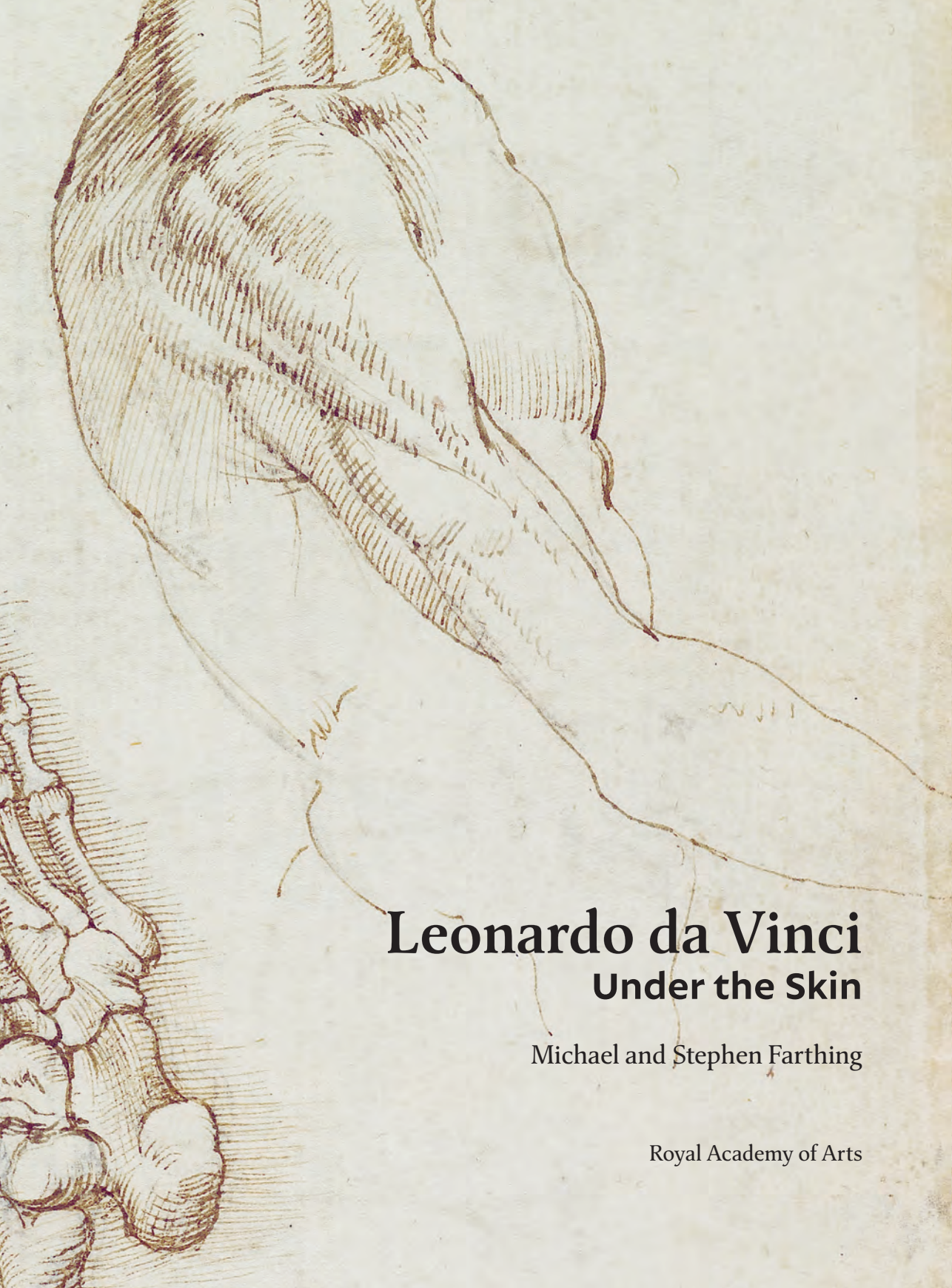
Michael and Stephen Farthing

Leonardo da Vinci

Under the Skin

Royal Academy of Arts



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To our forgiving families

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EDITORIAL NOTE

Pages 2–3: detail of fig. 51.
Dimensions of all works of art are given in centimetres, height before width.

The authors are indebted to Martin Clayton's indispensable and award-winning iPad app *Leonardo da Vinci: Anatomy*, produced by Royal Collection Trust in partnership with Touch Press and Primal Pictures on the occasion of the exhibition at the Queen's Gallery, London, in 2012.

Translations of Leonardo's annotations are taken from Kenneth D. Keele and Carlo Pedretti (eds), *Leonardo da Vinci. Corpus of the Anatomical Studies in the Collection of Her Majesty The Queen at Windsor Castle*, 2 vols and facsimiles, London and New York: Johnson Reprint, 1979–80.

Contents

Prologue

Around 1590 the drawings of Leonardo da Vinci were acquired by the sculptor Pompeo Leoni, who arranged them in bound volumes. The two of these to have survived suggest that he divided them into two broadly defined categories: scientific and artistic. The scientific volume is the Codex Atlanticus, now in the Biblioteca Ambrosiana, Milan; the artistic volume found its way into the collection of Charles II and remains at Windsor Castle – its binding now separated from the more than 500 drawings stored in boxes.

Among these are more than 100 sheets dealing with human anatomy, found in this artistic group because anatomy formed part of an artist's academic training. In the main, however, these drawings deal not in the tasteful anatomy of ideal proportions but in the messy inner organs of a working body. Most of the drawings would have contributed to a treatise on human anatomy on which Leonardo worked in 1510–11 in collaboration with Marcantonio della Torre of the University of Pavia, who was to have provided the background reading (supplying Leonardo's deficiency in Classical languages). Having been treated for many years as 'art for strong stomachs', these drawings were presented in 2012–13 at the Queen's Galleries in London and Edinburgh as exemplars of scientific enquiry at its most rigorous and far-sighted, in an exhibition jointly curated by Martin Clayton of the Royal Collection Trust and Professor Ron Philo of the University of Texas Health Science Center.

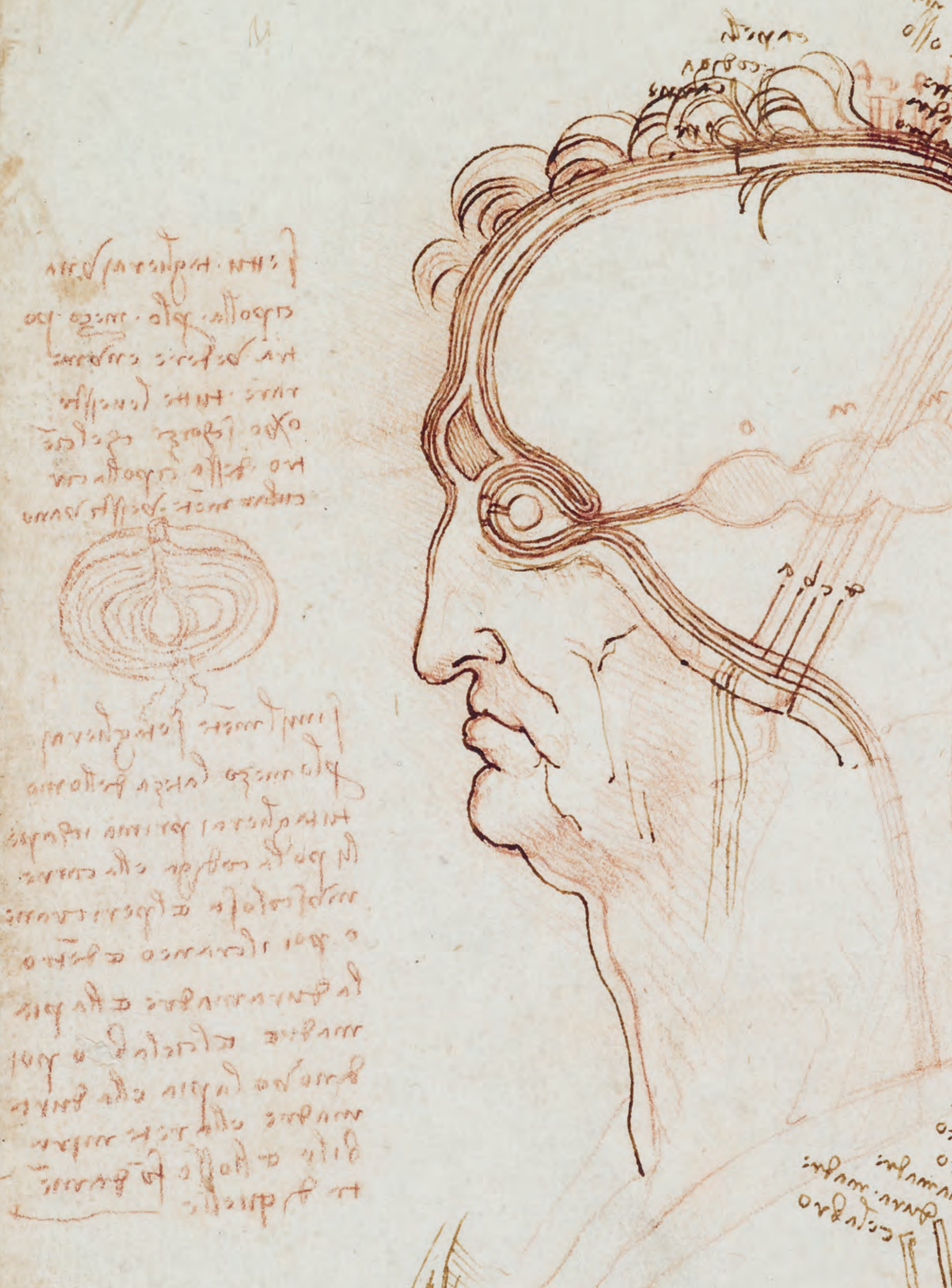
As part of the public programme during the exhibition's London showing I chaired a fascinating conversation between two brothers, Michael and Stephen Farthing, both professors – one of medicine and one of drawing – who discussed what Leonardo's work might mean to experts in such different disciplines. Their conversation kept coming back to the importance of drawing and the narrowness with which it is now defined. The rot set in back in the 1590s, with the separation of the two batches of Leonardo drawings. This was a symptom of a much more general and regrettable schism in European intellectual life.

Theorists of the Renaissance valued drawing as the *thinking* part of art. In Leonardo we see this thinking-drawing process at work as he invents but also as he observes and as he seeks to understand and explain what is in front of him. In time, academies of art encouraged the inventing part at the expense of the explaining part, though this discipline survived to some extent in watercolours recording botanical or geographic research.

Leonardo's contemporaries did not consider him as we do as a 'universal man'; after all, he lacked what they considered to be the basic pillar of learning – a command of Latin and Greek. The Classics may have lost their status, but the idea that language alone is the vehicle of thought survives largely unchallenged. This would imply that Leonardo could not think about or understand what he was drawing until he wrote down his famous mirror notes on the sheets. This book challenges assumptions of this kind and suggests ways in which Leonardo's use of drawing – as a branch of thinking as fundamental as language – might be revisited.

Desmond Shawe-Taylor
Surveyor of the Queen's Pictures

Detail of fig. 17



The foetus in the womb

During the course of the last century, radar, ultra-sound, X-rays and MRI scanning have enabled us to draw what had never before been seen. By bouncing energy (light, sound and magnetic waves) off objects not visible to the naked eye, we can not only locate them in space but can reconstruct them as two-dimensional images – so, for instance, we can now watch the foetal heart beating in real time in the womb. While Leonardo's drawing of the foetus in the womb is an image that in its day would have been understood as authoritative, it is not an observed event: as a drawing, it owes as much to the imagination as it does to observation and as such is pure theatre.

More allegorical than anatomical, the foetus is pictured within a burst 'nutshell' – perhaps less for the benefit of scientists wanting to understand the 'plumbing' that supports early life than to present one of nature's miracles as a comprehensible package for a general audience. Although inventive and beautifully drawn, *The foetus in the womb* tells us more about Leonardo's ability to imagine than it does about what he saw.

Almost exceptionally, this emotive drawing employs colour to heighten its impact. The red chalk Leonardo used was derived from haematite (from the Ancient Greek, meaning blood-red stone), an oxide mined in Italy and known to artists across Europe as 'sanguine' (derived from the French for blood). It became popular probably because the soft, fleshy line it produces works well to depict living things: at a poetic level it gives them 'blood'; at a technical level it is hard enough to produce a fine line but soft enough to blend into tone.

The position of the foetus within the uterus here appears accurate but there are a number of inaccuracies and misinterpretations of foetal function. Leonardo believed that pressure from the foetal heel on the perineum prevented urine flow from the foetal bladder into the amniotic space, and that 'the heart does not beat and it does not breathe because it continually rests in water, and if it breathed it would drown.' In fact, the foetal heartbeat is audible through the mother's abdominal wall by eighteen to twenty weeks using a foetal stethoscope – although of course this instrument was not available until the nineteenth century!

We do not know whether Leonardo ever saw a human placenta since all his drawings are of the bovine placenta, which is structurally quite different.

Perineum: the area of the body situated between the anus and the scrotum (man) or the vulva (woman).

Fig. 45 *The foetus in the womb*, *c*. 1511. Pen and ink over red chalk, 30.4 × 22 cm. The Royal Collection / HM Queen Elizabeth II, RCIN 919102*r*

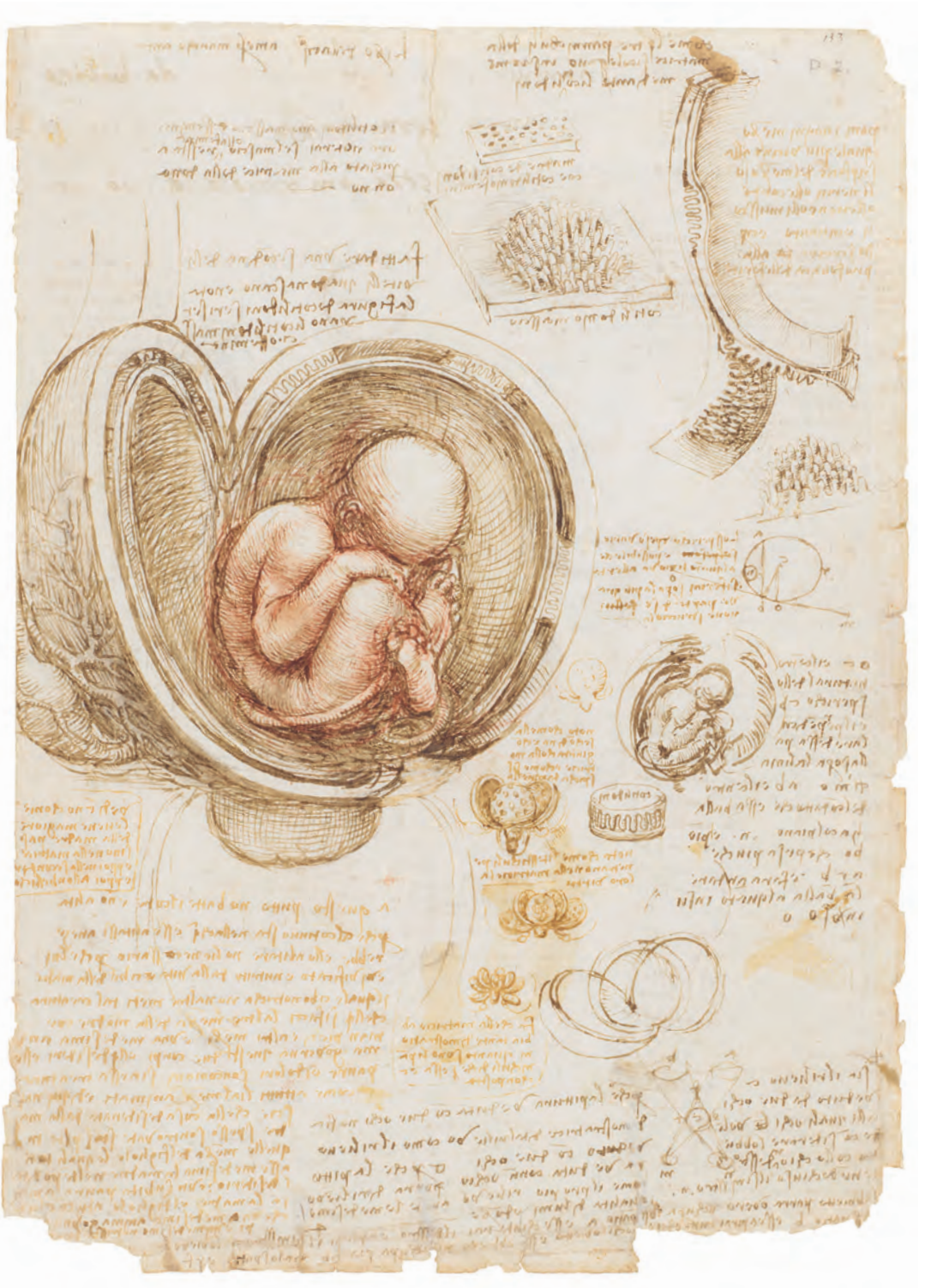


Fig. 46 *The gastrointestinal tract, and the bladder, c.* 1508.
Pen and ink over black chalk, 19.2 × 13.8 cm.
The Royal Collection / HM Queen Elizabeth II, RCIN 919031r

Fig. 47 *The gastrointestinal tract, and the stomach, liver and spleen, c.* 1508.
Pen and ink over traces of black chalk, 19.2 × 13.8 cm.
The Royal Collection / HM Queen Elizabeth II, RCIN 919031v

The gastrointestinal tract and the bladder

Caecum: a pouch-like structure in the right colon at the point where it joins the small intestine. In some herbivores, such as the rabbit, it is much larger than that found in the human.

Appendices epiploeicae: fat-filled pouches of visceral membrane located on the outer surface of the colon.

Leonardo would have faced a substantial challenge in undertaking a detailed examination of the organs of the abdominal cavity through dissection. After death, these organs degenerate rapidly, becoming extremely offensive. Full of digestive enzymes, the pancreas rapidly digests itself, which may be why it seems not to have been mentioned in Leonardo's notes or represented in his drawings.

Leonardo did not include the intestines in any of his early studies. A rudimentary intestine appears in *The hemisection of a man and woman in the act of coition* (fig. 37) as a thin spiralling tube in the abdomen connected to the stomach above; a detail shows the entire gastrointestinal tract in continuity from mouth to anus, including the oesophagus, stomach, small intestine and colon, but this almost childlike sketch was not based on direct observation. The dilated structure in mid-abdomen almost certainly represents the caecum, but more closely resembles that of a herbivore such as a rabbit than a human. An additional tube-like structure connects this caecum to the umbilicus, which may relate to the comment: 'And how it [the infant] is nourished through the umbilicus.'

During Leonardo's second period of dissection, *c.* 1508, more sophisticated images emerge, with the stomach appearing more lifelike but the intestines continuing to be diagrammatic. These later drawings might not be the most aesthetically pleasing of the collection, but they do approach structural accuracy and represent an advance in knowledge. The orientation of the small and large intestines is now consistent with that of humans and the size and orientation of the caecum seems to indicate that was probably drawn from direct observation. Leonardo correctly identifies and adds the appendices epiploicae on the outer margin of the colon – probably a medical first.

The verso (fig. 47) is a good example of a drawing that beyond its subject matter and content maps the draughtsman's thought process as a logical step-by-step pathway towards understanding. This diagrammatic sketch is most probably an intentionally didactic summary of a series of drawings made from the stomach and intestine of a human cadaver. Composed in three parts, it takes the viewer from the general to the particular. The central image locates the stomach and intestine within the human frame. Then we are given a closer look at the exterior of the stomach and finally in the lower margin is a drawing of the appendix. Many believe this detail is the first graphic representation of the appendix, a small, redundant part of the gastrointestinal tract.

The accompanying text suggests that Leonardo is aiming to explain how food nourishes us as it passes through the body, though in the drawing we see only how the pipework connects up, not how it works.

4 The limbs: muscles, bones and joints

Leonardo produced what are perhaps his most anatomically detailed and aesthetically exquisite drawings in his studies of the musculoskeletal system, particularly in his work relating to the arm and leg. Exposing every layer through rotational, almost panoramic, views, his approach promotes understanding of the structures he is exploring. These pages show us Leonardo at his most polished and least speculative, drawing what he sees, with a clearly understood story to tell. Most of the drawings are clearly annotated and positioned on the sheet without any distracting accumulation of unrelated images, as if made ready for the engraver and publication.

Leonardo's interest in muscles and bones began with the surface anatomy of the neck in 1495 (see *The head of Judas*, fig. 4), moving on to studies of the surface appearance of the skeletal muscles in preparation for major paintings such as *The Battle of Anghiari*. During his two later periods of dissection he made a series of magnificent studies of the muscles and bones of the upper and lower limbs, accompanied by insightful notes on structure and how muscles function, particularly around the joints.

He clearly understood the relationship between what the process of dissection would have revealed to be two co-dependent parts of the anatomy: the bones and their joints, and the muscles that animate them. As a consequence, there are no compelling examples of erroneous interpretation among these drawings. These aspects of human anatomy were not shrouded in mystical thinking or attributed with functions beyond those visible to the eye: bones and muscles were regarded as structural elements on which the body was built, with the more 'spiritual' functions attributed to the heart, liver and brain. There were therefore no major ideological issues to skew Leonardo's thinking.

Detail of fig. 54

The proportions of the leg and foot

During his early period of study, from 1487 to 1492, Leonardo extended his observations on the proportions of the body (see *The Vitruvian Man*, fig. 13) to produce drawings of the lower limbs. The series demonstrates how humans have used both drawing and mathematics to define themselves in relation to the world.

Leonardo made this collection of annotated pen-and-ink line drawings to gain a better understanding of human scale. Although he recorded actual measurements to accumulate information, *The proportions of the leg and foot* is not a finely measured technical representation and its precision is carried in the concepts within the annotations, for instance that the leg, '*a c* is half a head, and is the same as *d b*'.

Following Vitruvius, some of the assumptions Leonardo made, for instance that a man's height is equal to the span of his arms, broadly hold true. But many of his further refinements fail to take account of the diversity of human shape and size.

Fig. 48 *The proportions of the leg and foot*, *c*. 1490.
Pen and ink, 40.5 × 28.1 cm.
The Royal Collection / HM Queen Elizabeth II, RCIN 919136*v*