

## Unappreciated Contributions of Arabic Physicians to Cardiology and Why the Heart Is Truly the “King of Organs”

Paul J. Rosch, MA, MD, FACP<sup>1\*</sup> and Prof. Abdullah A. Alabdulgader, MD, DCH, MRCP, FRCP<sup>2</sup>

<sup>1</sup>Clinical Professor of Medicine and Psychiatry, New York Medical College, Chairman of the Board, The American Institute of Stress, Honorary Vice President, International Society of Stress Management.

<sup>2</sup>Senior Scientist, Interventional Congenital Cardiologist, Electrophysiologist, cryo and robotic ablation specialist and electrical devices implanter. PI of SAHACT. Prince Sultan Cardiac Center. Alhasa, Saudi Arabia.

### \*Correspondence:

Abdullah A. Alabdulgader, MD, DCH, MRCP, FRCP, Senior Scientist, Interventional Congenital Cardiologist, Electrophysiologist, cryo and robotic ablation specialist and electrical devices implanter. Prince Sultan Cardiac Center (Founder and Chief Physician). Alhasa, Saudi Arabia].

Received: 16 December 2020; Accepted: 10 January 2021

**Citation:** Rosch PJ, Abdullah Al Abdulgader. Unappreciated Contributions of Arabic Physicians to Cardiology and Why the Heart Is Truly the “King of Organs”. *Cardiol Vasc Res.* 2021; 5(1): 1-12.

### ABSTRACT

*The important contributions of stressful emotions, personality and temperament to heart disease and other disorders have been recognized since antiquity. However, early Greek, Roman, Egyptian, Chinese and Hindu cultures viewed the heart, rather than the brain, as the seat of emotions. Western medicine adopted the Hippocratic theory that illness was due to an imbalance of the four humors, and Galen later explained how this could be corrected. After the fall of Rome, most all medical texts were destroyed, and during the middle Ages, people reverted to primitive beliefs that illness was due to a misalignment of stars or punishment for some sin. There were no medical schools, the Church was responsible for medical care, and treatment was limited to various herbs from monastery gardens. This was in sharp contrast to Islam, since while Paris and London had no hospitals, Baghdad and Cairo had medical centers that included hospitals with interns and nurses, as well as libraries, pharmacies, interns, and nurses. The “House of Wisdom” and its huge multinational library, established in Baghdad in 830, attracted numerous, scholars, scientists and translators. During the tenth century, all the writings dealing with Hippocrates, Galen, and other Greek, Roman, Persian and Ayurvedic authorities had been translated into Arabic by scholars in Damascus, Cairo and Baghdad. This made Arabic the most important scientific language of the world, and stimulated Arabic physicians to make discoveries that were not anticipated in Western medicine for centuries. How these justify the heart as “King of Organs” is also explained.*

### The Origin of How the Heart Functions in Western Medicine

Early Greek, Roman, Egyptian, Chinese, Hindu and Christian cultures viewed the heart as the central organ that nourished the rest of the body. The ancient Chinese thought the heart (xin) was the source of happiness and all other emotions. It was also the seat of wisdom and moral values, and according to a 40-century-old text, "The heart is the root of life and causes the versatility of the spiritual faculties." The 35-century-old Ebers Papyrus suggests that the ancient Egyptians considered mind and body to be inseparable, and included a "treatise on the heart", which explains that the heart is the center of the blood supply, with vessels attached for every member of the body. A Hindu scripture dating from 200 to 400 B.C, describes the Paramatma as the supreme soul that resides

in the heart of every living entity. The heart chakra was also the location of complex emotions like compassion, tenderness and unconditional love.

“Heart” occurs over one thousand times in the Bible, making it the most frequent anthropological term. However, it had different meanings and connotations, since it was considered to be the seat of such varied emotions as fear, love, sorrow courage, joy, anger and hatred. In some instances, the heart also depicted personality and the ability to distinguish right from wrong, or conscience. For example, Abraham offers his weary guests food so that they might "sustain their hearts." (Gen 18:5. The heart thinks (Matt 9:4; Mark 2:8), remembers, reflects, and meditates (Psalm 77:5-6; Luke 2:19). Solomon's comprehensive knowledge of flora and

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fauna is described as his “breadth of heart” (1 Kings 4:29). Just, as the eyes were meant to see and the ears to hear, the heart is meant to understand to discern, to give insight. Around 200 B.C., Alexandrian Jewish scribes translated into Greek the Hebrew text of Proverbs 2:10, "wisdom will enter your heart" by "wisdom will come into your understanding" because to them it meant the same thing. When a person lacks insight, it is viewed by the Hebrews as a "lack of heart."

The fourth century B. C. Greek philosopher Aristotle identified the heart as the most important organ of the body, as it was the first to form based on his observations of chick embryos. He described it as a three-chambered organ that was the seat of intelligence, motion, sensation and vitality in the body. Since it was hot and dry, he thought other organs like the brain and lungs existed primarily to cool the heart. These views were reiterated by the 2<sup>nd</sup> century Roman physician Galen, who wrote "The heart is, as it were, the hearthstone and source of the innate heat by which the animal is governed." It was also the organ most closely related to the soul.

### **Hippocrates, Galen and the Humoral Theory of Illness**

Although he is often referred to as “The Father of Medicine”, not much is known about Hippocrates, since none of his writings have been preserved. What we do know comes from the Hippocratic Corpus, a collection of around seventy early Greek medical articles from physicians who were his students, as well as others, most of whom followed his precepts and teachings, and often added their own recommendations centuries later. It would appear that he was a prominent fifth century B.C. physician who was a keen and astute observer. He was the first to describe clubbing of the fingers as evidence of suppurative lung disease, lung cancer, and congenital heart disease as a cause of cyanosis. He detailed the symptomatology, physical findings, surgical treatment and prognosis of empyema, and was the first to perform thoracic surgery. He also described the Hippocratic face, which signaled impending death, as follows: [1].

If the patient's facial appearance may be described thus: the nose sharp, the eyes sunken, the temples fallen in, the ears cold and drawn in and their lobes distorted, the skin of the face hard, stretched and dry, and the colour of the face pale or dusky...and if there is no improvement within [a prescribed period of time], it must be realized that this sign portends death.

Although no longer in common use today, Shakespeare alluded to this when commenting on Falstaff’s death in Henry V.

Theories of various "humors" (i.e. chemical systems that regulated human health and behavior) were postulated in Greek medicine prior to Hippocrates, but he and his followers amalgamated and systemized them into these four: blood, phlegm, yellow, and black bile. An excess, deficiency or imbalance was an indication of illness. Hippocrates’ *On the Nature of Man*, treatise describes this theory as follows: [2].

The human body contains blood, phlegm, yellow bile and black bile. These are the things that make up its constitution and cause its pains and health. Health is primarily that state in which these constituent substances are in the correct proportion to each other, both in strength and quantity, and are well mixed. Pain occurs when one of the substances presents either a deficiency or an excess, or is separated in the body and not mixed with others.

Hippocrates also allegedly categorized illnesses as acute, chronic, endemic and epidemic, and used terms such as exacerbation, relapse, resolution, paroxysm, crisis, peak and convalescence that remain in the medical lexicon. He emphasized the importance of taking a complete history that included environmental factors as well as foods eaten by the patient that might play a role in his or her illness, and is best known for the Hippocratic Oath taken when graduating from medical school, This emphasizes medical ethics, especially *primum non nocere* (first of all, don’t harm the patient), and is still administered in a revised form in many medical schools on this occasion.

He rejected the prevailing view that illness was caused by superstitious notions such as possession of evil spirits or punishment by various gods. Hippocrates and his followers believed that illness had a physical and a rational explanation, and that the body must be treated as a whole, rather than just a collection of parts. He based his treatment on careful observations and study of the human body. His description of different diseases was precise, and he was the first physician to accurately detail the symptoms of pneumonia and epilepsy in children. He believed in the natural healing powers of rest, proper diet, fresh air and cleanliness, and that there were individual differences in the severity of symptoms, since some patients coped better with the same illness than others. He was also the first physician to propose that thoughts, ideas, and feelings come from the brain and not the heart as was generally believed and to note that injury to either side of the head produced spasm or paralysis of the contralateral side. As noted previously, since all we know about Hippocrates is from anecdotal and in some cases apocryphal comments from his followers, it's difficult to know how much of the above should be attributed to him or his followers.

### **The Alexandria School of Medicine**

We do know more about some of his followers, especially those from the Alexandria School of Medicine, such as Praxagoras, Herophilus and Erasistratus, all of whom made important observations about how the heart and blood vessels functioned. Alexandria was founded by Alexander the Great in 331 B.C. in northern Egypt as a port city on the Mediterranean. It quickly became a vital center of Hellenistic civilization, and dominated the Mediterranean World and most of West and Central Asia and Southern India. It remained the capital of Ptolemaic Egypt and Roman and Byzantine Egypt for almost 1000 years, until the Muslim conquest of 641 A.D. when a new capital was founded at what is now Cairo. Alexandria is most famous for its Lighthouse, one of the Seven Wonders of the Ancient world, and Necropolis

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(catacombs), one of the Seven Wonders of the Middle Ages, as well as The Great Library of Alexandria, It was the largest and most significant library in the world, and contained up to 400,000 papyrus scrolls at its height. As a result, Alexandria came to be regarded as the capital of knowledge and learning, attracted numerous scholars from all over the world in the second and third century B.C., and was second only to Rome with respect to importance. The library began around 295 B.C. but a medical school had already been established that attracted leading physicians interested in cardiology.

Praxagoras, who was born on the island of Kos in 340 B.C., was the first to identify anatomical differences between arteries and veins. He theorized that arteries begin in the heart and carry pneuma (air), while veins originate in the liver and carry blood. He was one of the first to recognize the diagnostic values of the pulse. His father and grandfather were physicians, but little is known about his personal life, and none of his writings exist. Much of what we do know comes from his student, Herophilus of Chalcedon (355-260 BC), who produced a large volume of anatomical writings on central nervous, gastrointestinal, and reproductive systems. He disputed Aristotle's view that intelligence resided in the heart, rather than in the brain, and connected the nervous system to motion and sensation. Herophilus also recognized the differences between veins and arteries, noting that arteries pulsed while veins did not and that arteries are thicker than veins, except for vessels to and from the lungs.

Erasistratus (315-240 BC) initially worked with Herophilus, and helped him trace the course of blood vessels and nerves in the body. He also proposed that the increased complexity of the surface of the human brain, as compared to other animals, was due to increased intelligence. As will be explained, he considered the heart to be the source of both arteries and veins and postulated an open-air system in which veins distributed blood through the body, whereas arteries only contained air. However, arteries bled when they were punctured, and to explain this, he suggested that blood moved from veins to arteries via invisible channels, after the arteries had emptied their air throughout the body.

### **Pedanius Dioscorides**

Dioscorides was a Greek physician, and around 70 A.D., wrote *De Materia Medica*, a 5-volume illustrated encyclopedia that described the medicinal properties of some 600 herbs and plants. Most of his entries were based on the fact that they had worked for generation after generation. He was born in what is now Turkey, and attended the medical school in Tarsus, which specialized in pharmacology and botany. He also recorded the Turkish, Roman, ancient Egyptian and North African names for some plants, which otherwise would have been lost had it not been translated into Arabic. It was never out of circulation, was widely read for more than 1500 years, and was the precursor for all subsequent pharmacopeias. The plant genus *Dioscorea*, which includes the yam, was named after him by Linnaeus [3,4].

### **Claudius Galen**

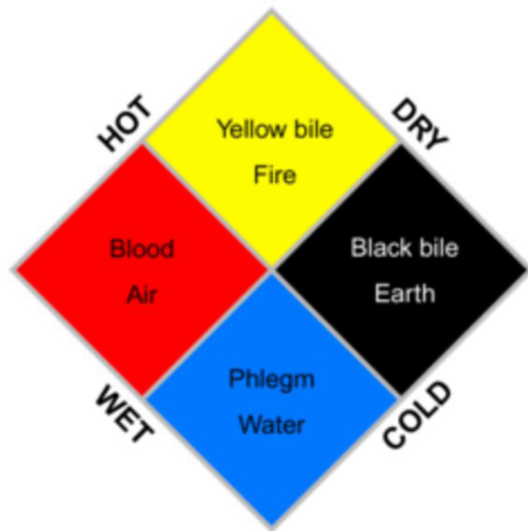
Galen was born in Pergamum, also in what is now Turkey, around 129 A.D., when the Roman Empire was at its height. He began his medical studies at the age of 16 in Pergamum, which was then a major cultural and intellectual center with a library that was second only to Alexandria. His father was a wealthy architect who was interested in philosophy and the sciences, and spared no expense to ensure that his son had the best possible education. He died in 148, leaving Galen independently wealthy at the age of 19, and he decided to follow Hippocrates' advice to observe how physicians in different parts of the world treated patients, and to evaluate their results. Over the next nine years, he visited Corinth, Crete, Cyprus, Smyrna and other Mediterranean medical centers, and spent the last three years at the great medical school and library of Alexandria, exposing himself to the various schools of thought in medicine.

In 157 A.D., at age 28, Galen returned to Pergamum where he was appointed to the post of physician to the gladiators of the High Priest of Asia, one of the most influential and wealthy men in Asia. He was allegedly chosen over other physicians after he eviscerated an ape and challenged other physicians to repair the damage. When they refused, Galen successfully performed the surgery himself. Over the next four years he learned the importance of diet, fitness, hygiene and preventive measures, as well as living anatomy, and the treatment of fractures and severe trauma, referring to their wounds as "windows into the body". Only five deaths among the gladiators occurred while he held the post, compared to sixty in his predecessor's time, a result that is in general ascribed to the attention he paid to their wounds. At the same time, he pursued studies in theoretical medicine and philosophy. News of his achievements and superb skills spread, and in 162 A.D., he traveled to Rome, where he quickly established a reputation as a leading medical authority. He was later appointed Physician to the Emperor Marcus Aurelius, and continued to serve as physician to his three successors.

Galen adopted and expanded on Hippocrates' belief that good health depended on a balance between the four humors; blood, yellow bile, black bile, and phlegm. He proposed that an ideal proportion was one quarter as much phlegm as blood, one sixteenth as much choler as blood, and one sixty-fourth as much black bile as blood. However, this equilibrium was difficult to maintain since levels of each varied with food and beverage intake, or physical activity, and one humor usually predominated [5].

Each humor was associated with a different disposition; blood (sanguine), yellow bile (choleric) phlegm (phlegmatic), and black bile (melancholy). Sanguine people were thought to be ruddy and cheerful, choleric - jaundiced and angry, phlegmatics - pale and listless, and melancholics - dark and sad. Melancholy is derived from the Greek words for black (melanin) and bile (khole). As shown in Figure 1, each humor was associated with one of the four elements: Earth, Water, Air, or Fire. In addition, they were also either hot or cold, as well as either wet or dry. This paradigm

served as the basis for treating imbalances due to a deficiency or excess of any humor.



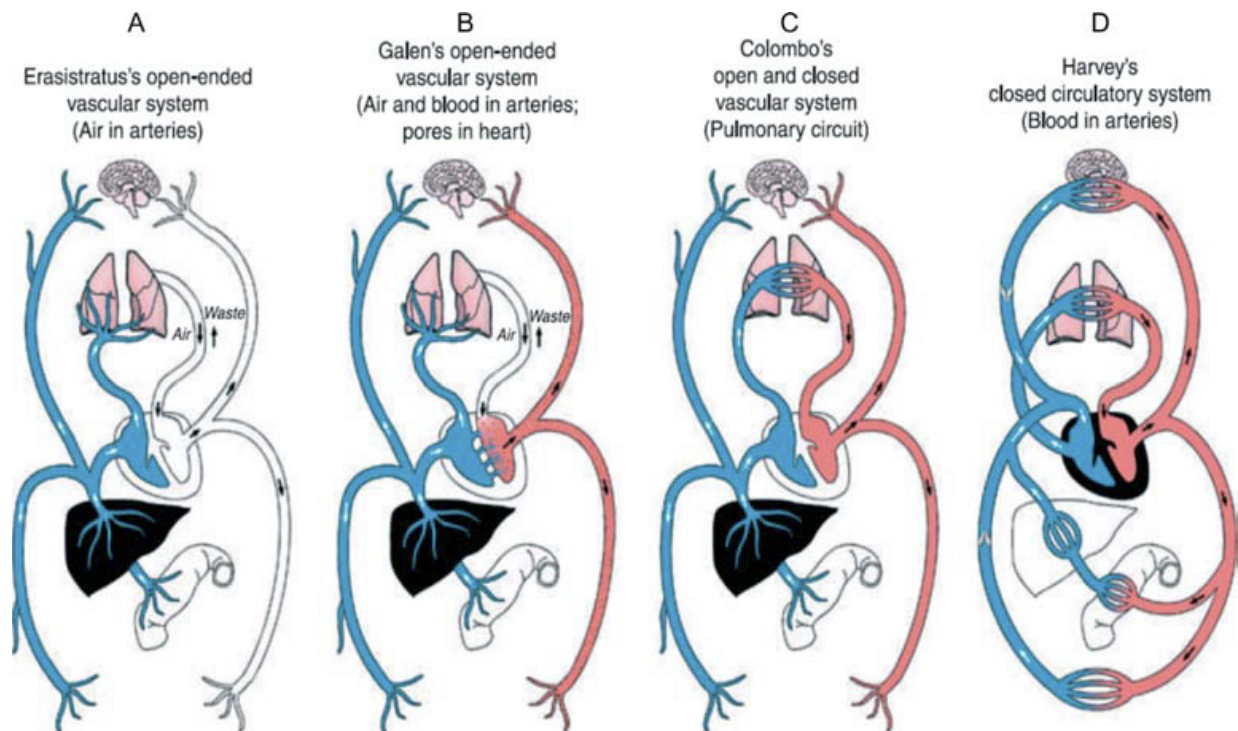
**Figure 1:** Humoral Characteristics

The old maxim “feed a cold and starve a fever” originated because it was believed that eating food would generate warmth during a “cold” and that avoiding food could help cool the body down when it was overheated or feverish. This saying has been traced to a 1574 dictionary by John Withals, which noted that “fasting is a great remedy of fever”, but was originally “feed a cold to stave off a fever”. Current advice is now to feed both. Foods

also possessed some combination of heat, moisture, coldness, or dryness in varying degrees, which is also influenced if they are cooked. Foods were categorized not on these properties, but rather how they affected each humor. Thus, while sugar may feel dry, it moistens and warms, since it was believed that opposites attract. Similarly, tart foods like lemon were associated with cold and dryness. Proper treatment depended on balancing an excess humor with its dietary opposite. As a result, it was believed that giving parsley or cucumber to a phlegmatic person would make them worse, whereas they would increase a choleric’s bilious disposition. This notion that “opposites attract” suggests that extroverts would appeal to introverts and vice versa, but it is more likely that “birds of a feather flock together.” The only time that opposites consistently attract, is when the opposite poles of two magnets are in close contact.

### Galen’s Conception of the Heart and Circulatory System

According to Galen, the liver was the source of all veins and the principle organ for blood production. Nutrients were concocted in the gut to form chyle which was then transformed into blood by the liver. The blood moved from the hepatic vein to the vena cava and supplied all parts of the body above and below the liver. In contrast to Erasistratus’ theory, Galen believed that arteries were filled with blood, which was infused with the vital spirits by a mixture of air from the lungs through the pulmonary vein and heat from the heart. The blood passed from the right ventricle to the left ventricle through invisible pores present in the inter-ventricular septum. The heart itself was not a muscle and did not have a pumping function; blood simply passed through it.



**Figure 2:** (A) Erasistratus’ model (B) Galen’s model (C) Colombo’s model (D) Harvey’s model [9].

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Like Erasistratus, Galen agreed that blood was not recycled, but rather evaporated or consumed by the organs and his theories persisted until William Harvey demonstrated they were wrong [6,7].

Prior to Harvey, Andreas Vesalius, who was a professor of anatomy at the University of Padua, had reshaped the study of human anatomy through his seven-book masterpiece “De Humani Corporis Fabrica”, published in 1543. Galen’s, anatomical studies were based on living or dead animals, since he was not allowed access to human bodies, but Vesalius carried out detailed human corpse dissections that challenged many of Galen’s views. Realdo Colombo, a student of Vesalius, also could not prove the presence of Galen’s interventricular pores [8]. He theorized that blood traveled through the pulmonary vessels rather than invisible pores, as shown in Figure 2 [9].

Harvey was the first person to study biology quantitatively, and showed that according to Galen, the liver would have to produce 540 pounds of blood a day. He demonstrated that: the dynamical starting point of the blood is the heart and not the liver; it was the contraction, not the dilatation of the heart, that coincided with the pulse; that the pulse was not produced by the arteries enlarging and contracting but by being filled with blood with each contraction; there is no pulsation in the veins, but rather a constant stream of blood from the periphery to the heart; the blood in the arteries is the same as that in the veins, there were no pores in the septum between the ventricles; the action of the right and left auricles and ventricles and the valves between them is the same with respect to the reception and propulsion of liquid, not air, since the blood on the right side, although mixed with air, is still a liquid; blood in the right ventricle is sent to the lungs and via the pulmonary veins returns to the left atrium and is then sent into the arteries and returns through veins that empty into the vena cavae, which returns it to the right side of the heart to complete its circulation [10].

It is impossible to overestimate the power Galen had over medicine during medieval times. He was such an unquestioned authority that he was often referred to as “The Medical Pope of the Middle Ages.” Although Harvey had announced his discovery in 1615, he waited 13 years before publishing his results since it was considered sacrilegious to challenge Galen [11]. Any contrary opinions were considered to be heretical, and would not only quickly end your career, or, like Michael Servetus, could even cause you to be burned at the stake [12]. Harvey’s hesitation to openly defy Galen proved to be justified. Most physicians rejected his 1628 *De Motu Cordis* book because he could not explain how the arteries and veins were connected. If organs did not consume blood, how did different parts of the body obtain nourishment? If the liver did not make blood from food, where did blood originate? Why was blood blue in veins but red in arteries? Nor could he explain how blood transferred from arteries to veins. The existence of capillaries was first made by Marcello Malpighi in 1642, over two decades after Harvey died. It was not until then that Harvey’s colleagues acknowledged his achievements [13].

## The Dark Ages of Medicine

Following the fall of the Roman Empire around 500 A.D., Europe was plunged into the middle Ages, as barbarians progressively invaded and dominated all its territories. During this period, which lasted 1,000 years, all of Galen’s and other Greco-Roman medical documents were destroyed or were unavailable and medicine regressed to primitive beliefs that illness was due to the stars, demons, bad smells, or punishment for some sin. People trusted supernatural powers that included God, charms talismans, witchcraft and astrology, and treatment consisted of a mixture of bleeding, purging, cupping, herbal remedies, praying and being whipped in an attempt to earn God’s forgiveness. Scattered among these were some approaches that did work, like cutting open buboes and draining the pus, trepanning (cutting a hole in the skull), lighting fires and spreading the smoke, removing rubbish from the street and banning new visitors from towns and villages. Epidemics were blamed on witches, nobility or Jews and other culturally different groups, who were often attacked. When the Black Death struck England in 1348, doctors were powerless to stop it from killing half the population. There were both supernatural and natural explanations, such as it was a punishment from God, the planets were in the wrong conjunction, or that it was caused by “foul air”.

Life expectancy at birth averaged 33 years in the Middle Ages and Infant mortality was extremely high, since 1 in 5 children died before their first birthday and many women died during childbirth. The average life span of males born in landholding families in England was 31.3 years and the biggest danger was surviving childhood. However, if a 13<sup>th</sup> century boy reached 20, he could hope to live to 45, and if he made it to 30, he had a good chance of making it into his fifties. Deaths from coronary heart disease were rare since few lived long enough to develop it. Almost 90 percent of the population lived in houses with thatched roofs that attracted insects and rodents carrying bacteria that fell on the inhabitants or their food. There was no plumbing; human waste was deposited outside fairly close to the house, where they were a breeding ground for cholera and typhoid, two of the biggest killers of this period. Typhus was rapidly spread by body lice living on infected people. The water was so dirty that it was unfit to drink and most people, including children drank wine and ale. Save for the nobility, few people bathed unless they had access to a bathtub made of wood, that was usually placed close to the fireplace to provide warmth. Although Queen Elizabeth I had a penchant for wearing fine clothing, she allegedly bathed only 4 times a year.

In the early middle Ages, there were no European universities, much less medical schools, so all who called themselves “doctors,” could only prescribe remedies they had learned from others or their own experience. Medicinal plants were extremely important, and although Dioscorides’ original text for *Materia Medica* had been destroyed, there were several copies and revisions that formed the basis for herbal therapies. Some plants were used for specific disorders while others were could cure multiple diseases, and some draughts contained several different herbs to relieve more than one

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complaint. Every monastic garden had medicinal plants, and sick people went to monasteries to obtain them and advice on how they should be used. The only alternative was to obtain a healing potion from a witch or someone claiming to be an apothecary.

By the twelfth century, there were medical schools throughout Europe, the most famous being the school of Salerno in southern Italy, which permitted women to attend. The medical school at Montpellier in the south of France dates back to the tenth century, though the university was not founded until much later, and by 1340, included a school of anatomy. In 1140, Roger II, king of Sicily and later Africa, forbade anyone from practicing medicine without a license. Anyone with a medical license could teach at Montpellier regardless of religion or background. In the late middle Ages, apothecary shops opened in important towns, but they also sold artists' paints and supplies, since apothecaries and artists belonged to the same Guild of Saint Luke, the patron saint of artists. Physicians were trained in the art of diagnosis, and were usually shown in early manuscripts as holding a urine flask up for inspection or feeling a pulse. In the sixth century, Cassiodorus, a sixth century Roman statesman and later a monk, wrote that "for a skilled physician the pulsing of the veins reveals the patient's ailment just as the appearance of urine indicates it to his eyes." Observation, palpation, feeling the pulse, and urine examination were the only diagnostic tools available to medieval physicians.

### **Advances in Medicine and Cardiology during the Golden Age of Islam**

However, things were quite different in Islam during the middle Ages. The prophet Muhammed had united Arab tribes torn by revenge, rivalry, and internal fights, to develop a powerful coalition extending from the Atlantic Ocean on the West to the borders of China on the East that included the Persian and Byzantine Empires. A century after Muhammed's death in 632, Islam had expanded further into Palestine, Syria, Lebanon, Iraq, North Africa and Spain and the Iberian Peninsula to become the greatest empire ever. The Muslims preserved the cultures of the conquered lands and remained the most advanced and civilized nation in the world for 1000 years because they stressed the importance and respect of learning, forbade destruction, fostered respect for authority and discipline, and tolerance for other cultures and religions. While Paris and London had hovels and mud streets and no hospitals, Baghdad and Cairo had medical centers that included hospitals with interns and nurses, as well as libraries, pharmacies, interns, and nurses. There were mobile clinics to reach the totally disabled, the disadvantaged, those in remote areas, and regulations to maintain quality control on drugs. Pharmacists became licensed professionals pledged to follow the physician's prescriptions and laws prevented doctors from owning or holding stock in a pharmacy. Life expectancy was considerably longer than in Europe [14].

Around 830, Hunayn ibn Ishaq, an influential physician and scientist, translated 129 of Galen's works from Greek into Arabic, and they soon became gospel. The concept of the four humors and

other views were considered irrefutable, not only with respect to diagnosis, but also treatment. Galen was so revered, that when dissections disputed his anatomical teachings, every attempt was made to somehow fit them into his system or to apologize profusely. In his Doubts about Galen, written around 900, Muhammad ibn Zakariya al-Razi (Al Razi), rejected several claims, including Galen's theory of the four humours. Other physicians accused him of ignorance and arrogance, even though Al Razi was careful to explain: [15].

*I prayed to God to direct and lead me to the truth in writing this book. It grieves me to oppose and criticize the man Galen from whose sea of knowledge I have drawn much. Indeed, he is the Master and I am the disciple. Although this reverence and appreciation will and should not prevent me from doubting, as I did, what is erroneous in his theories? I imagine and feel deeply in my heart that Galen has chosen me to undertake this task, and if he were alive, he would have congratulated me on what I am doing. I say this because Galen's aim was to seek and find the truth and bring light out of darkness. I wish indeed he were alive to read what I have published.*

Galen became worshipped even more due to the writings of Ibn Sina, the most prominent physician and philosopher of his time. Better known as Avicenna, his Latinized name, he wrote over 400 tracts or books, the most famous being the Al-Qanun fi al-Tibb (The Law of Medicine), which he completed in 1025. It is usually referred to as the Qanun or The Canon Of Medicine, and its 14 volumes containing over one million words was elaborately divided and subdivided to cover every conceivable aspect of medical practice. Much of it was rooted in Galen's works, with elaborative supportive commentary based on Avicenna's personal experience that he supplemented with information obtained from ancient Arabian Persian and Indian medical sources [16]. A Latin translation of the Qanun (Canon Medicine) appeared in Europe in the 11th century, quickly followed by others, and its 1593 publication in Rome made it one of the first Arabic books to be printed. From the 12th to 18th century, the Qanun was the most important medical text in the world because of its encyclopedic comprehensiveness and systematic arrangement. It is believed to have influenced Leonardo Da Vinci, and Sir William Osler wrote, "The Qanun has remained a medical bible for a longer time than any other work".

The Qanun also dominated Islamic medicine, until it was questioned by Ibn-Al Nafis, a 13th century polymath who was Chief Physician at the Al-Mansouri Hospital in Cairo and the Sultan's physician. As with many other Muslim physicians of his era, not only did Ibn Al Nafis excel in medicine, but he was also well versed in several languages, philosophy, Islamic law and history, and he wrote numerous works disputing both Galen and Avicenna [17]. Ibn-Al Nafis is considered by many to be the Father of circulatory physiology, because of his accurate description of the pulmonary and coronary circulation, and his anticipation of the existence of capillaries that were the interface between veins and arteries.

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One of his most important books, the 20-volume Commentary on Anatomy in Avicenna's Canon, written in 1242, explained that there were only two ventricles, not three, there were no pores through the interventricular septum, and the ventricle received its nourishment from the coronary vessels, not, as Galen and Avicenna had claimed, from blood deposited in the right ventricle. His premonition of a precursor to the capillary circulation was due to his discovery that "the pulmonary vein receives what comes out of the pulmonary artery, this being the reason for the existence of perceptible passages between the two."

Ibn-Al Nafis was an early proponent of experimental medicine, postmortem autopsy, and human dissection, at which he excelled. He drew several diagrams of his new physiologic system, some of which have been preserved, but his skill and ingenuity are evident in the following excerpts that explain some of the above observations in more detail [18].

*The blood from the right chamber of the heart must arrive at the left chamber but there is no direct pathway between them. The thick septum of the heart is not perforated and does not have invisible pores as Galen claimed. The blood from the right chamber must flow through the (pulmonary artery) to the lungs, spread through its substances, be mingled there with air, pass through the pulmonary vein to reach the left chamber of the heart and there form the vital spirit.*

The heart has only two ventricles ...and between these two there is absolutely no opening. Also, dissection gives this lie to what they said, as the septum between these two cavities is much thicker than elsewhere. The benefit of this blood (that is in the right cavity) is to go up to the lungs, mix with what is in the lungs of air, then pass to the left of the two cavities of the heart.

Al Nafis also proved Galen's theory that "every part of an artery pulsates simultaneously" was wrong, and that the motion of the pulse was due to "the arteries expanding and contracting naturally". He attributed the pulse to the force of cardiac contraction, noting that "the arteries and the heart do not expand and contract at the same time, but rather the one contracts while the other expands" and vice versa. He also recognized that the purpose of the pulse was to help disperse the blood from the heart to the rest of the body [18]. *These observations were made almost 400 years before Harvey's De Motu Cordis, but we're not known in Europe until 1547, when Andrea Alpago translated some of Al-Nafis' writings into Latin.* However, it is important to reemphasize that Galen's authority, like that of the Pope, could not be disputed. Six years later, Michael Servetus described the pulmonary circulation in his theological book, Christianismi Restitutio as "air mixed with blood is sent from the lungs to the heart through the arterial vein; therefore, the mixture is made in the lungs. The bright color is given to the sanguine spirit by the lungs, not by the heart." This was almost word for word what Ibn-Al Nafis had written but was considered heresy. As noted previously [12], Servetus was later burned at the stake along with his book for suggesting that the

blood actually passed from the right heart to the left heart via the lungs, rather than through the interventricular septum.

The great anatomist Vesalius also described the pulmonary circulation in a manner similar to Ibn-Al Nafis in the sixth book of his De Fabrica, which focused on the heart and associated organs. Vesalius corrected Galen's notion that the great blood vessels originated from the liver. And in the second 1555 edition, he questioned the existence of any interventricular pores. It is interesting that in the first edition (1543), Vesalius agreed with Galen that the blood "... soaks plentifully through the septum from the right ventricle into the left." In the second edition (1555) he omitted this, and replaced it with "I still do not see how even the smallest quantity of blood can be transfused through the substance of the septum from the right ventricle to the left" [19]. A similar description was given by Realdus Colombo in his 1559 De re Anatomica [8]. *All of these were obviously based on the 1547 translation of Ibn al-Nafis' work, but without ever acknowledging this.* The important contributions of Ibn-Al Nafis were largely forgotten and these details only came to light after 1924, when an Egyptian physician studying the history of Arabic medicine, discovered a handwritten script identified only as No. 62243 in the archives of a Berlin library. It included a portion of the Commentary on Anatomy in Avicenna's Canon that contained what was clearly the first accurate description of the pulmonary circulation [20]. Ibn-Al Nafis also identified mistakes made by Galen and Avicenna on how blood entered the brain, and pointed out other errors in his subsequent Al-Shamil fi al-Tibb (The Comprehensive Book on Medicine). This 44-volume encyclopedia was much larger than Avicenna's more famous Qunan (The Canon of Medicine), but only a few volumes have survived.

During the tenth century, all the writings available from or dealing with Hippocrates, Galen, Dioscorides and other Greek, Roman, Persian and Ayurvedic authorities had been translated into Arabic by scholars in Damascus, Cairo and Baghdad, so they could be preserved and systematized. The "House of Wisdom" and its huge multinational library, established in Baghdad in 830, had attracted numerous, scholars, scientists and translators, made Arabic the most important scientific language of the world for many centuries, and preserved knowledge that might otherwise have been lost forever. The center of scientific knowledge and activity shifted eastward, and Baghdad emerged as the capital of the scientific world. Although Muslim medicine had adopted the humoral theory of Hippocrates and Galen, it was also based on the Koran (Quran), divine revelations received by Muhammed, and the hadiths, which contained Muhammed's personal advice. According to these, Allah had sent a cure for every ailment save old age, and it was the duty of Muslims to take care of the spirit as well as the body.

### **Spanish Advances in Medicine and Philosophy**

Muslim Spain named ALANDALUS in Arabic was also undergoing a period of scholarly development and by the 10th century, Cordoba was the largest and most cultured city in Europe,

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and a major medical center that would include 50 hospitals, although some were just for the military. The greatest advances in surgery of the era were detailed by Al-Zahrawi or Albucasis as he was known in the West, who was born in 936 in a suburb of Cordoba. He became a skilled physician, surgeon, chemist and teacher and around 1000 AD, wrote his famous 30-volume encyclopedia “Al-tasreef liman ajiza an al-taaleef (educating authorship for those who are unable to author), a summation of fifty years of medical education, training, practice and experience. It described over 300 diseases and their treatments, provided detailed descriptions of numerous surgical procedures, and the use of over 200 surgical instruments. Often called “The Father of Surgery,” his medical encyclopedia covered various aspects of medical knowledge, with illustrations of the numerous instruments he had invented, including: forceps, pincers, scalpels, catheters, cauteries, lancets, and specula. It was translated into Latin around 1100, became a standard reference in Islamic and European medicine for over 500 years, and was repeatedly reprinted in Europe up until the late 18<sup>th</sup> century. One of his greatest innovations was the use of catgut for stitching up patients after an operation, which is still done. His recommendation to apply very cold sponges to reduce pain was also adopted by Western physicians for centuries [21].

The use of paper had spread from China into Muslim regions in the eighth century, and was available in Spain and Portugal. It was easier to manufacture than parchment, less likely to crack than papyrus, and could absorb ink, making it difficult to erase and ideal for keeping records. Islamic paper makers devised assembly-line methods of hand-copying manuscripts to turn out editions far larger than any available in Europe for centuries. It was from these countries that the rest of the world learned to make paper from linen. Dioscorides’ first century magnum opus *De materia medica*, on the medicinal qualities of plants and herbs was translated into Arabic in Cordoba, making it more accessible than ever before.

The renowned philosopher and physician Averroes was born in Cordoba in 1126 into a very prominent and wealthy family. He attended the best schools and universities, and his teachers were amazed by his intelligence and ability to memorize the hadiths and to comprehend abstruse concepts. Although best known for his commentaries on Aristotle and Plato, he served as physician to the royal court, and wrote several medical treatises. The most famous was *al-Kulliyat fi al-Tibb* (General Principles of Medicine). *Colliget*, a subsequent Latin translation, became a medical textbook in Europe for centuries. It included sections on anatomy, physiology, pathology, diagnosis, therapeutics, hygiene, and therapies. The largest section, which is dedicated to medicines and foods, discusses pharmacology and dietetics, and lists 300 remedies from medicinal plants that included the benefits of olive oil [22].

Maimonides (Moses ben Maimon), the celebrated philosopher, physician, rabbi and jurist was born in Cordoba in 1135. His father was a learned rabbi who recited to him what was known in the Torah and Old Testament at the time. He attended the best schools,

was an avid student, and learned all he could about Aristotle, Plato and other Greek philosophers, as well as Hippocrates, Galen and other physicians. When a fanatical Berber sect (who fought against the Islamic Ummayyad Caliph) conquered Cordoba in 1148, Jews and Christians could no longer practice their faith, and either converts to Islam, seek exile, or be executed. Maimonides and his family roamed through Southern Spain and Northern Africa, and in 1159, settled in Fez, the capital of Morocco. They stayed there for seven years, after which they sojourned in the Holy Land, before finally moving to Fustat (Old Cairo) around 1168. To support his family, Maimonides established a medical practice, that quickly thrived as news of his achievements rapidly spread, and although Jewish, was appointed personal physician to the court of Saladin, the Muslim hero of the Crusades, and Sultan of Egypt, Syria, Yemen, Jordan, Mesopotamia, Jerusalem and Mecca.

Maimonides was a prolific writer, and his first major work, begun at age 23 and completed 10 years later, was a commentary on the Mishna, the collected Jewish oral laws, followed by other contributions to religion, philosophy and medicine. He is best known for his 1158 *Guide for the Perplexed*, which attempted to reconcile the apparent differences between religion, philosophy and scientific facts [23]. He also wrote at least 10 medical texts, including *The Medical Aphorisms of Moses*, *Treatise on Poisons and Their Antidotes*, and *Treatise on Asthma*, in which he advised:

The first thing to consider is the provision of fresh air, clean water, and a healthy diet. City air is stagnant, turbid, and thick, the natural result of its big buildings, narrow streets, the refuse of its inhabitants...one should at least choose for a residence a wide-open site...living quarters are best located on an upper floor...and ample sunshine.... Toilets should be located as far as possible from living rooms. The air should be kept dry at all times by sweet scents, fumigation, and drying agents. The concern for clean air is the foremost rule in preserving the health of body and soul.

The *Treatise on Poisons and Their Antidotes* dealt with bites from mad dogs and snakes, that should be treated with tourniquets and sucking out the venom, as well as the stings of scorpions, spiders and other insects. Other chapters dealt with poisons in foods and minerals as well as herbal and other antidotes. The *Glossary of Drug Names* is essentially a pharmacopoeia consisting of 405 short paragraphs containing names of drugs in Arabic, Greek, Syrian, Persian, Berber, and Spanish. His best-known medical text is *Medical Aphorisms*, which contains approximately 1500 maxims he had compiled from the treatises of Galen that were available to him. In this, as well as *The Aphorisms of Hippocrates*, and *Guide for the Perplexed*, he acknowledges Galen’s numerous contributions, but accuses him of thinking that just because he is an expert in one area, that he is also an authority on others. He describes this as a common psychic “malady” that is especially severe when it affects someone who has achieved great success in one of the fields of knowledge, and is deceived into thinking that he is no less an expert in all other fields. He objected to the blind acceptance of everything Galen espoused, and explained “We



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naturally like what we have been accustomed to, and are attracted towards it; The same is the case with those opinions of man to which he has been accustomed from his youth; he likes them, defends them, and shuns the opposite views. What we believe should be based on facts that can be proven, not the opinions of anyone, no matter how celebrated they are” [24].

Maimonides had a holistic approach that advocated not treating the disease, but the patient suffering from it. Sir William Osler, who referred to him as “The Prince of Physicians”, later reiterated this in advising his colleagues and students, “It is much more important to know what sort of patient has a disease than what sort of disease a patient has” and “*The good physician treats the disease, the great physician treats the patient.*” Maimonides anticipated the development of psychosomatic medicine by emphasizing the important role of emotions in causing and coping with disease. In his 1198 Treatise on Hygiene, a Guide to Good Health written at the request of the Sultan AlMalik Al Afdal, eldest son of Saladin who had succeeded him, Maimonides stated that “The movements of the psyche should be kept in balance, and no other regimen should be given precedence” and “The physician should make every effort that all the sick and all the healthy, should be of most cheerful of soul at all times, and that they should be relieved of the passions of the psych that cause anxiety.” As he explained: [25].

It is known that emotions of the soul produce changes in the body which are great, evident and obvious. As testimony thereto, one sees a person of robust build, ringing voice and glowing face, when there reaches him suddenly news that greatly troubles him—at once his color becomes pale, the brightness of his face dims, his posture stoops, his voice becomes hoarse (or weak) and even if he attempts to raise his voice, he cannot. His strength diminishes and he often trembles from the great debility. His pulsebeat becomes weaker, his eyes sink and his eyelids become so heavy that they cannot move, his body surface cools and his appetite subsides. The reverse of this is seen in a person whose body is weak, whose color changes and voice are low as soon as something that greatly rejoices him occurs. His physical strength is increased, his voice rises, his face brightens, his movements become more rapid and his pulse strengthens. Therefore, physicians have directed that one look into the emotions of the soul and that one makes attempts to hold these in balance in conditions of health as well as disease. The physician should notice that every sick person is depressed (or anxious) and he should therefore remove the emotional passions that are causing the anxiety for in this way, health is maintained. The more mental training one possesses, the less one is affected by both fortune as well as misfortune.

### Other Arabic Contributions

It is difficult to overestimate the influence of these and numerous other Arabic physicians on Western medicine during the golden age of Islamic science between the 7th and 15th centuries. Many of these anticipated discoveries that were unknown or not appreciated in Europe until hundreds of years later, especially in medicine and astronomy. The 9th century, Andalusian inventor Ibn Firnas

created glass lenses to improve vision and magnify objects. Around the same time, Mawsili (al-Musali) created a syringe using a hypodermic needle, a hollow glass tube and suction to remove cataracts that was used for centuries, and in his book *De Gradibus* the Iraqi polymath Abu Yusuf Yaqub ibn Ishaq (Al-Kindi) introduced a mathematical scale to quantify the strength of drugs. Al Battani’s 10<sup>th</sup> century (Arabian astronomer and mathematician who is thought by many as the greatest and best astronomer in medieval Islamic world. He performed) measurements of the stars, moons and planets which allowed him to predict the lunar eclipse in what is now Syria. Around the same time, Ibn Butlan, a Christian physician from Baghdad, wrote *Table of Contents of Health*, a book about dietetics, which was quickly translated into Latin and was popular for centuries. And, In addition to his 11<sup>th</sup> century 14 volume *Canon of Medicine*, Avicenna’s astrophysical research suggested that there were multiple forms of energy. Two centuries later Ibn al-Lubudi rejected the four humors theory, as well as Galen’s assertion that women can produce sperm [26,27]. Ibn al-Bayṭār , a 13<sup>th</sup> century Andalusian pharmacist, botanist and physician and scientist wrote several books in Arabic, the most famous being his *Compendium on Simple Medicaments and Foods*. It listed 1400 plants, foods, and drugs, and their uses based on information compiled from 150 Arabic authors and 20 Greek authors. He expanded on Discorides’ *Materia Medica* as well as *Book Two of Avicenna’s Canon of Medicine* by adding additional botanicals and drugs they had omitted, but his 900 page pharmacopeia was not translated into German and French until the 19<sup>th</sup> century.

These and other contributions began to spread when trade routes between England and the Ottoman Empire grew, and merchants, diplomats, and clergy travelling to countries like Syria and Morocco were fascinated by local traditions of using herbs to treat illness. Along with shipments of stunning silk fabrics, they would send back medicinal plants and thousands of manuscripts. The hunger for this information was so great, that famous 17th century scientists like chemist Robert Boyle (Boyle’s Law) and astronomer Edmund Halley (Halley’s Comet) learned Arabic in order to better understand key texts. As previously indicated, Ibn al Nafis had anticipated Harvey’s discovery of the blood’s pulmonary route from the right to the left side of the heart 300 years earlier, but Harvey was unaware of this since at the time, English physicians doubted that Arabic beliefs and practices had anything to offer.

However, that began to change when smallpox epidemics that swept through England in the 18th century affected 60% of the population and had a 20% mortality rate. Lady Mary Montague had introduced variolation (immunization by injection of the cowpox virus) in 1721 after having observed its benefits in Constantinople (Istanbul) [28]. The Turks had used this for generations and smallpox vaccination had long been routine in Palestine. The technique involved popping open a virus-rich pustule and using a thorn dipped in the pustule’s ooze to puncture the skin. It was also a widespread practice in nomadic tribes and other uneducated populations in North Africa. “The idea that a technique used by

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'ignorant people in ignorant societies' could work in England seemed ludicrous" [29]. In 1729, Cassem Aga, the Ambassador of Tripoli, and one of three Arabic scholars that had been elected as Fellows of the Royal Society, provided detailed records of both the practice and the safety of vaccination in Tripoli, Tunis, and Algiers [30]. However, it was not until 1796 that Edward Jenner demonstrated the efficacy of cowpox vaccination in London. He allegedly discovered this when he learned that those who milked cows with cowpox often contracted the disease from ruptured pustules on their fingers that protected them from smallpox. However, it seems likely Jenner was also aware of the success of this type of vaccination in Arabic countries (Vaca is Latin for cow).

### Why the Heart Is King of Organs

In 2008, I was asked to participate in the second "Heart, King of Organs" conference in Al Ahsa, Saudi Arabia, organized by Dr. Abdullah Alabdulgader. I was intrigued with the title and asked for additional information, and subsequently learned that this was a sobriquet for the International Congress on Advanced Cardiac Sciences. The story of Dr. Abdullah Alabdulgader is of historical account. He passed a period of wonder and bewilderment due to what has been taught in the twentieth century teaching of the human heart as being merely a pump. In the contrary, the signet book of all Abrahamic religions, the Holy Quran, mentioned the heart in various synonyms about 145 times, ALL were denoting the functions of faith, believe, and emotional processing functions. The heart in the Holy Quran was referred as defined by Alemam Abu Hammed Algazaly [1058-1111AD] as: *The nice spiritual goddess with physical heart attached and that gentle is the reality of human being and the conscious of the world a round and the know legible piece of the human and the addressee, punished, appellant and demanded that has relationship to the physical heart.*

There is no single mention of the pumping functions human heart in Holy Quran. This massive contradiction and scientific gap between the pumping heart and the spiritual heart was creating great scientific and spiritual worries for Dr. Abdullah Alabdulgader and it was his dream to solve the mystery and fill in the gap. At a moment of success, in December 2005, he described new congenital heart anomaly and exploit this event to make his dream reality where he announced the establishment of his renewed unique cardiac conference: The King of Organs, the International Congress for Advanced Cardiac Sciences. Five conferences were held in 2006, 2008, 2010, 2012 and 2019 with hundreds of speakers and novel researches introduced to the scientific arena new understanding of the human heart. The founder of King of Organs Dr. Alabdulgader was the president of all conferences and I was the co-president in the last four conferences.

These meetings were designed to gain specific understanding of the interactions of the heart and neurological systems (in addition to human heart and cosmic interactions) through fostering cross-disciplinary research from different disciplines,

such as stress management, electrophysiology, electromagnetism, endocrinology, and neurocardiology. As well as astobiology, astropysics and geology, it was also apparent that this conference would feature fascinating presentations dealing with the historical and philosophical aspects of mind/heart relationships that included the numerous contributions of early Islamic physicians to Western medicine few of us are aware of. The scope of the program was very appealing, and reminiscent of the eclectic mix of topics responsible for the success of the American Institute of Stress annual Montreux International Congresses on Stress in Switzerland.

The nickname "Heart King of Organs" (KOO) conference was designed to emphasize that the heart was much more than a mere pump. This and subsequent conferences featured HeartMath and other research showing that the heart has its own brain composed of 40,000 neurons that can sense, feel, learn and remember, and is involved in a constant two-way conversation with the cerebral cortex and other parts of the brain. Diminished heart rate variability, which can now be measured in real time, is the most objective accurate measure of stress, and a powerful predictor of sudden death. Most people still believe that the heart pumps blood around the body. This is impossible since there are 10 billion capillaries, and it is only recently that this mystery has been explained by Gerald Pollack's discovery of a fourth phase of water that provides energy [31].

Harvey never viewed the heart as a pump, but likened it to a bellows that lifted water by using clacks (valves). "From the structure of the heart it is clear that the blood is constantly carried through the lungs into the aorta as by two clacks of a water bellows to raise water." This is the only mechanical analogy he ever offered, and was based on Aristotle's, "It is necessary to regard the structure of this organ [the lungs] as very similar to the sort of bellows used in a forge, for both lungs and heart take this form." Harvey's concept of circulation was consistent with the Aristotelian view that it was cyclical (such as the apparent movements of celestial objects), rather than being perfectly circular. The example Aristotle gave was the cycle of the sun causing evaporation of water that condensed into clouds, which falls as rain, and is again evaporated. As Harvey wrote in *De Motu Cordis*, "We have as much right to call the motion of the blood circular as Aristotle said that the air and rain emulate the circular movement of the heavenly bodies. Thus, water gives life to land just as blood gives life to the body" [10]. Harvey needed this air-water-air analogy to explain the transfer of blood from arteries to veins, since capillaries had not yet been discovered.

Harvey clearly recognized that the heart was much more than a mechanical pump, and that it reflected emotions and feelings, when he noted, "Every affection of the mind that is attended either with pain or pleasure, hope or fear, is the cause of an agitation whose influence extends to the heart." In the dedication of his book to King Charles I, he also wrote:

Most serene King! The heart of animals is the foundation of their

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life, the sovereign of everything within them, the sun of their microcosm, that upon which all growth depends, from which all power proceeds. Equally is the king the basis of his kingdoms, the sun of his microcosm, the heart of the state; from him all power arises and all grace stems [10].

Harvey metaphorically described the heart as the "king" or "sun" of the body to underscore its cosmological significance. In other words, just as the king is the sun that makes the body politic work, and does so from the center, so the heart is the sun that is the sovereign of the body and soul [32]. As Blaise Pascal, one of Harvey's supporters, wrote, "The heart has reasoned that reason knows not of. We feel it in a thousand things... Do you love by reason? "It is the heart which perceives God and not the reason. That is what faith is: God perceived by the heart, not by the reason."

There are many other reasons why the heart should not be viewed as a mere pump. An efficient pump would be designed to work directly on the system with the greatest volume, and the veins contain over five times more blood than the arteries (65% compared to 12 %). The aorta bends during systole, when it should straighten under the higher pressure. More importantly, replacement by a mechanical pump only works for a limited time, in contrast to heart transplants, which can function normally for more than two decades. This became apparent in January 1985, when despite the adequate pumping of William Schroeder's artificial heart for over a month, his doctors reported that he had an "unusual excess of fluid retention" (around 30 lbs.) that could not be explained and was difficult to reduce. He had suffered one stroke and subsequently had two more that left him in a vegetative and bloated state for over a year, when he died from a lung infection. In a January 7, 1985 letter published in the New York Times entitled "Can An Artificial Heart Have Its Reasons", I noted that the heart, in addition to being a pump, was also an exquisite endocrine organ that secreted powerful atrial natriuretic hormones that responded to excess fluid loads and lowered blood pressure faster and more profoundly than any known drugs. Deprived of this homeostatic mechanism, it was not surprising that an accumulation of excess fluid that his doctors said "could squash the blood vessels, slowing the circulation, thus increasing the chances for clots to form." Since then, it has been found that the ventricles also secrete a similar blood pressure reducing hormone, as well as oxytocin, the bonding and cuddling hormone. Alabdulgader expanded the scope of cardiac sciences through establishment of new branch of cardiology and was awarded the world gold medal from World Organization for Scientific Cooperation(WOSCO-2012) for this innovation in the field. Later on he with his scientific group were able to prove the delicate orchestration in the longest record in human history between heart rate variability (HRV) synchronized with Schumann Resonances , Solar Winds and Galactic Cosmic Rays [33]. Based on the novel findings he established the 1st consciousness theory based on heart beat in history in contrary to the famous quantum physicists theories in the last 80 years: Alabdulgader Heart Based Resonant Frequencies Theory of Human Consciousness [34,35]. Thus, as Dr. Abdullah Alabdulgader surmised, the heart is truly

the King of Organs.

### Editor's Dedication

Prof. Paul J. Rosch, born June 30, 1927, passed away on Wednesday, Feb. 26, 2020, after complications from a fall. He was 92 years old. For this reason I took over the correspondence responsibilities of this paper that I reviewed for him earlier. He was a prominent scientific figure in the history of sapience and medicine. At the age of collective wisdom, in 2008 Paul Rosch's scientific blessings extended to the eastern hemisphere. I invited him first to co-organize the King of Organs 2008 conference. I was captured with his sharp mind and comprehensive knowledge. He was cofounder and deputy president of the unique cardiac conference, King of Organs for Advanced Cardiac Sciences, for four consecutive conferences: 2008, 2010, 2012 and 2019. He energized me with his marvelous spirit. His extraordinary scientific character created scientific revolutions in the metabolic arena, disclosing the cholesterol myth and homocysteine metabolism as well as the heart mind sciences and stress management. He was a model scientist of the golden era with sky high consciousness. This paper is true documentation of his fairness for the human history regardless of religion ,race or ethnic groups. I taught this bravery from Paul. I admired him as my spirit father and mutually he was founding himself in my spirit when he was at my age. In February 26, 2020, Paul's soul responded to the heavens' call. At personal level, I lost a father, friend and life model. Paul's footsteps, bravery and wisdom in life will remain shining star for all generations. Allah Bless his magnificent soul.

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