (his treatise) and a man (Vesalius's treatise) that aligned him with anatomical research that was both new and distinct from Vesalius's. Likewise, at the turn of the century, in his *De vocis*, the anatomist Giulio Cesare Casserio, who practiced medicine in Padua and also taught at the university there, used comparative illustrations of the larynx and auditory apparatus of men and beasts (see figs. 38, 39). In his preface Casserio stated that Joseph Maurer (identified by some as the Swiss artist Josias Murer) was working for him as an

35. Attributed to Niccolò Boldrini (Italian, born ca. 1500, active in Venice 1530–70), after Titian. Caricature of *The Laocoön*, mid-16th century. Woodcut, image 10¾ x 15¾ in. (27.3 x 40 cm). The Metropolitan Museum of Art, Rogers Fund, 1922 (22.73.3-125)





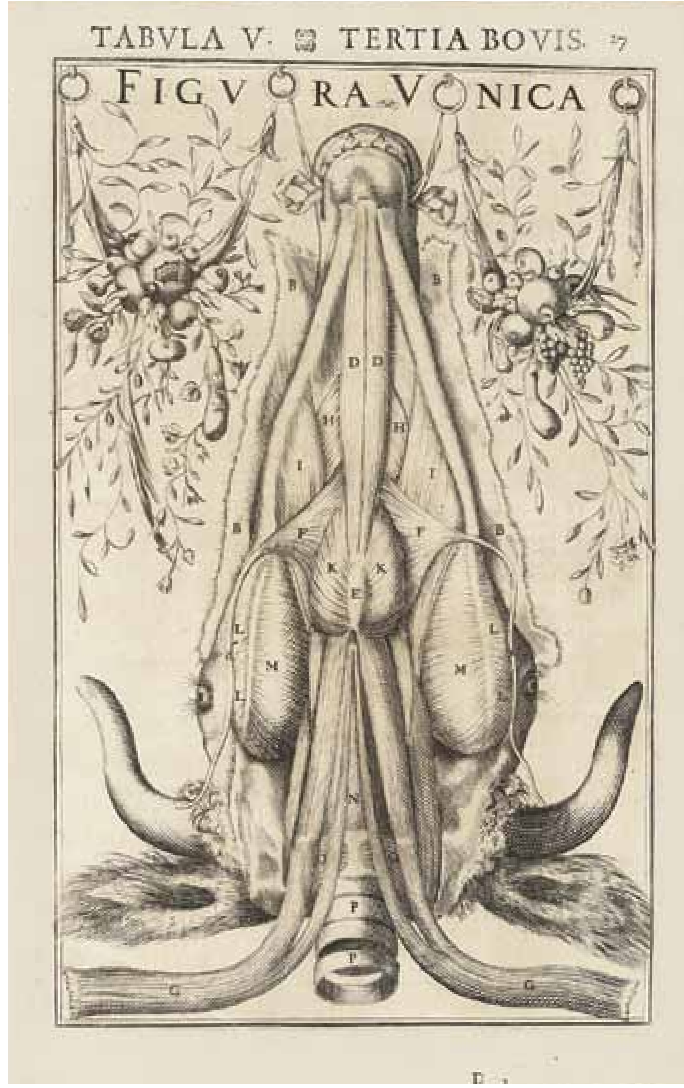
illustrator. From the point of view of content, anatomists' attention to specific organs (as in Eustachius's work) was confirmed, and as regarded visual language, so was their trust in engraving. Also belonging to this line of inquiry *de animalibus* was the work of the English physician William Harvey (also trained at the University of Padua), who in his *Exercitatio anatomica de motu cordis et sanguinis in animalibus* (An Anatomical Exercise on the Motion of the Heart and Blood in Animals), published in Frankfurt in 1628, finally succeeded in explaining the circulation of the blood.

What happened, during the course of the sixteenth century, to the artist-anatomists? Their number increased, but the relationship between art and anatomy never regained the stature it had enjoyed with Leonardo, Michelangelo, and Raphael. There was a divergence. Artistic activity, often quite mediocre, was overwhelmed by the intense anatomical research of artists and (especially toward the end of the century) by their theoretical and scholarly interest in the human figure. This was the era of the artist-scholars, who were occasionally the authors of didactic texts, and anatomy itself became an established part of the curriculum in art academies.

Contemporary artists and scholars were immediately aware of this state of affairs. Giorgio Vasari judged the nudes painted by Battista Franco, a Venetian artist who lived for many years in Rome, "di maniera cruda" and graceless in manner,

36. The arterial tree of the horse. Woodcut in Carlo Ruini (1530–1598), *Anatomia del cavallo, infermità et suoi rimedii . . .* , printed in Venice by Gasparo Bindoni il Giovane in 1602, vol. 1, p. 285. Book: 13 x 9 in. (33.1 x 23 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1947 (47.144)

37. The human arterial tree. Woodcut in Andreas Vesalius, *De humani corporis fabrica* (1st ed. 1543), printed in Basel by Johannes Oporinus in 1555, p. 483. Book: 15½ x 10½ in. (39.5 x 26.7 cm). The Metropolitan Museum of Art, Gift of Dr. Alfred E. Cohn, in honor of William M. Ivins Jr., 1953 (53.682)



38–39. Joseph Maurer (possibly Josias Murer; Swiss, Zurich 1564–?1630). Anatomy of a man's throat; Anatomy of the throat of an ox. Engravings in Giulio Cesare Casserio (ca. 1552–1616), *De vocis auditusque organis historia anatomica* . . . (Anatomical History of the Organs of Speech and Hearing . . .), printed in Ferrara by Vittorio Baldino in 1600–1601, pp. 15, 27. Book: 15⅜ x 10⅝ in. (39.1 x 27 cm). The Metropolitan Museum of Art, Gift of Lincoln Kirstein, 1953 (53.605.1)

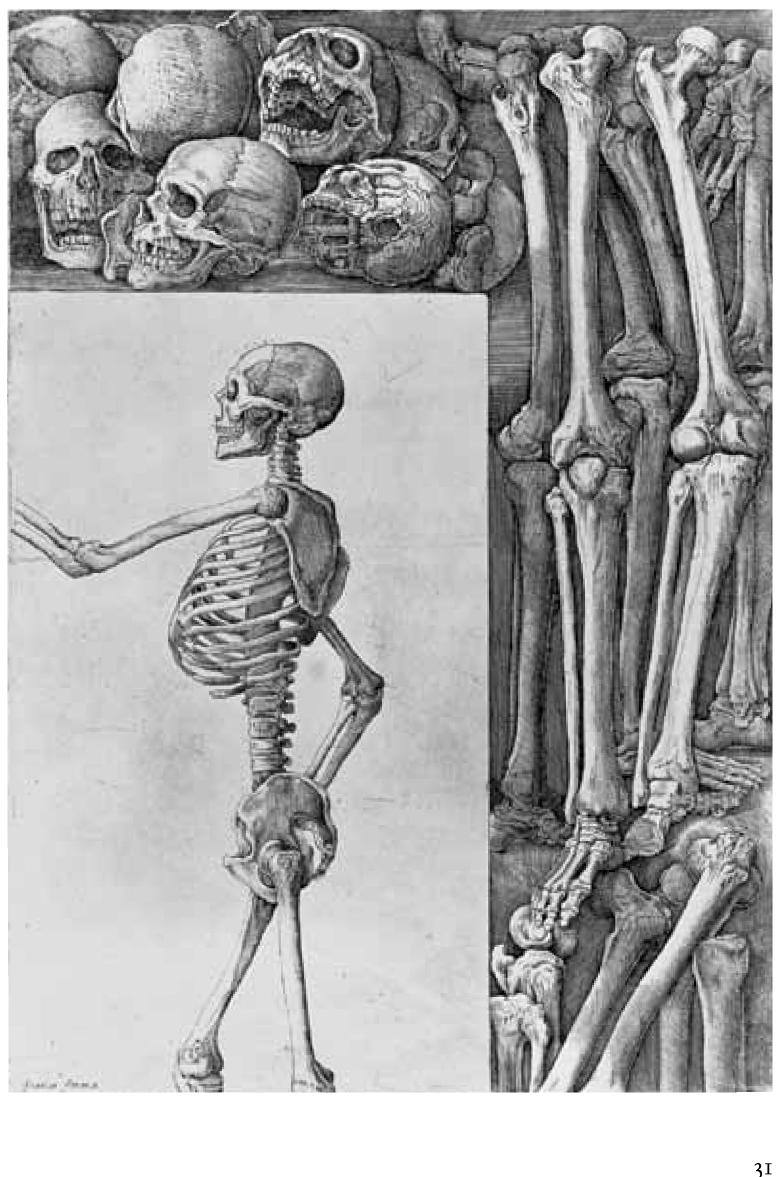
because Battista "wasted time beyond all reason over the minutiae of muscles and over drawing with too great diligence, while paying no attention to the other fields of art."[32] Vasari was referring to paintings like the *Arrest of Saint John the Baptist* Battista frescoed in the Oratory of San Giovanni Decollato in Rome in 1541. It is difficult to understand his reservations when it comes to Battista's anatomical drawings. Some of these drawings (see fig. 40) bear witness to the intense preparatory work Battista invested in a printed plate. He probably used a combination of lines incised with a burin and etching, a technique scientists would employ only years later. (The "anatomical caricature" and "Human Pyramid" prints attributed to the French-Italian sculptor Juste de Juste, who was at Fontainebleau in the 1530s before returning to his family's workshop in Tours, are further examples of etchings with anatomical subjects made by an artist.)

Battista Franco sought to convey the slightest variations in the surface appearance of bones, the "minutiae," as Vasari called them (see fig. 41), and he thus took up the challenge faced by anatomists in these years. Indeed, on this level he was decidedly ahead of his time: no scientific treatise of this period includes such a detailed illustration of bones. Artists who were also anatomists, like Battista—who may even have collaborated with Eustachius—were thus involved with hyperdetailed anatomy, the new subject attracting anatomists' interest. This seems to have been the very point Giovanni Battista Armenini, another Renaissance writer, was making when, like Vasari, he reproached those artists who lost themselves "in the minutiae of nudes" and indulged in "great and lengthy disputes over the minutest of lines in anatomy."[33]

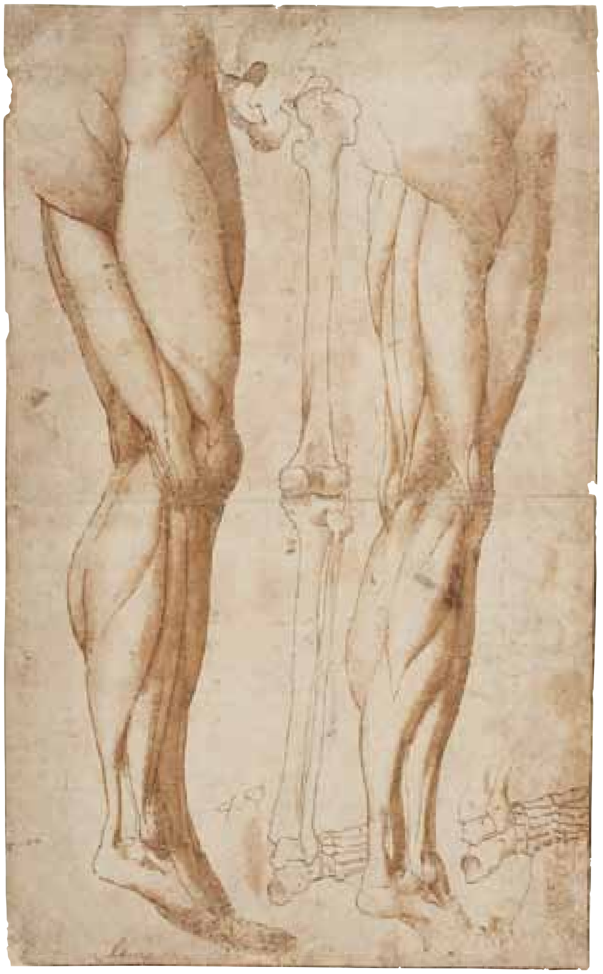
In any case, as far as is known these artists were more the exception than the rule, and during the sixteenth century the detailed structure of the muscles and other anatomical structures were illustrated only in scientific treatises—an important sign of the divergence of scientists' and artists' interest in anatomy at the time. The drawings made by artists generally represent the muscles in an abbreviated fashion, without much detail. Some highly finished, self-sufficient drawings, apparently not destined for engraving, were executed with wash, a quasi-pictorial technique that grants little opportunity for individual detail. In the mid-sixteenth century the Aretine artist Bartolomeo Torri used wash to render muscles in a summary manner (fig. 42). Bartolomeo is another example of an artist-anatomist who was completely engulfed by research, and Vasari described him in much the same way he did Battista Franco. Bartolomeo left his native Arezzo early on for Rome; there he worked with the miniaturist Giulio Clovio, yet his mind was entirely absorbed with anatomical drawings—what Vasari called his "sporcherie della notomia" (filthy anatomy). He "kept so many limbs and pieces of men under his bed and all over his rooms, that they poisoned the whole house" and forced Clovio to turn him out, notwithstanding the youth's promising talent. Torri died shortly thereafter in Arezzo, having persevered in his "usual studies and the same irregularities."[34]

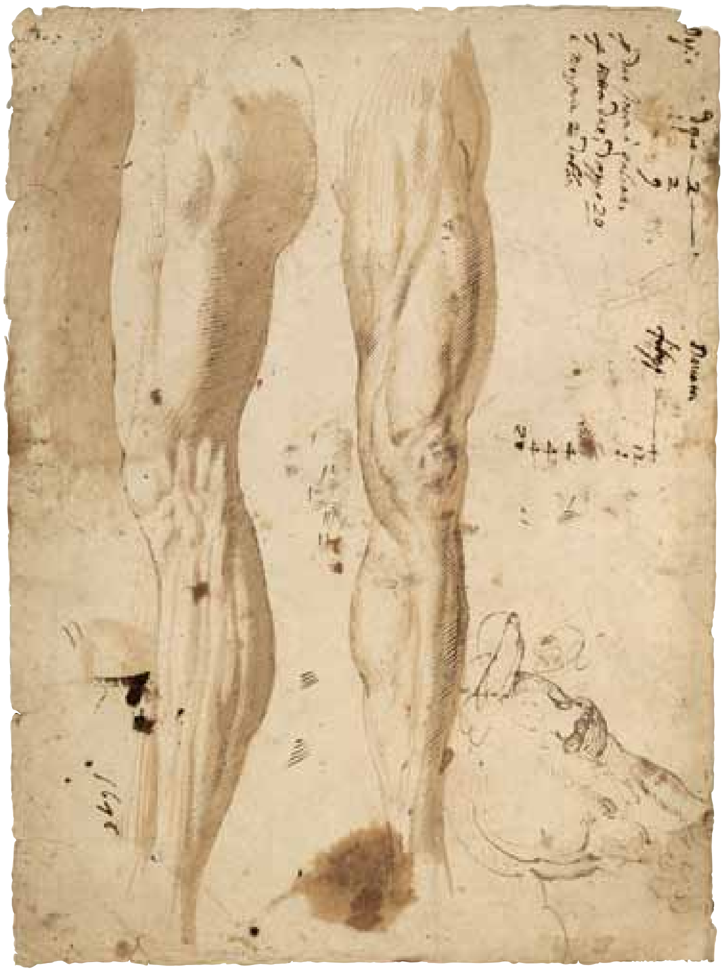
Unlike Battista Franco, whose more entrepreneurial spirit led him to consider the difficult but more promising market for printed images, Bartolomeo Torri apparently executed

40. Giovanni Battista Franco, called Il Semolei (Italian, Venice? 1510–1561 Venice), or copy after. Cranium and cervical column in profile. Pen and ink, 3⅞ x 2¾ in. (9.9 x 6.9 cm). The Metropolitan Museum of Art, Robert Lehman Collection, 1975 (1975.1.326). This drawing is either one of the various preparatory drawings Battista made for the engraving in fig. 41 or a copy after it.



41. Battista Franco. Skeleton in profile and bones. Etching and engraving, 18 x 12½ in. (45.8 x 31.8 cm). Albertina, Vienna (HB 3, Suppl., fol. 61,88 [Bartsch 69])





42. Bartolomeo Torri (or Torre; Italian, Arezzo ca. 1527–ca. 1552 Arezzo). Muscles and bones of the leg. Pen and brown ink, brush and brown wash; 16¾ x 10¼ in. (42.6 x 26 cm). Princeton University Art Museum, Bequest of Dan Fellows Platt, Class of 1895 (x1948-757)

43. Italy, 16th century. Studies of the superficial anatomy of the leg and a horse's head. Pen and brown ink, brush and brown wash; 13 x 9⅝ in. (33 x 24.5 cm). The Metropolitan Museum of Art, Robert Lehman Collection, 1975 (1975.1.377)

his anatomical-artistic drawings as independent works. Anatomical drawing, ostensibly based on the direct dissection of a cadaver (which Bartolomeo sometimes depicted hanging) appears to have been for him a genre in its own right. A sheet in the Metropolitan Museum that also falls into the category of a drawing using washes (fig. 43) is a typical study of how muscles relate to the surface of the body. To the right, directly above a horse's head, are the letters *Ba*. Could these be the first two letters of Bartolomeo Torri's name, which appears on other anatomical drawings certainly by him?[35]

Another singular and highly finished drawing (fig. 44) represents a body half flayed and half covered in skin. It seems to want to imitate the blackish tone of printed images without losing the pictorial quality of a watercolor. This could as easily be a study for a print as an experiment in comparing and emulating the different techniques of drawing and engraving.

The artist-anatomists such as Michelangelo and Bartolomeo Torri who carried out independent anatomical research are perhaps the most fascinating. These private dissections, quite distinct from the "public" ones performed in universities or hospitals, constitute an ever-mysterious and little-studied field, in part because there is so little official documentation. Vasari's description of Bartolomeo Torri keeping pieces of corpses in his home may be exaggerated. Yet when documents exist, they speak clearly. In the second half of the sixteenth century officials in Florence authorized the release of cadavers for dissection not only to physicians (understandable, to modern minds) but also to artists, including Vincenzo Danti and Alessandro Allori.[36] This was

44. Italy, 16th century. Figure with the right side of his body flayed. Pen, ink, wash, and white heightening, on watercolored paper, 9⅝ x 6⅞ in. (24.3 x 17.6 cm). The Pierpont Morgan Library, New York, Gift of H. P. Kraus, 1961 (1961.71)

45. Cornelis Cort (Netherlandish, Hoorn ca. 1533–1578 Rome), after Jan van der Straet, called Giovanni Stradano (Flemish, Bruges 1523–1605 Florence). *The Practitioners of the Visual Arts*, 1578. Engraving, 16⅞ x 11¼ in. (42.8 x 28.6 cm). The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1953 (53.600.509)

scarcely imaginable for most of contemporary society and offers further proof of artists' high social and cultural standing.

Artists' interest in anatomy also became institutionalized through academies. In Florence the Accademia del Disegno, founded in 1563, provided facilities for the study of anatomy through dissection during the winter months, and the same applied at the Carracci Academy in Bologna from the 1580s onward. The Accademia di San Luca in Rome, founded in 1593 under the direction of Federico Zuccaro, offered anatomy classes starting in 1607. A celebrated engraving by Cornelis Cort (fig. 45) is an ideal depiction of such settings. On the left, above a table bearing the word "ANATOMIA," is a flayed cadaver (or an écorché statue) hanging from a cord, a position often used for the study of muscles, as is proved by the drawings of Bartolomeo Torri and a passage by Vesalius about the plates illustrating muscles in his treatise.[37] Below that is a skeleton surrounded by young artists who are busily drawing it. Indeed, accepted practice dictated that students should start with the study of skeletons as the "foundation" of the human figure and then move on to other parts of the body, such as the muscles. After depicting sculpture, painting, and other artistic activities, Cort's engraving concludes at the right with academicians engraving on copper ("Typorum aeneorum INCISORIA"). That anatomy and engraving are arranged symmetrically at the left and right was surely not an accident.

A sheet in the Metropolitan Museum (fig. 46) exemplifies the didactic drawings categorized as "apprenticeship studies," which include direct studies of skeletons and

46. Italy, 16th century. Bones of the arm and other studies. Pen and brown ink, brown wash; 10⅝ x 7¼ in. (27 x 18.4 cm). The Metropolitan Museum of Art, Gift of Cornelius Vanderbilt, 1880 (80.3.613, verso)

47. Florence, 16th–17th century. An artist drawing an écorché. Pen and brown ink, brush and brown wash, with traces of black chalk or leadpoint; 14⅜ x 10 in. (36.5 x 25.4 cm). The Metropolitan Museum of Art, Gift of Cornelius Vanderbilt, 1880 (80.3.105)

48. Cigoli (Ludovico Cardi; Italian, Castelvecchio di Cigoli 1559–1613 Rome). Écorché, ca. 1600 (this cast, 17th–18th century). Bronze, h. 22⅞ in. (58 cm). Museo Nazionale del Bargello, Florence (29 [1879]). The wax original is also in the Bargello.

49. Leonardo da Vinci. The muscles of the shoulder, ca. 1510. Pen and ink with wash, over traces of black chalk; 11½ x 7¾ in. (29.2 x 19.8 cm). The Royal Collection, Royal Library, Windsor Castle (RL 19003v)

écorché sculptures, and also copies of famous sets of anatomical studies. Among the several studies on the Metropolitan sheet is one of the bones of the arm. The bones are represented almost lifesize, and written next to them are their scientific names in Latin: *Brachium* (arm), *fucilum minor* (radius), and *fucilum maior* (ulna). The names are abbreviated according to educated convention (*fucilū* instead of *fucilum*, for instance); the workshop in which the author of this study went through his paces was a fairly cultivated place.

Beyond drawing and engraving, especially after the middle of the sixteenth century, artist-anatomists also produced anatomical sculptures, called écorchés (French for "flayed"), representing the skinless body with its muscles in evidence, that were used in the place of cadavers for the teaching of anatomy. A large-scale, highly finished Florentine sheet (fig. 47) shows a young artist occupied in drawing an écorché. Like the engraving by Cort, this is a kind of artistic self-portrait, but it depicts a more realistic situation, since the statue it depicts recurs in various other drawings and thus actually existed.[38] The statue is similar to Cigoli's famous écorché of about 1600 (fig. 48), but it differs in the position of the head and the right arm (which recalls Michelangelo's *David*), in various anatomical details, and in its dimensions (Cigoli's statuette is about 23 inches high; the statue in the Museum's drawing is lifesize). As the most accurate of the several surviving drawings, this could therefore yield valuable evidence of a lost écorché sculpture of unusually large dimensions that would have been known by artists at the time.

Cigoli's statuette, in contrast to the drawing, represents not only the various muscles but also (and above all) the various directions of the muscular fasciculi (clearly visible in the bronze casts but less so in the wax original, which has been worn by prolonged use). That aspect has escaped scholarly notice, though it was remarked as early as the eighteenth century by Giovanni Battista Cardi, Cigoli's nephew, according to whom the artist represented not merely the origin of the muscles but how they "stretch lengthwise, or obliquely, or transversely."[39] This subject lay at the heart of questions that interested scientists more than artists; it was addressed in Cigoli's figure probably because the work was the outcome of his collaboration with the Swiss physician Théodore Turquet de Mayerne, who performed dissections at the hospital of Santa Maria Nuova in Florence.[40] The new formulation of muscular strands, until then expressed solely in graphic form (engraving), now existed in sculpture, with all the advantages of three-dimensionality.

The genesis of the statue in the Museum's drawing (fig. 47) was apparently strictly anatomical-artistic. Nonetheless, the similarities between the statue it depicts and Cigoli's statuette suggest they shared the same early origin: a tradition of anatomical study practiced in the studio of Pontormo (1494–1557), which included Bronzino (1503–1572), Alessandro Allori (1535–1607), and Cigoli, each the pupil of his predecessor and each the author of dissections carried out in the Florentine milieu of San Lorenzo. In his youth Pontormo had carefully studied the anatomical teachings of Leonardo, even though his best-known anatomical drawings reflect the style of Michelangelo.[41] The raised left arm of Cigoli's figure and of

the statue in the drawing recall a famous anatomical drawing by Leonardo (fig. 49) and may be a distant and indirect echo of Pontormo's initial interest in Leonardo's anatomical studies. It can hardly be fortuitous that the Metropolitan's drawing was initially assigned to the "school of Pontormo" and now carries a cautious attribution to Giovanni Battista Naldini (ca. 1537–1591), one of Pontormo's last pupils. A sheet in the Uffizi in Florence that reproduces the same statue also has a sketch of a Deposition similar to those Naldini studied in various drawings, including one now in the Metropolitan.[42]

As examples of Bronzino's and Allori's knowledge of anatomy Vasari cited two paintings of religious subjects: by Bronzino "a S. Bartholomew flayed, which has the appearance of a true anatomical subject and of a man flayed in reality, so natural it is and imitated with such diligence from an anatomical subject" (the fragmentary panel is in the Accademia di San Luca, Rome), and by Allori "a story of Ezekiel, when he saw a great multitude of bones reclothe themselves with flesh and take to themselves their members; in which this young man has demonstrated how much he desires to master the anatomy of the human body, and how he has studied it and given it his attention . . . in this his first work of importance" (*Ezekiel's Vision of the Resurrection of the Flesh*, now lost).[43] In each case the écorché body is part of a religious narrative. The notion of "Catholic anatomy" was valid for art as well as science.

In the spirit of the Galenist–Vesalian controversy that divided Catholic and reformed anatomists, public dissection became a parareligious ritual—an edifying spectacle in which the anatomist assumed the role of an officiating priest. Since every cadaver released by the authorities was that of a condemned criminal, the sinner could redeem his soul by shedding his blood on the dissecting table.[44] If on the one hand the Counter-Reformation Church covered the genitals of Michelangelo's nudes in the Sistine Chapel, on the other it encouraged artists to study anatomy as expedient for conveying the truths of faith to an uncultivated audience with immediacy and realistic, strongly emotive images, the martyred bodies of saints being particularly effective. This led to the further spread of anatomical awareness in painting, even if the process related more to the subject than to creative invention derived from the imitation of reality.

A baffling example of anatomy applied to painting in the spirit of the Counter-Reformation can be found in the bottom section of the *Last Judgment* in the dome of the cathedral in Florence. The fresco was begun by Vasari in 1572 and finished by Federico Zuccaro between 1575 and 1579. One of the major innovations Zuccaro grafted onto Vasari's plan was the introduction of dissected bodies in the scene of the damned, the so-called *termini*. A drawing by Zuccaro bears witness to his initial idea for one of these figures (see figs. 50–52), whose origin—whether an anatomical treatise, a sculpture, or an anatomical specimen—remains to be identified.[45]

After the middle of the sixteenth century, Lombardy saw a revival of the artistic tradition harking back to Leonardo, whose drawings and manuscripts, inherited by his pupil Francesco Melzi, were nearly all in or near Milan, at least until Melzi's heirs dispersed the collection in the late sixteenth century. (The sheets by Leonardo now in the Royal Library at Windsor Castle, including the anatomical drawings, were acquired in Milan by the sculptor Pompeo Leoni, who was living in Spain when he died in 1608, and they are are documented in Madrid in 1613, but exactly when they left Milan is not known.)[46] One of the protagonists of this revival was the Milanese painter Ambrogio Figino, who had direct access to Leonardo's drawings and who actually owned one of his manuscripts. A sheet by Figino, well known for its figures copied from the *Last Judgment* by Michelangelo (figs. 53–56), contains a number of much less studied but extremely interesting notations. Some are true miniatures, drawn with slender strokes of the pen or with red chalk that has either vanished or is visible only under close scrutiny. On the verso of the sheet, in the upper right corner, is a figure standing balanced on one foot, and to the left of this and below it are various drawings of the leg in which Figino studied the equilibrium of the pelvis in relation to the foot by means of a line between the pelvis and the tip of the foot (see fig. 56). The articulation of the hip is sometimes marked with a small circle. Both content and technique (red chalk and pen,

50–51. Federico Zuccaro (Zuccari; Italian, Sant'Angelo in Vado ca. 1540/42–1609 Ancona). Study for the *Last Judgment* in the cupola of Florence Cathedral, with a detail of the écorché at the lower right, ca. 1575–79. Pen and brown ink, brush and brown wash, over red chalk; 17⅝ x 9¾ in. (44.8 x 24.9 cm). The Metropolitan Museum of Art, Rogers Fund, 1961 (61.53)

52. Federico Zuccaro. *Last Judgment* (detail of border figure in the form of an écorché). Fresco, ca. 1575–79. Florence Cathedral

lines and circles) recall the studies made by Leonardo in his *Battle of Anghiari* period or immediately thereafter (see fig. 11)—the same studies that had influenced Raphael.

Also on the verso of the same sheet is another scarcely visible diagram (it can be reconstructed using another, similar drawing by Figino) that uses lines and arcs to study the dynamic divergence of arms and legs.[47] This kinematic study recalls a work that played a fundamental role in the evolution of Leonardo's legacy in Lombardy, the Codex Huygens by Carlo Urbino (see fig. 57). The Leonardesque origins are demonstrated by its relationship to the celebrated *Vitruvian Man*, in which Leonardo drew alternative positions of the arms and legs of the same figure. In the Codex Huygens, Urbino developed this visual formula with a kinematic analysis of the various circular trajectories described by the body and its limbs.[48]

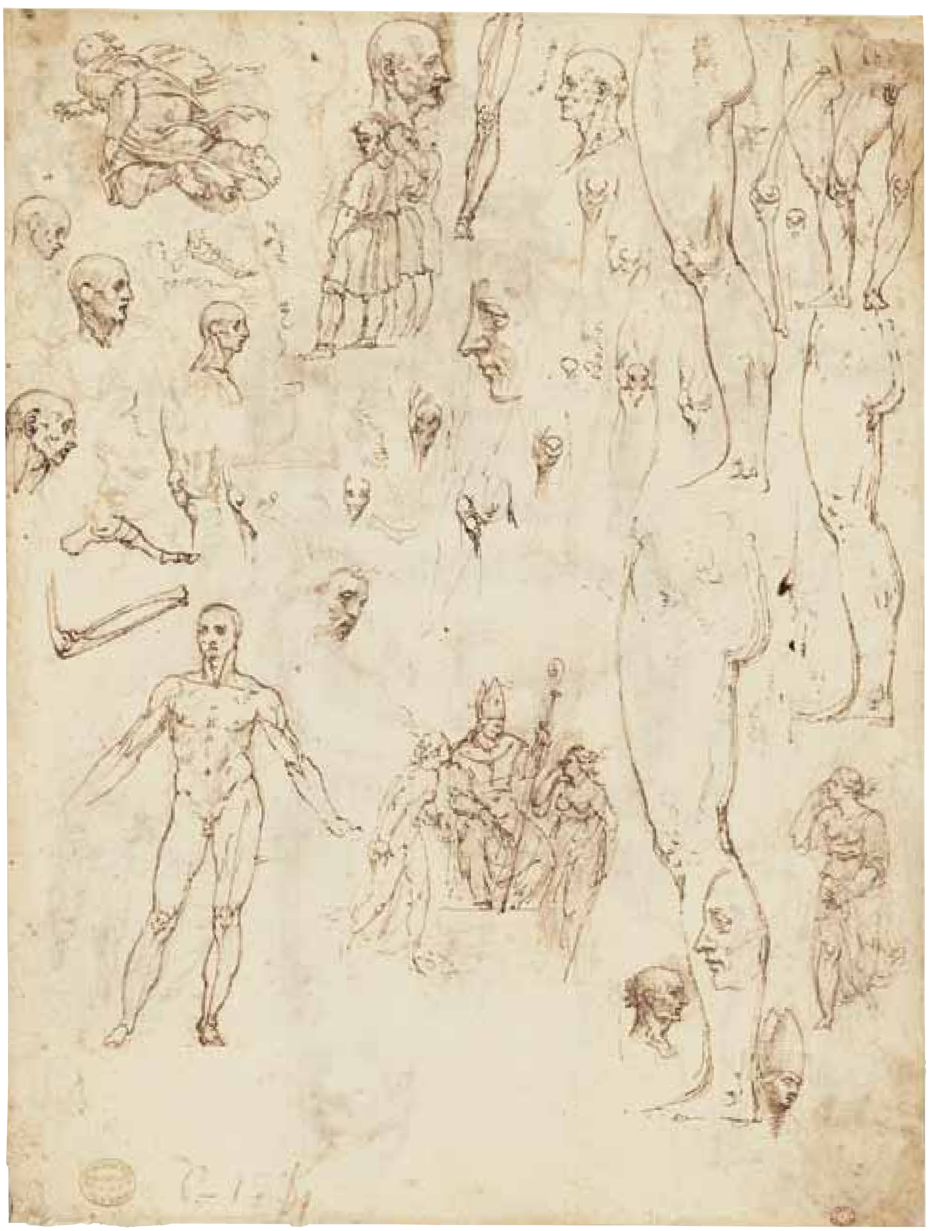
On the lower left of the recto of Figino's drawing are two anatomical studies of leg muscles. In one of these (fig. 54), two of the muscles are marked "1" and "2." A corresponding "2" appears in relation to the same muscle in another anatomical drawing by Figino now in the Accademia in Venice.[49] The numbering of muscles adopted by Figino has a precise source, and the key to it lies in another half-forgotten anatomical drawing by him (fig. 58). On two separate figures in the lower right corner of that drawing Figino indicated the thigh muscles marked "1" and "2" on the Metropolitan Museum sheet with the phrases "il primo che move la coscia" and "il secondo che move la coscia" (the first that moves the thigh; the second that moves the thigh). This corresponds to the classification used by Vesalius in *De humani corporis fabrica*: "primus femur moventium" and "secundus femur moventium," with the letters "u" and "y" indicating these muscles in a well-known plate in the treatise (fig. 29 and page 4).

53. Giovan Ambrogio Figino (Italian, Milan 1548/53–1608 Milan). Demon encircled by a serpent, after Michelangelo's *Last Judgment*, and other figure studies. Pen and brown ink, brush and brown wash, over red chalk; 11⅛ x 8½ in. (28.1 x 21.5 cm). The Metropolitan Museum of Art, Gift of Mrs. David F. Seiferheld, 1961 (61.179.2)

54. Detail of fig. 53, lower left, showing muscles marked "1" and "2"

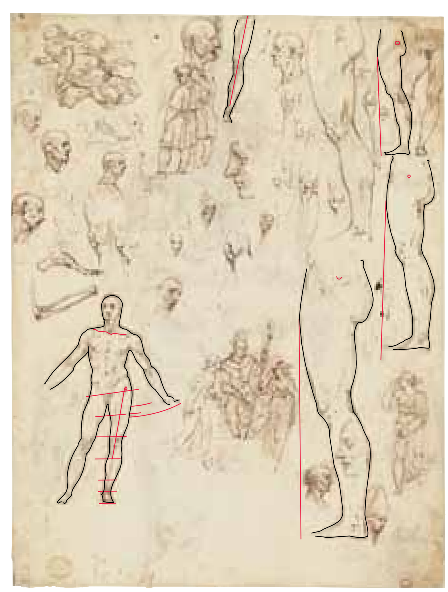
The style of Figino's anatomical drawings depends strongly on Leonardo, even for the form of certain muscles. Figino must therefore have studied anatomy with Leonardo's anatomical sheets on one side of him and Vesalius's book on the other. Leonardo's drawings were highly effective from a visual point of view but must have proved quite irksome regarding textual notes and names. In effect, Figino studied Leonardo's drawings with the aid of Vesalius, the Latin text notwithstanding. What seems to have taken second place is direct contact with anatomical dissection, supplanted instead by an inclination to collect anatomical notions from earlier authors. Anatomy becomes erudition. Yet this was not a sign of cultural decline: one of the most intriguing aspects of late sixteenth-century culture was precisely this scholarly tendency to assemble, put in order, and combine the information and documentation of other authors, both ancient and modern.

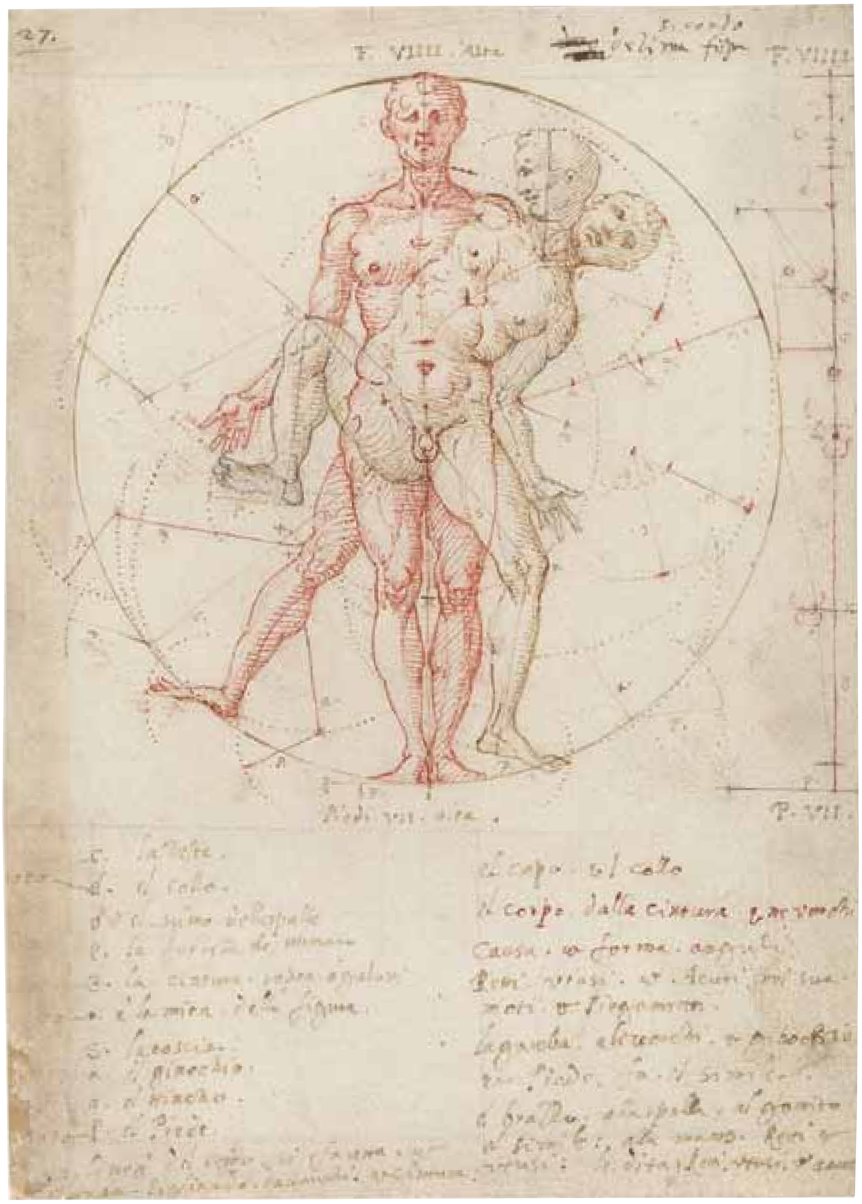
Peter Paul Rubens also studied anatomy using Vesalius's treatise, as well as through Valverde, from whom he appears to have absorbed even the new focus on the various directions and actions of the muscle fasciculi.[50] Rubens was one of



55. Ambrogio Figino. Studies of human anatomy and equilibrium and other studies (verso of fig. 53). Pen and brown ink, over red chalk

56. Graphic reconstruction showing (in red) plumb lines and other diagrammatic studies on fig. 55



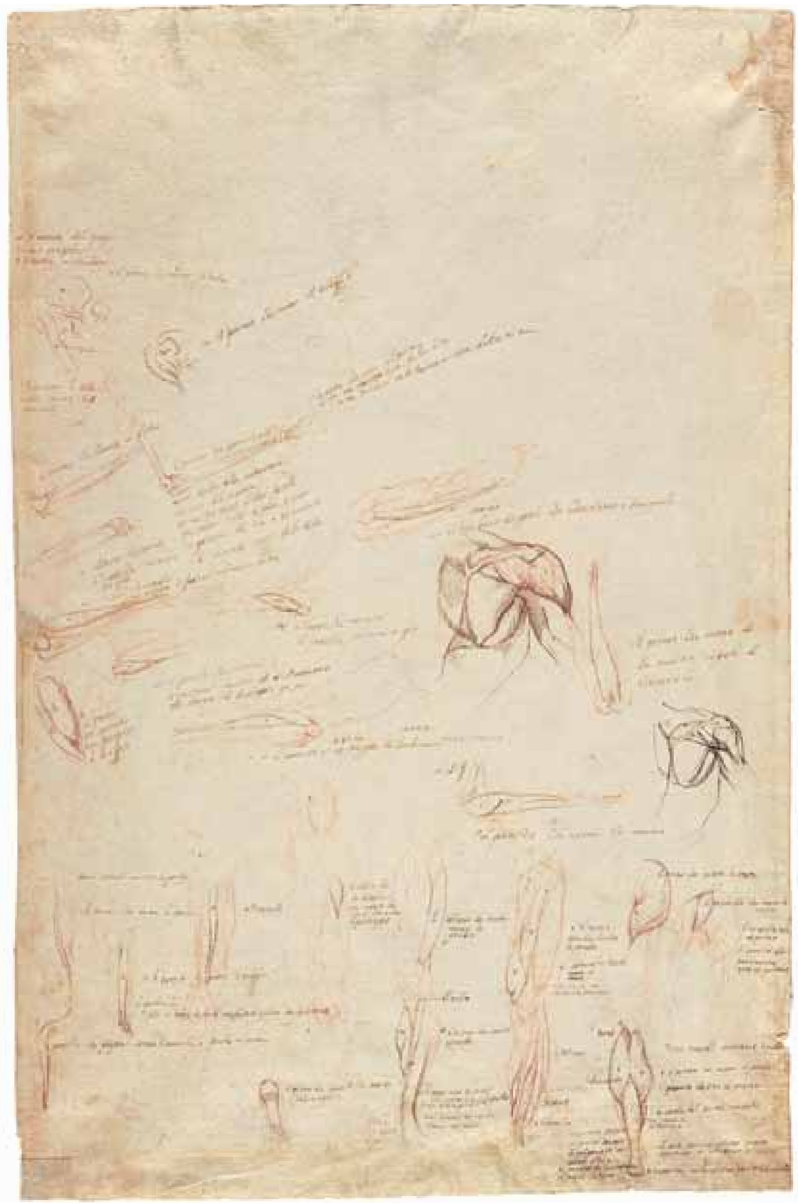


57. Carlo Urbino (Italian, Crema ca. 1510/20–after 1585 Crema). Study of the dynamics of the human body. Pen, inks of various colors, and traces of black chalk; ca. 7⅛ x 5⅛ in. (18 x 13 cm). Codex Huygens, fol. 27r. The Pierpont Morgan Library, New York, Purchase (2006.14)

the greatest examples of the artist-scholar. He knew classical languages and spoke modern ones fluently, and he held several important diplomatic posts. He reflected the social and cultural emancipation achieved by artists, which in Italy was also rooted in the nexus between art and science established by Leonardo and subsequent geniuses. Rubens was Flemish, though in his attention to anatomy, as in many other aspects of his art, he was much indebted to Italy. He was little more than twenty when he arrived in Mantua in 1600 as a guest of the Gonzaga court. In 1601–2, during the obligatory journey to Rome, he received his first important Italian commission, the creation of three paintings for the Roman basilica of Santa Croce in Gerusalemme. It was probably then that he made a remarkable group of twelve anatomical drawings.[51] Five of them (figs. 59–63), generically interpreted as studies of arms, must be read together to understand their true subject, the anatomy of the left arm seen from eight different points of view. The sheet in the Metropolitan Museum (fig. 59) shows the muscles and dorsal tendons of the hand and forearm from two points of view, and alternative views are illustrated on the other sheets. Clearly, Rubens was drawing after an écorché sculpture of the left arm. Indications on some of the sheets of a head, right arm, or torso were made only to create a frame for the image, and in fact these were omitted from the copies by Rubens's pupil Willem Panneels (see fig. 64).[52]

Rubens recorded his interest in the construction of anatomical models, in Italian, in his theoretical notebook, the so-called pocketbook he began keeping early in his career: "The true method for anatomy: take a man's bones and connect them properly with iron pins . . . , then gradually dress them in imitation of real anatomy with fake muscles, to be sewn together with lined fustian stuffed with straw."[53] In about 1600 in Florence, on Rubens's path between Mantua and Rome, Cigoli was assembling his celebrated anatomical statue (fig. 48) with the help of the Swiss anatomist Théodore Turquet de Mayerne, later an acquaintance of Rubens, who portrayed him on two occasions. Furthermore, in about 1598 in Bologna (on the same route between Mantua and Rome) Ruini based three of the plates in his *Anatomia del cavallo* on an écorché sculpture of a horse. A drawing by Rubens (known only through a copy) represents an écorché horse.[54]

Whether the three-dimensional anatomical models for Rubens's drawings of the left arm and seven others of the entire body that are part of the same group (see fig. 65) were of "lined fustian stuffed with straw" is not known, but what can be established with certainty is Rubens's participation in the debate over the most useful means of representing anatomy, which involved scientists and artists at different levels. There were several options: woodcut, engraving, etching, sculpture in various materials, and the use of color. The need for detail led anatomists to favor engraving over woodcut and then during the seventeenth century to use etching as well. Sculpture responded instead to the need for rendering anatomical forms from different points of view, and color to the need for an aspect of anatomy necessarily ignored by graphic methods. In about 1565, for his treatise *Anatomiae mundini cum expositione* (published posthumously as volume 10 of his complete works in 1663), the eccentric physician Girolamo Cardano, who took a polemical stance with regard to Vesalian images, planned a series of colored images and a three-dimensional anatomical model capable of demonstrating the various parts of the body in the clearest and most comprehensive way, as the great armillary spheres did with the harmonies of the celestial bodies. A little later another anatomist, Girolamo Fabrici d'Acquapendente, produced a spectacular series of colored anatomical plates (Biblioteca Nazionale Marciana,Venice), but they were never printed. It would be ahistorical to consider all this as empty polemics about matters of form. The reality is that before the advent of photography, pictorial language and content were of equal importance, evolving along parallel lines and with profound mutual dependency.



58. Ambrogio Figino. Muscles of the head, limbs, and shoulder. Pen and ink, over red chalk; 16¾ x 11 in. (42.6 x 28 cm). The Pierpont Morgan Library, New York, Gift of Mr. Janos Scholz (1993.400, verso)

Rubens's anatomical drawings can be profitably discussed in the context of an overall debate about visual language, which coincided with the artistic polemic on the *paragone*, or comparison, between the arts (painting, sculpture, music, poetry, and so on). The drawing of the left arm (fig. 59) was executed with cross-hatching of varying density and includes several series of little dots that seem to emulate the graphic network typical of engraving. Without ruling out the possibility that this drawing was preparatory to an engraving, it can be suggested that Rubens was creating a *paragone* between two forms of pictorial language, drawing and engraving, and showing that the first is capable of achieving all the visual solutions of the second.

The other *paragone* was between drawing and sculpture. That the representations of the left arm copied by Panneels are eight in number confirms that Rubens

59. Peter Paul Rubens (Flemish, Siegen 1577–1640 Antwerp). Anatomy of the left arm drawn from two points of view from a three-dimensional écorché model, ca. 1600–1602. Pen and brown ink, 11 x 7⅜ in. (27.8 x 18.6 cm). The Metropolitan Museum of Art, Rogers Fund, 1996 (1996.75)

almost certainly conceived his drawings as a series of eight images of the left arm, each from a different viewpoint. According to the Florentine sculptor Benvenuto Cellini (1500–1571), sculpture was seven times superior to painting because painting can represent an object from just one point of view, whereas sculpture does so from at least eight.[55] Rubens's drawings could be read in the light of this artistic debate; he may have intended to show that just like the sculpture on which they were based, the eight drawings were perfectly capable of providing an exhaustive depiction of the anatomy of the arm. The situation here is more specific, however, since the depiction from eight viewpoints relates to an anatomical subject, the arm in particular. It was Leonardo who




Peter Paul Rubens. Anatomy of the left arm drawn from six points of view from a three-dimensional écorché model, ca. 1600–1602:

60 (top left). Pen and brown ink, 10⅝ x 7⅜ in. (26.9 x 18.7 cm). Museum of Fine Arts, Boston, Collection of Horace Wood Brock (L-R 17.2010)

61 and 62 (top right and lower left). Present location unknown

63 (lower right). Black chalk, 10⅜ x 7¾ in. (26.4 x 19.6 cm). Art Gallery of Ontario, Toronto, The Thomson Collection

established this rule for obtaining an exhaustive representation of the anatomy of the arm, indicated schematically by an eight-pointed star, each point representing a point of view (see the lower right of fig. 13 and inside front cover). According to a biography written in 1699, Rubens had occasion to see Leonardo's anatomical studies, so it is likely that beyond their obvious Michelangelesque style, his drawings of the arm reflect Leonardo's rule.[56]

The competition between various visual languages, and in particular between drawing and sculpture, probably lay at the root of a specific trend in écorché statues, which were dominated by movement and which (like figs. 55–57) appear to address the subjects of dynamics and kinematics of the human body with greater freedom. Even though it is difficult to establish a direct relationship between them, when an

64. Willem Panneels (Flemish, ca. 1600–after 1632), after Peter Paul Rubens (see fig. 59). Anatomy of the left arm drawn from two different points of view, 1628–30. Black and red chalk, pen and brown and black ink; 6⅛ x 8⅛ in. (15.6 x 20.6 cm). Statens Museum for Kunst, Copenhagen (KKSGB6158)

65. Peter Paul Rubens. Figure falling backward and figure leaning forward in the pose of a runner, from three-dimensional models, ca. 1600–1602. Pen and ink, 11½ x 7½ in. (29.1 x 19.1 cm). Private collection. This is one of a series of seven drawings of the entire body that are on the same paper (some with the same Mantua watermark) as Rubens's five sheets with eight drawings of the left arm (figs. 59–63).

écorché made by Willem van Tetrode, a North Netherlandish sculptor and architect who lived for some years in Italy and was a pupil of Cellini's, is placed side by side with two anonymous sculptures of similar height (figs. 66–68), the result is a kinematic series showing the body in three successive and increasingly unstable, backward-leaning positions.[57] The same holds true for the striking group of seven anatomical drawings of the body in its entirety (see fig. 65) that Rubens drew from an anatomical sculpture like Tetrode's. These are similar to the anatomical drawings of the left arm in style, in medium (the paper is the same, and some of the sheets bear a watermark documented in Mantua in 1575), and in their dialectic with anatomical sculpture. All twelve of these sheets were probably made in about 1600–1602, the first two years of Rubens's Italian sojourn, given that a figure studied in one of them recurs in identical form in *The Raising of the Cross* of 1602, one of the works Rubens painted in Santa Croce in Gerusalemme in Rome (now known only through a faithful copy).[58]

In the sheet with one of the most complete views of the body (fig. 65), the drawings at the center and lower right of a head and torso inclined backward shown from two points of view are offset at the upper right by a figure with his head and torso thrust forward like a man running, and in another of the drawings in the series the figure's position is clearly that of a runner. These bodies have abandoned a pose of static equilibrium and lean forward or backward, connecting anew the study of anatomy and equilibrium. And here, too, as in his drawings of the left arm, Rubens may have developed ideas of Leonardo, who made a detailed study of the way the body creates movement by shifting its weight, especially how it generates upward or running motion by moving its weight forward and, conversely, how, "when man wishes to stop running forward and cease the impetus that moves him, he must lean back" (see fig. 12).[59] These subjects were broadly addressed by Rubens in his lost theoretical notebook, which was later reassembled, with the Latin text translated into French, by Charles-Antoine Jombert as *Théorie de la figure humaine,* published in Paris in 1773.

Post-Renaissance artists continued to study anatomy, sometimes with spectacular results. After the mid-seventeenth century, however, the anatomical interests of artists and scientists gradually separated, and anatomical research tended to center in northern Europe and England rather than Italy. Professional anatomists became increasingly interested in fine structure, that is, what lies below the forms immediately visible to the naked eye. The attention sixteenth-century anatomists had paid to the fascicular structure of muscles and to its representation through engraving were the first steps toward this new dimension in research. The steps that followed, thanks to instruments like the microscope and to new techniques of experimental investigation, resulted in the discovery of ever finer structures: fibers, fibrils, tissues, cells, and molecules. In the end, contemporary genetics identified DNA as the internal cause (genotype) of the external forms of anatomical organs and of the body (phenotype). Yet for two millennia, from Aristotle through the Renaissance, anatomists (and scientists in general) elaborated theories based on the external, macroscopic form of natural objects: what could be seen with the naked eye—the outer forms of these objects—explained their essence and ultimate purpose. The opposite approach, known as "atomism," which postulated that reality in fact lay behind visible forms and consisted of atoms or minute particles, already existed in antiquity, but it was a minority view, held, for example, by the Greek philosophers Democritus and Epicurus and the Roman Lucretius. The prevailing tendency had been to find explanations and scientific causes in the macroscopic forms of objects and natural phenomena. It was the dominance of this concept that fostered the unique conjunction of art and anatomy during the sixteenth century, because until the Renaissance scientists and artists had shared the same interest in the external

Three écorché sculptures in successive positions of a figure falling backward (from left to right):

66. 16th century. Bronze, h. 17¾ in. (45 cm). Yale University Art Gallery, New Haven, Maitland F. Griggs, B.A. 1896, Fund (1956.17.9)

67. Willem Danielsz van Tetrode (North Netherlandish, Delft? ca. 1525–?before 1588). Bronze, h. 17 in. (43 cm). Hearn Family Trust, New York

68. 19th century. Plaster, h. 20 in. (51 cm). École Nationale Supérieure des Beaux-Arts, Paris, Département de Morphologie (MU 12044). The original of this "dancing écorché," which has been traditionally and inconsistently attributed to Baccio Bandinelli, probably dates to the late sixteenth century. It is known only through late replicas like this.

69. Michael Henry Spang (Danish, died 1762). Écorché, 1761 (this cast attributed to Edward Burch [English, ca. 1730–1814]). Bronze, h. 9¾ in. (24.8 cm). The Metropolitan Museum of Art, Gift of Ogden Mills, 1925 (25.142.11)

"form" of the body and of its macroscopic underlying structures, among them muscles and bones.

Ever more frequently, especially starting in the eighteenth century, macroscopic anatomy was less about new research and more a didactic phenomenon, involving the teaching of already acquired notions that were obviously still important for surgeons and physicians. (One of the obvious exceptions to this general tendency was Pieter Camper's research on comparative and physiognomic anatomy, published in 1794 in *The Connexion between the Science of Anatomy and the Arts of Painting, Drawing, Statuary, etc.*, which looked ahead to modern physical anthropology.) Even in the anatomical-artistic milieu, it was the educational dimension that prevailed. Throughout Europe, schools of anatomy for surgeons, like William Cheselden's in London, and academies for artistic anatomy flourished, and anatomical treatises were printed specifically for artists.[60] This field of learning was a common meeting place for scientists and artists. The anatomist and pioneering obstetrician William Hunter held classes in anatomy at the Royal Academy of Arts in London from 1769 to 1772, and a much-reproduced écorché sculpture (fig. 69) should probably be associated with this endeavor of his.[61] The muscles on the statuette are rendered in a summary way, and the emphatic movement recalls the anatomical-artistic écorchés of the Renaissance; even the space between the Achilles tendon and the ankle has a Renaissance precedent (see fig. 42), although in fact this is present as well on the famous "écorché au bras tendu" sculpted in 1767 by Jean-Antoine Houdon. By contrast, in the anatomical plates most directly connected with Hunter's research, published in *Anatomia uteri humani gravidi* (The Anatomy of the Human Gravid Uterus) in 1774, the images are dominated by minute detail, and the illustrations consist of raw, purely scientific documentation that eschews aesthetic embellishment.[62] The chasm between anatomy and art deepened further in the nineteenth century with the advent of photography, which freed scientists from having to use traditional artists to document anatomy.

While since the 1500s scientists had studied ever finer internal structures of macroscopic forms, artists continued for centuries to limit themselves to the macroscopic forms. Only at the beginning of the twentieth century did artists like the Cubists begin to dissect the external forms of nature analytically, while others like Joan Miró and Jean Arp created abstract and biomorphic forms that evoked the microscopic dimension studied by scientists. Three centuries late, art had apparently caught up with science. But this involved indirect evocations and parallel developments, not convergent ones as in the Renaissance. By then the special interaction between anatomy and art that was one of the achievements of Renaissance Italy had ended, never to be repeated.

NOTES

1. Bibliothèque Nationale, Paris, Ms. Fr. 2030 (the painted panels are now lost); see Nicaise 1893.
2. See Choulant 1945, pp. 68–72, and Herrlinger 1970, pp. 43, 54–59.
3. Choulant 1945, pp. 75–80. Other types of printed images derived from the manuscript tradition illustrate phlebotomy (the cutting of veins for therapeutic purposes) or astrology, or both; two examples in the Metropolitan Museum are a *Kalender*, or almanac, printed in Augsburg in 1484, p. 60r, and a woodcut printed in Strasbourg in 1507 (MMA 26.56.1, 2009.161).
4. Mayor 1984, pp. 51–53; Langdale 2002, pp. 37, 40; Vasari (1568) 1996, vol. 1, p. 533.
5. It is discussed, for example, in Langdale 2002 and ignored in Choulant 1945, Herrlinger 1970, Roberts and Tomlinson 1992, and Moe 1995.
6. Biblioteca Nacional de España, Madrid, Madrid Codex II, fol. 128r, and Biblioteca Apostolica, Vatican, Codex Urb. Lat. 1270, fols. 117r, 118v (Leonardo 1995, sec. 334, 340; Kemp 2001, p. 130).
7. Leonardo 1995, sec. 177. See Laurenza 2001, pp. 49ff., 180ff., and Bambach 2003, pp. 539–44.
8. See Galluzzi and Laurenza in Galluzzi 2006, pp. 166–77. For another clear example, see Bambach 2003, no. 102, fig. 190.
9. Richard Pennington, *A Descriptive Catalogue of the Etched Work of Wenceslaus Hollar, 1607–1677* (Cambridge and New York, 1982), nos. 1558–1610B, 1768–74.
10. See Giorgio Vasari, *La vita di Michelangelo*, ed. Paola Barocchi (Milan, 1962), vol. 2, p. 124.
11. Condivi (1553) 1999, p. 17, fols. 7v–8r. See also Vasari (1568) 1996, vol. 2, p. 649.
12. Biblioteca Nazionale, Florence, Ms. Magliabechiano XVII, 17, fols. 121v–22r. The identity of the anonymous author ("Anonimo Gaddiano or Magliabechiano") of this manuscript containing biographies of Florentine painters has been the subject of debate. See Annamaria Ficarra, ed., *L'Anonimo Magliabechiano* (Naples, 1968).
13. Condivi (1553) 1999, p. 99, one of two sheets inserted between fols. 42 and 43.
14. For example, Royal Library, Windsor, RL 0474r, 0475, 0624r, 0802r, 0803r; and Teylers Museum, Haarlem, A 28r, A 39; see Kornell 1992, pp. 155ff., and Paul Joannides, *Michelangelo and His Influence: Drawings from Windsor Castle* (London, 1996), pp. 100–103, 134–37. Even if some of these drawings were to be considered copies, they would still represent precious evidence of lost originals.
15. Vasari (1568) 1996, vol. 1, pp. 741–42.
16. Pierpont Morgan Library I, 17; William Griswold and Linda Wolk-Simon, *Sixteenth-Century Italian Drawings in New York Collections* (New York, 1994), no. 56.
17. Eun-Sun Kang and Martin Kemp (in *Raffaello da Firenze a Roma*, ed. Anna Coliva [Milan, 2006], pp. 76–85, pl. p. 84, fig. 7) interpret this as a way of correlating various figures in the final composition.
18. See also the seated skeleton (another pose with a "static" meaning) in a drawing by Raphael in the Ashmolean Museum, Oxford (WA1855.91, verso). In the drawing of an écorché Crucifixion of about 1505–6 in the Biblioteca Marucelliana, Florence (84 E), Raphael inserted two marks corresponding to the articulations of the hip to emphasize either the tension at these anatomical points of static and dynamic importance or their placement at two different heights, or both.
19. Ashmolean WA1846.176, Windsor RL 12759.
20. See, for example, a drawing by Raphael in the Musée Bonnat, Bayonne (1707v; Knab, Mitsch, and Oberhuber 1983, no. 473) and one by Michelangelo in the Casa Buonarroti, Florence (9F; Charles De Tolnay, *Corpus dei disegni di Michelangelo* [Novara, 1975–80], no. 40).
21. Benvenuto Cellini, *Autobiography*, trans. John A. Symonds (New York, 1910), book 1, chap. 28. The drawing (fig. 22) on which Berengario based his plate is either by Raphael (see Knab, Mitsch, and Oberhuber 1983, no. 224) or a copy after an original by him (see Barbara Brejon de Lavergnée, *Catalogue des dessins italiens: Collections du Palais des Beaux-Arts de Lille* [Paris and Lille, 1997], no. 559).
22. Vasari (1568) 1996, vol. 1, p. 739. The painting could correspond to a copy in the Pinacoteca Nazionale, Bologna; the original is in the Uffizi, Florence. See Putti 1937, pp. 75–88, and Lind 1959, p. 10; and see also Lind 1975, pp. 159ff.; Marzia Faietti and Daniele Scaglietti Kelescian, eds., *Amico Aspertini* (Modena, 1995), pp. 339–41; and Gamberini in Pigozzi 2005, pp. 63–89. Among Berengario's discoveries were the thymus and the vermiform appendix.
23. The present location of the album is unknown; the copies are reproduced in Pedretti 2005, pp. 154–57.
24. On Estienne, see Huard and Grmek 1965 and Kornell in Cazort, Kornell, and Roberts 1996, pp. 137–39.
25. On Vesalius, see Saunders and O'Malley 1973 and Patricia Simons and Monique Kornell, "Annibal Caro's After-Dinner Speech (1536) and the Question of Titian as Vesalius's Illustrator," *Renaissance Quarterly* 61 (2008), pp. 1069–97.
26. See French 1990.
27. Kornell in Cazort, Kornell, and Roberts 1996, pp. 135–37, 153. On Eustachius, see also Adalberto Pazzini, *Le tavole anatomiche di Bartolomeo Eustachio* (Rome, 1944).
28. Lind 1975, pp. 307ff.
29. On Valverde, see A. W. Meyer and S. K. Wirt, "The Amuscan Illustrations," *Bulletin of the History of Medicine* 14 (1943), pp. 666–87; Kemp 1993; and Laurenza 2003, pp. 103–5.
30. H. W. Janson, "Titian's *Laocoon Caricature* and the Vesalian–Galenist Controversy," *Art Bulletin* 28 (1946), pp. 49–53.
31. On Ruini, see Bent Sørensen, "The Enduring Vitality of a Flayed Horse: Carlo Ruini, Bouchardon and Others," *Apollo*, no. 481 (2002), pp. 30–39.
32. Vasari (1568) 1996, vol. 2, p. 504.
33. Giovanni Battista Armenini, *De' veri precetti della pittura* (1586; Turin, 1988), p. 80.
34. Vasari (1568) 1996, vol. 2, p. 212.
35. Such as a sheet in the Cleveland Museum of Art (Holden Fund 75.26); Edward J. Olszewski, *The Draftsman's Eye: Late Italian Renaissance Schools and Styles* (Cleveland, 1981), no. 66.
36. Edgerton 1985, p. 160; Kornell 1992, p. 62.
37. See Saunders and O'Malley 1973, p. 29.
38. It appears, for example, in drawings in the Uffizi, Florence (7503F); the Biblioteca Comunale degli Intronati, Siena (Ms. S. II. 5, fol. 1r, which I believe to be by Bartolomeo Passarotti), and the Musée de Besançon (D 1610).
39. Quoted in Baldinucci (1681–1728) 1974–75, vol. 7, p. 50.
40. See Cardi in ibid., pp. 49–50; ibid., vol. 3, pp. 255, 279–82; Amerson 1975, nos. 6–12; Zygmunt Waźbiński, *L'accademia medicea del disegno a Firenze nel Cinquecento* (Florence, 1987), pp. 179–96; and Ciardi and Tongiorgi Tomasi 1984, no. 41.
41. See, for example, Janet Cox-Rearick, *The Drawings of Pontormo*, rev. ed. (New York, 1981), nos. 355, 364, 378–80. On Pontormo and Leonardo, see Laurenza 2009, pp. 24–25, 176–77.
42. Uffizi 7503F, MMA 1972.118.261.
43. Vasari (1568) 1996, vol. 2, pp. 873, 877.
44. See Park 1994 and Carlino 1999.
45. See Bean 1982, no. 277; and Cristina Acidini Luchinat, "Federico Zuccari e la cultura fiorentina: Quattro singolari immagini nella cupola di Santa Maria del Fiore," *Paragone/Arte*, no. 467 (1989), pp. 28–56.
46. See Bambach 2009, pp. 13–14, 19–20.
47. The other drawing is in the Accademia, Venice (939r, and see also 942; Perissa Torrini 1987, nos. 10, 11).
48. Erwin Panofsky, *The Codex Huygens and Leonardo da Vinci's Art Theory* (London, 1940); Sergio Marinelli, "The Author of the Codex Huygens," *Journal of the Warburg and Courtauld Institutes* 44 (1981), pp. 214–20.
49. Accademia 934 (Perissa Torrini 1987, no. 7).
50. See Jaffé 1987, lot 66, pp. 58–61; Garff and Pedersen 1988, no. 162; and chap. 15 of book 2 of Valverde's treatise (see note 29 above).
51. The drawings were sold at Christie's, London, on July 6–7, 1987, lots 57–67 (lot 66 is fig. 59; lots 57–62 are studies of the whole body), and July 6, 1999, lot 223 (the whole body). See Jaffé 1987, pp. 58–61; Goldner 1988, no. 85; Muller 1993; and Logan and Plomp 2005, no. 16.
52. For the rest of Panneels's copies, see Garff and Pedersen 1988, nos. 82, 83, 87, 215, 216; and *Rubens Cantoor* 1993, nos. 4, 6, 10, 19.
53. Courtauld Institute of Art, London, Princes Gate Collection, Ms. Johnson, fol. 22r; see Michael Jaffé, *Van Dyck's Antwerp Sketchbook* (London, 1966), p. 88n43.
54. For the portraits, see Frances Huemer, *Portraits*, Corpus Rubenianum Ludwig Burchard 19 (Brussels and New York, 1977), vol. 1, nos. 46, 47. For the copy of Rubens's drawing, see Garff and Pedersen 1988, no. 161.
55. Letter from Cellini to Benedetto Varchi, published in *Due lezioni di M. Benedetto Varchi* (Florence, 1549), cited in Leatrice Mendelsohn, *Paragoni: Benedetto Varchi's* Due Lezzioni *and Cinquecento Art Theory* (Ann Arbor, 1982), pp. 124, 155.
56. Roger de Piles, *Abrégé de la vie des peintres* (Paris, 1699), pp. 94–95.
57. On these sculptures, see Ameisenowa 1963, pp. 35–36; Amerson 1975, nos. 34, 35; Frits Scholten, *Willem van Tetrode, Sculptor (c. 1525–1580): Guglielmo Fiammingo scultore* (Amsterdam and New York, 2003), p. 72, no. 31; Comar 2008, no. 14; and Joly 2008.
58. On this painting, see Hans Vlieghe, *Saints*, Corpus Rubenianum Ludwig Burchard 8 (London and New York, 1973), vol. 2, nos. 110–12, especially pp. 61, 66–68; Michael Jaffé, *Rubens and Italy* (Oxford, 1977), p. 64.
59. Jean Paul Richter, ed., *The Literary Works of Leonardo da Vinci*, 2nd ed. (Oxford, 1939), sec. 375 (Royal Library, Windsor, RL 19038v), and see also sec. 372, 374. For upward movement, see ibid., sec. 369 (Institut de France, Paris, Manuscript A, fol. 28v).
60. Bernardino Genga and Giovanni Maria Lancisi's *Anatomia per uso et intelligenza del disegno* (Rome, 1691) and Jean-Galbert Salvage's *Anatomie du gladiateur combattant, applicable aux beaux arts . . .* (Paris, 1812; see Raymond Lifchez, "Jean-Galbert Salvage and His *Anatomie du gladiateur combattant*," *Metropolitan Museum Journal* 44 [2009], pp. 163–84) are two examples. The Metropolitan owns copies of both (54.615.2, 52.546.4).
61. See Kemp 1975, Kemp 1983, and Amerson 1975, nos. 41–51, especially no. 42.
62. For Hunter's illustrations, see Kemp 1993.

BIBLIOGRAPHY

Ameisenowa, Zofia. *The Problem of the Écorché and the Three Anatomical Models in the Jagiellonian Library*. Trans. Andrzej Potocki. Wrocław, 1963.

Amerson, L. Price. "The Problem of the Écorché." PhD diss., Pennsylvania State University, College Park, 1975.

Baldinucci, Filippo. *Notizie dei professori del disegno da Cimabue in qua*. Reprint of vols. 1–5 (1681–1728), ed. F. Ranalli (1845–47); vols. 6–7 with new notes by P. Barocchi and index by A. Boschetto. Florence, 1974–75.

Bambach, Carmen C., ed. *Leonardo da Vinci, Master Draftsman*. Exh. cat. New York, 2003.

———. *Un'eredità difficile: I disegni ed i manoscritti di Leonardo tra mito e documento*. XLVII Lettura Vinciana. Florence, 2009.

Bean, Jacob, with Lawrence Turčić. *15th and 16th Century Italian Drawings in The Metropolitan Museum of Art*. New York, 1982.

Carlino, Andrea. *Books of the Body: Anatomical Ritual and Renaissance Learning*. Chicago, 1999.

Cazort, Mimi, Monique Kornell, and K. B. Roberts. *The Ingenious Machine of Nature: Four Centuries of Art and Anatomy*. Exh. cat. Ottawa, 1996.

Choulant, Ludwig. *History and Bibliography of Anatomic Illustration*. Trans. and ann. Mortimer Frank. Rev. ed. New York, 1945.

Ciardi, Roberto P., and Lucia Tongiorgi Tomasi, eds. *Immagini anatomiche e naturalistiche nei disegni degli Uffizi, secc. XVI e XVII*. Florence, 1984.

Clayton, Martin, with Ron Philo. *Leonardo da Vinci: The Anatomy of Man. Drawings from the Collection of Her Majesty Queen Elizabeth II*. Exh. cat. Houston, 1992.

Comar, Philippe, ed. *Figures du corps: Une leçon d'anatomie à l'École des Beaux-Arts*. Exh. cat. Paris, 2008.

Condivi, Ascanio. *The Life of Michelangelo*. Trans. Alice Sedgwick Wohl; ed. Hellmut Wohl. 2nd ed. University Park, Pa., 1999. Originally published as *Vita di Michelagnolo Buonarroti* (Rome, 1553).

Cunningham, Andrew. *The Anatomical Renaissance: The Resurrection of the Anatomical Projects of the Ancients*. Aldershot, 1997.

Edgerton, Samuel Y., Jr. *Pictures and Punishment: Art and Criminal Prosecution during the Florentine Renaissance*. Ithaca, 1985.

Elkins, James "Michelangelo and the Human Form: His Knowledge and Use of Anatomy." *Art History* 7 (1984), pp. 176–84.

French, Roger K. "Natural Philosophy and Anatomy." In *Le corps à la Renaissance: Actes du 30e colloque de Tours 1987*, ed. Jean Céard, Marie M. Fontaine, and Jean-Claude Margolin, pp. 447–60. Paris, 1990.

Galluzzi, Paolo, ed. *The Mind of Leonardo*. Exh. cat. Florence, 2006.

Garff, Jan, and Eva de la Fuente Pedersen. *Rubens Cantoor: The Drawings of Willem Panneels. A Critical Catalogue*. Copenhagen, 1988.

Goldner, George R. *European Drawings, I: Catalogue of the Collections*. Malibu: The J. Paul Getty Museum, 1988.

Herrlinger, Robert. *History of Medical Illustration, from Antiquity to A.D. 1600*. Trans. Graham Fulton-Smith. London, 1970.

Hillard, Caroline S. "Michelangelo and Realdo Colombo: A Dialogue on Art and Anatomy." In *Italian Art, Society, and Politics: A Festschrift in Honor of Rab Hatfield*, ed. Barbara Deimling, Jonathan K. Nelson, and Gary M. Radke, pp. 163–77. Florence, 2007.

Huard, Pierre, and Mirko D. Grmek. *L'oeuvre de Charles Estienne et l'École Anatomique Parisienne*. Paris, 1965.

Jaffé, Michael. "Rubens's Anatomy Book." In *Old Master Drawings*, sale cat., Christie's, London, July 6–7, 1987, lots 57–67.

Joly, Morwena. *La leçon d'anatomie: Le corps des artistes de la Renaissance au Romantisme*. Paris, 2008.

Jones, Peter Murray. *Medieval Medicine in Illuminated Manuscripts*. Rev. ed. London, 1998.

Keele, Kenneth D., and Carlo Pedretti. *Leonardo da Vinci: Corpus of the Anatomical Studies in the Collection of Her Majesty the Queen at Windsor Castle*. 3 vols. New York, 1978–80.

Kemp, Martin, ed. *Dr. William Hunter at the Royal Academy of Arts*. Glasgow, 1975.

———. "Glasgow University: Bicentenary Celebrations of Dr. William Hunter (1718–83)." *Burlington Magazine* 125 (1983), pp. 380–81, 383.

———. "'The Mark of Truth': Looking and Learning in Some Anatomical Illustrations from the Renaissance and Eighteenth Century." In *Medicine and the Five Senses*, ed. W. F. Bynum and Roy Porter, pp. 85–121. Cambridge, 1993.

———, as ed. *Leonardo on Painting*. New Haven, 2001. First published 1989.

Knab, Eckhart, Erwin Mitsch, and Konrad Oberhuber. *Raffaello: I disegni*. Florence, 1983.

Kornell, Monique. "Anatomical Drawings by Battista Franco." *Bulletin of the Cleveland Museum of Art* 76 (1989), pp. 302–25.

———. "Artists and the Study of Anatomy in Sixteenth-Century Italy." 2 vols. PhD diss., Warburg Institute, London, 1992.

Langdale, Shelley R. *Battle of the Nudes: Pollaiuolo's Renaissance Masterpiece*. Exh. cat. Cleveland, 2002.

Laurenza, Domenico. *De figura umana: Fisiognomica, anatomia e arte in Leonardo*. Florence, 2001.

———. *La ricerca dell'armonia: Rappresentazioni anatomiche nel Rinascimento*. Florence, 2003.

———. "Figino and the Lost Drawings of Leonardo's Comparative Anatomy." *Burlington Magazine* 148 (2006), pp. 173–79.

———. *Leonardo: L'anatomia*. Florence, 2009.

Leonardo da Vinci. *Libro di pittura*. Ed. Carlo Pedretti; transcr. Carlo Vecce. Facsimile and text vol. Florence, 1995.

Lind, Levi Robert, trans. and ed. *Jacopo Berengario da Carpi: A Short Introduction to Anatomy (Isagogae breves)*, Chicago, 1959.

———. *Studies in Pre-Vesalian Anatomy: Biography, Translations, Documents*. Philadelphia, 1975.

Logan, Anne-Marie, and Michiel C. Plomp. *Peter Paul Rubens: The Drawings*. Exh. cat. New York, 2005.

Mayor, A. Hyatt. *Artists & Anatomists*. Exh. cat. New York, 1984.

Moe, Harald. *The Art of Anatomical Illustration in the Renaissance and Baroque Periods*. Copenhagen, 1995.

Muller, J. M. "Rubens' Anatomieboek / Rubens' Anatomy Book." In *Rubens Cantoor* 1993, pp. 78–94.

Murdoch, John E. *Album of Science: Antiquity and the Middle Ages*. New York, 1984.

Nicaise, E., trans. and ed. *Chirurgie de Maître Henri de Mondeville . . . composée de 1306 à 1320*. Paris, 1893.

Nitrans. and ed. *Chirurgie de Maître Henri de Mondeville . . . composée de 1306 à 1320*. Paris, 1893.

Nova, Alessandro, and Domenico Laurenza, eds. *Leonardo da Vinci's Anatomical World*. Venice, 2011.

Nutton, Vivian. "Representation and Memory in Renaissance Anatomical Illustration." In *Immagini per conoscere dal Rinascimento alla rivoluzione scientifica*, ed. Fabrizio Meroi and Claudio Pogliano, pp. 61–80. Florence, 2001.

O'Malley, Charles D., and J. B. de C. M. Saunders. *Leonardo on the Human Body*. Reprint. New York, 1983. First published 1952.

Park, Katharine. "The Criminal and the Saintly Body: Autopsy and Dissection in Renaissance Italy." *Renaissance Quarterly* 47 (1994), pp. 1–33.

Pedretti, Carlo, with Paola Salvi. *L'anatomia di Leonardo da Vinci fra Mondino e Berengario*. Florence, 2005.

Perissa Torrini, Annalisa. *Gallerie dell'Accademia di Venezia: Disegni del Figino*. Milan, 1987.

Pesenti Marangon, Tiziana. *Il "Fasciculus medicinae" ovvero le metamorfosi del libro umanistico*. Treviso, 2001.

Pigozzi, Marinella, ed. *Il corpo in scena: I trattati di anatomia della Biblioteca Comunale Passerini-Landi*. Exh. cat. San Bonico, Piacenza, 2005.

Putti, Vittorio. *Berengario da Carpi: Saggio biografico e bibliografico, seguito dalla traduzione del "De fractura calvae sive cranei."* Bologna, 1937.

Rifkin, Benjamin A., and Michael J. Ackerman. *Human Anatomy: From the Renaissance to the Digital Age*. New York, 2006.

Roberts, K. B., and J. D. W. Tomlinson. *The Fabric of the Body: European Traditions of Anatomical Illustration*. Oxford, 1992.

Röhrl, Boris. *History and Bibliography of Artistic Anatomy*. Hildesheim, 2000.

Rubens Cantoor: Een verzameling tekeningen ontstaan in Rubens' atelier. Exh. cat. Antwerp and Ghent, 1993.

Saunders, J. B. de C. M., and Charles D. O'Malley. *The Illustrations from the Works of Andreas Vesalius of Brussels*. Reprint. New York, 1973. First published 1950.

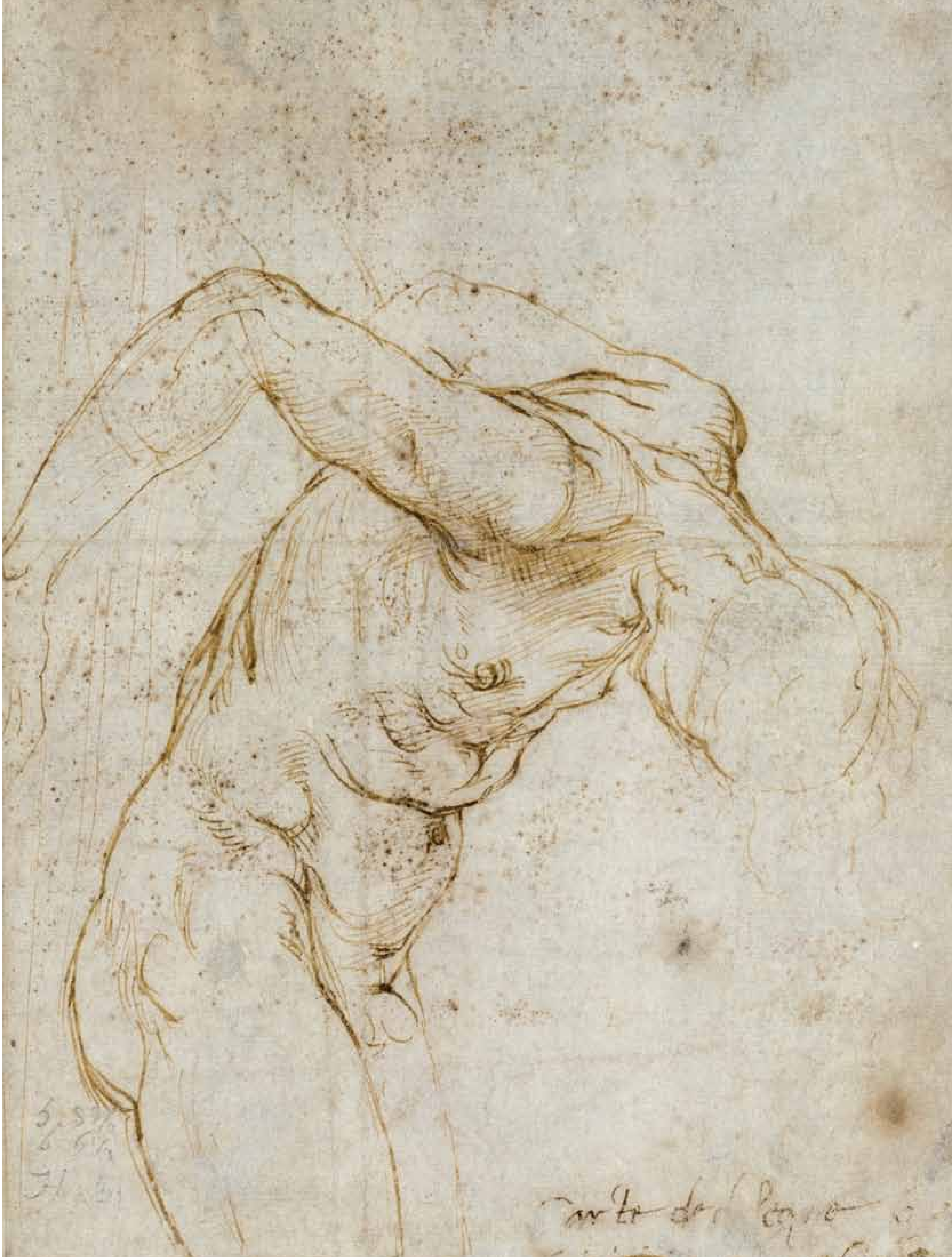
Schultz, Bernard. *Art and Anatomy in Renaissance Italy*. Ann Arbor, 1985.

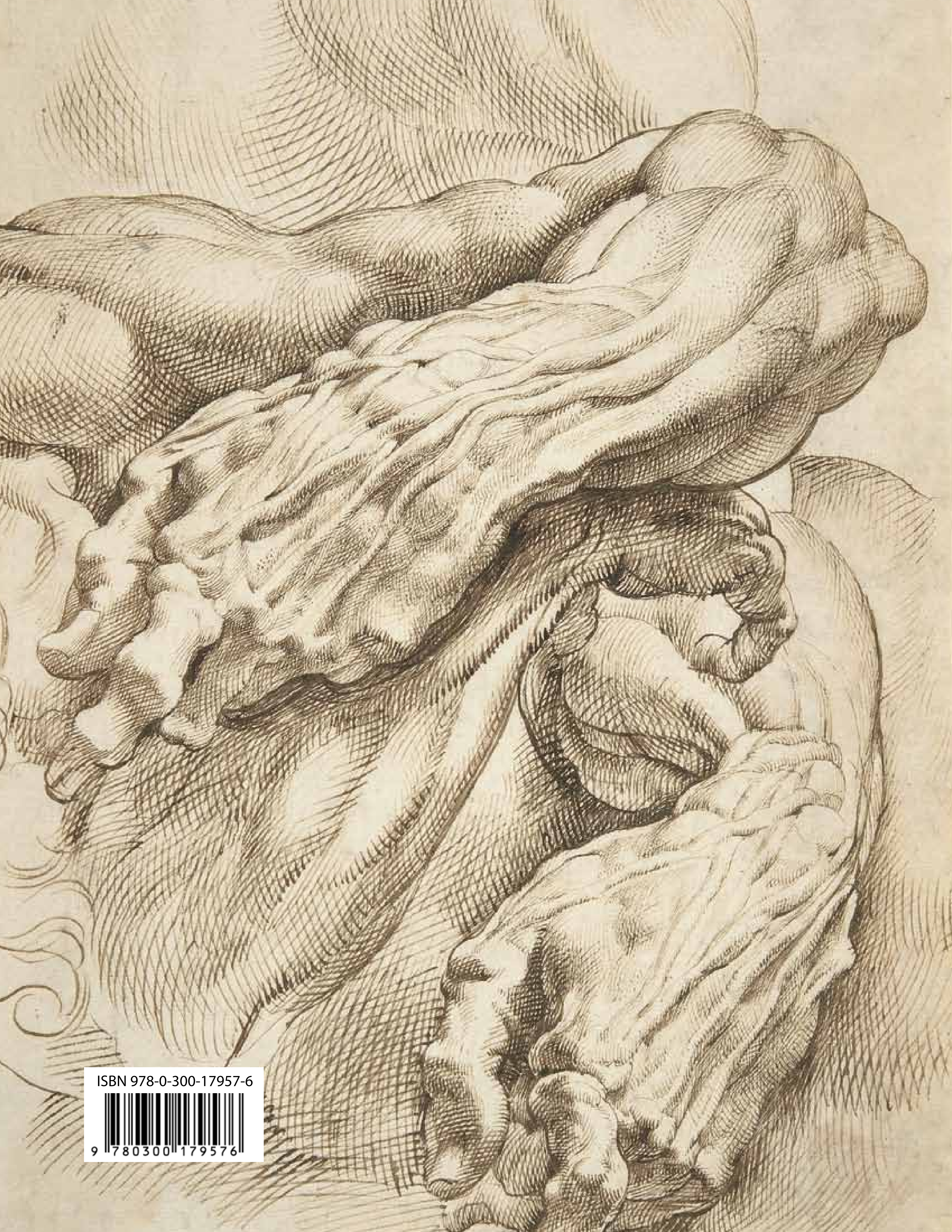
Sigerist, H. E., ed. *The Book of Cirurgia by Hieronymus Brunschwig* [1497]. Milan, 1923.

Singer, Charles, ed. *The Fasciculo di Medicina, Venice, 1493*, by Johannes de Ketham. 2 vols. Florence, 1925.

Siraisi, Nancy G. *Medieval & Early Renaissance Medicine*. Chicago, 1990.

Vasari, Giorgio. *Lives of the Painters, Sculptors, and Architects*. Trans. Gaston du C. de Vere; intro. and notes by David Ekserdjian. 2 vols. New York, 1996. Translation of *Le vite de' più eccellenti pittori, scultori e architettori*, 2nd ed. (Florence, 1568).





ISBN 978-0-300-17957-6