Medical Breakthroughs in Islamic Medicine
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Physicians occupied a high social position in the Arab and Persian culture. Prominent physicians served as ministers or judges of the government and were also appointed as royal physicians. Physicians were well-versed in logic, philosophy and natural sciences. All of the prominent Muslim philosophers earned their livelihood through the practice of medicine.

Muslim physicians made astounding break throughs in the fields of allergy, anatomy, bacteriology, botany, dentistry, embryology, environmentalism, etiology, immunology, microbiology, obstetrics, ophthalmology, pathology, pediatrics, psychiatry, psychology, surgery, urology, zoology, and the pharmaceutical sciences.

The Islamic medical scholars gathered vast amounts of information, from around the known world, added their own observations and developed techniques and procedures that would form the basis of modern medicine. In the history of medicine, Islamic medicine stands out as the period of greatest advance, certainly before the technology of the 20th century.

Aristotle teaching, from document in the British Library, showing the great reverence of the Islamic scholars for their Greek predecessor

This article will cover remarkable medical feats of seven Muslim physicians. However, the author is cognizant of the fact there were other physicians who were also trailblazers in the field of medicine..

(1) Yaqoob al-Kindi (801-873)

Yaqoob al-Kindi (801-873), in his most important work on medicine *De Gradibus*, demonstrated the application of mathematics and quantification to medicine, particularly in the field of pharmacology. This included the development of a mathematical scale to quantify the strength of drugs, and a system that allowed a doctor to determine in advance the most critical days of a patient's illness, based on the phases of the moon.

In his *Treatise on Diseases Caused by Phlegm*, he provided the first scientific explanation and treatment for epilepsy. He was the first to use the method of experiment in psychology, which led to his discovery that sensation is proportionate to the stimulus. He was also the earliest to realize the therapeutic value of music and attempted to cure a quadriplegic boy by using music therapy.

In his *Aqrabadain* (*Medical Formulary*), he described many preparations drawn from plant, animal and mineral sources.

To the drugs known to physicians such as Hippocrates and Galen, Kindi added knowledge drawn from India, Persia and Egypt. Like many Islamic works, the books contained information based upon medicinal herbs, aromatic compounds, such as musk, and inorganic medicines. Islamic contribution to the history of medicine saw the first divide between medicine and pharmacology as separate sciences.

Kindi invented a discipline of medicine called posology, which dealt with the dosages of the drugs. Dosages for the drugs were a guessing game in the ancient world. He formulated easy-to-use table that pharmacists could refer to when filling out prescriptions. By documenting amounts with a

mathematical formula that anyone could follow, al-Kindi revolutionized medicine. Drugs could now be formulated according to set amounts with the result that all patients would receive standardized dosages. His book on posology, *Risala fe ma'rifat quwa al-adwiya al-murakkaba* was translated into Latin as *De Medicinarum Compositarum Gradibus Investigandis Libellus* (The investigation of the strength of compound medicine).

(2) **Abu- Bakr ar-Razi** (865-925)

Abu Bakr al-Razi (a resident of Ray, hence Razi) was the first to invent surgical suturing, to make mercury ointment and to introduce a fully detailed explanation of paediatrics, gynaecology, obstetrics, and ophthalmology. He pioneered in conducting experimental research in medical sciences. He also tried proposed remedies on animals in order to evaluate their effects and side effects. He conducted some experiments on animals like monkeys. He used to give them a dose of medicine and record its effect. If it produced the desired result, he would start applying it on human beings.

Razi introduced alcohol in medicine, wrote first treatise on allergy and immunology, discovered allergic asthma, discovered hay fever, wrote first scientific treatise on infectious diseases, and invented hydrostatic balance to

weigh drugs. He was first to write a scathing critique of Galen in his "*Doubts concerning Galen – nal-shukook ala Jalinoos*". He wrote 56 books on the subject of medicine. In Europe he was called Arabic Galen.

He was the first to identify many diseases such as asthma, smallpox, and chickenpox and treated them successfully. He was the first physician who used alcohol as antiseptic. He invented many tools such as the mortar and pestle that are used by pharmacists. His books *Qarabadain Kabir* (The Great Book of Formulary) and *Qarabadain Saghir* (The Little Book of Formulary) were important in the area of pharmacology in that they introduced 829 novel drugs. He promoted the medical uses of chemical compounds. Razi was the first to write a book on home remedies, *Tibb al-Fuqara.* In its 36 chapters, he described diets and drugs that can be found in the kitchens, pharmacies, and military camps.

Razi introduced controlled experiment and clinical observation in medicine. He carried out the earliest known example of a clinical trial employing a *control group*. Razi began by selecting two sets of patients, all of whom are showing early symptoms of meningitis. He then treated one group with bloodletting, but not the second. He writes that 'by doing this, I wished to reach a conclusion (on the effectiveness of bloodletting) and indeed all those of the second group contracted meningitis'. (Jim al-Khalili, *The House of Wisdom*, London, 2011 p. 147) He was laying the foundation of what in allopathic medicine will be called controlled studies, which is the favoured way of investigating any therapy in this day and age.

Last page of *Kitab al-Havi fil al-Tibb*

Ar-Razi was the first to state that some diseases are hereditary. He was also the first to differentiate between arterial and venous bleeding. He was the first to describe cataract removal. He recommended building hospitals away from areas where organic substances could rapidly rot. In addition, he was the first to make the diagnosis of measles and smallpox in his book entitled, *'al-Judri wal-Hasba-* Measles and Smallpox', in which he introduced the symptoms and the fever accompanying both diseases. He also drew a very precise clinical discrimination between them, considering fever a medical symptom that accompanies several diseases, rather than an illness. Fever immediately ceases once the illness, causing it, is treated. Furthermore, he differentiated between the pulmonary diseases causing respiratory distress and pleurisy.

Last page of *Kitab al-Mansuri*, dated 1667

His other great achievement was in understanding the nature of illness, which had previously been described by the symptoms, but Razi made the great leap of looking for what was causing the symptoms. He made a distinction between curable and incurable diseases. In the case of smallpox and measles, he blamed the blood and, as he could not have known anything about microbes. (Queen's University Kingston, Bracken medical library has a copy of his book *Measles and Smallpox*, Arabic text with English translation, 1852).

Razi wrote extensively about human physiology and understood how the brain and nervous system operated muscles, and only the Islamic distaste for dissection prevented him from refining his studies in this area. He stated in *Kitab al-Hawi Fi Al-Tibb* that nerves had motor and sensory functions. He recognized that they originated as pairs from the brain or spinal cord where

they were covered by two membranes. He described 7 cranial nerves and 31 nerves.

In a church at Princeton University, New Jersey, USA there is portrait of Razi on the stained window glass as a tribute to this great doctor. The author has a computer generated, three feet long picture of this portrait, showing Razi holding his book *al-Hawi* written in Arabic.

Al-Razi ran the psychiatric ward in the Baghdad hospital at a time, when, in the Christian world, the mentally ill were regarded as being possessed by the devil. He is acknowledged as the father of psychology and psychotherapy. He advised physicians to study medical literature constantly to gain new information. He synthesized medicine by categorizing it into different fields like eye-disease, gastro-intestinal complaints, and dietary advice to case studies. ((Jim al-Khalili, *The House of Wisdom*, London, 2011 p. 146)

(3) Al-Zahrawi 936-1013

Abul Qasim al-Zahrawi wrote a book, *Kitab al-Tasrif li-man 'Ajizja 'an al-Ta'lif* (The Arrangement for One Who is Unable to Compile [a Manual for Himself]), a compendium of 30 volumes on medicine, surgery, pharmacy and other health topics compiled during a 50-year career. It's last volume, the 300-page On Surgery, was the first book to treat surgery as a separate subject and the first illustrated surgical treatise, covering ophthalmology, obstetrics, gynaecology, military medicine, urology, orthopaedics and more. It remained a standard surgical reference in Europe until the late 16th century. (Queens University Kingston medical library has English translation with Arabic text and commentary – *On Surgery & Instruments*- by by M. S. Spink and G. L. Lewis, London 1973)

Al-Zahrawi described a vast repertoire of procedures, inventions and techniques, including thyroidectomise, extraction of cataracts and an innovative method of removing kidney stones by diversion through the rectum that dramatically reduced the mortality rate for the procedure, compared to the method Galen recommended.

The *Arrangement of Medical Knowledge* was the earliest text to deal with dental surgery in detail, including re-implantation of dislodged teeth. It also described the carving of false teeth from animal bone, as well as how to correct non-aligned or deformed teeth. Al-Zahrawi also detailed procedures still used by today's dental hygienists to remove calculus deposits from teeth.

Al-Zahrawi used ink to mark the incisions on his patients' skin, now a standard procedure worldwide. He was the first one to wear a green gown in the surgery room, now used the world over. He was the first to use catgut for internal sutures, silk for cosmetic surgery and cotton as a surgical dressing. He described, and probably invented, the plaster cast for fractures-a practice not widely adopted in Europe until the 19th century. He produced annotated diagrams of more than 200 surgical instruments, many of which he devised himself. His meticulous illustrations, intended as both teaching tools and manufacturing guides, are the earliest known and possibly the first ever such published diagrams. His best-known inventions were the syringe, the

obstetrical forceps, the surgical hook and needle, the bone saw and the lithotomy scalpel-all items in use today in much the same forms.

A page from a 1531 Latin translation by Peter Argellata of El Zahrawi's treatise on surgical and medical instruments.

A list of major surgical procedures that Al-Zahrawi describes reads like a compendium of medicine in itself. Among his "firsts" were:

-Exposure and division of the temporal artery to relieve certain types of headaches
-Extraction of cataracts
-Guillotine tonsillectomy (as opposed to the more painful snare or ligature methods)
-Tracheotomy
-Using a hook to extract a polyp from the nose
-The supine posture for childbirth (now known as "Walcher's position")
-Application of ligature for bleeding vessels
-Treatment of anal fistulas
-Reduction of a dislocated shoulder (centuries before European techniques)
-Removal of thyroid cysts
-Thyroidectomy
-Mastectomy to treat breast cancer

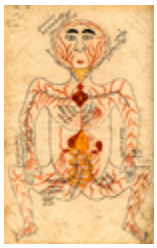
-Surgery for breast reduction
- discussed non-aligned teeth and how to rectify these.
- developed the technique to prepare artificial teeth and to replace defective teeth by these.
- described ligaturing of blood vessels long before Ambroise Pare.
- invented a bulb syringe for giving enemas to children and a metallic bladder syringe and speculum to extract bladder stones.
- early plastic surgeons who performed many plastic surgery procedures.
- developed new technique in cauterization and applied it on 50 different operations.
- first physician to describe an ectopic pregnancy, and the first physician to identify the hereditary nature of haemophilia.
- devised a mothod for treating a dislocated shoulder (now known as Kocher's method)
- describe the migraine surgery procedure that is enjoying a revival in the 21st century, spearheaded by Elliot Shevel a South African surgeon

He invented 200 surgical instruments such as the scalpel and sutures for stitching wounds. He also established surgical methods and procedures, such as stopping a haemorrhage by coagulation as well as ligature to stop the flow of a bleeding artery. He was also the first to set the basics of the science of surgical endoscope and used syringes and surgical punctures. He managed to do a lithotripsy for a bladder stone with the use of what resembled a modern endoscope. He was also the first to invent and use the vaginal speculum.

In hematology, Abu al-Qasim al-Zahrawi wrote the first description on hemophilia, a hereditary genetic disorder, in his *Al-Tasrif*, in which he wrote of an Andalusian family whose males died of bleeding after minor injuries

Medical historians claimed that Al-Zahrawi was the first to devote special attention to surgery and separate surgery from medicine. Also, Al-Zahrawi's surgical research replaced all former inquiries and remained the main reference in surgery for more than 500 years. His research included labelled drawing and pictures of more than 200 surgical tools. These diagrams and pictures had an immense influence on Western surgeons later, especially those who reformed and improved surgery in Europe in the thirteenth century. Haller, the great physiologist, said, "All the European surgeons who emerged after the fourteenth century turned to that research (Al-Zahrawi's research) to quench their thirst for knowledge." This book was the chief reference for surgery.

Muslims remained the pioneers in surgery up until the 15th century. European students came to the Islamic countries to learn and return to their countries to apply what they had learned. This indicated how essential surgical science was and how important it was to separate it from internal medicine.



human organs explained in Arabic

(4) Ibn-Sina (980-1037)

Avicenna (Ibn Sina) is considered the father of modern medicine, for the introduction of experimental medicine, clinical trials, risk factor analysis, and the idea of a syndrome in the diagnosis of specific diseases, in his medical encyclopedia, *The Canon of Medicine* (c. 1025), which was also the first book dealing with evidence-based medicine, randomized controlled trials, and efficacy tests.

Ibn Sina

Avicenna's contributions to medicine include the discovery of the contagious nature of infectious diseases, the introduction of quarantine to limit the spread of contagious diseases, the introduction of experimental medicine,

evidence-based medicine, clinical trials, randomized controlled trials, efficacy tests, clinical pharmacology, and the idea of a syndrome in the diagnosis of specific diseases. His contributions also include the first descriptions of bacteria and viral organisms, the distinction of mediastinitis from pleurisy, the contagious nature of phthisis and tuberculosis, the distribution of diseases by water and soil, and the first careful descriptions of skin troubles, sexually transmitted diseases, perversions, and nervous ailments, as well the use of ice to treat fevers, and the separation of medicine from pharmacology, which was important to the development of the pharmaceutical sciences.

He discovered many of the ailments which are still widespread, such as Ankylostoma parasite and he called it 'the round worm'.

In the third book of his masterpiece *Canon of Medicine*, Avicenna described patients with symptoms of carotid hypersensitivity syndrome. The conditions of these patients, who had excessive yawning, fatigue, and flushing, improved following pressure on their carotids. Based on such history, it seems that Avicenna was the first to note the carotid sinus hypersensitivity.

Avicenna was the first to describe meningitis and differentiate between of cerebral origin and that resulting from external (or peripheral) cause. He also described stroke that results from excessive blood flow, opposing what had been believed by the ancient Greek physicians. He differentiated between the renal colic and intestinal colic. Another breakthrough by Avicenna is his discovery of the modes of infection of some diseases like measles and smallpox and that their contagious nature is due to tiny living organisms in water and air. He once said, "*Water contains tiny living organisms, unseen by the naked eye, causing some diseases*." This was confirmed later in the 18th century by Van Leu-hook and other scientists after the microscope was invented. Hence, Avicenna was the first to establish parasitology, which is a very important branch in modern sciences' He was the first to differentiate between primary and secondary meningitis and other, similar diseases' He also described tonsillectomy, and added his own opinion about some kinds of cancers, like liver and breast cancers and lymph node tumours as well as other tumours.

Avicenna excelled in surgery. He mentioned several methods to stop haemorrhages; whether by legation, pack insertion, cauterization, and

chemical cauterization or pressing veins against flesh. He also dealt with arrows and how to get them out of wounds, warning surgeons against hurting a vein or a nerve while pointing out that understanding human anatomy is crucial for surgeons.

First page of Canon of Medicine

Avicenna was the first to describe the eye's six intrinsic muscles. He also said that the optic nerve is the organ that is responsible for vision, not the lens, as it had been believed before. He performed many fine surgical operations such as early-stage-malignant tumour excision. Moreover, he performed tracheotomy and laryngology and excised pleural abscesses. He also treated haemorrhoids by ligature, described urinary fistulas with precision and introduced a treatment for anal fistulas that is still in use. He also dealt with kidney stones and explained how to extract them, along with the precautions that must be taken.

Avicenna had immense experience in treating venereal diseases. He described some of the gynaecological diseases very precisely, like vaginal obstruction, fibroids and miscarriages. He also spoke about diseases that mothers would catch in their postpartum period such as haemorrhage and blood retention which may cause tumours and fevers. He also pointed out

that puerperal sepsis results from difficult labour or intrauterine fatal death; a fact that had not been known before his research. He also dealt with the gender of the fetes and attributed it to the father rather than to the mother; this is a fact which was confirmed later by modern genetics.

Avicenna had vast knowledge of dentistry. He said that the main purpose of treating tooth decay was to clear out the decayed part and analyze the substance which caused it. The *Canon* laid out the following rules and principles for testing the effectiveness of new drugs and medications, which still form the basis of clinical pharmacology and modern clinical trials:

1. The drug must be free from any extraneous accidental quality.
2. It must be used on a simple, not a composite, disease.
3. The drug must be tested with two contrary types of diseases, because sometimes a drug cures one disease by its essential qualities and another by its accidental ones.
4. The quality of the drug must correspond to the strength of the disease. For example, there are some drugs whose heat is less than the coldness of certain diseases, so that they would have no effect on them.
5. The time of action must be observed, so that essence and accident are not confused.
6. The effect of the drug must be seen to occur constantly or in many cases, for if this did not happen, it was an accidental effect.
7. The experimentation must be done with the human body, for testing a drug on a lion or a horse might not prove anything about its effect on man.

Avicenna found that drugs and diet are related in treating medicine. He understood that some stomach ulcers were from physical causes and others from mental worry and depression. Avicenna urged surgery to remove cancer and used music to help heal his patients.

Canon of Medicine printed in Italy 1593

Avicenna believed that many diagnoses could be made by simply checking the pulse and the urine, and a large part of the Canon is given over to making diagnoses from the color, turbidity, and odour of urine. Of course, this also needed to be set alongside the Islamic holistic approach of looking at diet and background.

His other breakthroughs were some suggestions for infant care and, based upon his belief that bad water was responsible for many ailments, he included guidelines on how to check the purity of water. Many of his remedies were ultimately ineffective, but he had many more hits than misses and contributed greatly to the history of medicine.

Avicenna was the first physician who advocated the theory of delayed splintage, suggesting that fractures should not be splinted immediately but only after several days. He also discussed how to deal with a fracture to the first metacarpal bone in the thumb, which modern textbooks describe as the "Bennett's fracture" who supposed discovered it in 1882. (Jim al-Khalili, *The House of Wisdom*, London 2011, p 179)

Spinal disorders, particularly spine traumas and their complications, have been one of the most challenging problems throughout the history of medicine and, indeed, throughout the history of humanity. In the *Canon* he provided detailed accounts of spinal disorders and strategies for their management with original contributions.

Avicenna devised the "floating man" thought experiment to refute the moral belief of earlier Muslim theologians that our physical bodies are all that exists. In the psychology section of *Kitab al-Shifa* he described a scenario that he believed proves the immateriality of human soul. The thought experiment told its readers to imagine themselves created all at once while suspended in the air, isolated from all sensations, which includes no sensory contact with even their own bodies. He argued that, in this scenario, one would still have self-consciousness. Because it is conceivable that a person, suspended in air while cut off from sense experience, would still be capable of determining his own existence, the thought experiment points to the conclusions that the soul is a perfect immaterial substance independent of the body. The conceivability of this "Floating Man" indicates that the soul is perceived intellectually, which entails the soul's separateness from the body. Rene Descartes words '*I think therefore I am'* on the issue of mind/body dualism runs close to Avicenna 's arguments. (Wikipedia.org)

As a tribute to Avicenna his portrait hangs in the Hall of the Avicenna *Faculty of Medicine* in the University of *Paris*. In the Bukhara museum there are displays showing many of his writings, surgical instruments from the period and paintings of patients undergoing treatment.

(5) Ibn al-Nafis (1213-1288)

Ibn Nafees contradicted Galen's theory of the presence of a cavity or an opening, between the left and the right ventricles. Ibn Nafees corrected this error and as a consequence he discovered the minor circulatory system. While studying the blood movement in the human body, he noticed that the blood reaching the left ventricle is mixed with air (oxygenated) and that the blood which has been cooled and has reached the right ventricle has no passage inside the heart and has no way out except to the lungs. Thus, he concluded that the blood in the right ventricle after it has been warmed must be carried to the left through the lungs. He rejected and disproved any other passage for the blood and that it moves in one direction not subject to any tide or reflux.

Ibn Nafees proved that the blood movement is as follows: It flows from the right ventricle to the lungs where it is oxygenated. Then, it flows from the lungs to the left ventricle through the pulmonary artery. He further described the pulmonary artery, asserting that it has two impenetrable and very

delicate layers. He also called it an artery for its pulsing nature. Thus, he presented a very precise description of the minor (pulmonary) circulatory system.

Avicenna had said that the heart has three ventricles; Ibn Nafis proved there are only two. Also, Galen and Avicenna had said there is a bone under the heart; ibn Nafees proved both of them wrong. Galen had said optic nerve from the brain – right affects the right eye and left affects the left eye, Ibn Nafees said each nerve goes to the opposite side. Ibn Nafees was the first physician to perform brain surgery. He was the first one to state blood flows through the capillaries. He also was the first one to say brain controls sensation, movement and cognition.

His other observation was that the heart was nourished by the web of capillaries surrounding it not, as proposed by Avicenna, the right ventricle of the heart. He touched upon the subject of the role of capillaries in circulation, proposing that the pulmonary artery and vein were linked by microscopic pores; it would not be until four centuries later that this theory was rediscovered and the idea of capillaries was extended to the rest of the body.

Ibn Nafis

The pulse was well known to Islamic medicine, and to the Egyptians before them, but Ibn Nafis was the first to understand the mechanisms behind the pulse. Galen proposed that the arteries pulsed naturally, and that the entire length of the artery contracted simultaneously, but Ibn Nafis believed that the pulsation was caused by the action of the heart pushing blood around the body. He correctly noted that the pulsation of the arteries lagged behind the action of the heart and that it did not occur simultaneously down the whole length.However, Ibn Nafis believed that this motion of the blood was a means to disperse spirit, which would burn out the heart if it resided there for too long. He proposed that this spirit would become stagnant if left to rest in the arteries, and so the circulation was essential. Whilst his theories of the heart and pulmonary circulation were reliant upon this invisible spirit, there is little doubt that his proposals were a major step towards understanding how the body works. Sadly, much of his knowledge did not pass into western history.

Some of his other observations were based upon his observations in dissection, of which he was a great proponent, and he corrected many misconceptions in physiology concerning the brain, gall bladder, bone structure and the nervous system. Sadly, because very little of his work was translated into Latin, his work was woefully underutilized by western scientists and even the likes of Leonardo Da Vinci made incorrect observations based upon Galen and Avicenna, without realizing that Al Nafis had already addressed many of these issues.

His other great contribution to Islamic medicine was his pharmacological works, which drew remedies from all across the world but also introduced mathematics and the idea of dosages to administration of treatments.

Early Muslims progressed and reached such great heights in ophthalmology that no one had ever reached before. Ophthalmology flourished in an unprecedented way. Neither the Romans nor the Greeks could compete with the Muslims' achievements. It is no wonder that many writers considered ophthalmology an Arab specialty.

(6) Ibn al-Quff (1233-86)

Ibn al-Quff was apparently the Arab physician to call for a standard set of weights and measures in medicine and pharmacy. He is also known to have

excelled in anatomical descriptions of the body, especially of the heart and the blood system. He “described accurately and with much care what we now call the capillary system, which connects arteries with veins for the completion of the blood circulation. The phenomenon was fully explained 400 later in the monumental work of the Italian anatomist, Marcello Malpighi (1628-94) with the aid of microscope. It was four centuries later before Europeans fully explained these structures and functions.

Ibn al-Quff also described in great detail the stages of growth of embryos. In his book on embryology *al-Jami al-Gharaz* he says, “The formation of a foam stage is the first six to seven days, which then in 13 to 16 days, is gradually transformed into a clot, and in 28 to 30 days into a small chunk of meat. In 38 to 40 days, the head appears separate from the shoulders and limbs. The brain and heart followed by the liver are formed before other organs. The fetus takes its food from the mother in order to grow and replenish what it discards. There are three membranes covering and protecting the fetus, of which the first connects arteries and veins with those in the mother’s womb through the umbilical cord. The veins pass food for the nourishment of the fetus, while the arteries transmit air. By the end of seven months, all organs are complete…. after delivery, the baby’s umbilical cord is cut at a distance of four-finger breadth from the body, and is tied with fine, soft woolen twine. The area of the cut is covered with a filament moistened in olive oil over which a styptic to prevent bleeding is sprinkled… After delivery, his mother nurses baby whose milk is the best. The midwife puts the baby to sleep in a darkened quiet room…. Nursing the baby is performed two to three times daily. Before nursing, the mothers breast should be squeezed out two or three times to get rid of the milk near the nipple”.

(7) Ibn Zuhr (1091-1161)

Spanish physician Abu Merwan Abd al-Malik Ibn Zuhr was one of the earliest physicians known to have carried out human dissection and postmortem autopsy. He proved that the skin disease scabies was caused by a parasite, a discovery which upset the theory of humors supported by Hippocrates, Galen & Ibn Sena. The removal of the parasite from the patient's body did not involve purging, bleeding, or any other traditional treatments associated with the four humors.

His most effective accomplishments was proof that scabies is caused by the itch mite, and that it can be cured by removing the parasite from the patient's body without purging, bleeding or any other (often painful) treatments associated with the four humours. This discovery sent a shudder through medical science, for it unshackled medicine from strict reliance on the theory of humours and, with that, blind acceptance of Galen and Avicenna. He made 5 notable discoveries in medicine: described tumours, inflammation of the middle ear, pericarditis, paralysis of pharynx, tracheotomy.

Ibn Zuhr also wrote about how diet and lifestyle can help a person avoid developing kidney stones. He gave the first accurate descriptions of neurological disorders, including meningitis, intracranial thrombophlebitis and mediastina tumours. He made some of the first contributions to what became modern neuropharmacology. He provided the first detailed report of cancer of the colon. Ibn Zuhr was the first to explain how to provide direct feeding through the gullet or rectum in cases where normal feeding was not possible—a technique now known as parenteral feeding.

Ibn Zuhr introduced the experimental method into surgery, using animals as test subjects—for example, a goat to prove the safety of a tracheotomy procedure he devised. He also performed post-mortems on sheep while doing clinical research on how to treat ulcerating diseases of the lungs. Ibn Zuhr is the first physician known to have performed human dissection and to use autopsies to enhance his understanding of surgical techniques.

Ibn Zuhr established surgery as an independent field by introducing a training course designed specifically for future surgeons before allowing them to perform operations independently. He differentiated the roles of a general practitioner and a surgeon, drawing the metaphorical "red lines" at which a physician should stop during his management of a surgical condition, thus further helping define surgery as a medical specialty. He was also among the first to use anaesthesia, performing hundreds of surgeries after placing sponges soaked in a mixture of cannabis, opium and henbane over the patient's face. His magnum opus *Al-Taisir Fil-Mudawat Wal-Tadbeer* (Book of Simplification Concerning Therapeutics and Diet) was influential in the progress of surgery.

This article has detailed seven Muslim physicians, who made amazing medical breakthroughs. There is a much longer list of very competent

physicians like Ali ibn Raban Tabari, Ali ibn Abbas, Ibn Maskaway, Ali ibn Isa, Ali ibn Rizwan, Ibn Jazla, Ismail Jurjani, Muffaq al-Din, Rashid al-Din Fadhlallah, Mahmudh Jaghmini, Abul Barkat Baghdadi, Ibn al-Jazar, Ibn al-Wafid, Ibn Bajja, Ibn Rushd, Ibn al-Khatib, Hakim Ali Gilani, Hakim Arzani and Sharf al-Din, Saleh ibn Nasrullah, who were trailblazers in their own right. We hope to detail their medical contributions in a subsequent article.

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