

# The Interconnection of Art and Science in the Renaissance: Leonardo da Vinci's Anatomical Sketches and Their Contribution to Knowledge

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**Abstract.** The period of Renaissance is known for significant advancement in art, literature, and science. It was marked by a surge of interest in learning from classical Greek and Roman ways of learning. As part of that interest in learning and discovering truth came a deeper exploration of human anatomy, which is about study of human bodily structure including muscle, veins, and bone. Artists like Leonardo Da Vinci during this period conducted anatomy to sketch how the body looked like beneath the skin. His sketches were not simply an artistic endeavor but also an advanced scientific inquiry into the functions of the body. This suggests that art and science cross path through the study of anatomy and that there exists a great connection between two fields. To evaluate how art and science intertwined through anatomy, this research focuses on several of Leonardo's anatomical sketches to show how scientific practices were reflected in his artwork. This research concludes that Leonardo's anatomy sketches synthesize art and science by using art materials to further one's understanding of the scientific discipline. In sketching how body parts looked like beneath skin and tissue, Leonardo's artistic exploration contributed to scientific inquiry to deepen understanding of the human body.

**Keywords:** Renaissance, anatomy, sequential layout, interdisciplinary.

## 1. Introduction

This research focus on the period of Renaissance that lasted from roughly the 14th to the 17th century. It was known for a cultural revival in Europe, marked by a curiosity for ancient ideals and a shift towards humanism. Art and scientific development flourished in this period and changed people's understanding of the world and themselves. A central component of this cultural revival focused on humanism, an intellectual movement that not only prioritized the study of the individual but also learning from classical texts [1]. Various scholars let go of traditional and religious themes and promoted thoughts on human nature. This cultural revival also saw prominent artistic innovation. Artists shifted from medieval art conventions to naturalistic styles of art. The motivation behind adopting naturalism was the desire to make artwork appear more human and realistic as part of artists' attempt to depict objects as they truly are [2]. This desire to realistically represent the human figure led to some of the earliest study and documentation of anatomy, allowing artists like Leonardo da Vinci, Michelangelo, and Dürer to create realistic depiction of both visible part of the body and also internal mechanisms that make the body function. Scientific inquiry of this period was highlighted by anatomical studies: artists like Leonardo da Vinci offered great knowledge in anatomical understanding by conducting dissections and sketching internal body parts [3]. His sketches not only depicted muscles, bones, and organ systems accurately but also symbolized how art and science interconnect.

This research is significant for understanding not just how art and science prospered during the Renaissance but also the significance of their connection. Leonardo's anatomical work reflect the era's holistic view of knowledge, where knowledge of art and science coexisted and informed one another. Whether it be artists sketching particular objects in the world or scientists discovering facts about the natural world, both wish to understand how the world function in order to depict truth as it is. It is significant for understanding period's interdisciplinary studies, by which collaborative insights

from both art and science contributed greatly to advancements in human anatomy, as well as bringing us closer to the truth [4].

As this essay focuses on how art and science are related during the Renaissance it will place Leonardo's anatomical sketches at the center of scrutiny. By examining these works, the essay will show how the artist's artistic practices were informed by his scientific investigations to allow the two disciplines to integrate.

The research engages in a qualitative analysis of Leonardo's anatomical sketches, accompanied by a review of scholarly articles from modern scholars. Primary sources include sketches within Leonardo's notebooks, such as *The Bone, Muscles, and Tendons of the Hand*, *Drawing of Torso and Arm*, and *The Muscles of the Shoulder, Arm, and Neck*, which detail his anatomical observations and findings. Analysis of anatomical sketches explore scientific inquiry through techniques, observations, and annotations. Secondary sources cover critical analysis from art historians, such as Martin Kemp and Michael Hawley, who evaluate Leonardo's work through the lenses of both art and science. Reviewing interpretations and critiques from contemporary scholars allows us to see the implications of the artist's work within Renaissance thought.

The objectives of this research are as follows:

To analyze how artistic and scientific practices interacted through Leonardo da Vinci's anatomical sketches.

To illustrate how interdisciplinary inquiry in the Renaissance was exemplified by these sketches.

To contribute to the comprehension of how art and science-informed one another during the scholarly pursuit of truth.

## 2. Analysis



**Fig. 1** Leonardo da Vinci, 'The Bone, Muscles, and Tendons of the Hand,' c. 1510. [5].

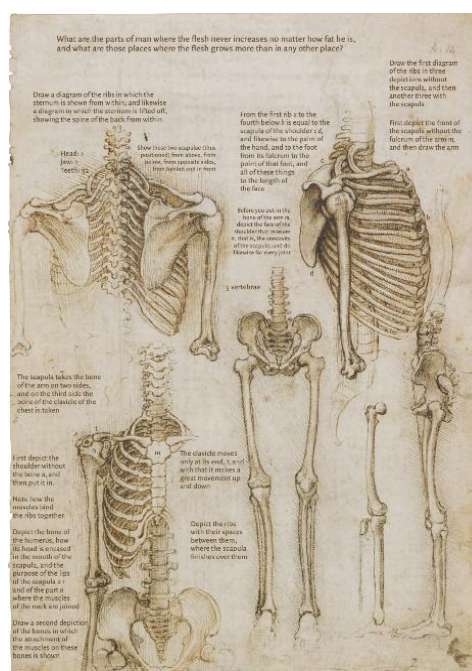
This essay moves on to analyze Leonardo's sketches that showcase anatomy (Figure 1). Starting with *The Bone, Muscles, and Tendons of the Hand*. The inclusion of various parts of the hand, including bone, muscle, and tendon, reflects anatomical studies. These things can only be detailedly observed through anatomy, which Leonardo did so through careful dissections. First, bones are drawn to demonstrate that they provide the skeletal framework for a human hand, which includes the finger, palm, and wrist. They are sketched with clarity, allowing viewers to understand how bones are arranged and connected. For instance, Leonardo added lines between each bone part to create phalanges. Phalanges show that bones in a hand are separated into different parts. Phalanges vary in terms of length, with the ones near the fingertip being the shortest and the ones near the wrist being

the longest. These phalanges illustrate arrangement and connectivity by informing viewers of how they are connected with other bone phalanges to form the skeletal structure of a hand. Bones provide structure for the hand and a significant component of anatomical studies deal with the structure of the organisms. This is an important component because structure is a vital framework that supports the body by offering a foundation to perform further functions [6, 7].

Meanwhile, muscles are sketched to show how the hand can stretch. Muscles surround the bone and add a new layer to the hand. Multiple muscles are drawn to inform the viewer that the hand is controlled by a diversity of muscles, it is also indicated that different muscles are attached to different fingers. Some muscles appear to overlap with others in this enclosed space, hinting at the fact that muscles are connected and that stretching one muscle would influence the movements of nearby muscles as well. This allows viewers to understand that while phalanges provide the structural framework for the hand, muscles control finger movements. In other words, they work in coordination with each other to help hand function.

Moving counterclockwise, we would reach the top of the sketch and see the tendons of the hand. Leonardo illustrates tendons through strings that appear from the wrist and go all the way down to the fingertip. There are five tendons in total and each connects to a finger through the wrist. Tendons are drawn expressing strength and thickness, with tendons of the palm being much thicker than tendons in other areas of the hand. Such a sketch helps us to understand the anatomical structure and mechanics of hand movement. Tendons connect muscle to bone and facilitate movement, they are mechanisms that enable fingers to bend. Without them, fingers would not be able to move or straighten.

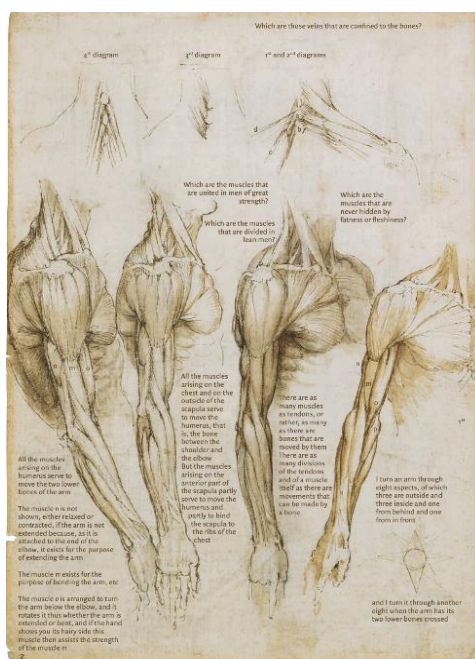
The attention to the various connection of hand parts illustrate the fact that hand parts function in a communicative and interactive way with various parts to enable movement. As Martin Kemp noted, Leonardo was not just letting the audience observe dissection but also making them “reach a true understanding of marvellous form and function of the body in its whole and its part.” [8]. Leonardo wants people to realize that the body functions like a “communicative system” by which nerves in the hand reflect a hierarchical system. Just as in a court, where “soldiers serve officer,” the nerve branch in a hand also serves their nerve chord. Here, Kemp drew a parallel between orders from officers and orders from the finger nerve chord. Both resemble social hierarchy because movement is directed by a superior. Just as soldiers are an extension of the officer in the sense that they perform tasks ordered by them, our fingers move after receiving signals from nerves to act in a particular way [8].



**Fig. 2** Leonardo da Vinci, 'Drawing of the Torso and the Arms,' c. 1519. [5].

Another sketch, entitled Drawing of Torso and Arm, studies the skeleton of the body and focuses mostly on ribs and scapula and a bit on leg bone (Figure 2). Compared to previous sketch, this only depicts the bones of the body, which is why there is an emphasis on the characteristics of the body's structural framework. The combination of multiple skeletons forms body build relationship. As one can see, the scapula is not drawn as a single part but is always connected to the ribs of the body, just as ribs are attached to the spine, connecting to the pelvis and legs in the final phase of the sketch. This relationship is significant because it shows the interconnectivity of various bones and how they combine to form something new and more meaningful. In other words, these parts are not acting alone but always as a part of a larger whole to help the body function. Without them, the body would lack the means to be supported by a strong and robust structure [6, 7].

In terms of the composition of this sketch, skeletons, and bones are meticulously drawn, including curvature, surface texture, and how they connect via points of articulation. They are drawn as accurately as possible, enabling one to understand the size and length of each particular bone of the chest. Such anatomical accuracy gives us a clear understanding of the function of skeletons, including how they are impacted by motion or physics. This may seem hard for the audience to picture, as bones seem still and unable to move flexibility, compared to other body parts like muscles and tendons. However, what one may not know is that they too possess movement. Ribs can expand and contract during inhalation and exhalation. In particular, drawing the rib from the side lets us see and awe at the extent to which ribs extend during each breath. This allows us to understand that skeletons not only protect one's vital organs but also allow for movement and expansion during breathing. Such drawing leads to a more dynamic depiction of the skeleton rather than a static one.



**Fig. 3** Leonardo da Vinci, 'The Muscles of the Shoulder, Arm, and Neck,' c. 1510-11. [5].

Moving on to his third sketch, entitled The Muscles of the Shoulder, Arm, and Neck, is a sketch of the many angles of the shoulder as it moves around the person (Figure 3). Leonardo sought to depict the muscle detailedly from shoulder pads down to the wrist, including the tricep, brachialis, bicep, and pronator teres, all of which are major parts of the shoulder. Detailed drawings of the shoulder muscle enable viewers to understand its functionality. For instance, the shoulder muscle, which is drawn to connect with the body, shows that it helps the limb to bear weight. Without that thick and muscular connection, the person would not be able to lift easily. Meanwhile, Leonardo used long lines to create the long arm muscles of the upper and lower arms. One observes how various muscles represent different muscle strips. Those muscle strips let one understand how the arm extends and how flexible it can become, which allows the arm to rotate with ease. Together, muscles play crucial roles in shoulder mobility and strength [6, 7].

### 3. Discussion

By integrating artistic representation with scientific inquiry, Leonardo's sketches of the hand, ribs, and shoulder show art and science can intersect through anatomy. One way it integrates science is detailed observation. Every layer of the drawing is thoroughly sketched and annotated with meticulous attention to detail. For example, the sketch that depicts ribs is detailedly drawn to illustrate how they connect and protect the body. This level of detail demonstrates his scientific curiosity through the use of empirical observation, by which Leonardo used personal and direct experience to collect information, rather than relying on theory or traditional sources of interpretation. By relying on empirical observation, Leonardo extract information about the human body that can be measured and verified, forming the basis for scientific inquiry [9].

Another reason that art and science intervene is through the sketches' functional analysis. By showing how the bone protects the body, how the muscles extend the arm, or how tendons direct movement, the audience gains insight into the mechanics of body parts and how they collaborate with another part to move. Hence, his sketch captured not just the static form of the body but also the dynamic side of it. This dynamic potential comes from the interaction of muscle and bone to move. This approach is a reflection of the scientific method to study how anatomical components cooperate to produce movement and functionality.

Annotations are also crucial here as they grant scientific explanations. Each sketch is detailedly annotated with notes and personal thoughts from the author to explain each diagram and offer explanations. Here, annotation promotes scientific study by introducing words and phrases with definitions to connect to the image. This annotation clarifies different parts of anatomy and provides additional insight into each component. When reading the annotation, viewers would notice details that they would otherwise miss if they only looked at the drawing. A translation of the annotation can be found in Martin Clayton's *Leonardo da Vinci: Anatomist*. On the other hand, if sketches were just images, then viewers would think of them as less of a scientific masterpiece and more of plain drawings. Leonardo's sketches are exceptional due to the very use of such annotations for scientific inquiry [10].

By incorporating realism in art, the human form is represented more realistically and allow for scientific inquiry. presence of realism marks a shift from religious values to secular themes in the Renaissance. This is because artist wanted to get closer to truth and have more realistic features in their artwork, contrary to creating depictions that reflect traditional teachings and idealistic forms of representation. This can be observed in Leonardo's sketches, by which he measured proportion and highlighted the relationship between different body parts. He did those things through black chalk and ink, which are mediums that create expressive lines for body parts, allowing the audience to observe and distinguish between functions of body parts in motion. As Leonardo achieved anatomical correctness, he facilitated the future use of anatomical terminology when describing body parts. This is important as understanding anatomical terminology enables scholars to prevent both confusion and misunderstanding when studying the body [11].

Lastly, the use of sequential layout as the layout of these sketches shows how art and science blend through layout. A sequential layout offers a step-by-step understanding of a body part, similar to how anatomical sketches are often in a layered format to facilitate comprehension. For example, the sketch *The Muscles of the Shoulder, Arm, and Neck* depict shoulder muscles in four angles from the left to right as the shoulder twists and turns. This procedural process of observing the hand enables the viewer to observe each anatomical component in a sequence of actions. One can better understand anatomy by examining each component separately before moving on to different components. On the other hand, if these three parts of the hand were drawn in a single layer, then the level of details and features would decrease, contrasted to the high level of detail that can be found in a sequential layout with separated layers. This artistic representation of body parts is another way that contributes to scientific inquiry.

## 4. Conclusion

In conclusion, Leonardo's anatomy sketches are a synthesis of art and science during the Renaissance. These sketches showcased artistic skill and rigorous scientific inquiry, as well as highlighting that anatomy was both an artistry and a scientific discipline. Renaissance art was the impetus for scientific exploration and understanding. The research revealed that Leonardo's anatomical documentation and innovative artistic techniques laid the groundwork for future anatomical studies.

The results of this demonstrate Leonardo's revolutionary approach. By challenging the conventional ways of studying the body and performing dissections, his creativity enhanced his scientific understanding of anatomy. By blending artistic perspective with anatomical accuracy, he bridged the gap between these two seemingly contrasting fields. Such a synthesis advanced medical knowledge and influenced generations of artists and scientists.

The impact of this research is significant for examining the insights into the dialogue between art and science. It extends beyond the Renaissance as the two disciplines still cross paths in modern times and shape today's disciplines. When recognizing how artist-scientists like Leonardo mapped this intersection, contemporary scholars can appreciate the value of interdisciplinary approaches. This connection is essential for solving complex modern challenges.

Looking forward, this research opens new explorations for how artistic practices can inform scientific methods for scholarship and knowledge seeking. Future studies could focus on how emerging visualization techniques contribute to scientific discovery. By continuing the investigation between interdisciplinary fields, one can inspire subsequent generations of scholars to carry on Leonardo's creative legacy.

All in all, interdisciplinary studies like art and science during the Renaissance illustrate the wonderful collaboration between different disciplines. Leonardo's anatomical sketches, in particular, exemplified the synthesis of art and science for the study of human anatomy. This holistic approach underscored the belief that understanding the natural world could enhance human expression and creativity. As the future becomes increasingly complex, cultivating these connections will advance both artistic expression and scientific advancement.

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