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Ellie H. Barany
Riverdale High School

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Ellie Barany

L. Keldorf

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The Rise and Fall of Human Dissection

Open up any medical textbook and a detailed lay out of human anatomy is found. While modern anatomical knowledge is attributed to the late Renaissance period, much older writings from the 3rd century BCE or Hellenistic period reveal that extensive knowledge of human anatomy were known to scientists and doctors of ancient Greece. The scientist, Herophilus of Chalcedon was the first to dissect and systematically record detailed and accurate anatomical findings of the human body. He lived and worked in Alexandria, where scientific inquiry flourished with the support of its monarchs. Herophilus' work was remarkable because he defied Ancient Greek taboos regarding purity, death, and the human body. Ultimately, his work disappeared from medical practice and history for over 1500 years. After the death of Herophilus, systematic human dissection was not practiced until the Renaissance period. Though Herophilus' contributions did not outlast him, his work was remarkable for his time. Herophilus' practice of systematic human dissection was part of an institution built by the Ptolemies, Soter and Philadelphus. The Ptolemaic monarchs encouraged and supported the intellectual elite of the Hellenistic Empire to live and work in the vast research institution, known as the Alexandrian Museum. Systematic human dissection flourished

in the Hellenistic era because of the patronage, invitation and tolerance promoted by the Ptolemaic kings.

Anatomical knowledge began with the Greek philosopher and scientist, Aristotle. Aristotle, considered a natural philosopher, believed that knowledge could be obtained by observation and experimentation. This led him to dissect animals and recorded his findings in his book, *On the Parts of Animals* written around 350 BCE:

The kidneys of this animal are more solid than those of any other, and in form resemble the kidneys of the ox. The human kidneys are of similar shape; being as it were made up of numerous small kidneys, and not presenting one unbroken surface like the kidneys of sheep and other quadrupeds. For this reason, should the kidneys of a man be once attacked by disease, the malady is not easily expelled. For it is as though many kidneys were diseased and not merely one; which naturally enhances the difficulties of cure. (Aristotle).

Based on his findings, Aristotle made inferences from the anatomy of animals to humans. During his time, human anatomy was only known through comparison. While Aristotle made contributions to the field of zoology, not much is learned directly about human anatomy.

The first glimpse of internal human anatomy came from surgical procedures and treatment performed on wounded soldiers. These findings were limited as they were anecdotal and not systematic. Systematic dissection of humans for the purpose of scientific research didn't occur until the 3rd century BCE, during the Hellenistic age.

Herophilus of Chalcedon (325-250 BCE) lived and worked in Alexandria as a physician and was the first to dissect and analyze the human body. According to Professor Marshall Clagett from the University of Wisconsin, a majority of work involving dissection is credited to him. Also known as the “Father of Anatomy.” Herophilus pioneered techniques to conduct human dissections. He provided comprehensive, accurate descriptions of human organs and categorized the human body into functional systems (Clagett). His work focused on the nervous system, cardiovascular system, and gastrointestinal system. By opening the human head, Herophilus was able to define cranial nerves of the brain and distinguished the cerebrum from the cerebellum. By opening the chest, Herophilus found the four valves of the heart, and distinguished arteries and veins. By opening the abdomen, Herophilus was able to observe the small intestine, as well as define the functions and appearance of the liver and pancreas. Remarkably, much of Herophilus’ work is accurate consistent with modern anatomical findings (Clagett). Based on his research Herophilus hypothesized that human disease originated within the organs of the body. New understandings of disease mechanisms were only possible because of Herophilus’ inaugural and controversial practice of human dissection.

The practice of systematic human dissection was highly controversial in the Greek world. Dr. Heinrich Von Staden from Yale University attributes this to social and religious taboos that the Greeks placed on the manipulation of human bodies. Human dissection for the purposes of medical research violated these taboos in multiple ways.

One of these taboos regards the cutting and violation of human skin. Dr. Von Staden states that human skin was a symbol of community, and health of both an individual, and the society in which they live. Skin represented the protection and stability that “enveloped” civilization. Without it, the Greeks believe, their community is vulnerable and subject to danger. Von Staden writes that cutting the skin, “was to interfere with the surface version both of the physical and of the moral condition of a person” (Von Staden 229). Cutting open skin was considered sacrilege. Moreover, during sacrifice, the skin of the animal is not burned, and is instead left behind as a symbol of moral integrity (Von Staden).

Another taboo in Greek history regards the purity of life and the impurity of the human corpse. Professor Vivian Nutton from the UCL Centre for the History of Medicine, states that the Greeks viewed the human corpse as a source of contamination. This taboo stemmed from the prohibition of death and dead bodies on religious grounds such as temples and sanctuaries (Nutton). Moreover, if a death occurs in a household, the body must purified in a process of being cleaned, anointed in oil, and dressed in white robes. After burial, the mourners must purify themselves as well as wash the grounds of their home with seawater. Even then, the mourners must wait up to two months before walking on religious ground. Those who came into contact with a corpse had to purify themselves or they would be shunned. The impurity of the human corpse was thought to be so strong, that it was even believed to have the ability to contaminate divine figures (Von Staden). Touching, much less cutting open, a human corpse was seen as a cultural violation.

A radical shift in culture during the Hellenistic age allows these taboos to be disregarded, and therefore systematic human dissection to be practiced. Sir Geoffrey Lloyd from Cambridge University discusses how the new culture of intellectualism in the Hellenistic world was created and supported by the monarchs from the Ptolemy family. Ptolemy I Soter, and his successors, including his son Ptolemy II Philadelphus, maintained power in Hellenistic Egypt from 305-30 BCE. The power of the Ptolemy family was centralized in Alexandria; a city founded by Alexander the Great in 332 BCE. The Ptolemies claimed to have lineage to Alexander the Great and were determined to continue his legacy (Lloyd). Therefore, the Ptolemies sought out and succeeded to make Alexandria the political, economic and intellectual center of the Hellenistic empire. Scholars have a number of theories regarding the Ptolemies' ambitions for Alexandria. It may have been another way to extend their influence throughout the empire. Lloyd suggests that, "scientific knowledge holds the key to material progress" (7) which is consistent the economic and political aims of the Ptolemies. Von Staden suggests that the Ptolemies enjoyed the prestige that came with collecting the elite like "birds in a gilded cage." Whatever the motivation, Alexandria became the center on Hellenistic intellectual life.

One of the most significant factors contributing to the development of Herophilus' work was the support and patronage of the Ptolemaic kings, Soter and Philadelphus. Among the Ptolemies' greatest contributions was the establishment of the Alexandrian Museum and Library. Unlike modern definitions, the Museum was a research institution and think tank, where new scientific ideas were published and shared.

According to Dr. Harold Dorn from Johns Hopkins University, the Museum included the Library of Alexandria, a vast database of records. The Ptolemies provided spaces within the Museum for scientists and intellectuals to study and conduct research. Researchers contributed to the fields of mathematics, astronomy, philosophy, zoology, and medicine. Advances were made in geometry, heliocentric theories of the solar system, as well as engineering and architecture (Lloyd). While other dynasties within the Hellenistic Empire had similar institutes, none compared to the Alexandrian Museum. Notable scholars lived and worked at the Museum, while the Ptolemies sponsored their work by providing resources, stipends and grants (Dorn).

It was among the scholars in the Museum where Herophilus conducted his research on human anatomy. Ptolemies were supportive and encouraging of Herophilus' work to the degree that they provided him with human corpses. One of the more controversial provisions from the Ptolemies were live subjects. Dr. Von Staden writes, "Herophilus obtained imprisoned criminals 'from the kings.' This part of the account seems compatible with the ambitious patronage extended by the first two Ptolemies" (*Herophilus* 144). Herophilus was legally allowed to perform dissections on living human prisoners for the purposes of medical research. This procedure is known as vivisection. Vivisection is truly unique to Hellenistic Alexandria; as Herophilus was the first and only Greek of record to ever perform them. It was likely that the Ptolemies were supportive of Herophilus' work because they believed that his work would have practical and beneficial applications in the advancement of medical science.

Another way the Ptolemies contributed to Herophilus' practice of systematic human dissection at the Museum was by inviting notable scholars and scientists of the time to work in Alexandria. Some of the greatest names in Greek history travelled to Alexandria to study, including Euclid, who was known for geometry; Archimedes who was known for computing pi; and Eratosthenes known for calculating the circumference of the Earth (Mark). Not only an intellectual center, Alexandria was a thriving port city uniting the Eastern and Western territories; thus creating an economic center within the greater Hellenistic Empire. Alexandria was a city filled with people from all over the Empire, merchants, travelers, soldiers, slaves and scholars passed through this port city daily. This, in addition to the establishment of the Museum and Library made Alexandria attractive to scholars and intellectuals.

Alexandria became a melting pot of minds from Syria, Palestine, Crete, Cyprus, Ionia, and Mesopotamia. Each of these areas had unique religious beliefs, languages, philosophy and culture that intermingled (Von Staden). As long as the Ptolemies' retained power and loyalty, Alexandrian culture accepted and adopted worldviews that differed from traditional Greek beliefs. The Hellenistic Empire became a rich environment for scholars to conduct their work while being fed and surrounded by new ideas.

Herophilus was among those that came to Alexandria to study. He was born in Chalcedon in Asia Minor, what is now known as modern day Turkey. He furthered his medical education at the Museum. It was during this time he began his research on

anatomy with the legal approval from the Ptolemies. Dr. Goran Strkalj from the University of The Witwatersrand points out that physicians were included among the intellectuals invited to work at the Museum. It was in the Museum's academic environment that the thinking behind medical science made a shift in views of the body, and the role that dissection played toward the development of medicine.

Philosophers demystified the deceased human body, viewing it more materialistically as nothing other than an inert object...But an atmosphere conducive to dissection would not of its own have been sufficient were it not for physicians who believed in the importance to medicine of anatomical knowledge, and who were prepared to engage therein. (Strkalj 9)

Whereas, in Classical Greece, the purity of the human body was highly valued. Thus physical contact with corpses was considered taboo. However, in Alexandria, this new way thinking developed into the possibility that the human body could be seen as an object of study, paving the way for Herophilus' work.

Arguably, the most significant contribution from the Ptolemies was their monarchical government, which allowed tolerance for controversial scientific endeavors in Alexandria. In contrast, this tolerance did not exist in smaller city-states such as Athens. Unlike Alexandria, Athens was a democracy that could "vote to ostracize or exile him [an individual] on grounds of impiety" (Von Staden 231). Athenian democracy was run by consensus where dominant perspectives were enforced. Those who violated these perspectives were cut off or expelled (Von Staden). An example of this is the case of

Protagoras, as discussed by Professor Gábor Bolonyai from Eötvös Loránd University. Protagoras was a Greek philosopher who lived in Athens during the 5th century BCE. He disbelieved the existence of gods, which was a highly controversial view to have in the ancient city-state of Athens. When Protagoras publically announced his atheism he was expelled from Athens, his books were burned, and his reputation as an “impious atheist” was spread throughout Greece (Bolonyai). Ironically, democracy is perceived as the greatest contribution of Ancient Greek civilization to the modern day. However, the reality was that the democratic state became narrow minded and conservative. The Athenian government was insistent on preserving their traditional beliefs, including taboos around the human body (Von Staden). Violation of sacred Greek beliefs was unacceptable in Athens but not, however, in Alexandria.

The absence of democracy in Alexandria made it possible for Herophilus to conduct his research. Since Alexandria was a monarchy, the Ptolemies were in charge of every aspect of Alexandrian life. This included education, knowledge, and research all of which were advocated for, by the Ptolemies. The Ptolemies were creating their own version of a Hellenistic culture. Therefore they could, “blatantly and openly violate entrenched taboos, also concerning relations between bodies” (Von Staden 232). It is ironic that the scientists at the Museum were able to work freely in such an autocratic regime. The Ptolemies aimed to establish Alexandria as the center of scientific discovery and knowledge. They made a shift that new knowledge was based on observation, experimentation and hypothesis. While Athens laid the foundations for democratic styles of government, Alexandria laid the foundations of modern science.

The work of Herophilus died with him in 280 BCE. What is known about Herophilus is based on secondary sources, primarily that of the Roman physician and writer Galen (Lloyd). There are two major reasons why the work of Herophilus was suppressed, and his research on human dissection discontinued. The first has to do with ancient taboos and belief reemerging as a dominant view within Alexandrian culture. The second reason reflected a diverging view of medicine and the role of medical research.

While the Museum was a center of intellectual advancement, the population of Alexandria still held onto notions of body purity and the contamination of corpses, similar to classical Greek belief. Despite the fact that the Ptolemies ignored and refused to practice Greek taboos, these taboos still resurfaced and took hold in Alexandrian society. Thus, tolerance amongst the Alexandrian community for Herophilus' research diminished until it was no longer encouraged or valued (Von Staden).

Simultaneously, a different philosophy towards medicine and medical practice was developing. This was called Empiricism and it focused on external treatment. Empiricist physicians cared more about curing the patient than diagnosis and pathology. They believed that human dissection was irrelevant to medical practice and knowledge. A corpse was considered an "inaccurate guide to the understanding of living anatomy. Moreover, they were convinced that opening a body significantly altered it and that it could no longer provide useful insights into its internal structures" (Strkalj 16). Empiricists saw dead bodies as so distinctly different from the living that they were useless to obtain understanding of how to treat patients.

Herophilus' work reveals progressive, sophisticated, and detailed knowledge about human anatomy that was the first of its kind in western civilization. Herophilus could have only practiced human dissection in Alexandria because of the multicultural society that allowed innovation, and cutting edge ideas. Alexandria is a notable example of a hub of scientific research that follows the politics and cultural norms of its time. Since it was acceptable and even considered prestigious to violate norms and expectations, Herophilus' career excelled. As culture and politics evolve, its tolerance for radical ideas changes as well. New theories and practices replace old ones, causing seeds of tremendous possibility to flourish.

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