

*Chapter Three*

**Arab Scientific Heritage and Its  
Impact on European Intellect**

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In the previous chapter, we summed up the significant role of Muslim scientists in constructing the world renaissance and linking the early ages' sciences and those of the modern ages.

Not only did Arabs transmit the Greek heritage, but they also added to it much of their own creations.

The books of many of Muslim/Arab scientists like *El-Kendy*, *Ibn el-Haytham*, *Ibn el-Nafeis*, *el-Bayrouni*, *Jaber Ibn Hayyan (Geber)*, *el-Khawarezmy*, *Ibn Sina (Avicenna)*, and many others remained the accredited references in European universities until the 17<sup>th</sup> century A.D.

Convinced that the rational logical method was not sufficient to develop physical sciences, those scientists found it necessary to undertake experiments, and record observations. Hence, they adopted the proper scientific techniques that were followed later by the European renaissance scientists.

The following is a review of Arabs impact in the development of mathematics, astronomy, chemistry, physics, medicine and pharmacy.

### **Mathematics**

Muslim/Arabs were so brilliant and efficient in the science of mathematics particularly that they combined Greek and Indian sciences, and added to them new distinguishing features of their own civilization. They transmitted that inheritance to Europe in a new shape through translation from Arabic into Latin in the 12 and 13<sup>th</sup> centuries. Arab/Muslim scientists developed mathematics, and added to it new materials much admired by the Europeans. Their additions included arithmetic, geometry, algebra, trigonometry, mechanics, and astronomy.

*Abu Arrayhan al-Biruni* (973 / 1048) took wide steps in the art of drawing geometric sketches. He also checked a number of arithmetic rules in his two books *Remaining Traces of Former Nations* and, *Investigating What Is Rational or Irrational in Indian Sayings*. Besides achieving great developments in mathematics and trigonometry, he managed to solve many geometric problems that became known with the name of Byronic problems. In his book *Deducing Tendons in a Circle by Properties of Its Curved Line*; he explained how to obtain the angles opening with innovative geometric

and algebraic techniques. Europeans, therefore, were interested in publishing his books. The German scientist Edward Sakhaw translated his book (the remaining traces) and described him in the introduction as "*a pride for humanity, and a man of civilization who respects science and scientists, and seeks scientific knowledge in every language*"

It is known that the Arabs adopted the Indian numerical system and used it to replace the sentence calculation -that was prevalent in the early ages- after they translated the famous Indian book in astronomy and mathematics in the reign of *Abi Gaafar El Mansour*. The book's name was *The Sindhind* ; it introduced Indian arithmetic sciences in the Arabic language, with its numbering system. Indians had many numerical shapes, The Arabs chose two series of the them, one known as (the Indian numbers) which is used in most Arabic countries and the other known as ( the dusty numbers- as they were drawn by spread dust on a wooden board then drew digits on it) this is used in western Arab countries. They were prevalent in Arabic Andalusia and then were transmitted to Europe where they were known as Arabic numbers. The man credited for transmitting and using this Arabic numerical system is the Arabic scientist *Mohamed Ben Mousa el-Khawarizmy*, the first one to include them in his writings and books in arithmetic.

In addition, Arab/Muslims founded the decimal counting, put the sign of the decimal fraction and used the *zero*, using the zero revolutionized the science of mathematics

One of the merits of their numerical system is that it consisted only of 9 digits, and a zero; while the Greek digits were based on sentences counting and included a quantity of numbers equal to the alphabetical letters. The idea of the zero was the most important gift offered by Arab/Muslims to West Europe. *al-Ya'cobi* considered the zero the most serious digit known by the human mind in mathematics.

*el-Khawarizmy* explained also the means of using these new numbers including the zero in a research translated by the Europeans into Latin in the first quarter of the 12<sup>th</sup> century. Therefore, the Europeans received the new numbering system, coupled with his name and therefore they called it *Algorithmi*.

**El-Khawarizmy** – who lived in the Abbasid era in the days of *Caliph el-Maa'moun*, was heading *Beit El Hekma* (house of wisdom) – and was the inventor of the algebra science and was the first one to use it as independent from of arithmetic. In his book *Algebra and Comparison*, he was also the first one to use the word (algebra) that entered European languages in its Arabic pronunciation. He could also blend Indian arithmetic and Greek geometry – an achievement that proved once more the benefits of the inter-civilizations dialogue, and their mutual interaction, resulting in constructive scientific creations, human development, and progress.

**El-Khawarizmy** composed his book on a request of *Caliph El-Maa'moun*. The book included profound information, that was a rich source for both, Arabic, and European scientists, who quoted, and added comments to many of its theories. It was translated to many European languages in 1831 A.D, as a reference for researchers. The book also affirms that the Arab/Muslims divided the equations into 6 sections and put solutions for each one of them, using geometric methods. They also used symbols in the mathematical works, preceding European scientists like *Feta, Stephen, and Descartes*.

Their ability to combine both algebra and geometry in some works, initiated the science of analytic geometry, by which modern mathematics began in a detailed system in the 17<sup>th</sup> century. New branches soon emerged, like the science of integral and differential calculus prepared by both Arabs and Greeks. That science was then transmitted to Italy and Spain and other European countries.

**El-Khawarizmy** was followed by a number of Muslim scientists such as *Abou al-Wafaa al-Bozgany* and *Abou Bakr al-Karkhi* who founded special signs in algebra, using them in mathematical equations and thus preceding the Europeans by hundred years. The poet *Omar El Khayyam* also solved the quadratic and cubic equations using geometric models – a method deemed the best achievement of mathematicians in present time.

Regarding geometry, Arab mathematicians translated - in the era of *Abi Gaa'far el-Mansour* – the book *Euclid* from Greek into Arabic, naming it the book of *Origins*. They also applied geometric theories in practical life.

*Al-Hassan Ibn el- Haytham (Alhazen)* used geometry in his researches about light and wrote many books about his theories in

arithmetic, algebra, astronomy and trigonometry like *Explanation of Euclid Origins in Geometry and Numbers and The comprehensive in Origins of Arithmetic*. The Egyptian scientist Dr. Ali Musharafa lauds the man's precise thinking, deep research, and independent judgment, and asserts, "The Arabs put trigonometry in a systematic, scientific form. They also combined algebra and geometry and applied geometry on logic, besides applying most sciences on different aspects of life." Trigonometry is, thus, an Arabic science founded by Arabic / Muslim scientists like Nassir Eddin el-Tossi, Thabet Ibn Korra and el-Byruni.

In conclusion, we can say that Arab/Muslim scientists took wide steps in the science of mathematics that paved the way for contemporary scientists to reach mathematical and physical laws. No one can deny their efforts in this particular respect, even after the lapse of 500 years. The translations of their books enabled European scientists to launch their researches and even to reach the moon.

Accordingly, it is justified that we must call now for the dialogue of civilizations and their interaction, as a must for their continuation, instead of their clash and disputes.

### **Astronomy**

Muslims had many good reasons to be highly interested in the science of astronomy, and to know about the movement of the suns and the stars.

Settling in different places, and having to pray 5 times every day, Muslims had to define precisely the direction of al-Quibla (direction of al-Qaa'ba in Macca) towards which they pray, and to estimate the exact time of each prayer in different geographical locations, they were also interested in studying the twilight conditions to spot the crescent denoting the beginning of the month of Ramadan to begin a month of fasting, and to decide the time of their Lesser and Greater Bairams.

Accordingly, studying astronomy and astrological phenomena was their means to fulfill these compulsory religious requirements, and Muslim scientists were deeply interested in astronomy, emanated it from mythological trends, and fortune telling, and managed to reach many new and unprecedented methodologies never known before by Greeks, Persians or Indians.

Muslims' Interest in astronomy increased highly during the Omayyad era due to the involvement of *Khalid Ibn Yazid Ibn Moawia* in it. At that time, a famous book in astronomy was translated from Greek named *Review of the Star key*. In addition, the Caliph *Abdul Malek Ibn Marwan* was interested in astronomy, and ordered the translation of other books.

Because of blending the Greek, Persian, and Indian civilization with the Arabic one – especially in the in Abbasid era– Arabs were interested in developing further this science. Caliph *Abu Ga'afar el-Mansour* ordered the translation of *The Great El Sind Hind*, the book that investigates the movements of the sun and the stars, and the related phenomena.

Succeeding Abbasid Caliphs like *El Mahdy* and *El Rasheed*, also encouraged studying this science.

Still, Arabs did not confine that science to theoretical aspect, but expanded it into meteorology, and practical applications. Consequently, they established observatories. The first astrological observatory was built in Damascus in the era of Omayyads, and other two were built in the reign of the Abbasid caliph *el-Maa'moun*, one in Damascus and the other in Baghdad. Observatories then, spread in Islamic countries and were equipped with instruments and tools to follow up the movements of the sun, moon, and stars with great precision.

Arabs were the first to make a real measurement of the earth's circumference and estimating the distance between its diameter and its middle in a correct way that verified that earth has a round shape. They also knew the reasons of the sun eclipse, defined the length of the year and the seasons, discovered some kind of error in the moon movement, recorded the cycle of seasons, and estimated the length of the solar year with a very slight error of 2 minuets and 22 seconds.

Arab\ Muslim scientists were aware of the roundness of the earth and its movement around the sun, as well as the movement of the stars. In his book *The Pleasure Excursion of One Who is Eager to Traverse the Regions of the World*, *al- Sharif Abdullah el -Idrisi*, mentioned that the earth is as round as a ball. The *Mass'oudi* also mentioned in his *Meadows of Gold*, that when the sun sets in China; it is rising at the same time on Algeria, and vice versa. This shows clearly that Arabs preceded *Copernicus*

and *Galileo* in discovering the spherical shape of the earth, and the movements of stars, that was contrary to the views of the church, *Ptolemy*, and other European scientists who believed that the earth is the center of the universe, and to what European scientists believed of the rotation of the sun, stars, and the moon around the earth.

**Al-Bairuni**, due to his researches in the observations of the stars, and in astronomical tables, together with his other valuable compositions, was considered the father of the scientific renaissance in astronomy that was lead later by *Galileo* and *Copernicus*. He wrote a number of books highly appreciated by orientalist such as *The Mas'oudy Law in astronomy and Stars* – a great astronomical encyclopedia reviewing the whole world with its earth and the sky -, and *Understanding for the Pioneers of Astrological Industry, and flattening of the spheres.*, *al-Bairuni* also studied the art of drawing astronomical charts and had an equation for calculating the hemisphere of the earth still used up until now. In the words of the Italian scientist *Nilleno*, “the history of astronomy is not completed without *al - Baironi*”.

Among Muslim astronomers, there were many clever people as well. While *Mohamed al-Battany* corrected some errors of *Ptolemy*, *Ibn Yunis el- Masry*, in the late 10<sup>th</sup> century, made researches in the eclipse of the sun and the moon.

*Al-Ferghani*'s book *Principles of Astronomy* had a great effect in scientific development. The translation to Latin of *al-Batruhi*'s book *Astronomy*, was of a great effect in the development the astronomical knowledge of *Copernicus*.

To sum up, we can say that the Arabs went deep in studying astronomy and purified it from many myths that were related to it. They brought it back to the scientific form left by the Greek, keldanian, Persian, and Assyrian scientists; an inductive science based on observations and calculations. They excelled in making instruments, and observing the celestial objects with their creative, precise methods, and thus rendering precious services to humanity. Their researches and concepts highly assisted to establish the European renaissance and modern sciences later on.

There are still hundreds of Arabic names in European astronomical encyclopedias e.g.: Caph, Arnab, Arkab, Saif, Sud Sadal, Tauri, denob

## Chemistry

Chemistry originated in ancient Egypt, expired with the Greeks and Romans, and was reborn once again by the Arabs, who founded its scientific bases. There was a consensus that *Khalid Ibn Yazid Ibn Mu'awiya* was the first one interested in it. By ordering the translation of Greek heritage of chemistry into Arabic, *Khalid Ibn Yazid Ibn Mu'awiya* presented the roots of this science, to Arab/Muslim scientists for further study and research. *Khalid Ibn Yazid* himself was the first to make use of this heritage, as he wrote some books in chemistry like (*Al Serr el Badi' fy fak el ramz el manie'*) (The magnificent secret of how to solve the difficult code) also (*al-Ferdaous*) (The Paradise) and some other messages.

Due to the efforts of some Muslim scientists, chemistry became a real science, because they introduced objective experimentation in studying it, Europeans made much use of these Arabic efforts. In other words, chemistry, in its scientific form, was a great achievement of Arab/Muslims. They introduced precise observations, and scientific experiments, and were keen to register the results; they also analyzed many materials chemically, differentiated between acids and alkalis, and discovered the relation between them, and studied and described hundreds of drugs. One of their most important discoveries was finding the relation between chemistry and medicine; they were the first to apply chemistry in medicine and gave it the name *Alchemy* that became chemistry in English.

The name of Kufi scientist *Jaber Ibn Hayyan (Geber)* occupies a remarkable position among chemists, as a genius, he is a pride to the orient, who demonstrated the importance of experimentation, and put it as a condition for any real science, he advised scientists to make precise observations, be always cautious and, avoid rushing. He wrote about 500 books in chemistry that were studied in Europe for centuries, and are still appreciated in our present days.

*Jaber Ibn Hayyan (Geber)* is considered the father of chemistry; he was the first to prepare acids, and to prescribe several chemical processes like distillation and dissolution. He was also, the first chemist who prepared the sulfuric acid, discovered the nitric acid, and gold water; for all this Europeans estimated him highly, and translated his books to the Latin language. His book *the chemical compounds* was one of the first Arabic

books translated in the beginning of the twelfth century; most Europeans who studied the science of chemistry in the middle ages were his scholars.

He benefited the Europeans by acquainting them with some poisons, ammonia salt, potassium, and gold water. *Ibn Khaldoun* gave him much credit, and described him as the chief (imam) of chemists.

People in recognition of *Jaber Ibn Hayyan (Geber)* and his relation to chemistry, gratefully gave it the name "*Gaber's science*".

The first cause of reaching *Jaber Ibn Hayyan (Geber)* the great results he achieved, was that he was committed to the solid scientific rules of experimental school in science, and by this, could make valuable additions to the human scientific treasure. That made his name one of the first immortal names in the history of human intellect.

*Jaber Ibn Hayyan (Geber)* wrote in many subjects, but his most important books were *The Sun Book*, *The Moon Book*, *Book of formulas*, *book of secrets*, *book of poisons and drugs*, and *the book of clarification*. In the later book, he mentioned, the composition of metals, and the making of gold, he has many other books.

**Examples of the many inventions related to him are:**

- Using manganese dioxide in glass industry
- Preparing an anti-rust sort of paint for iron
- Using alum in fixing dyeing materials
- Manufacturing a sort of paper that can not be burnt
- Refining metals, preparing steel, and tanning leather.
- Distillation of vinegar to produce concentrated acetic acid

In brief, the efforts of *Jaber Ibn Hayyan (Geber)* granted him a high rank that makes him match the contemporary modern scientists.

**Abu Bakr al-Razi (Rhazes)** The famous physician and philosopher, was one of *Ibn Hayyan's* students. He liberated chemistry from myths; his method in thinking was a clear one. He was inclined to study chemistry because of its close relation to medicine, and managed to prepare medicaments, and drugs. He composed numerous books, many of which were lost; but his book *the secret of secrets (serr el asrar)* gained a great fame in Europe and was translated into German. Studying his books deeply revealed that, he was one of the greatest knowledge seekers ever lived before the emergence of a new dawn of science in Europe with *Galelio*. He

was distinguished with his spirit of investigation, and scientific curiosity. To summarize, his theory in material, he said that there are five absolute elements, which are the creator, the spirit, the body, the space and the time. He made it clear that, bodies are composed of, an undividable element, surrounded by empty space; he, also said that elements are characterized by having a fixed volume, and that elements are four, dust, water, air, and fire. The characteristics of these four elements are lightness, heaviness, transparency, color, softness, and hardness; these characteristics can be measured by the density of metals which is the vacuum separating the atoms.

In his book (secret of secrets), he explained his experiences and the essence of his researches; he began by pointing out what materials he worked on, then what tools and instruments did he use, and the methodology he adopted in preparing the compound. Therefore, he was interested in scientific chemistry preferring it to theoretical contemplation. By all this, he created a revolution in chemistry.

What characterized *al-Razi (Rhazes)* of systemic thinking and tidy knowledge made him the first organized planner in classifying the materials used by chemists of that era, depending on the natural characteristics of materials, and was able - in most times - to differentiate between metal and non-metal elements.

**Al-Razi (Rhazes)**, was considered without the least doubt the founder of two sciences : curative chemistry, and drugs. *al-Razi (Rhazes)* was the first also to describe the processes of preparing sulphuric acid and called it zag oil; He also prepared alcohol by distilling fermented sugary or starchy materials and used it in pharmaceuticals.

Europeans adopted his idea of classifying the chemical materials to metal, animal, and plant categories, such a classification had the greatest effect in the development of the modern science of chemistry.

**Ibn Sina (Avicenna)** was the unparalleled genius of his era. He was not only fond of knowledge, but he lived it as well, he spent all his time seeking knowledge. He agreed with *Ibn el-Hayyatham* in his theory of the composition of elements. In his book ( al qanoun) *The Law of Medicine*, he referred to a large number of chemical operations such as distillation, sublimation, infiltration, extraction, and waxing, he used different

apparatuses to achieve his results. In his book (al-Shefa) *Recovery*, which is considered a principal chemical source, he mentioned a number of chemical compounds of a botanic or animal origin.

**Al-Magriti** was another name among the 10<sup>th</sup> century A.D scientists. He had a book in chemistry that was translated into Latin as a major source in the history of science.

Other names can be mentioned in the same field like *Ibn el -Beitar*, *Ibn Maymoun*, *Ibn el-Nafis*, *Daowoud al-Entakky*, *Az-Zahrawi*(*albugasis*), and many others.

To sum up, Arab scientists made great developments in chemistry that enabled them to apply conclusions they reached, on different industries (what is now known as industrial chemistry) they used their expertise in dying of fabrics, leather tanning, metal industries, and composing perfumes. Arab chemists also discovered gunpowder that made a revolution in military arts and weaponry, also in projects like making roads and breaking rocks. They, preceded Europe in resorting to experiments to prove theories, and were the first to extract and/or prepare many of the acids, and compounds on which the modern industry still depends. They prepared compounds, still used nowadays to make soap, paper, silk, explosives, dyes, and industrial fertilizers. Their impact can be proved by the large number of Arabic words included as chemical terms in European languages. Without Arab/Muslim contributions, the science of chemistry could never achieve its ends – a fact stressed by the orientalist *Guatave Lebon*.

### **Physics**

Arab/Muslims were very superior in the field of physics, mainly in the field of lenses, optics, sound, magnetism and gravity. Most of their researches were translated into Latin. They called the science of light (the optics) or the science of scenes.

**El-Kendy** composed two books on this science : *Difference of Views* and *Difference of Mirror' Views*.

**Ibn Sina (Avicenna)** also worked in this field and had new theories which he mentioned in his book (*Recovery*).

**Al-Hassan Ibn al-Haytham (Alhazen)** (965 – 1020) was the most prominent specialist in this science. He was the most genius scientist of

physics in the middle ages, and the one whose name remains connected to the science of optics and lenses.

**Ibn al-Haytham** (Alhazen) made the first significant contributions to optical theory since the time of the Alexandrian astronomer Ptolemy in the 2nd century. His books remained the first references in the science of light until the 17<sup>th</sup> century A.D. In his famous book *scenes*, he proved that both angles of falling and reflection of light are in the same level. The book was translated five times into Latin and spread all over Europe in the middle ages. It consists of seven volumes dealing with the science of optics including the anatomy of the eye, the name and function of each of its parts, and how can we see by both eyes at the same time, also how the rays pass from the seen object to the eye, hence its falling on the eye retina. Then there was a research on lenses and light theories. Roger Bacon and most writers of the middle ages depended mainly on this book. In his book *On the Burning Glass*, he revolutionized the nature of focusing, magnifying, and inversion of the image.

**Ibn al-Haytham** (Alhazen) also wrote a number of other books and articles on the same topics. He finally managed to prove the error of Ptolemy's theory in stating that the ratio between the two angles of falling and refraction is fixed, and indicated that it is changing.

His experiments included moonlight, stars' light, and investigations of bright and dim lights, this put him in line with modern scientists like Calvin, as he grasped knowledge of theoretical, experimental, and applied physics.

**Ibn al-Haytham** (Alhazen) was the founder of the science of modern optics, that was based on replacing the old theory of vision - which stated that vision takes place due to emission of rays of light from the eye to fall on the seen object - by his new theory, stating that vision takes place when rays of light are emitted from the seen object to fall on the eye and to reach its retina, from the retina the effect reaches the brain via the optic nerve, and by this the object will be seen.

He was the first to say that the convex lens magnifies the images. His researches in magnifying lenses paved the way for using them in correcting the defects in eye vision later on. He was also the first to describe the parts of the eye, and giving them their names that we still use nowadays, like retina, cornea, vitreous body...etc.

Dr. *Moustafa Nazif* confirmed that most researches and light discoveries have been included in Ibn al-Haytham (Alhazen)'s books .

**Abou Arrayhan al-Bayruni** was also distinguished with his scientific creations in the field of physics. He concluded that light is faster than sound, and that objects that produce sounds will cause a movement that affects air to move inside the objects it passes through. He also investigated hydraulic laws controlling springs and wells' waters. Furthermore, he made studies in defining specific density of eighteen precious stones, and formulating the law of specific density, it is worth mentioning that the specific densities estimated by al-Bayruni are about the same as what we know now, after using sophisticated scientific measuring tools.

**Abu Bakr al-Razi (Rhazes)** Was concerned with calculating the density of bodies, using a special scale which he called the physical scale.

The Arab scientist **al-Khazin El Basry (965 – 1038)** invented a special tool for knowing the specific gravity of any liquid. In his book *The Scale of Wisdom*, he discussed the phenomenon of air pressure, stating that air -like liquids- has also a lifting power; which means that air can carry objects. He also stated that the weight of an object immersed in water is lesser than its real weight, and made researches in gravity, and the relation between the speed of a falling object and the distance from which it falls, which means that he was aware of the concept of gravity before the formulation of its law by *Newton* .

In addition, Arabs had valuable researches on levers, they actually used several types of levers which al-Khawarezmy mentioned in his book (keys of sciences). They also wrote about sound; their scientists showed that sound is transmitted through air, which led them to make researches in musical sounds and the making of musical instruments, classifying the grades of sound, knowing the relation between the length and degree of tension of the string of the musical instrument and the quality of the sound it produces. They explained why echo happens, and why lightning is seen before the sound in thunders.

Because of all these efforts, the Europeans translated books of Arab scientists to their European languages. An example of this was the translation of the books of al-Khazin el-Basry to Latin, then to Italic since an early date, European scientists benefited of them, an example is *Robert*

*Gnosseteste* (1175 – 1253 ) who was considered the most eminent among western European scientists in the 13<sup>th</sup> century A.D., He did benefit of al-Khazen el-Basry books, another examples are Witolo Paul, and Roger Bacon, who by his turn, benefited from *Gnosseteste*, and Witolo.

Thus, the ideas of the Arab/Muslim scientists, helped the birth of European age of renaissance, and the emergence of several genius European scientists. As is the example of Newton's making use of the ideas of Ibn Sina, and al-Bayruni in discovering the laws of gravity; and Kippler making use of the book of Ibn al-Haytham in optics, and so on.

Orientalist, Briffault said that modern physics is indebted to the Arabs not only for their scientific discoveries and new theories, but also to the Arabic culture for its existence, because modern physics emerged in Europe as a result of the scientific spirit introduced by Arab scientists into European civilization.

### **Medicine**

Between the 8<sup>th</sup> and 15th centuries A.D, There was no worthy medical science in the civilized world except the Arabic one, Arabs' medical superiority in medicine from scientific, organizational, and practical aspects, is an undoubted fact.

Arab civilization had its own medical sciences even before they were acquainted to the Greek civilization, they had their own procedures and methodologies, the number of Arab physicians was so great as Ibn Aby Osaybea mentioned in his huge volume (degrees of physicians)

Indeed Muslims absorbed books of medical Greek scientists like Gallen, added to them, and wrote new chapters in medicine and pharmacy depending on their special observations and experiments; they even corrected the faults of the Greeks as is apparent al-Razi's book *al Fesoul* , where he warned of errors made by *Hippocrates* and *Gallen*. His opinions highly conform to the modern science of medicine. Other Arab physicians reviewed the two European scientists' medical comments to affirm the correct ones, and abandon the wrong ones. They also built hospitals, known as Maristans since the Omayyad age. The first one in Islam was built by the Caliph *al-Walid Ibn Abd el-Malek*.

In the Abbasid age, Islamic medicine witnessed a huge progress due to Caliphs' interest in medicine. While *al-Mansour* was close to and generous with physicians, *al-Rashid* established a large maristan in Baghdad for medical education of students, and treatment of patients. These hospitals were built in the best and most suitable locations; they preceded in their systems the university hospitals of today. A large number of medical schools were built in the Abbasid age. They received scholars from everywhere to learn Arabic/Muslim discoveries and inventions in the medical field.

By contrast, the Europeans lacked sufficient medical information, because the clergy considered ailments as a sort of divine punishment for men, hence it was taboo to try to cure sick people. The church also banned the anatomy of the human body; their physicians were obsessed with superstitions. Such a gap between the medical level of Arabs and that of Europeans was clear in the tales narrated by the historians of the crusades. In Europe, for example, insane people were hit to rid them of the devils inside their bodies. Europeans referred urgent cases referred to Arab physicians, seeking their superior talents. Some European princes had Arabic physicians instead of their inefficient physicians.

As a result of Arab scientists' superiority in the medical sciences, Europeans were eager to translate and publish their writings in their languages.

**Al-Razi** – the most famous Muslim doctor – who was called by Europeans "the Arabs *Gallin*" composed a wealth of books about fever and pediatrics, which were considered among the basic references on which physicians of West Europe relied for a long period.

In general, his books were distinguished with his vast knowledge in the science of anatomy. He applied new techniques in treatment based upon his knowledge of chemistry and pharmacology achieving great success; these techniques are still applicable by modern physicians.

One *al-Razi's* most famous books, was *al-Hawy* (the container) which was considered the greatest medical book dealing with medical profession, it includes 24 parts containing all that he collected from different medical books and referring everything to its original creator. He dealt with subjects of anatomy, drugs, surgery, and diseases. This book was translated

to Latin language in 1279 by Farag Ibn Salem for *Charl Anglo*. It was discovered that the book was reprinted more than once and used in European universities till the 19<sup>th</sup> century.

**al-Razi** wrote other books in spiritual medicine, joints diseases, gout and sciatica. Aside from his cleverness in diagnosing fever and prescribing medicine, he discovered alcohol and sulfuric acid.

European translations of Arab/Muslim medical references extended to include those of the scholars following *al-Razi*.

**Ibn Sina (Avicenna)**, was called by his contemporaries the boss sheikh, or the second teacher after the first one *Aristotle*. He was a physician, a philosopher, and a scientist likewise. His books like *Recovery*, *The Law of Medicine* and *Medical Remedies* were the main references of all medical schools in Europe, and therefore were translated into Latin for many times to be studied as basic texts in all European universities. Besides, he was also famous for his psychological treatment and the first one to use hypodermic injection as well as anesthetization for performing surgeries.

One of the interesting stories told about how Ibn Sina could practice psychological treatment was about a young man who physicians failed to treat, after trying hard to do. Ibn sina summoned a man who knows every district in the city, and asked him -while the young man was attending- about the districts one by one. Ibn Sina was watching the young man's face closely, and feeling his pulse; On mentioning a certain district the pulse of the man became faster, then on enumerating the houses of the district one by one, on mentioning a certain house the boy's pulse became more fast. Ibn Sina then concluded that the young man was in love with a girl in this particular house, his prescription was advising his parents to wed their son to the girl.

In surgery, Europe asked the help of a number of Andalusian physicians. One of the most most prominent of them was Az-zahrawi (Albucasis), the senior Muslim surgeon.

**Az-zahrawi (Albucasis)** was the first to prescribe the operation of crushing stones in the urinary bladder, conduct research in joint inflammations and tuberculosis, use female nurses and recommend their assistance in operations, particularly for women to comfort them. In addition, he had several compositions in medical profession, His 30 -part

medical encyclopedia, *At-Tasrif* ("The Method") contained over 200 surgical medical instruments he personally designed, and was a surgical treatise that had a tremendous influence on Western medicine.

*At-Tasrif* ("The Method") was Translated into Latin in the 12th century by the Italian scholar Gerard of Cremona, *at-Tasrif* stood for nearly 500 years as the leading textbook on surgery in Europe, preferred for its concise lucidity even to the great works of the classical Greek medical authority Galen of Pergamum.

Last and not least, Muslims introduced new medical methods. They used anesthetic drugs extracted from poppy plants in operations, opium in treating nervous diseases, and cold ice packs for treating fever and stopping bleeding. They also discovered and treated leprosy as well as tuberculosis and paralysis.

In addition, they resorted to psychological treatment in treating some organic diseases, performed operations of removing cataract from the eyes, identified the blood circulation and put the first description of it. Moreover, they invented new instruments in surgery, drafted sketches for them and used the strings taken from the intestines of cats and other animals in stitching wounds.

Besides, they discovered the benefits of adding lemon juice, oranges and carnation to medicines to improve their bitter taste.

Therefore, Muslim scientists' books in medicine remained as references for European researchers for six centuries.

In brief, we can sum up some of their achievements in the following points:

- 1) Arab/Muslims transmitted Greek medicine in a new form carrying their own stamp and spirit.
- 2) They developed anatomy and pharmacology, particularly after the discovery and explanation of *Ibn el-Nafeis* of the minor blood circulation.
- 3) They invented the science of differential diagnosis. *al-Razi* is credited for initiating such a science with his investigations and interpretations of signs, and distinctions between different diseases.
- 4) Europeans benefited from Arabic medicine as a profound scientific subject related to clinical medicine. They quoted their knowledge of

drugs and remedies and their experience in surgery. They also adopted the system of their hospitals .

**Europeans benefited of Arabic medicine in adopting:**

- Text books dealing with all branches of medicine, the most important of which was an encyclopedia by the name of al-Qanun fi at-Tibb ("The Canon of Medicine"), the most famous single book in the history of medicine in both East and West.
- Extensive scientific materials about clinical medicine after al-Razi
- Scientific knowledge about drugs and pharmaceuticals, after Ibn el-Bitar
- Experience in surgery, after Az-zahrawi
- Hospitals and hospital systems

We can see apparently how an inter-civilization dialogue in medicine was more beneficial for the humanity than conflicts and wars.

**Pharmacy (Pharmacology)**

Arabs outstanding knowledge in chemistry was one of the reasons of their efficiency in pharmacy. They added to known remedies several compositions they invented. Their books in drugs benefited the Europeans largely.

Importation of Arabic drugs was an essential component of the Italian trade with Arabic east, In that sense, Venice flourished as a commercial port for selling expensive drugs from the Arab East.

In fact, Arabs were the founders of the science of pharmacology. They knew much of it, and used their knowledge in the treatment of diseases.

**Ibn el-Bitar (1197 – 1248)** In his book, *Compiler of Remedies and Food Items*, he gathered a collection of medicaments extracted from plants like rhubarb, tamarinds, nutmeg, camphor, and alcohol. Also paints like rose paint, daffodil paint, and elderberry paint. He was caring to describe the substances of drugs, their characteristics, and use.

**Ibn Rushd (Avirroes)**, mentioned the medicines necessary for treating diseases in the forms of herbs, or liquids.

**El-Idrisi**, composed a book about the characteristics of plants, in this book he mentioned the names of medical plants unknown to others before, like zaatar, castor, ginger, colocynth, khella, and wormwood. He

also mentioned alcohol, emulsions, plasters, arsenic, poisons, and others. **Dawoud al-Antaky** In his books, was also interested in the description of medical plants, especially pomegranate.

**Ibn El Nafeis** had a technique in treatment mainly that depended on using food more than drugs, as is apparent In his books, *Law of Pharmacy*, and *Recovery*.

**Ibn Sina (Avicenna)** described medical plants from which drugs are extracted, the way of using them for treatment. He described the way plant absorbs its nourishment, and how the juices infiltrate to its different parts. He also wrote many chapters in botanic and zoological studies. Such valuable researches accounted for the need to translate his book for fifteen times and using it as a reference in European universities up to the 17<sup>th</sup> century.

Furthermore, Arab/Muslims were the first to establish drugs stores, and establish a school of pharmacy.

In their treatments, Arab physicians not only prescribed medicines but also food in its different kinds and forms, indicating the benefits and harms of each of them.

**Al-Razi**, demonstrated in his book, *Benefiting of Foods and Avoiding Their Dangers*, demonstrated this point in details. **Ibn Sina (Avicenna)** advised taking the proper amount of food , no less , no more.

Europeans adopted from Arab/Muslim pharmacists their diagnosis of diseases, prescriptions of medicines, and their knowledge of drugs.

**Ibn el-Bitar's** book was their major reference in this respect until the latest 18<sup>th</sup> century.

One of the major contributions of the Arabs was establishing schools for preparing medicines. These schools were under the control of the state, and the observation of scientists. To prevent any illegal activities. Pharmacists were requested to have an official license to be able to practice.

Arabs combined pharmacy with medicine; they established a pharmacy in every hospital or (bimaristan).

Arab/Muslim pharmacists also discovered many drugs and composed a number of beverages, emulsions, and different medical extracts – quoted by Europeans, and some are still preserving their Arabic names.

So, Arabic/Muslim scientists played a key and honorable role in serving human civilization. They transmitted the Greek scientific heritage coupled with their precious additions to Europe, and thus sharing in developing modern civilization. They also managed to build close relations with other world civilizations. They laid the bases of scientific research in its modern sense in all fields of knowledge.

Arab/Muslim civilization was embraced by the Europeans who acknowledged its superiority and excellence. It was them who civilized Europe intellectually and morally \_ a fact confirmed by many orientalisks like *Lebon* who Descriped them as the *professors of Christians* .

The West is indebted to Arabic/Islamic civilization for rescuing it from the darkness of the middle ages. Similarly, the Arab/Islamic world is now indebted to the West for the knowledge and sciences transmitted to it in the modern times. Arabs and Muslims now need to carry out discussions with the West and benefit from its modern civilization and developed potentialities.