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Historical note

Two Millennia of Anatomical Discovery: Shaping the Evolution of Medicine

Dos Milenios de Descubrimiento Anatómico: Moldeando la Evolución de la Medicina

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SUMMARY: The development of anatomy as a scientific discipline spans thousands of years, evolving from ancient practices to today's advanced technologies. This abstract outlines the historical progression of anatomical knowledge, starting with early contributions from ancient civilizations such as India, Egypt, and Greece. The Edwin Smith Papyrus (1600 BCE) and Charak (300 BCE) provided foundational insights, while Greek scholars like Hippocrates, Aristotle, and Galen advanced systematic anatomical studies. However, some of their ideas were later found to be inaccurate. Galen's theories dominated Western medicine for over a millennium until the Renaissance when anatomists like Andreas Vesalius challenged traditional views through detailed human dissections, documented in his groundbreaking work '*De Humani Corporis Fabrica*' (1543). During the Islamic Golden Age, scholars such as Ibn al-Nafis (1213-1288) made significant contributions, including the first description of pulmonary circulation, refining earlier theories. The 16th to 18th centuries marked a transformative era for anatomy, fueled by the invention of the printing press and the work of pioneers like William Harvey, who demonstrated blood circulation. Artists like Leonardo da Vinci also played a key role, blending art and science through detailed anatomical illustrations. The 19th century saw the systematization of anatomical knowledge, with discoveries such as the cardiac conduction system by Purkinje, His, Keith, Flack, and Tawara. Modern anatomy, supported by technological advancements, has expanded into fields like histology, molecular biology, and stem cell research, leading to breakthroughs in understanding organ function and treating congenital diseases. While human anatomy is now well-documented, ongoing research explores nonhuman anatomy and unresolved questions, such as the role of stem cells in cardiovascular therapy. Anatomy remains a cornerstone of medical science, continuously evolving through interdisciplinary collaboration and technological innovation.

KEY WORDS: History; Middle Ages; Anatomy; Dissection; Plastination.

INTRODUCTION

The development of anatomy as science extends from the first examinations of victims of sacrifices to the sophisticated analyses currently done by modern scientists. It is characterized, over time, by the continuous development of the understanding of the body's structure and the organs' function. Human Anatomy has a prestigious history and is considered the most prominent of the biological sciences until the 19th century and early 20th century. Study methods improved dramatically, allowing study from examination through dissection of bodies to the use of technologically complex.

Anatomy is one of the foundations of medical education and has been taught since at least the end of middle age. The format and amount of information prepared for young doctors have evolved and changed in association with the demands of the medical profession. What is trained today differs significantly from the past, but the teaching methods have not changed much. For example, the famous public dissections that occurred at the end of the Middle Ages and early Renaissance can now be considered the 'anatomical demonstrations' used in practical classes.

Ancient anatomy

Charak was born in 300 BCE and was a significant contributor to the ancient Indian art and science of Ayurveda (Ayurveda is the name given to medical knowledge developed in India about 7,000 years ago, which makes it one of humanity's oldest medical systems. Ayurveda means,

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in Sanskrit, Science (Veda) of life (ayur)). CE is the Common Era, which measures the time from the first year in the Gregorian calendar. It is an alternate term for Anno Domini, Latin for "in the year of (Our) Lord," also translated as the Christian Era. All these names of eras are chronologically equivalent. The number of any given year is the same regardless of which of these names of ages is used. Background years are described as 'Before the Common Era' (BCE) when using the term' Common Era.' When using the terms anno Domini or Christian Era, antecedent years are described as before Christ or the Christian Era. None of the designations uses a zero year, and the two are numerically equivalent; then, '2012 EC' corresponds to 'AD 2012' and '399 BCE' corresponds to '399 BC'. *Charak* studied the anatomy of the human body. He described the number of bones as 360, including the teeth, and mistakenly believed that the heart had only one cavity connected to the rest of the body through thirteen channels. Numerous others of varying sizes would supply the various tissues from these channels. He also said that obstruction in one of these channels would lead to disease and deformity of the body.

a) Egypt

There have been reports of anatomical studies of the human body since 1600 BCE, the date of Edwin Smith's surgical papyrus. This treatise shows that the ancient Egyptians recognized the heart and its vessels, the liver, the spleen, the kidneys, the hypothalamus, the uterus, and the bladder. They also knew that the blood vessels were from the heart. Other vessels were described, some containing air, others containing mucus. Two vessels connected to the right atrium were said to hold 'the breath of life,' while two connected to the left contained 'the breath of death.' Egyptian iconography illustrates the story of the 'weighing of the heart' (Fig. 1) as a necessary test before Osiris raises the dead.

Fig. 1. Ancient Egypt - weighing the heart at the resurrection ceremony.

The Ebers papyrus (1550 BCE) deals with the 'heart' theme and regards the organ as the center of the blood supply, with vessels attached to each limb. The Egyptians knew little of the function of the kidneys and made the heart the meeting point of numerous vessels that carry the body fluids - blood, tears, urine, and sperm.

b) Greece

The earliest scientific medical work that has survived to this day is due to *Hippocrates* (460-377 BCE), who had a basic knowledge of skeletal and muscular structure and the beginning of understanding the function of some organs, such as the kidneys. *Hippocrates* was the first to recognize the tricuspid heart valve, which he documented in the treatise on the heart (in the Hippocratic Body).

Diogenes (of Apollonia) was a pre-Socratic philosopher who lived in the 5th century BCE and made the first systematic description of the architecture of blood vessels in man. In the 4th century BCE, *Aristotle* (Fig. 2) and several of his contemporaries produced a system of knowledge based on the dissection of animals.

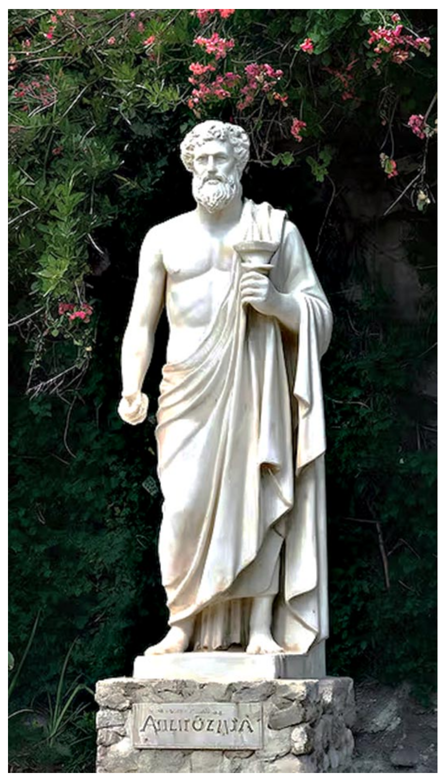

Fig. 2. Aristotle (384–322 BCE) was a Greek philosopher and polymath whose contributions to anatomy and natural sciences laid the groundwork for centuries of scientific inquiry. Although his anatomical knowledge was primarily based on animal dissections, his systematic approach to studying the structure and function of living organisms marked a significant advancement in early science.

Praxagoras is recognized as being the first to identify the differences between arteries and veins. The first use of cadavers for anatomical research occurred in the 4th century BCE with *Herophilus* and *Erasistratus*. They could dissect still-living individuals (vivisections) in the case of criminals of Alexandria under the auspices of the Ptolemy dynasty. *Herophilus*, in particular, synthesized anatomical knowledge more closely to current expertise than any other until that time. The Greek *Theophrastus* (? - 287 BCE), an Aristotle disciple, also dissected humans. He coined the term' anatomy' (Greek, 'anna temnein'), which became generalized, encompassing the whole field of biology that studies the form and structure of living beings, existing or extinct.

c) Galen

Aelius Galenus or *Claudius Galenus* (Pergamon, 129, now Bergama in Turkey - probably Sicily, 200) was a prominent Greek physician (educated in Alexandria), surgeon, and philosopher (Fig. 3). *Galen* contributed much to understanding numerous scientific disciplines, including anatomy, physiology, pathology, pharmacology, neurology, and philosophy. Galen's anatomy and medicine were influenced by the 'humorism' theory practiced by many Greek physicians, including Hippocrates.

Fig. 3. Galen (129–c. 216 CE), a Greek physician and philosopher, was one of the most influential figures in medicine and anatomy. He became a prominent physician to gladiators and Roman emperors. His work dominated medical thought for over 1,400 years, shaping Western and Islamic medicine. Despite inaccuracies, Galen's legacy as a pioneer of systematic anatomical study and his influence on medical practice remains unparalleled in the history of science.

Galen's theories dominated and influenced Western medical science for almost 'two millennia.' His anatomical analyses, based on the dissection of animals (apes, pigs, and dogs), remained incontestable until 1543, when detailed descriptions and drawings of dissections of the human body were published in *De Humani Corporis Fabrica* (by *Andreas Vesalius*). Galen's theory for the functioning of the circulatory system still lasted until 1628, when *William Harvey* published the *Anatomical Exercitatio of Motu Cordis et Sanguinis in Animalibus* and established that the blood circulated, and the heart propelled it like a bomb.

Galen elucidated the anatomy of the trachea and was the first to demonstrate that the larynx generates the voice. *Galen* probably understood the importance of artificial ventilation because one of his experiments was used to inflate the lungs of a dead animal. One of his most significant medical contributions was his work on the circulatory system. He was the first to recognize differences between venous (dark) and arterial (bright) blood. With his anatomical experiments on animals, he better understood the circulatory, nervous, respiratory, and other structures. However, his work still contained many inaccuracies. *Galen* believed the circulatory system consisted of two unidirectional blood distribution systems rather than a single unified circulation system. He understood that venous blood would be generated in the liver (from where it would be distributed to the body and consumed). *Galen* also postulated that arterial blood would be produced in the heart (from where it would be distributed to the body and consumed). The liver and heart would then regenerate the blood and complete the cycle. *Galen* believed in the existence of a group of blood vessels called the rete mirabile near the dorsal part of the brain.

Unfortunately, Galen's original work was lost in time. We know a fraction of his work thanks to the compilations made by Arab medicine, which were recovered in the Renaissance in Europe.

Middle Ages - The Arab Anatomy

After the decline of the Roman Empire, the study of anatomy stagnated in Christian Europe as it flourished in the Islamic world. The Persian physician *Avicenna* (980-1037) absorbed the anatomical teachings of *Galen* by expanding them in his "Principle of Medicine" (1020), the most important treatise on anatomy in the Islamic world until the appearance of *Ibn al-Nafis* in the 13th century, whose book dominated medical education in medieval Europe until the16th century.

The physician *Ibn Zuhr* (1091-1161) was the first Arab to perform dissections in man and necropsies to study the cause of death. He recognized that scabies were caused by a parasite, a finding contrary to the 'mood theory' from the Greeks. Removing the parasite from the patient's body produced healing and did not involve purging humor, bleeds, or any other traditional treatment associated with the four humors. In the 12th century, the private physician of the great politician and conqueror Saladin, *Ibn Jumay*, also dissected the human body and urged his peers to do the same to understand medicine better. Another Arab physician, *Abd-el-Latif*, observed and examined many bodies during the famine in Egypt in 1200, which led him to disagree with Galen's teachings on the formation of bones, especially the jaw and the sacrum.

The Arab physician *Ibn al-Nafis* (1213-1288) was prominent in dissecting human bodies and performing necropsies. In 1242, he described, for the first time, the pulmonary circulation and the coronary circulation and was therefore considered the 'father of the circulation theory.' *Ibn al-Nafis* also issued the first concept of metabolism and developed new systems of anatomy that replaced the doctrine of the four humors of *Avicenna* and *Galen*. He described the pulse, bones, muscles, intestines, sensory organs, bile ducts, esophagus, stomach, and anatomy of almost every part of the human body.

Early modern anatomy

The 'Principle of Medicine' (from *Avicenna*, which incorporated the teachings of *Galen*) was translated into Latin. With this, it remained the most important anatomy text in medical education in Europe until the 16th century. The first significant development in anatomical knowledge in Christian Europe since the fall of Rome occurred in Bologna between the 14th and 16th centuries. Several anatomists dissected corpses and contributed with more precise descriptions of organs, identifying their functions.

The first significant challenge of Galen's doctrine in Europe occurred in the 16th century. Thanks to the advent of the Gutenberg press. *Johannes Gensfleisch zur Laden zum Gutenberg* (Mainz, 1398-1468) was a German inventor and graphic designer who introduced the modern form of book printing. His invention of the mobile mechanical type for printing began the Revolution of the Press and is widely considered the most important event of the modern period. He played a key role in developing the Renaissance, the Reformation, and the Scientific Revolution. He laid the material foundation for the modern knowledge-based economy and the spread of mass learning. Therefore, there was a collective effort in Europe to circulate the works of *Galen* and *Avicenna*. *Andreas Vesalius* (1514-1564) published a treatise on anatomy in 1543, *De humani corporis fabrica libri septem* (Fig. 4) (this book, along with *Nicolaus Copernicus's* "On the Revolutions of the Celestial Bodies" and *Isaac Newton's* "Principia Matematica" compose the list of the three books that most revolutionized human knowledge).

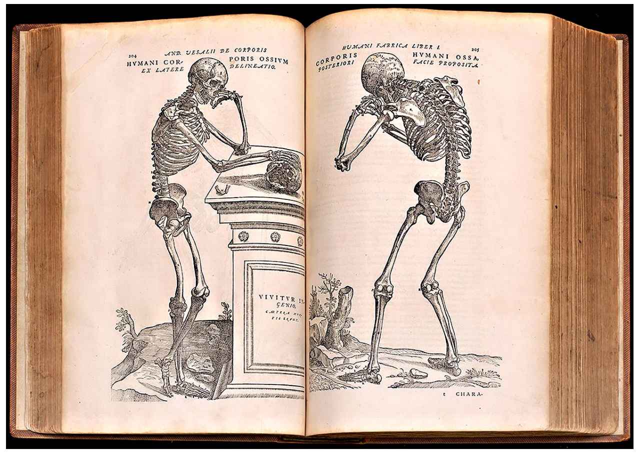

Fig. 4. Illustration of the book of Vesalius (1543), *De Humani Corpori Fabrica Libri Septem.*

Vesalius went from Leuven to Padua, where he could dissect the bodies of criminals condemned to death (hangings) without fear of being persecuted. His drawings are detailed descriptions of the human anatomy that evidence the differences in the reports made by *Galen* (in animals). Many other anatomists who came after *Vesalius* challenged 'galenic knowledge,' but it still reigned for another century.

The foundation of the School of Medicine of the University of Bologna was a long process that began in 1063, with the first Professorial Professors appearing around the year 1170. The statute of the city of Bologna for teaching medicine dates from 1378. Many prominent personalities have contributed their activities through the centuries to the celebration of the University of Bologna. Between the end of the 13th century and the beginning of the 14th century, *Mondino Dei Liuzzi* (1270-1326) reestablished the Alexandrian school tradition of vivisection practice and published his observations in an anatomy book that was used until the late 16th century (in fact, can be considered the first book of experimental research in anatomy). In Bologna, *Alessandro Achillini* (1463-1512) studied the bile duct and the gallbladder; *Berengarario da Carpi* (1466-1530) was a famous surgeon for his description of the vermiform appendix, the thymus, the function of the heart valves (he also talked about fracture treatment and already used mercury in the treatment of syphilis); *Giulio Cesare Aranzio* (1530-1589) became interested in embryology ('the duct of Arancio') and blood vessels (bodies of Arancio); *Costanzo Varolio* (1543-1575) studied the encephalon ('bridge of Vario').

Miguel Servet (1511-1553) was a Spanish theologian, physician, cartographer, and humanist, the first European to describe the function of pulmonary circulation. He participated in the Protestant Reformation and, finally, created 'non-Trinitarian Christology' (which ignored the Holy Trinity), which was condemned by both Catholics and Protestants. He was arrested in Geneva and burned on a stake as a heretic by order of the Protestant governor of Geneva under the direction of John Calvin (1509-1564), a French Christian theologian (Calvinism) who was never ordained a priest. After he departed from the Catholic Church, he was the voice of the Protestant movement. He was persecuted in France and fled to Geneva in 1536, where he died). Servet studied medicine in Paris, graduating degree in 1536. Among his professors were *Sylvius*, *Fernel*, and *Guinter* (who spoke of him to *Vesalius* as 'his most skilled assistant in dissections'). Despite *Servet's* contribution to the knowledge of pulmonary circulation, his work was not recognized in his time mainly because his descriptions were made in a treatise on theology, *Christianismi Restitutio*, and not in a medical book. Many copies of this treatise were quickly burned after publication in 1553 because of persecution by religious authorities. Only three copies were spared, but they remained hidden for many years.

The most prominent 'son' of Bologna was *Marcello Malpighi* (1628-1694), the 'father of microscopic anatomy' and a defender of the use of experimental methods. *Malpighi* graduated as a Doctor of Medicine at the University of Bologna in 1653. He married Francesca Massari, the younger sister of his anatomy professor, in 1654. *Malpighi* used the microscope to study the capillaries of the pulmonary alveoli (Figs. 5-6), the corpuscles of the kidney, the spleen corpuscles, and the epidermis follicles. His pupil, *Antonio Maria Valsalva*, investigated the vagus nerve and created the 'Valsalva maneuver.'

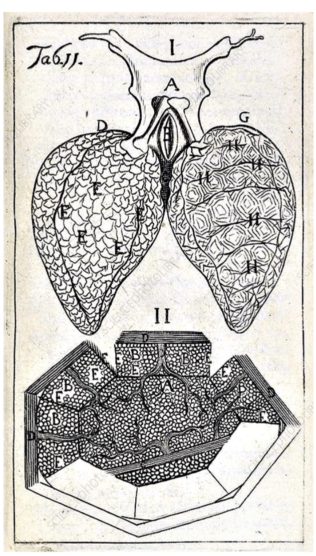

Fig. 5. Illustration from the Malpighi book describing the 'pulmonary capillaries.'

Fig. 6. Tomb where Marcelo Malpighi lies, in Bologna.

A succession of anatomists refined anatomical knowledge and lent their names to numerous anatomical structures. The 16th and 17th centuries witnessed remarkable advances in understanding the circulatory system, the function of the heart, and venous valves. Blood flow was described, and the hepatic veins and lymphatic vessels were identified as separate portions of the circulatory system.

17th and 18th Centuries

The study of anatomy flourished in the 17th and 18th centuries with the advent of the press, which facilitated the dissemination and exchange of ideas because anatomy was heavily based on observation and drawings (the anatomists' popularity was related to their ability and talent in drawing).

William Harvey (1578-1657) was an English physician who studied at the University of Padova, a disciple of *Fabrizio d'Acquapendente* (1533-1619) (who built the Anatomical Theater in Padua, where he taught for 50 years; the exact description of the venous valves). *Harvey* received his medical degree in 1602 and maintained a lifelong friendship with D'Acquapendente. Harvey's interest in D'Acquapendente's work, '*De Venarum Ostiolis*,' led him to study blood circulation.

Harvey was not the first anatomist to postulate that blood circulation was through the arteries and veins, but he was the first to demonstrate this fact convincingly. He also did experiments on the function of the heart by pumping blood. *Harvey's* mathematical reasoning led him to calculate the blood volume in the body, which counteracted the Galenian theory that the blood was made in the liver.

In *De Motu Cordis* (Fig. 7), Harvey adapted the diagram used by his master *D'Acquapendente in De Venarum Ostiolis.* There are distended veins in the forearm and the position of the venous valves. When the vein is pressed centrally (milked), and its extremity is closed (compressed), it only fills with blood when pressure is relaxed. Blood cannot be forced into the 'wrong' direction.

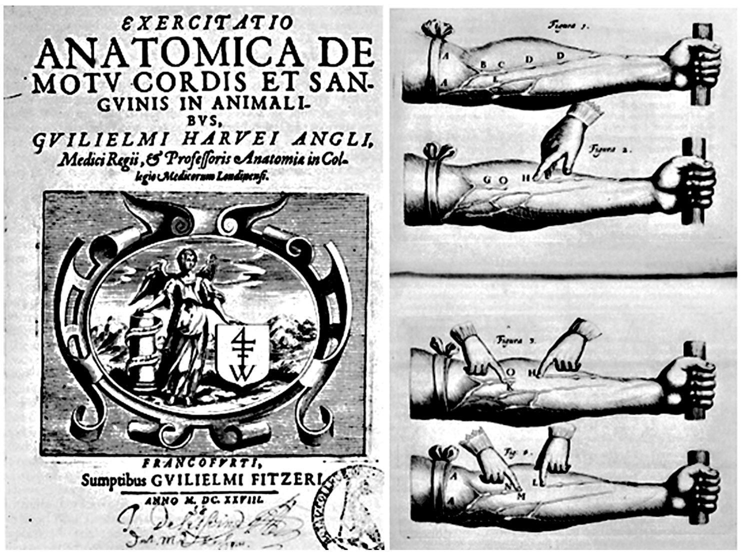

Fig. 7. Illustration from Harvey's book on blood circulation. A - Frontispiece of the book (Thesis), B - direction of blood flow in the veins of the forearm.

Many famous artists studied anatomy dissected bodies, and published their drawings for money, from *Michelangelo* and *Da Vinci* to *Rembrandt. Leonardo Da Vinci* (1452-1519) learned anatomy with *Andrea del Verrocchio* (1435-1488). As an artist, he quickly became a master of topographical anatomy, and he designed many studies on muscles, tendons, and other anatomical parts, always seeking perfection. Being a successful artist, he was allowed to dissect human bodies at the Hospital of Santa Maria Nuova in Florence and then in hospitals in Milan and Rome.

Leonardo Da Vinci (1452-1519) studied the skeleton and muscles. We can say that these studies are a harbinger of the modern science of biomechanics. He also designed the heart and vascular system, sexual organs, and other internal organs. He made the first scientific drawing of copulation (Fig. 8) and the development of the fetus in the uterus. He also designed the effects of aging and emotion on the human face and the 'three-dimensional anatomy' of body segments (Fig. 9). From 1510 to 1511, *Da Vinci* collaborated with *Marcantonio della Torre* (1481-1511). Together, they prepared an anatomy work in which *Da Vinci* drew more than 200 boards (which was only published in 1680, 161 years after Da Vinci's death, under the title of Treaty of Painting).

Fig. 8. Leonardo Da Vinci drew his interpretation of copulation.

Fig. 9 . Leonardo Da Vinci drew different levels of dissection of a body (possibly that of a 100-year-old elder he met still alive, dead on the same day).

Many European cities such as Amsterdam, London, Copenhagen, Padua, and Paris had Anatomical Academies held by the local government. Thus, *Nicolaes Tulp*, mayor of Amsterdam, can perform numerous dissections and public demonstrations (Fig. 10). Dr. Tulp's "Anatomy Lesson" is an oil painting on canvas by *Rembrandt*, painted in 1632. It is one of his most famous and revolutionary works. The body that appears in the picture is of a marginal who had been condemned to death by robbery the day before the lesson. Anatomy lessons existed and took place in amphitheaters, given by anatomist doctors. At that time, students traveled through Europe where bodies were available (hanged, for example) to perform dissections (there was no way to keep bodies in study conditions long after death, and their dissection should be done quickly).

Fig. 10. The "Anatomy Lesson of Dr. Nicolaes Tulp" is a famous oil painting by the Dutch artist Rembrandt, completed in 1632. The painting depicts Dr. Nicolaes Tulp, a prominent Amsterdam physician, conducting a public dissection of the arm of an executed criminal, Aris Kindt. It is considered one of Rembrandt's early masterpieces and a significant example of 17th-century Dutch Golden Age art. The painting is housed in the Mauritshuis Museum in The Hague, Netherlands.

Europeans interested in anatomy traveled to Italy, the center of anatomy at the time. Only in Italy was it possible to dissect a woman's body, for example. *Renaldus Columbus* (1516-1559) and *Gabriele Falloppio* (1523-1562) were disciples of *Vesalius*. *Columbus* was his successor in Padua and later a professor in Rome. *Columbus* accurately described the bones, the shape of the heart cavities, the pulmonary artery, the aorta, and their leaflets, and traced the course of blood from the right to the left side of the heart. Also, it made a good report of the encephalon and its vessels and the ventricle of the larynx. The name of *Columbus* is also associated with the description of the clitoris (which he considered *Amor Veneris, Vel Dulcedo Appelletur*, that is, "must be called love or sweetness of Venus"). *Columbus* was not the first to designate the clitoris but was one of the first to propose its role in female sexual pleasure. Fallopio described the uterine tubes ('Fallopian tubes').

19th century

During the 19th century, the anatomists finalized and systematized the human descriptive anatomy inherited from the preceding centuries' anatomists. The increase in anatomy research has increased the demand for corpses, which led to the mistrust that some used obscure means to obtain them (including committing a crime: Two Irishmen, *William Hare* and *William Burke* of Edinburgh, in the mid-19th century committed a series of murders in order to sell the victims' bodies for dissection in anatomy classes). Discipline has also progressed and has increasingly established connections with the histology and biology of development, not only in man but also in other animals. The Société Anatomique de Paris is one of the oldest medical societies still in operation, founded by *Dupuytren and Lænnec* in 1803 under the aegis of Emperor Napoleon Bonaparte (currently works at UFR Biomédicale des Saints-Pères (Fig. 11).

Fig. 11. UFR Biomédicale des Saints-Pères (Université Rene Descartes, Paris V, currently Paris-Descartes), where the Société Anatomique de Paris worked for many years.

Why does the heart pulse? The issue is known as myogenic versus neurogenic theory, which dominated cardiac research in the 19th century. *Marie Francois Xavier-Bichat* and *Nysten* reported experiments with beheaded individuals (in Paris, 1800-1802) in whom they caused the heart to resume pulsating using electric shock (during the French Revolution, it should not have been a problem to obtain bodies of beheaded). Individual rights were suspended daily, with widespread applause, and carried out publicly and en masse. The Jacobin leader *Robespierre*, sanctioning the summary executions, had announced that France needed no judges but more guillotines. The result was the death sentence of 35,000 to 40,000 people.

Jan Evangelista Purkinje (1787-1869) discovered in 1839 fibers in the subendocardium of the ventricles ('Purkinje fibers' of the conduction system of the heart). *Walter Gaskell*, in 1886, described specialized muscle fibers connecting the atria and ventricles, which, when sectioned, cause blockage. It also identified the area of onset of cardiac excitation in the region derived from the venous sinus. *Wilhelm His, Jr* (1863-1934) examined a series of histological sections of human embryos' hearts and showed that connective tissue surrounds a beam from the right atrium to the ventricles, His bundle. *SunaoTawara* (1873-1952) followed the 'bundle of His' (atrioventricular, AV) to its connection with the 'compact' portion of the AV node at the base of the interatrial septum. *Tawara* concluded that the 'AV connection system' originates from the AV node, penetrates the septum (like the His bundle), and divides into right and left branches, ending in the 'Purkinje fibers.' *Arthur Keith* (1866-1955) and *Martin Flack* (1882-1931) found, in 1907, a peculiar structure at the sinoatrial junction that recalled the structure of the AV node; they considered that the heart rhythm started there and called it the sinoatrial node region. In 2006 and 2007, we celebrated the 100th anniversary of the anatomical discoveries of the cardiac conduction system.

A unique opportunity for *in vivo* experiments occurred in 1882. Catharina Serafin (Prussia), a 46-year-old woman, had a chest tumor that was excised along with the left wall of the left hemithorax, exposing the heart, which could be seen covered by a thin layer of skin. *Hugo Von Ziemssen* stimulated Mrs. Serafin's heart using an electric current, which altered the frequency of heartbeats. Years later, *Einthoven's* electrocardiogram showed a better understanding of the electrical phenomenon in the heart's contraction.

Modern Anatomy

In the last 100 years, anatomical research has benefited from technological innovations and the growing understanding of related sciences such as 'evolution' and 'molecular biology.' Endocrinology explained the purpose of the glands that the anatomists could not tell. Sophisticated medical devices allow us to study anatomy in living people. Today, progress in anatomy is mainly in the study of ontogenetic and phylogenetic development and the study of the function of specific structures, using techniques such as immunohistochemistry / confocal microscopy by laser scanning, neuronal tracers, or others.

Increased knowledge of cardiac anatomy and congenital heart disease led to the first surgery to treat congenital heart disease in November 1944 at Johns Hopkins Hospital in 1938, the persistence of ductus arteriosus had been corrected, but now, for the first time, there was a specific procedure to correct a congenital heart defect). The operation was called the *Blalock-Taussig* shunt, opening the door for new methods to be attempted in this area.

Anatomy is already thoroughly documented in man, but the nonhuman anatomy is still full of possibilities. Modern anatomists are still interested in performing experiments on animals since they allow us to understand the primary organization of organs and the principles of functioning of structures using advanced techniques of microscopy, physiology, and cellular and molecular biology (Fig. 12).

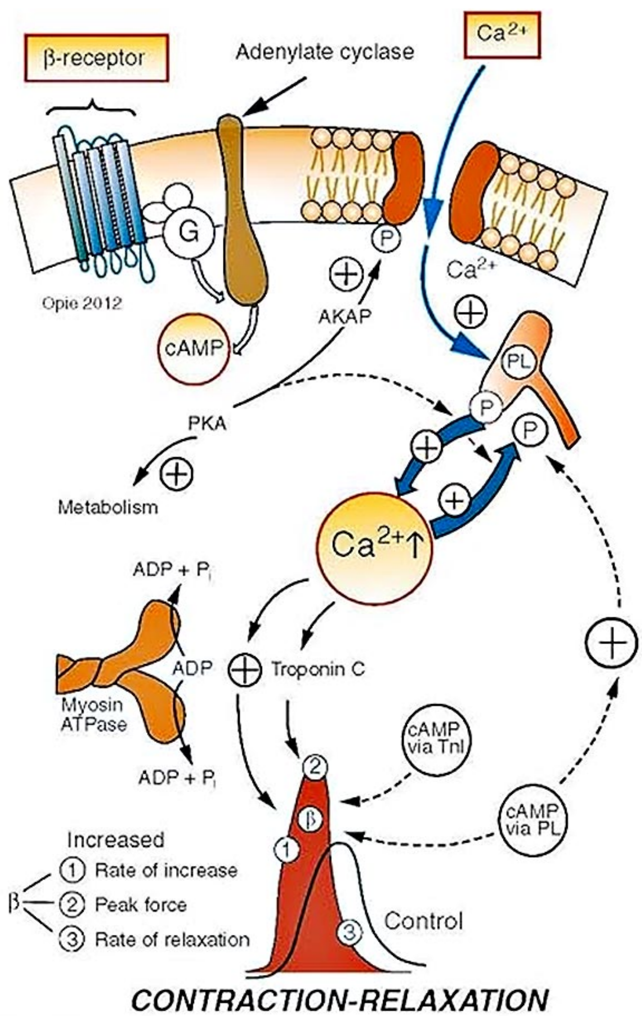

Fig. 12. Diagram illustrating the molecular basis of muscle contraction and relaxation (Opie & Gersh, 2008).

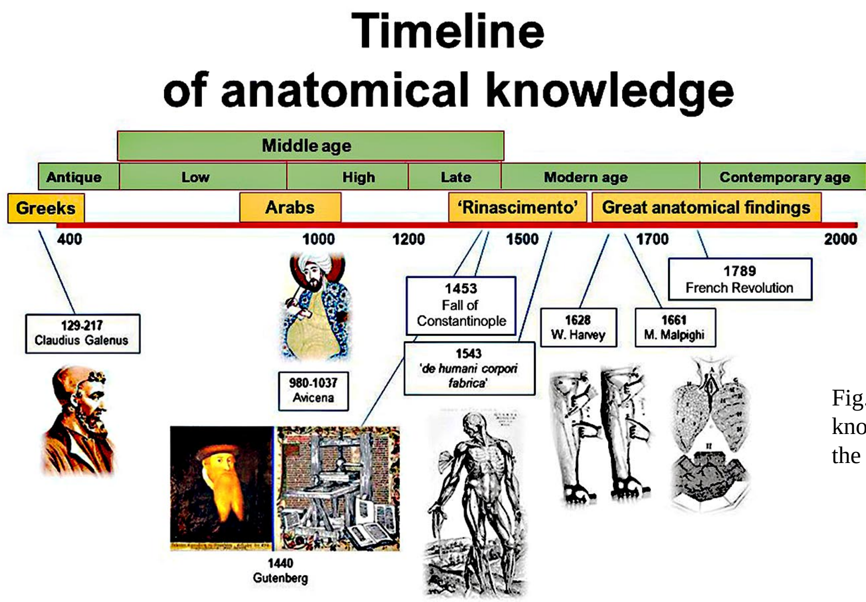

Fig. 13. Timeline of the evolution of anatomical knowledge from antiquity to the beginning of the 21st century.

There are still mysteries in the human body that need clarification. The current challenge of cardiovascular morphology is to characterize the exact role of stem cells (Stem cells are cells found in every multicellular organism. They are characterized by the ability to renew by mitotic division and differentiate into a wide range of specialized cell types). Stem cell research has increased activity since the works of *Ernest McCulloch* and *James Till* in the 1960s at the University of Toronto. There are two types of stem cells in mammals: embryonic stem cells, isolated from the inner cell mass of the blastocyst, and stem cells found in adult tissues. Possible mechanisms of stem cell activation in heart cell therapy include the generation of cardiomyocytes, stimulation and growth of new blood vessels (angiogenesis), secretion of growth factors, and possibly some other mechanism still unknown.

Finally, we present a diagram that captures the timeline of anatomical knowledge's evolution over the past two millennia, leading up to the dawn of the 21st century. This visual summary highlights the remarkable progress made by anatomists throughout history, showcasing their contributions to medicine and humanity. Their enduring legacy continues to shape our understanding of the human body and advance medical science (Fig.13).

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RESUMEN: El desarrollo de la anatomía como disciplina científica abarca miles de años, evolucionando desde las prácticas antiguas hasta las tecnologías avanzadas de la actualidad. Este resumen describe la progresión histórica del conocimiento anatómico, comenzando con las primeras contribuciones de civilizaciones antiguas como la India, Egipto y Grecia. El Papiro de Edwin Smith (1600 a. C.) y Charak (300 a. C.) proporcionaron conocimientos fundamentales, mientras que los eruditos griegos como Hipócrates, Aristóteles y Galeno avanzaron en los estudios anatómicos sistemáticos. Sin embargo, más tarde se descubrió que algunas de sus ideas eran inexactas. Las teorías de Galeno dominaron la medicina occidental durante más de un milenio hasta el Renacimiento, cuando anatomistas como Andreas Vesalius desafiaron las visiones tradicionales a través de disecciones humanas detalladas, documentadas en su obra pionera "*De Humani Corporis Fabrica*" (1543). Durante la Edad de Oro islámica, eruditos como Ibn al-Nafis (1213-1288) hicieron contribuciones significativas, incluida la primera descripción de la circulación pulmonar, refinando las teorías anteriores. Los siglos XVI al XVIII marcaron una era transformadora para la anatomía, impulsada por la invención de la imprenta y el trabajo de pioneros como William Harvey, quien demostró la circulación sanguínea. Artistas como Leonardo da Vinci también desempeñaron un papel clave, fusionando arte y ciencia a través de ilustraciones anatómicas detalladas. El siglo XIX fue testigo de la sistematización del conocimiento anatómico, con descubrimientos como el sistema de conducción cardíaca de Purkinje, His, Keith, Flack y Tawara. La anatomía moderna, apoyada por los avances tecnológicos, se ha expandido a campos como la histología, la biología molecular y la investigación con células madre, lo que ha llevado a avances en la comprensión de la función de los órganos y el tratamiento de enfermedades congénitas. Si bien la anatomía humana ahora está bien documentada, la investigación en curso explora la anatomía no humana y las preguntas sin resolver, como el papel de las células madre en la terapia cardiovascular. La anatomía sigue siendo una piedra angular de la ciencia médica, evolucionando continuamente a través de la colaboración interdisciplinaria y la innovación tecnológica.

PALABRAS CLAVE: Historia; Edad Media; Anatomía; Disección; Plastinación.

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