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Original Pioneering Medical Islamic Discoveries and/or Inventions (Plagiarized by The West) – A continuation

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In our Critique, we mentioned that most if not all of the Islamic Medical history in literature is**disconnected focused snapshots of individual biographies and/or a limited review based on a book or a chapter of a book** written by one of the prominent figures in Islamic Medicine during **a very specified period of time** (Table).

Giant Muslim and Arab Doctors with their famous Books in Medicine and/or Surgery[1]
Ishac Ibn Hunain (830-910) إسحاق بن حُنين العبادي (مفقود) كتاب صنعة العلاج بالحديد San'at Al-IlajBilHadeed (craft of treatment with iron)
Abu Bakr Rhazes (865-935) أبو بكر الرازي Liber Continens (23 Volumes) الحاوي في الطب
Galen of Arabs جالينوس العرب
Hali Abbas (died 994) علي بن عباس Kamil Al-Sina'at or Al-Kitab Al-Malaki
Liber Regius (20 Articles) الكتاب الملكي
Albucasis (936-1013) أبو القاسم الزهراوي كتاب التصريف لمن عجز عن التأليف (كتاب واحد من أصل 30 جزء) Father of modern surgery and Surgeon of Arabs أبو الجراحة الحديثة وجراح العرب
(Al-Tasreef Liman Ajaza An Al-Ta'leef) (30 Vol. encyclopedia)or 'The Clearance of Medical Science For Those Who Can Not Compile It'
Ibn Al-Haytham (Alhazen, 965–1040) ابن الهيثم Book of Optics (7 Volumes)
كتاب المناظر
Ammar al-Mawsili (996-1020) عمار الموصلي (The book of choice in ophthalmology)
كتاب المنتخب في علاج أمراض العين
Avicenna (980-1037) ابن سينا Al-Qanon Fil Tibb (Canon in Medicine 3 Volumes)
Prince of Physicians القانون في الطب أمير الأطباء
Avenzoar (1094-1062) ابن زهر Al-Taisir Fil Mudawat Wal Tadbir (2 Volumes)
التيسير في المداواة والتدبير
Averros (1126- 1198) ابن رشد Kitab Al-Kulleyyat Fil Tibb (1 Volume)
Philosopher of Arabs فيلسوف العرب كتاب الكليات في الطب
Ibn Al-Nasfis (1288 -1213) ابن النفيس Shar'h Tashreeh Al-Qanon (1 Volume)
مكتشف الدورة الموية الصغرى (الرئوية) شرح تشريح القانون
Ibn Al-Quff (1286-1233) ابن القف Al-Omda Fi Sina'at Al-Jiraha (2 Volumes)

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العمدة في صناعة الجراحة
Ibn Abi Usaybia (1269-1303) ابن أبي أصيبعةUyun Al-Anba' Fi Tabaqat Al-Atibba' (1 Volume)
عيون الأنباء في طبقات الأطباء

There is therefore, a major hiatus or lacuna (gap) in our knowledge and understanding of the history of Arab/Islamic Medicine. This original article therefore, aims to bridge this serious gap, for it is **thefirst thorough in-depth analysis and comprehensive review of collectivepioneering discoveries/inventionsin the field of Medical Islamic history,highlighting the major achievements that changed the World, putting things holistically in a complete picture, through an interconnected perspective throughout the various periods of the history[(1)].**

The consecutive series of this subject when completed and taken in its entirety,will reveal a panoramic picture with a skeleton background of Islamic Medicine, and provides a springboard for future meaningful and focused research in this fertile field of Islamic Medicine.

The World's First Qualifying Medical Examination in Medical/Surgical Practice 931AD (319 AH)

Institution of theHisbah(an Islamic invention):

The initial attempt to regulate the practice of medicine was during the reign of the Abbasid Caliph, ***Al-Ma'mum***, via the **institution of theHisbah**. This, essentially, was a religious office enforced by a government officer, the **Muhtasib**, who replaced the older office of *Sahib-al-suq*. **Hidbah** is equivalent to our current **Audit**; the **Muhtasib**was appointed by a ruler or judge, and was the modern-day equivalent of the **Ombudsman**. He protected the citizenry from unethical practices in business and other public transactions. As citizens could also be deceived by the doctor and the pharmacist, they too were under his jurisdiction. The Hisbah, therefore, sought to regulate and supervise the dealings between doctor, pharmacist and patient. In Arabic, the term ***hisbah*** means an act performed for the common good, or with the intention of seeking a reward from God. The concept of ***hisbah*** in Islam originates from Qur'anic verses and Hadith. It is an obligation placed on every Muslim to call for what is good or right and to prevent or denounce what is bad or wrong الأمر بالمعروف والنهي عن المنكر. The Qur'an states: ***"Let there arise from you a group calling to all that is good, enjoining what is right and forbidding what is wrong. It is these who are successful."*** (Qur'an3:104). The Hadith states: ***"Whosoever among you sees an act of wrong should change it with his hands. If he is not able to do so, then he should change it with his tongue. If he is not able to do so, then with his heart, and this is the weakest of faith''.***The Hisbah is an important institution that is in charge of commanding good and forbidding evil, as well as monitoring the marketplace, craftsmanship and manufacturing concerns to make sure that business ethics are upheld by these entities and quality standards are maintained.The 11th century physician, Ibn-Ridwan, described two distinct types of doctors: those devoted to the art of medicine; and those practising purely for financial gain, often establishing surgeries by theroadside or travelling door to door in search of patients [(9)].

In 931 during the era of the Abbasid Caliph ***Al-Muqtadir*** **بالله المقتدر**(908-932 AD) following the death of one of his subjects from malpractice, ordered his ***muhtasib*** to prevent doctors from practising medicine until they had passed a qualifying examination. Thus, all practicing doctors in the vast Islamic Empire were ordered to stop practising, and to come down to Baghdad in order to be examined by the Caliph's own Court Physician: ***Sinan Ibn Thabit Ibn Qurrah***(880–943 AD), a Sabian convert to Islam, who served as the Court Physician of Abbasid Caliphs ***Al-Muqtadir*** (reigned 908–934), ***Al-Qahir*** بالله القاهر (r. 932–934), and ***Al-Radhi*** بالله الراضي(r. 934–940). Although Sinan ibn Thabit was primarily a Courtphysician, having supervised building several hospitals in Baghdad and having overseen a licensing system for physicians, he himself, was apparently,too busy to write anything on medicine!

Crowds of practising doctors arrived at Baghdad from everywhere in consecutive groups, preparing themselves for the medical examination (only those in the service of the Caliph or of distinguished reputation were exempt). Doctor ***Sinan Ibn Thabit IbnQurrah*****examineda total of 860** practising doctors in ***Al-Sayyeda Teaching Hospital in Baghdad***(named after ***Al-Sayyedashaghab***, the Caliph's motherand the wife of his father Caliph ***Al-Mu'tadhid***). Obviously, such examination must have involved an oral examination in addition to a clinical examination (being conducted in a hospital environment). Those who passed the examination were given a piece of parchment paper as a**license *(ijazah)*** or a***Certificate***

carrying Doctor Sinan's signature, allowing them to practice Medicine and Surgery(3).

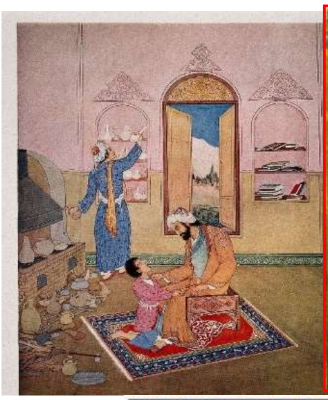
This is the first organized medical examination with a certificate in the World; it was the prototype forerunner and predecessor, preceding the current MB,ChB, (or MD), FRCS, MRCP, MRCOG, and American Boards in Medicine and Surgery.Furthermore, the qualifying Medical examination became a necessity for appointment and selection of new doctors staffing newly founded hospitals.

As original pioneering achievements, the qualifying medical examinations go hand-in-hand with the establishment of hospitals (***double Islamic inventions – See Hospitals in a separate future article***).

Obviously, these hospitals were established for patient care as well as for medical teaching and training; these were the precursors for Medical Schools and Colleges.

The clinical methods adopted and used at that time by Arab/Muslim doctors to examine patients were very similar to our currently employed methods eliciting vital signs and clinical examination (photos).

In Islamic Hospitals, Muslim doctors were the first to perform the initial bed checkup diagnosis on a patient's entry to Hospital. The temperature is checked using the palm, the pulse is measured using fingertips, the liver and abdomen are checked by hand and hollow tube (the first stethoscope), and a patient flask of urine is inspected (see below) to make such a diagnosis. Europe adopted this system of clinical examination after 6 centuries.



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3

(1) Al-Razi examining the oral cavity, head and neck of a patient(Persian miniature painting by *Hossein Behzad* died 1968).

(2) European depiction of Rhazes (Muhammad bin Zakariya Al-Razi) in Gerard of Cremona's "Recueil des traités de médecine“ circa 1250-1260. **He is holding a flask of urine in the left hand and examining a patient's pulse with the right hand.**

(3) As the chief physician of Baghdad hospital, Al-Razi treated many patients, writing the first known description of smallpox. His book: '*al-Judariwa al-Hasbah'* الجدري والحصبة(On Smallpox and Measles) was the first book to differentiate Smallpox from Measles as two distinct diseases. Also, His book ('what is the difference'؟كتاب ما الفارق) makes him the father of Differential Diagnosis in Medicine.

There is another way for granting **license *(ijazah)*** in Medicine, ie, on a completion of educational course by a famous physician (see below).During the reign of Saladin, a physician working in Aleppo by the name of ***al-Shayzari***wrote a manual in which he discussed the supervising of the medical community; he explained that**theInspector was to administer the Hippocratic oath to physicians.** The oculists (ie, ophthalmologists)were to be qualified,based on the book ***Ten Treatises on the Eye*** written by ***Hunayn ibn Ishaq***; bonesetters were to be tested with the Arabic translation of a portion of Greek books.

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The Eye, according to a manuscript in Hunain ibn Ishaq's book 'Matters of the eye' المسائل في العين (From National Library - Cairo, dated circa 1200).

It has sometimes been asserted that a physician in the medieval Islamic world was granted a **license *(ijazah)*** following the completion of his education[4].There are isolated examples of students being given a signed statement that they successfully read and mastered a particular treatise.

The National Library of Medicine (NLM) has one of these very rare documents. The certificate is written at the end of a commentary on the Hippocratic treatise ***On the Nature of Man*** by the Damascene physician ***Ibn al-Nafis***, who spent much of his life in Cairo, where he became **`Chief of Physicians'**, dying there in 1288 (687 H) and bequeathing his house and library to the recently constructed **Mansuri hospital**. The certificate occurs at the end of the manuscript in the handwriting of ***Ibn al-Nafis*** himself, and reads as follows:

*[In the name of] God the Provider of Good Fortune. The wise, the learned, the excellent **shaykh Shams al-Dawlah Abu al-Fadl ibn al-shaykh Abi al-Hasan al-Masihi**, may God make long lasting his good fortune, studied with me this entire book of mine -- that is, the commentary on the book by the imam Hippocrates, which is to say his book known as **`On the Nature of Man'** -- by which he demonstrated the clarity of his intellect and the correctness of his thought, may God grant him benefit and may he make use of it. Certified by the poor in need of God, **`Ali ibn Abi al-Hazm al-Qurashi**[known as **Ibn al-Nafis**] the physician. Praise be to God for his perfection and prayers for the best of His prophets, Muhammad, and his family. And that is on the twenty-ninth of Jumada I [in the] year six hundred and sixty eight [= AD 25 January 1270].*

The signed statement made by Ibn al-Nafis (d. 1288/687 H) that his student,a Christian namedShams al-Dawlah Abu al-Fadl ibn Abi al-Hasan al-Masihi, had read and mastered Ibn al-Nafis's commentary on a Hippocratic treatise.
The certificate is in the handwriting of Ibn al-Nafis himself anddated the 29th of Jumada I in 668 H (25 January 1270). NLM MS A69, fol. 67b.

In another recorded example, also from the 13th century, the physician ***Muwaffaq al-Din Ya`qub al-Samiri***wrote at the back of a copy of a commentary on a treatise by Hunayn ibn Ishaq that a student named ***Amin al-Dawlah Tadrus*** had read the text before him with the purpose of understanding, questioning and verifying its contents.

These individual cases of the certified completion of a reading course, as important as they are for the history of medical education, are not, however, equivalent to the licensing of physicians upon completion of an approved period of training. In addition, the term ***ijazah,*** often translated as ***`license,'*** is not entirely applicable to medicine, for an *ijazah* was traditionally also, given in the fields of law and theology (especially ***fiqh* and *hadith***) and were recorded in medieval bio-bibliographical registers for those fields in order to establish chains of authorities[4].

The newly graduatedphysicians or the junior fully-fledged doctors in the Abbasid Bagdad centre of education of the Islamic World were dressed in**Abbasid Black Aba with Black Turban; this Abbasid dress became the Standard Graduation Black Gown and black cap Worldwide.**

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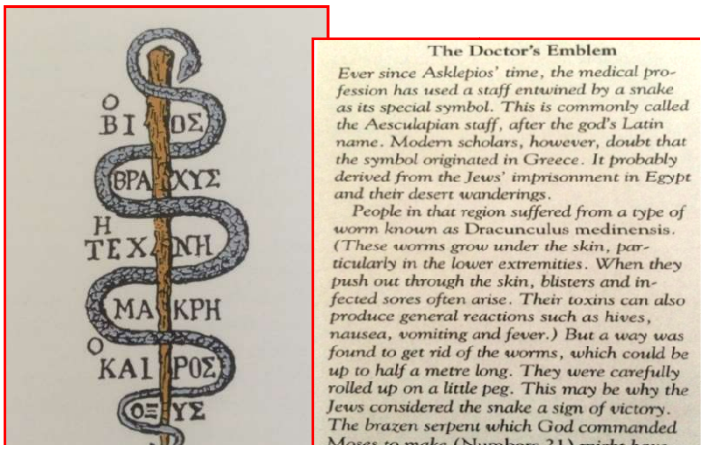
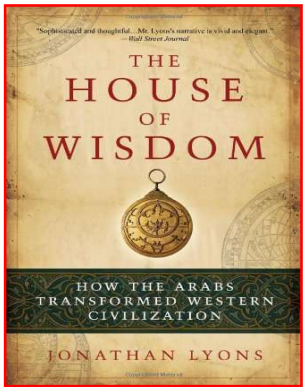
As for Medicine's purpose and ethics, the **Hippocratic oath** (as translated from Greek) was administered to the physicians. The **Greek Asklepion medical emblem** of a snake and a staff or a goblet is hotly debated. It is in fact an **Arabic (possible Jewish) emblem based on a careful extraction of *Dracunculus medinensis* on a peg of wood; complete extraction of the worm from the skin, denotes a skilful doctor**(see **photos**).***Dracunculus medinensis*** ("**little dragon from Medina**"), derives its name from its one-time high incidence in the **city of Medina** (in Saudi Arabia); its other common name, **Guinea worm**, is due to a similar past high incidence along the **Guinea coast of West Africa** (It is no longer endemic in either location)[5].



First Proper Anatomical Body Dissection

Western scholarship belittles the contribution of the physicians of the Islamic world. They are usually perceived as students of their Greek masters, and projected as mere conveyors and simple purveyors of Greek science to the scholars of European Renaissance! Historical evidence provedthat this was a***bigWestern fallacy***!While students sometimes outsmart their masters, they can be creative with achievements far above and beyond their masters abilities.



Jonathan Lyonswrote a brilliant, evocative book (**The House of Wisdom, Bloomsbury Press published 2010**),which reveals the story of how Europe drank from the well of Muslim learning; he restores credit to the Arab thinkers of the past in this riveting history of science - from its earliest and most thrilling days[6].

For centuries following the fall of Rome, Western Europe was a benighted backwater, a world of subsistence farming, minimal literacy, and violent conflict. Meanwhile Arab culture was thriving, and had become a powerhouse of intellectual exploration and discussion that dazzled the likes of British adventurer *Adelard* of Bath(who translated many Greekscientific works from Arabic versions into Latin, which were then introduced to Western Europe). It dazzledmany Europeans fortunate

enough to visit cities like ***Baghdad or Antioch***. There, philosophers, physicians, mathematicians, and astronomers were steadily advancing the frontiers of knowledge, as well as keeping alive the works of Plato and Aristotle. Arabs could measure the earth's circumference (a feat not matched in the West for eight hundred years); they advanced medicine; discovered algebra; were adept at astronomy and navigation, developed the astrolabe, translated all the Greek scientific and philosophical texts. When the best libraries in Europe held several dozen books, Baghdad's great library, the **House of Wisdom**, housed 400,000 (***four hundred thousand)*** *books*. ***Jonathan Lyons*****shows just how much "Western" ideas owe to the Golden Age of Arab civilization.** Even while their countrymen waged **bloody Crusades** against Muslims, a handful of intrepid Christian scholars, hungry for knowledge, travelled East and returned with priceless jewels of science, medicine, and philosophy that **laid the foundation for the Renaissance.** Without Muslims, and the knowledge that travellers (like *Adelard*) brought back to the West, Europe would have been a very different place over the last millennium.

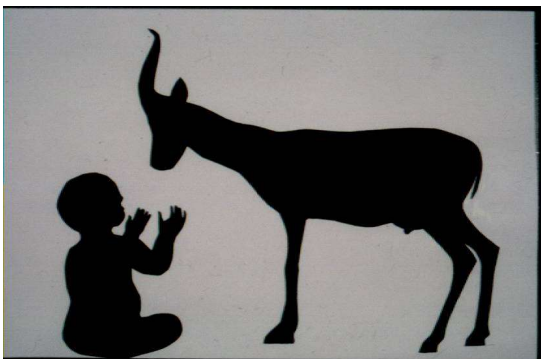
Indeed, the hard factual evidence speaks louder than words.In Anatomy, the assertion that Islam forbids dissection is untenable; the Qur'an states: ***"And in yourselves, Can ye then not see?***" Al-Thari'at, verse 21. The Andalusian (now Spain) 10th-century physician ***Abu 'l-Qasim al-Zahrawi*** (***Albucasis*** in Latin and the ***Father of Modern Surgery***), in the introduction to his book, al-Zahrawi expounded that ***'good practice in surgery requires a sound knowledge of anatomy'*** (will be discussed in future). **There is plenty of evidence for Dissection by Arab/Muslim physicians[7]:**

- **Monkeys and apes** were dissected by ***Yuhannah Ibn Masawayh***in a special institute which he erected on the banks of the Tigris, and that a certain species of ape, considered closely to resemble man, was supplied to him by the ruler of Nubia in AD 836 by the command of Caliph ***Al-Mu'tasim***.

Monkeys and Apes (eg. Gorillas,chimpanzees, orangutan, and gibbons) were brought specifically from Nubia (Sudan) on the personal order of Abbasid Caliph Al-Mu'tasimBillah to his Court doctor Yuhannah Ibn Masawayh in order to be dissected in his own laboratory/hall on Tigris River circa 836

- Deers were dissected by ***Ibn Tufail*** in 1185.
- Dead pregnant mothers and dead foeti were dissected by ***Rhazes*** and ***Albucasis***.
- Dead human bodies were dissected by ***Avicenna*** (circa 1020) and by ***Ibn Al-Nafis*** (1288).
- Dead human bodies and skeletons were carefully studied by ***Abd al-Latif al-Baghdadi*** (1200 AD).
- Dead and wounded bodies of disbelievers were probably, a matter for anatomical exploration too.

Dissection of deers by Ibn Tufail as revealed in his book ***"Hai Ibn Yakthan"*** (1185 AD) revealed his deep practical knowledge in animal dissection; his book was translated into Latin as "***PhilosophusAutodidactus"*** by Mirandola (1494 AD) and Pocock (1671 AD) and appeared in many languages:



- **DanielDofoe's*"Robinson Crusoe"*,**
- **Edger Rice Burroughs' *"Tarzan"*[Notice similarity between Tarzan=Yakzan],**
- **Rudyard Kipling's "Jungle Book"**

were all corruptions of **the Original 'Hai Ibn Yakzan' story (or *PhilosophusAutodidactus*)**.

Based on animal observations, **Galen** stated that the blood was produced in the liver, charged with ***natural spirit*** and taken by way of the veins into lower limbs and the right ventricle of the heart. From the latter, it was filtered through **small invisible pores** into the left ventricle, mixed with ***vital spirits*(lungs).**The resulting blood in the pulmonary veins does not reach the left ventricle, but is used by the lungs as nourishment. In other words, **there is no pulmonary circuit.** Instead, blood in the left ventricle (and hence the systemic arteries) is derived directly from the right ventricle, through invisible pores in the interventricular septum. Blood reaching the brain became charged with the third and noblest spirit, the ***animal spirit***. Having given up the vital spirit to the tissues, the blood returned into the heart through the same channels by a process similar to *theebb and tide of the sea*! Galen's authority forced generations of doctors to apply his knowledge of animal anatomy to human beings. When the seats of learning fell into hands of the Church, his writings became like Gospels and bore the stamp of Church's authority and infallibility[8].

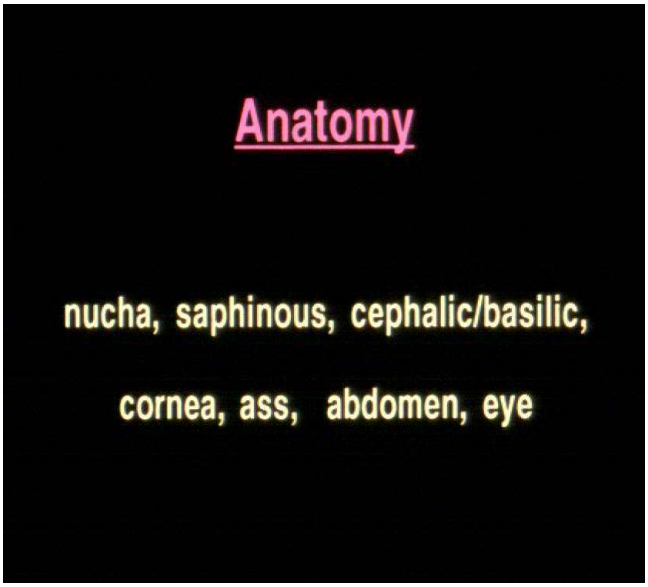
Ibn al-Nafis, (Damascus-Syria) in 1288 AD, however, opposed both Avicenna and Galen vehemently on their concept of blood passage through invisible pores; he re-addressed the question of blood movement in the human body. The authoritative (wrong) explanation had been given by the Greek physicians more than 1000 years earlier. But the problem was how the blood flowed from the right ventricle of the heart to the left, prior to being pumped out into the body. According to Galen (2nd century), blood reached the left ventricle through invisible pores in the inter-ventricular septum. Based on human dissection, ***Ibn al-Nafis*** described the firm, impenetrable nature of the inter-ventricular septum and made it clear that there were no pores or passages in it. Instead, he concluded, the blood in the right ventricle must be carried to the left by way of the lungs. He described the circulation of blood from the right ventricle into the lungs for purification prior to its return to the heart for redistribution. The **description of the pulmonary circulation by Ibn al-Nafis was a breakthrough in the understanding of human anatomy and physiology.**

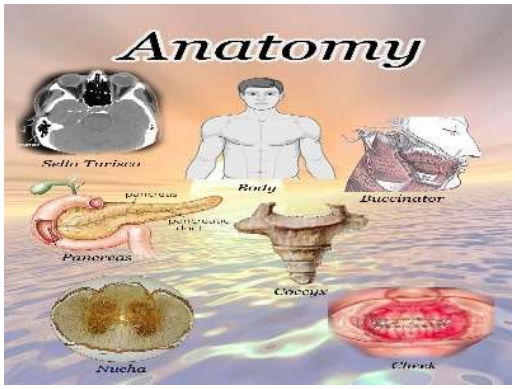
Galen stated in his book ***De ossibusadtirones***, that the lower jaw consists of two pieces, which can be proven when cooked; it is divided from the middle. However, ***Doctor Muwaffaq al-Din Abd al-Latif al-Baghdadi*** (1162 –1231 born and died in Baghdad) and while visiting Egypt, he came across several skeletal remains of people who had died of starvation due to a famine near Cairo caused by the Nile failing to overflow its banks in **597 AH (1200 AD)** . ***Al-Baghdadi*** examined the skeletons and concluded that the lower jaw consisted of one piece, not two, as Galen wrongly believed. He documented that in his book (***Testimony and Consideration in Matters Observed and Accidents Observed in the Land of Egypt***
الإفادة والاعتبار في الأمور المشاهدة والحوادث المعاينة بأرض مصر):

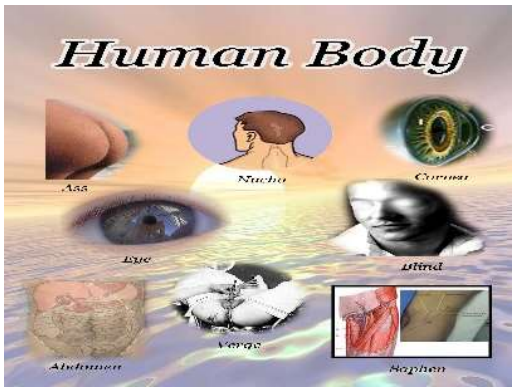
(What I saw in this part of the corpses convinced me that the bones of the lower jaw are one piece, without a break or a link. I have re-examined more than two thousand heads... and many have helped me repeat the same tests both in my absence and under my supervising eyes).

Unfortunately, none of those who wrote on the history of medicine were interested in Baghdadi's discovery, perhaps because he wrote it in a book on the geography of Egypt, and perhaps the reason for ignoring such discovery was that scientists at the time did not accept the idea that ancient authors were mistaken [8][9].

Indeed, Arabs left indelible imprints in Anatomical terms e.g.***nucha*** (from Arabic nucha'a, pertaining to spinal cord), ***saphenous*** (safin, the conspicuous), ***cephalic and basilic veins*** (al bazili, the draining) and cephalic vein (kafili, the sponsoring), ***cornea*** (carania), and ***ass*** (asst), ***mesentery*** (mesareeq), ***cornea*** (cara'nia), ***abdomen*** (albadan/albatan), ***pupil, eye***, and ***blind*** (bila Ain) – (see **photos**)[10].







First Understanding of Proper Physiology

The blood circulation preoccupied Arabo-Islamic physiciansin the 8th century AD, (and particularly during Golden Islamic era), when Europe was sinking in dark medievalages(between the fall of Rome 476 AD and the beginning of the Renaissance in the 14th century); Arabo-Islamic medicine flourished and contributed to the evolution of concepts in cardiovascular system[11].

The work of famous Arabo-Islamic physicians reflects their knowledge of heart function and heart disease. ***Rhazes*** (864-925), claims that heart has two ventricles, while ***Hally Abbas*** علي عباس المجوسي (930-994), was one of the first to deny the existence of communication between the right and the left cavities. ***Avicenna***(980-1037) observed that there are three valves in the aorta's outflow, which open when the volume of blood is ejected from the heart during contraction and close during the expansion of the heart. Avicenna was a pioneer in examining and studying **pulse and its wave**. According to him, each pulse beat consists of two movements and two pauses. So, the normal pulse wave is: *dilation, pause, constriction, pause*. Thus, he rejected the ideas of Galen about a particular kind of pulse for each organ separately andfor each disease. The symptoms, effects and treatment of cardiac flutter are also explained in detail in his work. As he mentions, flutter is caused by heart trauma, pericardial or neighbouring organ injury. All kinds of heart failure led to flutter due to its inconsistent operation. Avicenna supported the view that acute flutter leads to loss of sensation, while acute and prolonged flutter leads to death. He described the faint pressures following carotid stress and provided the first description of carotid body hypersensitivity and syncope. In an attempt to describe vascular stenosis, he mentioned that it was provoked by the local concentration of 'abnormal juices' in vessels which eventually lead to obstruction.

So far as the cardiological drugs are concerned, Avicenna devoted a special treatise called ***Kitabal Adviyt al Qalbiye*** (Book of Medicines of Heart Disease كتاب الأدوية القلبية). This treatise has a physiological-philosophical character and was first translated into Latin at the beginning of the 14th century by ***Arnaud de Villeneuve*** (1238–1314) titled ***De Medicines Cordialibus***. The book describes simple and complex cardiological drugs divided into stimulants, diuretics and inhibitors. Altogether, 83 simple and 17 complex drugs are mentioned in the form of elixirs, mortars, pills and syrups derived from plants, animals and minerals, and their mode of action in the heart is extensively explained. In addition, the strength and dosage of each drug is described. One of the drugs mentioned in the book is the ***'zarnab'*** (*Taxusbaccata L.)* which provided 'relaxation of the heart'. Currently we know that ***Taxus baccata***, also known as ***common yew***, contains poisonous toxin alkaloids and it has been shown to have ***calcium channel blocker activity***. It can be said that Avicenna used such a type of medicine long before the use of synthetic drugs, although it remains unclear in which cases he prescribed this drug[11].

Avicenna and the 10th-century Arabo-Islamic doctors claimed that blood circulation is made in two directions: firstly, much of the blood in the heart is transported to the lungs for **'purification'**. Secondly, the pure blood is mixed with the inhaled air and returns with breathing to the left ventricle of the heart for **redistribution**. They were convinced that two vessels were leaving the left heart, a vessel called the venous artery and carrying blood to the lungs and a second largest artery known as aorta. Aorta was divided into two arteries: one to the head and the cervix, and the other to the other organs, transferring them to the 'vital spirit' and natural heat. Finally, the vein over the liver transported the blood fromthe viscera and by ejecting into the lower cavity it reached the right heart cavity. However, ***Ibn Al-Nafis*** (1213-1288) was the first to describe pulmonary circulation, or the pulmonary passage of blood, thus defying Galen's theory of **no pulmonary circuit**.***Ibn Al-Nafis,*** wrote that blood **does not permeate the**

interventricular septum, but rather circulates in the lungs via invisible connections between the pulmonary arteries and veins.In his work, he mentioned: ***(the heart has only two ventricles .... and between them there is absolutely no opening, because the septum is too thick. The advantage of this blood of the right cavities is that it mixes with air in the lungs and then goes to the left cavity, from the two that has the heart ...)***. But also, in the pulse issue he had his own view: ***(pulse is the result of both physical and forced movements of the arteries ... the forced movement must be the contraction of the arteries and it comes from the heart, while the physical movement that characterizes them must be their dilation... The heart and arteries do not contract and expel simultaneously. Rather, the opposite happens when one organ contracts the other expands and vice versa).*** Ibn-an-Nafis, studied in Damascus and practiced medicine at Al Mansouri Hospital in Cairo. An admirer of Hippocrates and Avicenna, he was particularly interested in commenting on their works and he did not hesitate to break completely with the erroneous ideas of the earlier medical scholars. Ibn Al-Nafis's fundamental changes to the misconceptions of Galen and Avicenna were as follows:

1) He rejected the existence of pores in the interventricular septum of the heart.
2) Blood from right ventricle goes to lungs, where part of it is filtered into pulmonary vein with air.
3) The idea that the blood or the spirit from the mixture of blood and air passes from the lung to the left ventricle, and not in the opposite direction.
4) The claim that there are only two ventricles, not three as claimed by Avicenna.
5) The statement that the ventricle takes its nourishment from the blood flow to its wall (the coronary arteries) and not as Avicenna says of the right ventricle blood.
6) A premonition of capillary circulation, with the claim that the pulmonary vein receives the blood coming out of the pulmonary artery, means there are some passages between the two.

Ibn al-Nafis in his Commentary on Anatomy of Avicenna's Canon makes the first description of pulmonary circulation. Initially, he says that the blood after being cleansed in the right ventricle must then be channelled somehow into the left cavities where the vital spirits are created. In contrast to Galen and Avicenna, who supported the existence of communication between right and left ventricles, Ibn-an-Nafis makes clear that the septum is compact with no interventricular pores or communication. He then clarifies that blood from the right ventricle ispumped to the lungs to mix with the air and then return to the left cavities. He also analyzes the composition of the vessel walls (arteries and veins) and observes the difference of the pulmonary arteries and veins from the opposite vessels of the rest of the body, so far as the anatomy of the lungs is concerned[11].

Finally,***Ibn al-Nafis***(1213-1288) was the first to describe the **"Pulmonary Circulation"** in his book (***Commentary on the anatomy in the canon of Ibn Sina***);and for this reason, he is considered as a true father of cardiology.His approach to the study of medicine was exemplary for a scientist of his time, as he demonstrated the need to evaluate the existing knowledge and reject those concepts that were inaccurate as shown by his own observations [6]. Thus, he was able through dissection of human bodies, to further and rectify the medical knowledge inherited wrongly from the Greeks. He also discussed systemic circulation vaguely in his book ***"The Synopsis of The Law in Medicine"*** (**Al-Mougiz Fi Al-Canon**).

Ibn Al-Nafis' contemporary ***Ibn Al-Quff*** (1233-1286 AD), in his manual on the surgical art, gave the most comprehensive description of surgical operations and treatment of bodily injuries ever contained in any Arabic text of its kind. ***He explained the function of the capillaries for the first time and discussed the uni-directional action of valves in veins and in heart chambers.*** He also made the first appeal for uniformity of standards for weights and measures used in Medicine, Pharmacy and Surgery[10]. Therefore, in physiology:

- **Systemic blood movement was described by Haly Abbas Al-Majusi (prior to 994) 6.5 centuries before Harvey's description in 1628.**
- **Capillaries discovery by Haly Abbas and Ibn Al-Quff (1233-1286) 4 centuries prior to M. Malpighi's discovery in 1661.**
- One of the greatest Islamic achievements still remains the comprehensive and detailed description of pulmonary circulation, centuries before Michael Servetus (1511-1553), Realdo Colombo (1516-1559), and William Harvey's (1578-1657) leading contribution. Indeed, **Pulmonary circulation was described by Ibn Al-Nafis (1211-1288) 3 centuries before Michael Servetus (1511-1553) reporting in 1553.** Whether the Spanish**Servetus**(1511-1553)was influenced by ***Ibn Nafis*** (1210–88 AD) or by Italian***Realdo Colombo*** (1516–1559 AD), is open for discussion and further research.However, some claimed that Ibn al-Nafis's work was translated into Latinin 1547;therefore, there is no evidence that his ideas were known to Servetus and Colombo, who rediscovered the pulmonary circulation in the 1500s, unless there is a personal ability of either authors to

read the Arabic text directly (prior to formal translation into Latin).

Interesting Comment by William Harvey on Islamic Equality of men and women:

For a thousand years before the Western impact began, Muslims (like the Romans before them) were aware that northern European males had peculiar attitudes towards their womenfolk. They did not adequately wrap them up, and paid excessive attention to their opinions.This cultural idiosyncrasy was a cause of occasional concern to the males of northern Europe themselves; the Englishman William Harvey (d. 1657), better known for his work on circulation of the blood, was of the view that:
(We Europaeans knew not how to order or governe our woemen, and that the Turkes were the only people used them wisely). (Source:Michael Cook's 'THE KORAN', Oxford 200, page 37).

Blood supply in the human Body.(illustration attributed to Avicenna.

Furthermore, the 11th-century Iraqi scientist ***Ibn al-Haytham***, (***Alhazen*** in Latin), developed a radically new concept of human vision. Ancient Greek notions of a visual spirit emanating from the eyes and allowing an object to be perceived, were replaced by a straightforward account on the eye as an optical instrument. ***Ibn al-Haytham***'s detailed description of ocular anatomy forms the basis for his theory of image formation, which is explained through the refraction of light rays passing between 2 media of different densities. ***Ibn al-Haytham*** derived this fundamentally new theory from experimental investigations. His ***Book of Optics*** was translated into Latin in the 12th century and continued to be studied both in the Islamic world and in Europe until the 17th century[12].

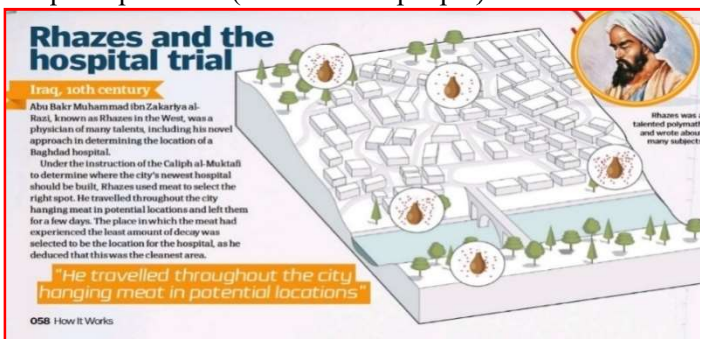
Additionally, in his book ***al-Quadi wa al-muqtadi*** كتابه الغادي والمقتدي circa 959 AD,***Ahmad ibn Abi al-Ash'ath***(أحمد بن بن أبي الأشعث died 975 AD in Mosul, Iraq) described the physiology of the stomach in a live lion.He wrote: (When food enters the stomach, especially when it is full, the stomach dilates and its layers get stretched... The onlookers thought the stomach was rather small, so I proceeded to pour jug after jug in its entry opening…the inner layer of the distended stomach became as smooth as the external peritoneal layer. I then cut open the stomach and let the water out. The stomach shrank and I could see the pylorus opening…)
Ibn Abi al-Ash'ath,thus observed the physiology of the stomach;this description preceded the American William Beaumont(1853 – 1785) '***Beaumont's Experiments and Observations on the Gastric Juice and the Physiology of Digestion, 1838'***by almost 900 years, making ***Ahmad ibn Abi al-Ash'ath*** the first person to initiate pioneering experiment on gastric physiology[13].

Infectivity and Infectious Diseases

- In Arabic language, ***gerthoma or germs*** were mentioned (***Aroma*** and ***Gerthoma***, being the origin of beings and disease, respectively).Germs or (Gerthoma) flourishing in bad air with poor hygiene was recognized by Rhazes during his selection of hospital's site of predilection (see below).
- In Microbiology, **Islam considered leprosy and plague as infective diseases and advised the quarantine principle for the control of plague and pandemics.**Prophet Muhammad documented the infectivity of Leprosy **"Flee from the leper as you would from the lion."**and regading Plague**"If you hear of an outbreak of plague in a land, do not enter it; and if the plague breaks out in a place while you are in it, do not leave that place."** (*Sahih al-Bukhari*).
- The rule of isolation (**Quarantine Principle**) is purely Islamic; for details, see the reference [14]. Furthermore, Muslims built Quarantines for infected diseases in distant locations (remote from people).
- Arabs named **influenza**(and ***related common cold***) as ***Anf-alanza*** (goatrunny nose) and as ***Anf-alwazzah*** (sneezing goose nose); they also used the crushed rotten bread spray for Tonsillitis, thus unwittingly discovered antibiotics before Alexander Fleming.
- **Methods for skin cleansing** in trauma, in compound fracture and prior to surgery included the use of Alcohol (discovered by Rhazes); soap and water (Initially, Arabs discovered cleaning power of frothy Christ's thorn leaves with water); cotton, rose oil and egg white for compound fractures (before reduction);

Water and Honey; and used Vinegar for skin cleansing.

- Muslims established Hospitals on healthy sites of principal cities (accessible to people).



Rhazes and the hospital trial(for a congenial establishment site with fresh air).
(From: Iraq, 10th century, Abu Bakr, Baghdad, 17 May 2018 - Pressreader.com)

In the 10th century five more hospitals were built in Baghdad. The earliest was established in the late ninth century by the Abbasid Caliph***'Al-Mu'tadhid'***(892-902 AD; he is the father of Caliph***Al-Muqtadir***) المعتضد بالله هو أبو الخليفة المقتدر بالله, who asked Rhazes(865–935AD) to oversee its siting, construction and operations of the newly founded ***Al-Mu'tadhidi Hospital*** (after the Caliph's name).

To start, Al-Razi wanted to determine the most salubrious hygienic place in the city: He travelled around the city, hanging pieces of fresh meat placed in various potential places and left them for few days. Latterly, he checked to determine which piece of meat had rotted the least. **The place in which the meat had experienced the least amount of rot and decay was selected to be the best location for the hospital, as he deduced that this was the cleanest area with fresh air and congenial atmosphere.**When it opened, it had 25 doctors, including **oculists**(ie,ophthalmologists),**physician/surgeons**

(borderland was sometimes non-existent at the time), and **bonesetters**[15].

Portraits of Rhazes depicting him as a Doctor, a Chemist, and a Philosopher. As the chief physician of Baghdad hospital, Al-Razi used hospital as a clinical base for treating patients, but also as an academic institution for writing his original observations and experimentation as well as teaching juniors and colleagues.

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