History of the Circulatory System: discovery of the basics

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Today, the field of cardiology is understood as a highly evolved and mature specialty of medicine. However, the journey towards our current grasp on the subject has been a long one. The discovery of the most basic heart physiology and anatomy has a history of more than two millennia. This paper discusses the development of the most fundamental principles of heart physiology and anatomy while outlining the influential contexts of their origins.

The field of cardiology has long been perceived as a highly sophisticated arena of understanding with physiologically intricate problems and technologically advanced solutions. And though it is just that, it was not always so. In the greater timeline, cardiology as a medical specialty is still in its infancy. More so, cardiothoracic surgery remained a field unborn until after World War II, making it the tardiest of surgical specialties by twenty years. The study of the human heart in general has had a much longer history with fascinating accelerations, tedious plateaus, and, at times, disappointing regressions. But the history that is discussed herein is the history of that part of cardiology that most people, scientist or not, take for granted as obvious knowledge; this is the understanding of the most basic principles of the circulatory system.

I begin at the end of this history by summarizing its accomplishment. The heart is a pump. It contains four chambers. The right side of the heart pumps blood to the lungs where it picks up oxygen and then enters the left side of the heart. The oxygen-rich blood in the left side of the heart is separated from the oxygen-poor blood in the right side of the heart by the interventricular septum. The oxygen-rich blood is pumped through the left side of heart to the entire body by arteries where it supplies the different tissues with oxygen. Oxygen exchange occurs in the smallest vessels called capillaries and oxygen poor blood subsequently is carried back to the right side of the heart by veins.

The most basic principles of the circulatory system took thousands of years to uncover. An Egyptian papyrus dating back to 1500BC correctly correlated the character and frequency of the pulse with the patient’s health status. Hippocrates (460-355BC) and his pupils also drew accurate conclusions regarding the nature of blood flow. One pupil described the perpetual movement of blood “with courses of rivers returning to their sources after a passage through numerous channels”. However, this concept of circularity would only be confirmed two millennia later by William Harvey. It was Aristotle, the anatomist, philosopher, and know-it-all of the time who began the disruption of scientific understanding of the heart and its system. While some of his physiological ideas bore some value, he also committed the academic disservice of attributing ‘the seat of body intelligence’ and the source of body heat to the heart. Such exaggeration of the heart’s function in the body was mirrored by Erasistratus (c. 310-240BC) who first described the heart’s valves, and explained that air entered the heart from the lungs where it was transformed into ‘pneuma’, the vital spirit, ‘a most subtle vapor’ to be carried to the body by arteries. Only veins, he erroneously conceived, contained blood.

So, for a period of 500 years little advance was made in the understanding of the circulatory system. However, the understanding of our world and all things in it was forever changed with the birth of Christianity and its popularization. Indeed, the next advancement in circulatory physiology came from Galen (c. AD 130-200), whose work was viewed favourably by the Church. Galen, though not Christian, was monotheistic and his worship of one god, Aesculapius, the god of medicine, shaped his theories in such a way that they were compatible
with the views of the Church. The Church was, at the time, fighting Roman polytheism and so Galen’s worship of a single God who created all things for a purpose was agreeable enough.¹

In brief, Galen found that arteries contained blood, instead of air as had been the belief to that point. He conceived of two systems: the venous system which was nutritionally relevant, and the arterial system, which was responsible for body heat. Included in his theories are the belief in the existence of pneuma, the vital spirit on which life depends as well as two other spirits, the ‘animal spirit’ and the ‘natural spirits’. Galen falsely connected these two systems of the right and left heart by supposed pores in the interventricular septum.¹, ⁴ 

Galen’s theories were more thorough and complex than detailed in this essay. His views were intricate enough for the critical scientist, compatible enough with the Church, and mystical such that it encouraged the philosopher’s understanding of the heart as the seat of the soul. As a result, his views went largely unquestioned for a staggering 1500 years!

The first physician to question Galen’s views was Ibn An-Nafis (1210-88), whose work made the first reference to the pulmonary circulation. However, this knowledge was likely lost until this same finding was independently discovered three centuries later by Servetus, a Unitarian, who was rewarded for his science and his anti-Protestant belief by John Calvin in Geneva, who had him placed on a stake and burnt to the core.¹ This wise maneuver, which praised the King whom he and many admired, perhaps aided in his avoidance of harm for his publication of contrary views. Through his lectures and in his publication, he explained that blood pumps with ventricular contraction through the lungs back to the heart and then through the body where it ‘passes through pores in the flesh’ and returns from the periphery through veins increasing in size as they approach the heart.¹ He specified that blood moves, ‘as it were, in a circle’ and ‘this is the only reason for the motion and beat of the heart’.¹ He emphasized that the heart is no other thing but a pump as if to crush the spiritualistic functions imposed on the heart until that time. Finally, Marcello Malpighi (1628-1694), Jacob van Swammerdam (1637-1680), and Anthony van Leeuwenhoek (1632-1723) used the microscope to explain the shape of the red blood cell and the capillary networks that form the connection between arterioles and venules.⁴

So, over a great many years the myths of the heart were dispelled and the truth came to be accepted like in most cases of discovery, slowly and with much dissent. Yet the heart remains an eternal symbol. A ubiquitous metaphorical force made reference to by the holiest of books and by the most lucrative of commercial recording artists. In Genesis 6:6 God is described as possessing a symbolic ‘heart’ when he decides that a great flood is in order, “And the LORD was sorry that He had made man on the earth, and He was grieved in His heart”.⁷ God who has...
no other body part, but perhaps for a guiding ‘hand’, must also possess a ‘heart’, an enigmatic box of emotion. More comically, Tom Waits, the guttural crooner, explains that he has a “bad liver and a broken heart”. While cocktails and the likes may have done the job on his liver, it was an emotional cocktail of sorts that harmed his heart. The liver’s problem is physiological but the heart’s is of a different nature. The ‘heart’ as a human-constructed symbol is an entity which attempts to transcend its physiological functions and touch on the intangible aspects of what it is to be human. Then is it so surprising that with all of this attached symbolism, the academic uncovering of the function of the heart took as long as it did? It was a lot to lose and yet, the symbol has never been lost at all.

References
1. Richardson, Robert G. The surgeon’s heart. Cox & Wyman Ltd. 1969.