# Islamic Alchemy in the context of Islamic Science

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Alchemy in Islamic Times

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Based on the book George Sarton, *Introduction To the History of Science*. Edited and prepared by Prof. Hamed A. Ead

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# Technical Arts Related To Alchemy in Old Egypt

## Part 1:

### Technical Arts Related To Alchemy in Old Egypt

One of the oldest civilizations all over the world was that of ancient Egypt, which emerges from pre-history into the period of more or less precise chronological record at a date perhaps not far removed from 3400 B.C. This highly developed civilization endured for over 3,000 years, during which it spread its influence far and wide; some archaeologists, indeed, claim to see in all other civilizations the signs of an Egyptian origin. However this may be, it is universally agreed that in technical arts Egyptian workers pointed the way to the rest of the world, and it is to them that we must turn for the first discovery of those facts that make chemistry possible.

Of course, our knowledge of the very earliest developments of chemical arts is dependent upon the discovery of products as far as some 3000 years B.C. tin bronzes were made.

Primitive arts that provide data of a chemical nature are those of the metallurgist, the glass-maker, the dyer and the like, many of which reached an astonishingly high level of perfection in ancient Egypt.

**Metallurgy**

Metallurgy in particular was carried on with an elaborate technique and a business organization not unworthy of the modern world, while the systematic exploitation of mines was an important industry employing many thousands of workers. Even as early as 3400 B.C., at the beginning of the historical period, the Egyptians had an intimate knowledge of copper ores and of processes of extracting the metal. During the fourth and subsequent dynasties (i.e. from about 2900 B.C. onwards), metals seem to have been entirely monopolies of the Court, the management of the mines and quarries being entrusted to the highest officials and sometimes even to the sons of the Pharaoh. Whether these exalted personages were themselves professional metallurgists we do not know, but we may at least surmise that the details of metallurgical practice, being of extreme importance to the Crown, were carefully guarded from the vulgar. And when we remember the close association between the Egyptian royal family and the priestly class we appreciate the probable truth of the tradition that chemistry first saw the light in the laboratories of Egyptian priests.

**Copper and Iron Extraction.**

In addition to copper, which was mined in the eastern desert between the Nile and the Red Sea, iron was known in Egypt from a very early period and came into general use about 800 B.C. According to Lucas, iron appears to have been an Asiatic discovery. It was certainly known in Asia Minor about I300 B.C., for one of the Kings of the Hittites sent Rameses II, the celebrated Pharaoh of the Nineteenth Dynasty, an iron sword and a promise of a shipment of the same metal . The Egyptians called iron 'the metal of heaven' or ba-en-pet, which indicates that the first specimens employed were of meteoric origin, the Babylonian name has the same meaning. It was no doubt on account of its rarity that iron was prized so highly by the early Egyptians, while its celestial source would have its fascination. Strange to say, it was not used for decorative, religious or symbolical purposes, which - coupled with the fact that it rusts so readily - may explain why comparatively few iron objects of early dynastic age have been discovered. One which fortunately has survived presents several points of interest: it is an iron tool from the masonry of the great Pyramid of Khufu at Giza, and thus presumably dates from the time when the Pyramid was being built, i.e. about 2900 B.C. This tool was subjected to chemical analysis and was found to contain combined carbon, which suggests that it may have been composed of steel. By 666 B.C. the process of case-hardening was in use for the edges of iron tools, but the story that the Egyptians had some secret means of hardening copper and bronze that has since I been lost is probably without foundation. Desch has shown that a hammered bronze, containing 10.34 per cent. of tin, is considerably harder than copper and keeps a cutting edge much better.

Of the other non-precious metals, tin was used in the manufacture of bronze, and cobalt has been detected as a coloring agent in certain specimens of glass and glaze. Neither metal occurs naturally in Egypt, and it seems probable that supplies of ore were imported from Persia. Lead, though it never found extensive application, was among the earliest metals known, specimens having been found in graves of pre-dynastic times.

Galena (PbS) was mined in Egypt at Gebel Rasas ('Mountain of Lead'), a few miles from the Red Sea coast; and the supply must have been fairly good, for when the district was re-worked from 19I2 to 1915 it produced more than I8,000 tons of ore.

The vast quantities of gold amassed by the Pharaohs were the envy of contemporary and later sovereigns. Though much was imported, received by way of tribute, or captured in warfare, the Egyptian mines themselves were reasonably productive.

Over one hundred ancient gold workings have been discovered in Egypt and the Sudan, though within the limits of Egypt proper there appear to have been gold mines only in the desert valleys to the east of the Nile near Ikoptos, Ombos and Apollinopolis Magna. Of one of these mines - possibly near Apollinopolis - a plan has been found in a papyrus of the fourteenth century B.C., and the remains of no fewer than 1,300 houses for gold-miners are still to be seen in the Wadi Fawakhir, half-way between Koptos and the Red Sea. In one of the treasure chambers of the temple of Rameses III, at Medinet-Habu, are represented eight large bags, seven of which contained gold.

The Egyptian word for gold is nub, which survives in the name Nubia, a country that provided a great deal of the precious metal in ancient days. French Scientist Champollion regarded it as a kind of crucible, while Rossellini and Lepsius preferred to see in it a bag or cloth, with hanging ends, in which the grains of gold were washed - the radiating lines representing the streams of water that ran through. Crivelli has more recently advanced the theory that the gold symbol is the conventional sign for a portable furnace used for the fusion of gold, and that the rays represent the flames, which, 'as can be observed in the use of this type of furnace, are unable to ascend because the wind inclines them horizontally'. In the later dynasties, the Egyptians themselves forgot the original signification of the sign and drew it as a necklace with pendent beads, though Elliot Smith says that this was the primitive form and became the determinative of Hathor, the Egyptian Aphro dite, who was the guardian of the Eastern valleys where gold was found.

The gold mines in Nubia and other parts of the Egyptian empire seem to have been very efficiently designed and controlled, though with a callous disregard for the human element employed.

Alluvial auriferous sand was also treated, a distinction being made between the gold obtained in this way and that extracted from the mines. The latter was called nub-en-set, i.e. 'gold of the mountain', while alluvial gold was named nub-en-mu, i.e. 'gold of the river'. Auriferous sand was placed in a bag made of a fleece with the woolly side inwards; water was then added and the bag vigorously shaken by two men. When the water was poured off, the earthy particles were carried away, leaving the heavier particles of gold adhering to the fleece. There is a picture of this operation on one of the buildings at Thebes.

**Mercury**

Mercury (Greek-hydrargyros, liquid silver; latin-argentum vivum, live or quick silver) is stated to have been found in Egyptian tombs of from 1500-1600 B.C.

**Metal and Mysticism.**

In the early centuries of our era, however, there gradually developed a mysticism among chemical writers due to Egyptian and Chaldean religious magical ideas, and there developed a fanciful relation of the metals as such to the sun and the planets, and as a consequence there arose the believe that it was necessary to confine the number of metals to seven.

Thus Olympidorous-in the 6th century of our era gives the following relation:

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Gold....................the Sun
Silver..................the Moon
Electrum................Jupiter
Iron....................Mars
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Copper...................Venus
Tin......................Mercury
Lead.....................Saturn
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Metallurgy was by no means the only art practiced with conspicuous success by the ancient Egyptian craftsmen. Glass was almost certainly the invention, not of the Phoenicians, but of the Egyptians, and was produced on a large scale from a very early date.

**Art of Glass Making**

This art is of very ancient origin with the Egyptians, as is evident from the glass jars, figures and ornaments discovered in the tombs. The paintings on the tombs have been interpreted as descriptive of the process of glass blowing. These illustrations representing smiths blowing their fires by means of reeds tipped with clay. So can conclude that glass-blowing is apparently of Egyptian origin, at the beginning of our era.

The remains of glass furnaces discovered by Flinders-Petrie at Tel-El-Amarna (1400 B.C.) illustrate the manufacture of rods, beads, and jars or other figures, formed apparently by covering clay cores with glass and later removing the cores.

Egyptian glass articles were of colored glass, often beautifully patterned.

From analyses of ancient Egyptian glass articles, it show that generally the glass was a soda-lime glass with rather soda content as compared with modern soda-lime glass. The given analyses do not differ from those of some soda-lime glasses of modern times. Lead was used in glasses from very ancient times. French scientist analyzed a vase of the Fourth dynasty in Egypt which contained about one quarter lead.

Artificial pearls, made of glass, were manufactured in such numbers that they formed an important article of export trade, and the old legends of enormous emeralds and other precious stones are most reasonably explained on the assumption that the preparation of paste jewelry was widely undertaken.

The earliest glass-works of which the remains have been found date from the eighteenth dynasty, and the oldest dated glass object is a large ball bead bearing the cartouche of Amen-Hotep I, now in the Ashmolean Museum at Oxford. The invention of glass-blowing, as opposed to the older method of glass-molding, is comparatively recent, dating back only to about the beginning of the Christian Era. Sir Flinders Petrie has shown that the relieves at Beni-Hassan, which were formerly supposed to represent glass-blowers are more probably to be interpreted as metal-workers blowing a fire.

**Textile and Dyeing Materials.**

The begining of the art of weaving and the art of dyeing are lost in antiquity. Mummy cloths of varying degrees of fitness, still evidencing the dyer's skill, are preserved in many museums.

The invention of royal purple was perhaps as early as 1600 B.C. From the painted walls of tombs, temples and other structures which have been protected from exposure to weather, and from the decorated surfaces of pottery, chemical analysis often is able to give us knowledge of the materials used for such purposes.

Thus, the pigments from the tomb of Perneb (at estimated 2650 B.C.) which was presented to Metropolitan Museum of New York City in 1913, were examined by Maximilian Toch. He found that the red pigment proved to be iron oxide, haematite; a yellow consisted of clay containing iron or yellow ochre; a blue color was a finely powdered glass; and a pale blue was a copper carbonate, probably azurite; green were malachite; black was charcoal or boneblack; gray, a limestone mixed with charcoal; and a quantity of pigment remaining in a paint pot used in the decoration, contained a mixture of haematite with limestone and clay. So many analyses results made by known scientists all serve to illustrate the character of the evidence furnished by chemical analysis of surviving samples of the products of early chemical industries.

# Part 2:

## Earliest Chemical Manuscripts of the Chemical Arts In Egypt

In spite of Egypt is generally recognized as the mother of the chemical and alchemical arts, but unfortunately her monuments and literature have left little of the early records which explain these arts.

Some of these ideas have been transmitted to us through Greek and Roman sources but the character of these sources do not enable us to discriminate between the matter derived from Egypt and the confused interpretation or additions of the early Greek alchemists.

The stories told us that about 290 A.D. the Emperor Diocletian passed a decree compelling the destruction of the works upon alchemical arts and on gold and silver throughout the empire, so that it should not be the makers of gold and silver to amass riches which might enable them to organize revolts against the empire. This decree resulted in the disappearance of a mass of literature which doubtless would have furnished us with much of interest in the early history of chemical arts and ideas.

# Discovery of earliest chemical manuscripts

**Leyden Papyrus**

However, fortunately there have been saved to our times two important Egyptian works on chemical processes; the earliest original sources on such subjects discovered at Thebes (South Egypt), and both formed part of a collection of Egyptian papyrus manuscripts written in Greek and collected in the early years of the nineteenth by Johann d'Anastasy, vice consul of Sweden at Alexandria.

The main part of this collection was sold in 1828 by the collector to the Netherlands government and was deposited in the University of Leyden. In 1885, C. Leemans completed the publication of a critical edition of the texts with Latin translation of a number of these manuscripts, and among these was one of the two works above mentioned. It is known as the Papyrus X of Leyden.

The French chemist Marcelin Berthelot who was interested in the history of early chemistry, subjected this Papyrus to critical analysis and published a translation of his results into French with extensive notes and commentaries

On the basis of philological and paleography evidence, he concluded its date is about the end of the third century A. D. It is, however, manifestly a copy of a work previously written, as slight errors evidently due to a copyist, are found. That the original is later than the first century A. D. is certain, as there are included in it extracts from the *Materia Medica* of Dioscorides. The work is a collection of chemical recipes and directions for :

1. Making metallic alloys,
2. Imitations of gold, silver or electrum,
3. Dyeing and other related arts.

In 1913 at Upsala, Otto Lagercrantz published the Greek text with critical commentary and with translation into German of a similar Egyptian papyrus, the " Papyrus Graecus Holmiensis." This work like the Leyden manuscript is a collection of recipes for alloys, metal working, dyeing, imitations of precious stones and similar arts. Investigation developed that this manuscript also came from the Swedish vice consul at Alexandria, d'Anastasy, presented by him to the Swedish Academy of Antiquities of Stockholm. Here it slumbered apparently unnoticed until 1906 when it was transferred to the Victoria Museum at Upsala.

Examination and comparison with the Leyden Papyrus made it evident that the new papyrus was not only identical, but in all probability was in part at least written by the same hand.

Both papyri were in remarkably well preserved condition. Both gave internal evidence of having been copied from other originals. Berthelot has suggested that the Papyrus X had been preserved in the mummy-case of an Egyptian chemist, and Lagercrantz agreed in the opinion and is convinced that the two works were the property of the same person, and that these copies were probably made as deluxe copies for the purpose of being entombed with their former owner in accordance with a common custom of placing in the tomb articles formerly owned or used by the deceased.

The two manuscripts were taken together from an interesting collection of laboratory recipes of the kinds which Diocletian ordered destroyed and which apparently were very generally destroyed. The date ascribed to them is about the time of the decree of Diocletian, and it may be presumed that, in the mummy case, they escaped the execution of that decree.

The laboratory manuals from which these copies were made, were written not for public information but for the guidance of the workers. The recipes themselves are often very detailed directions, but often also were mere hints or suggestions, sometimes elliptical to such an extent as to give no clear idea of the process as carried out.

The Leyden papyrus comprises about seventy-five recipes pertaining to the making of alloys, for soldering metals, for coloring the surfaces of metals, for testing the quality of or purity of metals, or for imitating the precious metals. There are fifteen recipes for writing in gold or silver or in imitation of gold and silver writing. There are eleven recipes for dyeing stuffs in purple or other colors. The last eleven paragraphs are extracts from the *Materia Medica* of Dioscorides, relating to the minerals or materials used in the processes involved.

Berthelot notes that the artisan who used these notes while a practical worker in metals, especially the metals used by the jewelers, seemed to be a stranger to the arts of enamels and of artificial gems. It is, therefore, of great interest to discover that the Stockholm papyrus supplements the Leyden recipes in this direction. The Stockholm manuscript contains in all about a hundred and fifty recipes. Of these, only nine deal with metals and alloys, while over sixty relate to dyeing and about seventy to the production of artificial gems. Some ten others deal with the whitening of off-color pearls or the making of artificial pearls.

It has been noticed that there is practically only a duplication of recipes contained in each of the manuscripts, and very similar recipes occur in both. The recipes in both are empirical with no evidences of any occult theories, nor any of that obscurity of language which is so characteristic of the later alchemists.

The parts dealing with the metals are largely concerned with transmutation of gold, silver or electrum from cheaper materials, or with giving an external or superficial color of gold or silver to cheaper metal. There seems to be no self-deception in those matters. On the contrary, there are often claims that the product will answer the usual tests for genuine products, or that they will deceive even the artisans. The vocabulary of materials used is practically that of Dioscorides, with few changes in the meaning of such terms as are used by him, although at times the Latin equivalents of Vitruvius and Pliny have been employed.

There is little to be found in these manuscripts which suggests that there has been any advance in the practical arts as known in the times of Dioscorides and Pliny and which had been less specifically described by them, but the papyri in the more definite and detailed directions they give, throw a very interesting light upon the somewhat limited fields of industrial chemistry, of which they treat.

Examples will best serve to illustrate the character of the recipes and of the knowledge of practical chemistry which underlies them.

The following are some selections of the Papyrus of Leyden, as found in the previously mentioned translation of Berthelot:

**Manufacture of asem (eleetrum)**

Tin, 12 drachmas; quicksilver, 4 drachmas; earth of Chios, 2 drachmas. To the melted tin add the powdered earth, then add the mereury, stir with an iron, and put it into use.

[This, then, is a tin amalgam intended to give the appearance of asem or silver. The earth of Chios as described by Pliny appears to have been a white clay. Pliny says it was used by women as a cosmetic.]

**The doubling (diplosis) of asem**

Take refined copper (chalchos) 40 drachmas, asem 8 drachmas, button tin 40 drachmas. The copper is first melted and after two heatings the tin and finally the asem is added. When all is softened, remelt several times and cool by means of the preceding composition. Clean with coupholith (tale or selenite according to Berthelot). The tripling (triplosis) is effected by the same process, the weights being proportioned in conformity with what has been directed above.

[This recipe would yield a pale yellow bronze containing mercury if, as seems probable.]

**Purification of tin**

Liquid pitch and bitumen, one part of each. Throw it on and melt and stir. Of dry pitch 20 drachmas, bitumen 12 drachmas.

[This is manifestly a process of obtaining an unoxidized clean tin for further use.]

**Manufacture of asem**

Take soft tin in small pieces, four times purified. Take of it four parts and three parts of pure white Copper (or bronze, "chalchos"), and one part of asem. Melt and after casting, clean several times and make what you will with it. This will be asem of the first quality which will deceive even the artisans.

[Copper was whitened by the ancients sometimes by alloying with arsenic. A recipe in this papyrus gives directions for this whitening of copper.]

**Augmentation of gold**

To augment gold, take Thracian cadmia, make the mixture with the cadmia in crusts; or cadmia of Gaul misy and sinopian red, equal parts to that of gold. When the gold has been put into the furnace and has become of good color, throw in these two ingredients and removing [the gold] let it cool and the gold will be doubled.

[Cadmia, it will be remembered, is the impure zinc oxide, containing sometimes lead and copper oxides, from the furnaces in which brass was smelted. Misy was the partly oxidized iron or copper pyrites, essentially basic sulphates of iron and copper. Synopian red was haematite. This mixture, assuming the reducing action of the fuel in the furnace, or of any other reducing agent not specified in the recipe would yield an alloy of gold and zinc, with some copper and perhaps some lead.]

**To make asem**

Carefully purify lead with pitch and bitumen, or tin as well; mix cadmia and litharge in equal parts with the lead. Stir till the mixture becomes solid. It can be used like natural asem.

[Reduction in the furnace must here also be assumed. The soft white alloy so obtained must have been a cheap and poor substitute for electrum or silver.]

**Preparation of chrysocolla (solder for gold)**

The solder for gold is prepared thus: Copper of Cyprus 4 parts, asem 2 parts, gold 1 part. The copper is melted first, then the asem and finally the gold.

[It will be recalled that the term "chrysocolla" was applied also to malachite, verdigris and copper acetate, all of these being used for soldering gold.]

**To determine the purity of tin**
Having melted it, place paper (papyrus) underneath it and pour it out.
[If the paper is scorched the tin contains lead.]
**To make asem black as obsidian**
Asem, 2 parts, lead, 4 parts. Place in an earthen vessel, throw on it a triple weight of native sulphur, and having put into the furnace, melt. After withdrawing from the furnace, beat and make what you will. If you wish to make figured objects of beaten or cast metal, polish and cut it. It does not rust.
[This process yields a metallic mass blackened with sulphides of lead and silver, similar to the black silver bronze as described by Pliny.]
To give objects of copper the appearance of gold, so that neither the feel, nor rubbing on the touchstone can detect it, to serve especially for a ring of fine appearance.
Gold and lead are reduced to a fine powder like flour, 2 parts lead to 1 of gold. When mixed, they are mixed with gum and the ring covered with this mixture and heated. The operation is repeated several times till the article has taken the color. It is difficult to detect because rubbing gives the mark (or "scratch") of a genuine article, and the heat consumes the lead but not the gold.
[This is an interesting process of gold plating by using lead instead of mercury, the lead being oxidized and volatilized in the heating.]
**Test for purity of gold**
Remelt and heat it. If pure, it keeps its color after heating, and remains like a coin. If it becomes whiter, it contains silver, if it becomes rough and hard, it contains copper and tin, if it softens and blackens it contains lead.
**To gild silver in a durable way**
Take quicksilver and gold leaf, making to the consistency of wax. Clean the vase with alum, and taking a little of the waxy material spread it on the vase with the polisher and let it stand to fix. Do this five times. Take the vase with a linen cloth so that it be not soiled, and removing it from the coals, prepare ashes, smooth with the polisher and use it as a gold vase. It will stand the test for real gold.
[The recipes for writing with letters of gold vary much according to the material upon which the were to be applied, as also with respect to their relative durability.]
**To write in letters of gold**
Take quicksilver, pour it into a suitable vase and add gold leaf. When the gold appears dissolved in the quicksilver, shake well, add a little gum, one grain for example, and letting it stand, write in letters of gold.
Cheaper imitations of gold writing were also used as illustrated in the following:
Orpiment of gold color, 20 drachmas; powdered glass, 4 staters; or white of egg, 2 staters; white gum, 20 staters; safran.....
After writing, let it dry and polish with a tooth.
[An animal's tooth used by jewelers for polishing up till now. In other recipes, the yellow or gold color is obtained by sulphur mixed with gum; the "bile of the tortoise," or of the calf, "very bitter," serves also for the color. These may be secret trade names for some substances of different character.]

# Part 3:

## Earliest Chemical Manuscripts of the Chemical Arts In Egypt

## Dyeing Processes in Leyden and Stockholm Papyri

The processes of dyeing are treated much more fully in the Swedish papyrus than in the Leyden one, and can better be discussed in connection with that work. Here you will find a comparison of dyeing processes in both papyri***:
**Leyden papyrus**
Preparation of purple: Break in small pieces Phrygian Stone; bring to a boil and having immersed the wool, leave it till becomes cool, then throwing into the vessel one mina of algae, boil and throw in the wool and letting cool, wash it in sea-water to purple coloration. The Phyrygian stone is roasted before breaking.
**Stockholm papyrus**
Purple - Roast and boil Phrygian stone. Let the wool stay in till cold. Then take it out; put into another vessel orseille (sea-wood or algae) and amranth, one mina of each, boil and let the wool cool in it.
***It is a pretty evidence (as Berthelot said) that the two recipes are practically the same, the one helps us to understand the other.

**Phrygian Stone**
-It is considered by Berthelot probably to have been an alunite, or basic sulphate of aluminium and potassium.
-While Pliny describes it as a porous stone resembling pumice which is saturated with wine and then calcined at red heat and quenched in sweet wine-the operation is three times repeated.
-Its only use is in dyeing cloths.
-The algae used are manifestly the source of the dyestuff were probably lichens such as were formerly much used and which yield the dyestuff called archil or orseille.
The notes on dyeing form an important part of the Stockholm papyrus, and furnish more specific information as to methods and materials employed than any other source of information as to the dyeing processes in use in Egypt in ancient times.
The recipes are almost exclusively devoted to the dyeing of wool. The colours range from purple and reds to rose, yellow, green and blue, though the greater number of recipes have to do with purple. That term with the ancients, included deep red and even red brown as well as purples proper.
**Hints for testing the quality of dyestuffs**
-Woad should be heavy and dark blue if good, if light and whitish, it is not good.
-Syrian Kermes—crush those which are best colored and lightest, those which are black or spotted with white are bad. Rub up with soda and dissolve the fine colored.
-Rub up the best colored madder and so make the test.Purple colored and fast orseille is purple snail-colored, but the white spotted and the black is not good.
-When you rub up very fine colored orseille, take and hold it in your hand. (A rough color test on the palm of the hand?)
-Alum must be moist and very white, but that which contains saltness is not fit.
-Of "flowers of copper" that fit for use should be either dark blue, a very green leek-color or in general possess a very fine color (Flowers of copper, the flos aeris of Pliny, seems generally to be used for the copper oxide)
**Methods For Whitening Pearls**
Method 1:
If the pearls have a brownish tint as if smoked, it is directed to make a solution of honey in water, to add fig roots pounded fine, and to boil down the mixture. Spread it on the pearls as and let it harden, then remove it and wipe off with a linen cloth. If the pearls are not yet white, repeat the process.
Method 2:
Mordant or roughen the pearls by letting them stand in the "urine of a young boy" then covering them with "alum" and let what remains of the mordant dry. They are then put into an earthen vessel with "quicksilver" and "fresh bitch's milk". Everything was then heated together, the process being regulated. It was cautioned to apply the fuel externally and to maintain a gentle fire.
Notice: Lippmann suggested that "quicksilver" above mentioned cannot be mercury, but was probably some finely divided substance of pearly or silvery character, calculated to give the pearly luster.
** A curious method given for whitening a pearl is that of causing it to be swallowed by a cock, afterwards killing the cock and recovering the pearl, "when it will be found to be white."
**Method of making Artificial Pearls:**
One recipe of the Swedish papyrus that gives us the earliest account of methods of making artificial pearls is as follows: Mordant or roughen crystal in the urine of a young boy and powdered alum, then dip it in "quicksilver" and woman's milk.
The word "crystal" often meant with the ancients quartz crystal, but it is very evident that with the authors of these notes the term was used in a more comprehensive sense to include other transparent or translucent stones. This use is very evident in the many recipes for imitation of precious stones, where the processes involve a degree of porosity or absorbent power towards colored solutions not possessed either by quartz crystal or by glass, while certain agates, micas, alabasters or other stones possess this property. In case of the above recipe, it is doubtful whether any such mordanting would in a reasonable time roughen the surface of real quartz crystal adequately. The "quicksilver" here mentioned is evidently the same substance of pearly luster previously referred to.
A more elaborate process for making artificial pearls is the following, suggesting the modern "Roman pearls.":
"Take a stone easily pulverized, as glimmer, and pulverize it. Take gum tragacanth and soften it for ten days in cow's milk. When it is softened, dissolve it till it becomes thick like glue. Melt Tyrrhenian wax. Take also the white of an egg and "quicksilver."
There must be two parts of "quicksilver" and three parts of stone, but of all other materials one part each. Mix (the stone and wax), and knead the mixture with the "quicksilver. " Soften the paste in the solution of gum and the contents of the egg.

Mix in this way the whole liquid with the paste. Then make the pearls which you wish according to pattern. The paste will soon be like stone. Make deep round impressions and bore them while moist. Let the pearls solidify and polish them well. Treated as they should be, they will excel the natural. "

**Trade Names of Materials used in the Recipes**

The use of the trade names for the purpose of concealing the character of the substance used where secrecy seemed desirable was not unknown at that period.

There is a passage in Leyden papyrus concerning this and says that: "Interpretation drawn from the sacred names, which the sacred writers employ for the purpose of putting at fault the curiosity of the vulgar. The plants and other things which they make use of for the images of the gods have been designated by them in such a way that for lack of understanding they perform a vain labor in following a false path. But we have drawn the interpretation of much of the description and hidden meanings."

The secret names in this manuscript which are placed with the real names are thirty-seven in number. They are such names as the later alchemists used extensively: "blood of the serpent," "blood of Hephaistos," "blood of Vesta,""seed of the lion," "seed of Hercules," "bone of the phyasimian," etc.

It is very probable that the term "quicksilver" in the preceding recipe takes its name from a similarity in appearance rather than from the deliberate attempt to mystify, for these recipes are for the artisan himself, not for the public, but it is also possible that some special constituents of these recipes were intentionally so named as to avoid advertising unnecessarily the more valuable secrets of their business.

The "blood of the dragon" for the red resin of the pterocarpusdraco is doubtless a surviving remnant of the fanciful names used for mystification. The Swedish papyrus has a few other names of the same character, though in general its vocabulary is plain and direct. Thus the Greek word for garlic is used to designate human feces, sometimes used in mordanting wool. The manuscript itself gives this translation.

The term "blood of the dove" used in the papyrus, Von Lippmann has identified from other sources as meaning red lead or sometimes cinnabar.

# Part4

## Alexandria-Egypt and Early Alchemists

**Introduction**

1-When Alexander the Great conquered Egypt in 33 B.C. and his general Ptolemy became King of Egypt, the Greek city of Alexandria was founded, and soon became not only the most important city of Egypt, but through the foundation of schools and the accumulation of libraries became the acknowledged center of the intellectual world.

2-The collection of manuscripts is estimated at from 400,00 to 500,000 works. Scholars from all parts of the then civilized world thronged there to take advantage of its books and its teachers. The culture which developed was a blending of Greek, Egyptian, Chaldean, Hebrew and Persian influences. Greek philosophy, Egyptian arts, Chaldean and Persian mysticism met and gave rise to strange combinations not always conducive to improvement upon the relative clarity of the Greek foundation.

3-As the power of Rome grew, Greek and Egyptian power declined. Egypt became a Roman province in 80 B. C. A fire, started, it is recorded, from ships burning in the harbor during Caesar's conquest of Alexandria, burned an important part of the collection of manuscripts of the Alexandria libraries.

4-Under the Roman Empire, Alexandria, however, still exerted great influence and in the reign of Augustus was a metropolis second only to Rome itself, but in the succeeding centuries when Rome was suffering from internal disintegration and the Roman Empire was crumbling from successful barbarian invasions; Alexandrian culture also yielded to the general demoralization.

5-In the third century, the conditions throughout the Empire were such as to justify the statement of competent critic—"In the tempest of anarchy during the third century

A.D. the civilization of the ancient world suffered final collapse. The supremacy of mind and of scientific knowledge won by the Greeks in the third centur B.C. yielded to the reign of ignorance and superstition in these social disasters of the third century A.D."

**Alexandrian Alchemical Mystics**

In the light of present knowledge, it was in the period of the first to the third centuries that the mystical cult which cultivated the fantastic ideas of that kind of chemical philosophy which later came to be called alchemy, first developed. The beginning seems to have been the development of a secret cult of Alexandrian mystics bound by oath never to reveal to the uninitiated the mysterious knowledge which they claimed to have. That the members of the cult were originally of the Egyptian priesthood or foreign scholars initiated by them, seems probable, for Egyptian deities or mythological personages are prominent as authorities in their writings. That the cult was of comparatively late development is evidenced by the prominence of Persian, and Hebrew authorities which were also frequently cited in their early writings. All this points to the cosmopolitan influence of the Alexandrian schools the melting pots of Greek, Egyptian, Hebrew, Persian and Chaldean philosophies, sciences, religions and superstitions. The universal sway of the Roman power and the pax Romana had also the effect of spreading the various cultures and national religions, but at the same time of weakening their authority.

In the early centuries of our era, Rome and Athens contained temples of Egyptian Isis, and shrines to Mithra, the Persian sun god, were frequent in Greek and Roman cities, symptoms of a decline in the power of the ancient religions in the centers of civilization under the Empire.

**Fate of Alexandria University**

There was rising the new and at first persecuted sect of Christians destined soon to supplant the old faiths. Reconized and protected early in the fourth century under the Emperor Constantine, the new sect as it gained influnce waged war upon the schools of ancient pagan philosophies.

In 389 A.D. the Serapion of Alexandria was destrosyed, and its library destroyed or scattered under an edict of Theodosius calling for the destruction of all paean temples within the Empire, an order executed with much severity and cruelty. In the same year, Zeno, Emperor of the East, closed the important school at Edessa and its Nestorian teachers were banished, findingg refuse in Asia. The Museum of Alexandria, a real university, still maintained a precarious existence until 415 when in riots incited by the Christians, the last remnants of Alexandrian schools of philosophy and science were swept away and the last notable teacher and philosopher of that school, Hypatia(370 - 415) fell a victim to the violence of the mob.

Hypatia (http://www.astr.ua.edu/4000WS/HYPATIA.html)

**Alexandria In Times Of Muslims**

When the Muslim State ruled Asia Minor, the Syrian scholars were patronized by the Caliphs, were employed in influential positions as physicians, as tronomers, mathematicians, engineers, etc., and the Syrian manuscripts of Greek and Alexandrian authors were translated into Arabian. The early Muslim culture was more hospitable to these ancient sciences and philosophies than the early Christian, and thus Arabians became in medieval times the best trained scholars in mathematics astronomy, medicine and chemistry. As the wave of Muslim culture in the seventh and eighth centuries swept over Egypt and Morocco to Spain, Spain became the seat of a high degree of Muslim culture which endured until the final expulsion of the Moors in 1492 put an end to the Muslim rule in Western Europe. From Spain, however, the classical culture preserved by

Syrian scholars and by them transmitted to Arab scholars, found its way to Europe, and Arabian mathematicians, physicians, alchemists, were held in high esteem as scientific experts. Arabian translations, elaborations and commentaries from ancient Greek and Greek-Egyptian authors received from Syrian versions and finally translated into Latin in the twelfth and thirteenth centuries, became the great authorities in natural science. So completely had the original Greek writings disappeared from sight in the middle ages of Europe that later centuries quite generally assumed that the Arabians were originators of very much that they had acquired and transmitted from original Greek and Alexandrian writers through Syrian and Arabic translations. Particularly was that true in the field of chemical knowledge, though modern research has made it clearer that the additions in that domain to the knowledge possessed by Alexandrian writers of the third and fourth centuries is of very subordinate significance. In the history of chemical science in Europe, Arabian influence is of importance because it was through this channel that interest in the science was again introduced to Latinized Europe.

**The Earliest Alchemical Writers In Alexandria**

At about the beginning of our era, it was in Alexandria, so far as we can ascertain, that that phase of chemical activity and speculation which we call alchemy originated. The earliest alchemical writers whose writings have been in part at least preserved to us were manifestly Alexandrian Greek-Egyptians. They wrote in Greek and their writings contain allusions and traditions connecting with the ancient Greek philosophy of nature, with Plato and Aristotle, but also allusions and ideas related to Persian and Egyptian culture. In so far as these writings contain references to the devices and methods of experimental chemistry, these earl alchemists allude to just such practical operations as we have seen in the Egyptian papyri from Thebes (see Part 2 Lyeden and Stokohlom Manuscripts in this site), although they are rarely so definite and clear as the latter descriptions and directions, and are mingled with a confused mass of obscure allegorical narratives and descriptions. These find their analogies in the fantastic notions of the later Alexandrian neoplatonic philosophers and related mystical cults belonging to the transition period of the fall of the Egyptian and Greek culture and the rise of the Christian philosophy with its mixture of traditions and ideas from many different ancient cults and religions.

Internal and external evidence are to the effect that the phase of chemical activity and interest which so long held the stage not only in Europe but in Arabia and Asia, spreading even to India and China, had its origin in the practices of the metal workers of Egypt (see Part 1 of this section) and in the theories of matter and its possible changes as developed in the neoplatonic school of natural philosophy.

In so far as the neoplatonic philosophy as applied to alchemy possessed a basis in ancient Greek philosophy, it was based mainly upon Plato's conceptions as formulated in his work entitled "Timaeus."

This metaphysical physical science of Plato, imaginative and fantastic in itself, became even less logical and more fantastic by the elaborations and interpretations of the later neoplatonists who "based their philosophy on revelations of Deity and they found those in the religious traditions and rites of all nations."

As the Timaeus of Plato appears to have furnished the more fundamental concepts which dominated the ideas of matter and its changes to the early and later alchemists, it will be of help in understanding some of these ideas if this work is explained in some detail.

In the form of dialogue, though substantially a monologue, Timaeus is represented as explaining to Socrates his formulation of the generation and development of the physical universe.

# A study of the treatment and Conservation of Coptic Icons

## With the Applications on Some Icons from Museums, Churches and Monasteries in Lower Egypt

A new thesis submitted by: Abdel-Rahman Mohamed Abdel Rahman El-Serogy To Faculty of Archaeology, Conservation Department at Cairo University for the Master Degree in Archaeology 1997.

**Summary**

This thesis deals with the treatment and conservation methods of Coptic icons. It consists of the following Studies:

**1-Introduction on Coptic Art**

Coptic art was introduced in Egypt since the introduction of Christianity in Egypt. It is an art that was influenced by several factors and had it is own features. The artistic features that preceded the Coptic icons are discussed. Also the demolition of Coptic icons, the most famous Coptic artists and the main subjects painted on the icons are dealt with.

**2-Different kinds of icons and their preparation**

Icons vary in materials and methods of preparation, especially the wooden or linen supports and the various ground layers such as calcium carbonate "Chalk" or calcium sulphate hydrate 'gypsum" or kaolinite or zinc or other painting grounds. Adhesives and binding media were also numerous and differed in their methods of preparation. They were mainly used to bind the previously mentioned fillers. The main adhesives or binding media were animal glue, fish glue, gelatin, rabbit glue, albumin, casein, etc...

Also, the various painting techniques, e.g: Tempra (egg - white, gum Arabic, animal glue), encaustic painting and oil painting were discussed.

**3-The different colourants used on icons**

The most important colourants that were used for colouring the icons were discussed. Colouring theories and properties of colourants such as refractive index, coverage, particle size, specific gravity and relative density are mentioned. In addition to that, the groups of natural mineral colours and organic dyes are dealt with, e.g.:

**White colourants: gypsum, zinc, titanium.

**Red colourants: red ochre, kermes

**Yellow colourants: yellow ochre, osfor

**Blue colourants: Egyptian blue, indigo. and other colourants such as: violet; brown and black.

**4-Deterioration Factors of Icons:**

The physical deterioration factors that affect the wooden support, the gesso layer and the colour layer are the change of relative humidity in the environment around the icon. The different layers contract and expand according to the changes. As a result the icon may deteriorate.

In addition to that an increase on relative humidity encourages biological attack. Heat, which is another physical factor causes embrittlement and weakening of the wooden support, the gesso layer and the binding media (animal glue), as a result the surface of the icon and the wooden support deteriorate.

Light, another physical factor, causes fading or weakening of colourants. The chemical deterioration factors, which decay the support layers for the colourants, are sulphur oxide, ozone, nitrogen oxides, gases, etc.....

Insects and fungi are the major biological deterioration factors, that attack icons under certain conditions.

Last, but not least, man-made deterioration factors are a major problem. They could be due to destruction on purpose, touching the icon as a blessing or incorrect restoration within the Egyptian church.

**5-Investigation and Analysis of an Icon.**

The importance of using modern scientific methods, for investigating and analyzing the ground layer or colour layer, is considered.

I.R., U.V. and X.ray radiography are sources used to reveal the condensed layers which are not evident to the naked eye, cracks or previous restoration.

I.R. and U.V. spectroscopy are used to identify the binding media in the ground layer or colour layer.

Scanning electron microscopy is used to study the deterioration forms of all the layers of an icon.

**6- Methods of Treatment and Conservation of Icons.**

There are various methods and materials that can be used for cleaning wax, soot or fly secretions from an icon's surface. Also, old and new varnish layers may be cleaned or removed when blooming occurs. In cases where cracks, pitting or separation of the icons layers are evident treatments may be applied. In some cases, where the wooden support is badly deteriorated, the linen support with all the drawings may be removed. After that the wood may be completely treated and consolidated.

Another point of treating Coptic icons is the retouching or repainting of colours and the use of new varnishes after

cleaning an icon, in order to retain its ol glamour.
The last step of treating an icon in a museum or church is to exhibit it under suitable conditions.
**7-Practical Part**
The various methods for preparing an icon according to the old techniques were applied by the researcher. These new icons were artificially aged and treated. Therefore, it was possible to choose the most suitable treatment for ancient icons, before application.
Several painting grounds were prepared, according to different references. These grounds were then coloured by using organic or mineral colours. They were all placed in a drying oven at high temperature and high humidity, as a means of artificial ageing.

# Alchemy in Islamic Times

## History of Botany Part 1: The Date Palm in Ancient History

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## Introduction:

Date palm has given the latin name Phoenix dactylifera L.
**The part L.**: denoting Linnaeus (1707-1778), the Swedish botanist who brought this binomial name.
**Phoenix:** There are three explanations as to the etymology of Phoenix:
1. In Ancient Greece: It was the name of a legendary bird which haunted people's minds throughout antiquity and still exists in the religious and artistic traditions of the Far East. The Greeks described Phoenix bird as a wonderful bird which lived through periods of many hundred years. It was said that before dying, this bird built its own funerary pile, setting fire to it by fanning it with its own wings and eventually arose again from its own ashes.
2. In Ancient Egypt: The date palm was known from the first Pharaonic dynasties. The Egyptian legendary bird was the greedy heron which was so widespread in the Nile valley and they called it 'Bennu' bird Fig (1). This bird was found on the mural paintings which decorate the tombs of the kings and the nobles, this bird was assimilated to the great 'Sun-God' 'Ra' and the sun itself. The terms 'Bennu', 'bnr', 'bnr.t' were also applied to the date palm fruit and to every thing sweet. The date palm was linked in ancient Egypt to the sun-bird and they giving both the same name indicating the importance of this tree to their life (Bircher,1990).
3. In Theophrastus' days: (The famous botanist; 370-285 BC): There was Phoenicia which was the narrow coastal strip between the Mediterranean sea and the Jordan valley which is now 'Israel' and a part of 'Lebanon'. This region was inhibited with a population with famous purple colour from the Murex shellfish, this colour called 'Phoenix' in their language. Theophrastus may derived the word 'Phoenix' and gave it to date palm fruits which appear purple on ripening (Bircher,1990).
**Dactylifera:** This latin term was derived from the Greek word 'Dactylos' which means finger. According Linnaeus this was meant tall and slender form. This word was used by ancient 'Hebrew' and Syrian names for date palm itself.

## DATE IN ANCIENT EGYPT

Date palm has special religious, feeding and industrial values in Ancient Egypt. It was probably cultivated in the Nile Valley several thousand years before the first Hieroglyphs marks appeared. Date palm was given various names in Ancient Egypt, These names were cited in Hieroglyphic symbols (Darby, et al 1977 and Bircher, 1990) among of them: 'Buno', 'Phuno', 'Bni', 'Bnr' , 'Benrt', 'Amt' , 'Bnrit' and 'Bniw' for date juice. .
1. **Old stone-age period:** The earliest date palm finds recovered from Egypt was a date palm trunk found in Kharga Oasis (western desert). The sample was dated back to the old stony period.
2. **Predynastic period:** In Ruzikate (Sharkia province ) the excavations revealed a mummy robed with date palm leaves, in a site dating back to Predynastic period (c.3500 BC; Bircher, 1990). Fleshy part of date palm fruits was detected among the plants, identified from a beer cocktail excavated from a vat in Hierakonpolis site (upper Egypt).

The site dated back to Predynastic period (3450 BC.). This was the earliest sample used as reference for usage of date palm for beer sweetening (Amer, 1994). However Darby, et al (1977) mentioned that date palm was used in Ancient Egypt for Beer sweetening.

3. **Dynastic period:** "In a clean place shall I sit on the ground. Beneath the foliage of a date palm of the goddess Hathor..." The Egyptian Book of Dead.

Date palm seeds were excavated among the botanical remains recovered from Abu Sir (Giza) tombs. These were used as mortuary offerings; the site dating back to the king's 'Down' family belonging to the first dynasty (c. 2950 BC; Annual report, 1992). The columns' crowns of king 'Sahure' in Saqqara were decorated with palm leaves Fig (2). A small date palm tree was found in Saqqara tomb dating back to the first and early second dynasty (c.2850 BC. ). Date was mentioned under the name 'Bnrit' among the decoration of 'Nfer-Mehat' tomb in Midoum dating back to fourth dynasty (c.2600 BC.). Rocky stones decorated with palm tree were found in 'Ra Or' tomb in Giza and 'Betah Hotop' tomb in Saqqara from the fifth dynasty (c.2400 BC; Nazir, 1970). Date palm trees were cultivated around a rectangular swimming pool in 'Rakh Me Ra' garden; this decoration was depicted on his tomb walls (Nazir, 1970). In Tel-El Amarana eighteenth dynasty (c.1580 BC.); the garden in the magnificent temple of priest 'Meri Ra', was decorated with various types of trees; the most notable ones were: date palm, dome palm, in addition to fig and pomegranate (Nazir, 1970). Date palm trees were cultivated in the nobles and kings gardens. Anna's (Ineini), who was the keeper of cereal storage bins in 'Amon Hotob' the first era (New kingdom). The walls of his tomb were decorated with a paints representing his house garden. The names and the numbers of the cultivated trees were written too. There were twenty plant species among of them: seventy three fig trees; thirty one persa trees; one hundred and seventy date palm trees; one hundred and twenty dome-palm trees all these were cultivated around a large rectangular swimming pool( Nazir,1970). Some representative drawings are outlined in Figs(3, 4,5&6).

4. **Graeco-Roman period:** Date palm seeds were excavated from Douch Necropolis (Kharga Oasis-western desert); the site was dating back to Graeco-Roman period, 350 AD (Wagner,1982 and Barakat 1986).

5. **Roman period:** Large number of date palm seeds were excavated from Abu-Sha'ar site (Red sea coast); the site dating back to Roman period (c.500 AD.). The excavated seeds were morphologically sorted into five categories it was believed that these seeds were belonging to different desertic date palm cultivars.

# ANCIENT RELIGIOUS TRADITIONS

Ancient Egyptians used date palm leaves as an emblem of longevity; the excavations revealed a kneeling man holding in his hands a bunch of palm leaves for longevity. Date palm was an emblem of the greatest God 'Ammon Ra'. Hathor' the goddess of life, joy, music, dancing and fertility had the date palm as one of her emblems. At Denderah (upper Egypt), a beautiful palm grove surrounded her famous sanctuary (Bitrcher,1990). 'Thot' the god of science and time (they believed that he who separates time into months and years had also the date palm as one of his attributes.) Whenever a pharaoh king celebrated the thirtieth jubilee of his reign, the so called 'Heb Sed' ceremony; he helds in his hands a bunch of palm mid-ribs (Fig 7). It was believed that into these very mid-ribs the god that had carved the notches corresponding the number of years that were still allowed to the reign and life of the king (Nazir,1970 and Bircher,1990).

Date fruits were among the wages paid to the workmen at Dier El-Medina temple (Darby, et al, 1977). In the dynastic period palm leaves were carried to the tombs as mortuary offerings Fig (8). The mortuary bouques made of date palm leaves were still used till the Graeco-Roman period (Barakat, 1982).

**Date palm preservation:**

Date palm fruits were preserved in Ancient Egypt by two methods:

1- The simplest method: It was by drying the fruits in a direct sun light for two or three days and left at shaded place till become completely dried to be in 'Tamr' form. A representative sample of this method was deposited in Agricultural Museum, Cairo; the sample dating back to eighteenth dynasty and excavated from 'Tibba' (Upper Egypt).

2- The second method: It was applied to date palm fruits with higher moisture content than the previous method. This method was performed by pressing a large number of date fruits in basket made of date palm leaves for several days. The resulted date was called 'Agua'. A representative sample was deposited in Agricultural Museum, Cairo (No. 39897); the sample dating back to the New Kingdom. Both methods are still used in Arab countries for date preservation.

**Ancient date industries**

Ancient Egyptians used palm trunks for roofing and leaves for basket making (Fig 9; Nazir,1970; Darby, et al, 1977). Leaves were used for manufacture of sandals (Fig 10) especially for the priests and the temple's workers to whom animal substances were not allowed (Nazir,1970). There were three hundred and sixty date palm products mentioned by Wilkinson (1854). Among of these products a special type of wine known as 'Araqe', which is still manufactured in rural areas of Egypt (Nazir,1970). Date palm wine was mentioned on two ostraca of the nineteenth dynasty in the Cairo Museum. Pliny was cited that date palm wine was made throughout all the countries of the East; which probably was meant to include Egypt (Lucas and Harris,1962).

## MEDICINAL USES OF DATE PALM IN ANCIENT EGYPT

Date palm fruit or their juice were used in Ancient Egypt in many medicinal remedies. Some of them here mentioned based on Darby, et al (1977) and Manniche (1989):
1. A remedy for swelling of any limb of a man: Fresh dates, date kernels, dry myrrh, wax were combined to a paste and bandage for four days.
2. A remedy made for swollen and aching legs: Red natron was mixed with fermented date juice and the legs were bandaged therewith.
3. A remedy to suell cough in a child: Dried crushed date are ground in a 'hin' of milk and drunk by the child.
4. A remedy to kill worms: Date kernels, carob pod pulp, sweet beer were mixed, boiled, strained and drunk; the remedy had instant effect.
5. A remedy to cure heat of the heart: Fresh dates, honey, sweet beer were mixed and administer to the anus for four days.
6. A remedy for sneezing: Date juice fill the opening of the nose with it.
7. A remedy to accelerate hair growth: Bone of a dog, date kernels, donkey's hoof, boiled well in a jar with oil or fat and used as an unguent. Date beer was mentioned with many writers (Lucas and Harris,1962; Darby, et al ,1977; and Nazir,1970) that it was used in mummification.

## DATE IN JEWISH RELIGION , TRADITIONS AND LEGENDS

The Ancient explanations of Tawrah (The Law ) were believed that the fermented juice (Le Skiar) which not permitted to Jewish monks was made of date palm honey 'Dabas'. Jewish children were offering this drink to the ever persistent God from the earliest production of date trees. Date palm tree was depicted among the Hebrew's drawings (Qudama,1985). Jews were given the name 'Tamara' (the word derived from the word Tamr); to their girls. They dreamed that their girls became smart, tall, pretty and fertile like date palm tree (Qudama,1985).

## DATE PALM IN CHRISTIANITY, TRADITIONS AND LEGENDS

1. RELIGION: Date palm was known in Coptic Egypt as 'Bnne'. Christians of Jerusalem were carried fronds of date palm as they went out to meet their Prophet when he had announced "On the next day people that were come to the feast when they heard that Jesus was coming to Jerusalem took branches of palm trees and went forth to meet him..." Gospel of St. John. "....A great multitude which no one could number of all nations and kindred's and people and tongues stood before the throne and before the lamb, clothed with white robes and palms in their hands, and cried with a loud voice:" Salvation to our God who sitteth on the throne, and unto the lamb." Revelation of St. John.
2. TRADITIONS: Christians have never ceased to adorn their churches with palm leaves for the celebration of the last Sunday before Easter. Beneath the domes of Ancient Coptic churches or the double towers of more recent ones, palm Sunday still commemorated with rituals dating back to the first centuries of Christian faith. Palm fronds are everywhere: In the sanctuary above the screen separating the officiating priest from the faithful as well as in the hands of the worshippers. Palm leaves were also carried by every attendant of the solemn morning procession, along with fragments of fronds the leaflets of which had be painted into various decorative shapes (Bircher,1990). Palm groves surround the fortress-like desert monasteries; some of them were the sites of the very first convents ever built and where the embittered monks had faced constant danger of pillage, depredation and death. Dates were mentioned sparsely as Coptic remedies, once in a poultice with other ingredients for stomach ache (Darby, et al 1977).
3. LEGENDS: There are some charming legends concerning the Divine Child and the date palm based on Bircher(1990): One of them is connected with the flight of the Holy Family to Egypt. They having left their country in great haste and utter anguish. Saint Joseph and the virgin Mary had taken no food with them on their way. As they entered the palm groves of Egypt. One of these fine date bearing trees gently bent its head towards them; inclining it so deeply that could feast on the delicious fruits while the cherubs who were seated on the fronds welcomed them by singing and wishing them peace.
Another legend is connected with Saint Christophorus, the patron-Saint of travelers and car-drivers: As the Holy Family was preparing to cross a river, a man called Christophorus took the infant Jesus on his board shoulders and carried him safely across the water. But the tiny child proved to be so heavy that he would have broken down under its weight... for with him he was carrying the burden of the entire world... had he not been able to lean on his staff which was made from the midrib of palm frond ... As they reached the shore the Divine infant told Christophorus to

thrust his staff into the soil. The man obeyed and the sticks sprouted into a wonderful date palm. From that time Christophorus become a convert and lived a saintly life ever after.

# THE DATE PALM IN ISLAMIC RELIGION, TRADITIONS AND LEGENDS

**I. Date palm in Qora'n:**

Palm tree was mentioned in Qora'n (the book of books) twenty times. On fifteen occasions it is mentioned among other plants in a God's bounty towards the human race. Qora'n statements will mentioned according to Ali (1934) and verified with ( English copy by International group for computer systems,1995 ).

----"It is He who sendeth down rain from the skiers: with it We produce vegetation of all kinds: from some We produce green (crops), out of which We produce grain, heaped up (at harvest); Out of the date palm and its sheaths (or spathes) (come) clusters of dates hanging low and near". (An' âm 99)

---"It is He who produceth gardens with trellises and without, and dates, and tilth with produce of all kinds and olives and pomegranates, similar (in kind) and different (in variety). ((An'âm 141)

---"Set forth to them the parable of two men: For one of them We provided two gardens of grape vines and surrounded them with date palms; in between the two We placed corn-fields." (Kahf 32)

---(Pharaoh) said:"Believe ye in him before I give you permission ? Surely this must be your leader who has taught you magic ! be sure I will cut off your hands and feet on opposite sides, and I will have you crucified on trunks of palm trees: So shall ye know for certain, which of us can give the more severe and the more lasting punishment" (Tâ -Hâ 71)

---"And corn-fields and date palms with spathes near breaking (=with the weight of fruit ( Shu'arâa 148)

---"And tall (and stately) palm trees, with shoots of fruits stalks, piled one over another". (Qâf 10 ) ---"Plucking out men as if they were shoots of palm trees torn up (from the ground)". (Qamar 20)

---"Therein is fruit and date palms, producing spathes (enclosing dates)". (Rahmân 11)

---"In them will be fruits, and dates and pomegranates" (Rahmân 68)

---"So that thou couldst see the (whole) people lying prostrate in its (path): As if they had been roots of hollow palm trees tumbled down!" (Hâqqa 7) ---"And produce therein corn And grape and nutritious plants And olives and dates" (Abasa 27-29)

---"And the pains of childbirth drove her to the trunk of a palm tree: She cried (in her anguich): Ah ! would that I had died before this ! would that I had been a thing forgotten and out of sight ! (Maryam 23)

---"And shake towards thyself the trunk of the palm tree it will let fall fresh ripe dates upon thee". (Maryam 25)

---"Does any of you wish that he should have a garden with date palms and vines and streams flowing underneath, and all kinds of fruits". (Baqara 266)

---"And the earth are tracts (Diverse though) neighboring and gardens of vines and fields sown with corn, and palm trees growing out of single roots or otherwise: Watered with the same water ". (Ra'd 4)

---"With it He produces for you corn, olives, date palm, grapes and every kind of fruit". (Nahl 11)

---"And from the fruit of the date palm and the vine, ye get out whole some drink, and food: be hold in this also in a sign for those who are wise". (Nahl 67)

---"Or (until) thou have a garden of date trees and vines, and cause rivers to gush forth in their midst carrying abundant water" (Bani-Isrâ'il 91)

---"With it We grow for you gardens of date palms and vines: In them have ye abundant fruits: And of them ye eat (and have enjoyment) (Mu-minun 19 )

---"And We produce therein orchards with date palms and vines and We cause springs to gush forth therein". (Yâ-Sin 34)

---"A good word like a goodly tree, whose root is firmly fixed, and its branches (reach) to the heavens" (Ibrahim 24) Annas said that the Prophet Mohammed said about this goodly tree that: This tree is the date palm tree (El Nadawi,1994).

**II. Date palm in the Prophet Mohammed's speeches and life:**

---Abd Alla Ebn Omar Said that "Prophet Mohammed said that: Among the trees there is one with non-fallen leaves, it's similar to the muslim; think about it" .The Muslims said that:That is date palm tree.

---Salama Bent Kais said that "Prophet Mohammed said that: Feed women with Tamr after their delevary (on puperium stage); whose feeds on Tamr her child grow up most merciful; it was the food of virgin Mary in Juses birth. If the God knows other best one 'He' had to feed her on it"

---Soliman Ebn Amer El Dabbi said that "Prophet Mohammed said that:: If one eats one eats after fast, it is preferably to eat Tamr if not available, her drinks some water it is cleared and pure".

---Annas said that " Prophet Mohammed had eaten Rutab after fast and before his prayers, if no Rutab he eats Tamr if no Tamr, he drinks some water ".
---Eisha (Prophet Mohammed's wife) said that: "A house free from Tamr their owner hungry".
---Eisha said that " Prophet Mohammed said that: Excellent Agua has a curative effect".
---Eisha said that "Prophet Mohammed had named Tamr and Milk, the two best(best among all food)".
---Emam Musleim was mentioned that:" Abd Alla Ebn Ghfar had seen the Prophet Mohammed eats cucumber with Rutab".
---Ebn Ody said that: Ali was mentioned that:"Prophet Mohammed Said that: The best of your Tamr is 'Berni' it is curative". Or Abi Hourira Said that " Prophet Mohammed said that: 'Berni' is curative and free from infection".
---Saad said that "Prophet Mohammed said that: Whose eat seven fresh Tamr fruits at breakfast, he gets over magic and poison on that day" .

**III. Date palm and the Prophet Mohammed legends:**

Based on Gaber Ebn Abd Alla who said that: "the Prophet Mohammed was standing next to a date palm trunk during his prayers. One day a woman offers a seat to the Prophet to sit on it; when Mohammed is sitting on this seat the date palm trunk was crying sadly for missing the Prophet's support" (Sawan,1993). Another interesting legend was mentioned by Abn Abas who mentioned that "An Arabian man came to the Prophet Mohammed and said to him, 'how can I know that you are the Prophet of God?' Prophet Mohammed answered that: 'I can call the date fruits from that tree to come down', and so he did; after that he ordered the date fruits to return up again and be reconnected to the tree; the fruits did. Then the Arabian man believed that the Prophet Mohammed is the Prophet of God" (El-Nadawi,1994).

**IV-Ancient Islamic traditions and habits:**

1. A great multitude of Ansar (Madina inhabitants, who believed with Mohammed) were celebrating the Prophet Mohammed coming and met him in Madina border terraces with palm leaves; they cried with load voice " A'la Akber" (Allahu Akbar).
2. Qura'n was written in Ancient times on palm leaf bases: After the death of Prophet Mohammed; Omar and Abu Baker (the Prophet friends and his followers) were ordered Zeid Ebn Thabet to collect Qura'n words: Zeid said that: I started to collect it from the date palm leaves and whose know it ".
3. Madina mosque: The Mosque in it the Prophet Mohammed was buried, it was the first Islamic Mosque built in Madina after Prophet Mohammed and his followers migrated to it. The earlier achitectures of this Mosque were made of mudbricks and palm fronds, the columns were made of palm trunks, the area in which Prophet Mohammed was buried is still surrounded with decorated palm sticks. The houses of Prophet Mohammed's wives were made of palm leaves and palm trunks in addition to mudbricks (El-Nadawi, 1994).

Many authors were treated of the uses of date palm in folk medicine; some of these preparations were cited in old medicinal dictionaries, some others still handled in rural areas everywhere in Arab region. Among these authors were Qabani (1973); Darby, et al (1977); El Gameli (1983); Qudama (1985); Manniche(1989); Aref(1991); Famuyiwa, et al (1992); Abd El Hamed (1994) and Abd El Salam and Askar (1994). Based on these references some common folk preparations of dates are cited here.

The decoction of the fruit was used to treat bronchitis, cough and colitis as well as its uses as expectorant. In addition to its uses as an emollient, in gout and blood pressure cases.

1. Tamr is remedy for potassium deficiency diseases; Tamr is a general restorative if eaten as a daily food. Tamr treats the cardiac disorder especially after diarrhea and vomiting or after diuretic medications.
2. Tamr as lactagogue: Tamr containing Potassium; Glycine and Threonine; which activate the milk hormone (prolactin). Tamr acts as lactagogue if it is used in daily feeding of a woman in her lactation period.
3. Tamr as aphrodisiac:

i. Remedy of tamr mixed with milk and cinnamon is aphrodisiac and activates the formation of sexual desire.
ii. A breakfast meal composed of black bread and cooked yolk (seven eggs) with 100 gram Agua (or tamr ý) and 15 gram margarine is aphrodisiac food. This breakfast must followed with a cup of milk or carrot juice thus activates the sexual behavior.

4. Date and tumors: Feeding on tamr increase the body immunity and resistance to cancer diseases. Estron hormone is extracted from date kernels (seeds) and treated chemically to obtain 'stradiol' which can be used for cancer treatment.
5. Date and abscesses: A remedy of warm Agua paste (or tamr paste) and margarine is applied externally on the abscesses. The remedy is analgesic and a local antipyretic.
6. Date and skin allergy: Remedy of tamr paste in water is antihistaminic, the remedy is externally applied to the skin. Food containing tamr is sedative to allergy. Zinc is the active ingredient inducing allergic inhibition.
7. Date and poisonous bites: Prophet Mohammed said that: The direct external use of tamr past on the poisonous

bites gets rid of its poisonous effect.
8. Date and muslim's fasting: Muslims in the fasting month (Ramadan) start their meals with tamr soaked in water for a period ranging from 3-12 hours. Soaked tamr containing a soluble sugars which are absorbed in 5 minutes from the soft tissues of the digestive tract. Tamr sugars recompansate the loss in the level of blood sugar during the fasting period (Famuyiwa,et al .1992).
9. Date and delivery: The consumption of tamr as ingredient of the daily meals of a woman after and before her delivery is acting as tonic for uterine muscles. In addition to its help activating the delivery process as well as prevent the post delivery bleeding due to the presence of constricting substance in tamr; the quiet typical example for this case Virgin Mary delivery and her feeding on tamr.
10. Date and pediatric anxiety: A child consumes seven dates (tamr) daily; is a remedy for anxiety and nervous disorders.
11. Date and ascaris: Daily dosage of seven dates Agua before sleeping kills ascaris worms due to its dysentery effect.
12. Date stones and eyes: The burned date seeds (stones) were powdered and added to 'kohl' (50%/50%; wt/wt). The remedy improve the ophthalmia and activate the growth of eye lashes.
13. Date and chest infection: A remedy used for throat and chest infections is: 50 gram tamr, 50 gram fig, 50 gram hibiscus and 50 gram dried grapes ( fruits). The mixture boiled in one liter water. The remedy is one dosage three times daily; it is recommended as an expectorant.
14. Date and renal calculei:
i. A cup of hot tamr decoction (seven tamr) two times daily for a period of 15 days; the remedy is lithonotryptic and diuretic.
ii. A drink made from powdered date stones with dosage three times daily, is lithonotryptic for hepatic and renal calculei.
15. Date and dehydration: Tamr decoction free from fibrous material is added to some table salt to recompensate for water and mineral loss. This remedy used to treat the dehydration resulting after vomiting and diarrhoea.
16. Date and hemorrhoids: The continuous feeding on tamr relief the hemorrhoids pains and increase the body resistance to this disease. The calcium, phosphorus and iron of dates are active ingredients in treatment of hemorrhoids.
17. Date and obesity: A daily meal containing tamr and almond or peanuts activate the person obesity.
18. Date and dermatitis: A medicinal soap made of powdered date stones, fats, alkali and antimicrobial substance is used for treatment of skin allergy and acrodermatitis.
19. Date and gout: A researches on tamr stones (seeds) were carried out in Egyptian Institute of Medicinal researches. The researches revealed that a coffee made from powdered tamr stones drunk twice daily relieves the gout pains.
20. Date and bronchial asthma: Decoction of tamr and fenugreek if drunk twice daily is recommended in the treatment of bronchial asthma.
21. Date and hyperacidity: Tamr or Agua when added to the food gets rid of stomach hyperacidity as well as blood acidity.
22. Date and general health: Mixture of 50 gram nuts (pinus + hazel nut + almond + walnut) and 50 gram of tamr were added to 15 gram margarine. The mixture is a dosage of one spoon (10 gram) before breakfast followed with a cup of hot Chamomil decoction. The mixture has general benefits for health and activity especially cardiac muscles and nervous system in addition to its increase of body immunity.
23. Date and renal disorder: Tamr is a renal restorative; its daily consumption prevent the formation of renal calculei due to its diuretic and anti-inflammatory actions.
24. Date and night blindness: the daily consumption of tamr in meals and its decoction as eye-lotion help in maintenance of eye hygiene and remedy curative to the night blindness and ophthalmia.
25. Date is a hygienic fruits: Date (tamr, Agua and Rutab) cannot transfer the infectious germs. Tamr were mixed with germs of Cholera (100-1000 times as noticed in the waste of infected persons) after three days the tamr under investigation were completely free from Cholera germs.
26. Palm and stomach bleeding: A remedy composed of the terminal bud of palm tree (Gomar) and honey for daily breakfast gets rid of stomach bleeding. The breakfast must be followed with a cup of Chamomile decoction.
27. Palm and depression: A decoction of palm leaf sheaths (fibrous sheath) sweetened with fructose sugar and drunk twice daily is efficient as an anti-depression drug.

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## History of Botany Part 2: Ancient Egyptian Agriculture and Crop Processing

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## Introduction:

First Farming settlements in Egypt.
Crop processing in Ancient Egypt.
1 -Ploughing.
2-Sowing.
3-Harvesting.
4-Parching.
5-Threshing.

6-Winnowing.
7-Sieving.
8-Storage
References

## First Farming settlements in Egypt.

The earliest agricultural sites in Egypt date back to the fifth millennium B.C. and slightly earlier (Wetterstrom,1993).

**I-In lower Egypt:**

(1) A series of Neolithic sites in the Fayum which span the period 5200 B.C. to about 4000 B.C
(2) Merimde Beni Salama on the Delta which was occupied from about 4800 B.C. to 4400 B.C. or probably later.
(3) The site of El-Omari near Helwan which is insecurely plased by a single radiocarbon data at 4100 + 260 Cal B.C. (Hassan 1985).

**Il-In upper Egypt:**

Badarian region (Hemamieh site) 6050 + 300 BP now regarded as the earliest manifestation of farming communities in Egypt.
The above mentioned sites were cleared that the earliest agriculture in Egypt was started at Nile Valley which owes its existence to the alluvial deposits (El-Hadidi and Kosinova' 1971). Ancient inhabitant's in the Nile valley was considered the year as three seasons based on crop processing:
1-Flooding season "Akhet" started from mid June to mid October.
2-Sowing season "Brt" meaning the reappearance of land again after flooding season or the seed appearance. It started from mid October to the end of February.
3-Harvesting season "Shmo" meaning the summer season started from February to July.

## Crop processing in Ancient Egypt

Prior the cultivation in Dynastic period the land to be cultivated was divided into plots with banks extended parallel to the Nile as well as other banks at right angle with the first (photos after Nazir 1970).

**1 -Ploughing:**

The cultivated land was subjected to an efficient mouldboard plough by wooden axe"Ti" tomb Saqqara; Fifith Dynasty; Old Kingdom.

**2-Sowing:**

Cereal grains were hand-sown; goats walked over the sowed area to press the grains down into the soil away from the birds. "Ti" tomb Saqqara; Fifith Dynasty; Old Kingdom.

**3-Harvesting:**

Cereal crops were harvested by sicklereaplng using glazed wooden sickles. "Meri Roka" tomb Six Dynasty, Saqqara; Old Kingdom.

**4-Parching:**

The reaped cereals were collected in bundles and carried on donkeys to an open dry-area to avoid grain and straw spoilage. 'Tibba" tomb 18 th Dynasty; flew kingdom. "Shik Sahid" tombs area: Old Kingdom.

**5-Threshing:**

In the dry Egyptian summer the parched cereal crop was spread and trampled by donkeys hooves. Donkeys were used in the Old Kingdom. While cows were used in the Middle Kingdom. The process involve the fragmentation of spikelets and straw producing crop grains, light chaff. Threshing by donkeys in Old Kingdom.

**6-Winnowing:**

The process occurred by using simple wooden forks. It was convenient to eliminate the light chaff and straw from the crop grains. The process was done by women as depicted on "Neket" tomb 18 th Dynasty; New kingdom.

**7-Sieving:**

The process was done by coarse riddle sieves made from palm leaves or reeds. Sieving separate the crop grains from longer chaff and larger weed seeds or grains.

**8-Storage:**

The pure crop was stored in muddy bins until its consumption. "Helwan" area First Dynasty, Old Kingdom.

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# Medicine In Old Egypt

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# Medicine In Old Egypt

[Transcribed from the *History of Science* by George Sarton
Edited and prepared by Prof. Hamed A. Ead at Heidelberg, Germany 10th, September 1998]

## Introduction

It is not necessary to emphasize the antiquity of Egyptian medicine; in every culture medicine develops very early, for the need of it is too universal and too pressing ever to be overlooked. We may be sure that some kind of medicine was already practiced in Egypt in the earliest prehistoric days, many millennia before Christ. To quote an example, the use of malachite as an eye paint and an eye salve goes back to the Badarian age; the use of galena for similar purposes was introduced later, though still in predynastic times. Circumcision is a rite of immemorial age; bodies exhumed from prehistoric graves (as early as, say, 4000 B.c.) show traces of it. A very clear representation of the operation was sculptured on the wall of a tomb of the Sixth Dynasty (c. 2625-2475).

## Imhotep

The earliest physician whose name has been recorded, Imhotep," was the wazir of Zoser, founder of the Third Dynasty, in the thirtieth century. Imhotep was a learned man, astronomer, physician, architect (he may have been the builder of the first pyramid, the step pyramid of Saqqara). In later times he was worshiped as a hero, as a blameless physician, and later still as the god of medicine, the prototype of Asclepios (even as the learned God Thoth was the prototype of Hermes and Mercury). We know precious little about Imhotep's medical knowledge but his apotheosis is significant and we may well take him at the Egyptian valuation as the first great man in medicine. The people who speak of Hippocrates as the father of medicine should bear in mind that Hippocrates comes about half way between Imhotep and us. That would improve their perspective of ancient science.

## Egyptian Physicians

Not only were there many physicians in the Pyramid Age, but there were very specialized ones. The skill of an early dentist is beautifully illustrated by a mandible found in a tomb of the Fourth Dynasty (2900-2750), in which an alveolar process was pierced to drain an abscess under the first molar. From the tombstone of Iry, chief physician to a pharaoh of the Sixth Dynasty (2625-2475), we learn that he was also "palace eye physician" and "palace stomach bowel physician" and bore the titles "one understanding the internal fluids" and "guardian of the anus." '

## Egyptian Papyri

The medical papyri that have come to us, seven or more, are relatively late. They date from the Twelfth Dynasty to the Twentieth (2000 to 1090), but most of them reflect professedly earlier knowledge, going back to the Old Kingdom, as far back as the Fourth Dynasty. The two earliest papyri, the Kahun and the Gardiner fragments (c. 2000), deal with diseases of women, children, and cattle. The two Most important ones, the so-called *Smith* and *Ebers* papyri, date from the seventeenth and sixteenth centuries B.C.. The Smith one is of the same age as the *Rhind* mathematical papyrus. Roughly speaking, we may say that the outstanding, mathematical and medical treatises that have come to us are of the same period, the the Middle Kingdom and the beginning of the NewKingdom just prior the imperial age, when Egypt dominated the world.

## Smith and Ebers Papyri

Let us consider more carefully the two outstanding, the *Smith* and the *Ebers*, both of which are much larger than any others. On the basis of the figure given by Sarton, the seven medical papyri listed by him include 3746 lines, the *Smith* has 469 lines and the *Ebers* 2289, so that together they have 2758 lines, which is almost 74 percent of the total. As all the manuscripts are ultimately derived from similar Old Kingdom sources, we may safely assume that the study of the Ebers and the *Smith* papyri will give us a fair knowledge of ancient Egyptian medicine.

We shall begin with the younger one, the *Ebers* papyrus, because it is by far the largest (almost five times as large as the Smith) and was the best known until very recent times. The difference in age is small anyhow, about a century, and negligible if one bears in mind that both texts represent older traditions. We are sure that the *Ebers* papyrus was written somewhat later than the Smith one, but it would be unwise to conclude that the contents of the former are of later date than the contents of the latter.

## Ebers Papyrus

The *Ebers* papyrus is a roll 20.23 m long and 30 cm high; the text is distributed in 108 columns of 20 to 22 lines each. It contains 877 recipes concerning a great variety of diseases or symptoms. Spells are recommended only in twelve cases and in other cases the therapeutics does not seem irrational, though we are seldom able to understand either the trouble or the remedy. The contents are arranged in the following order:

1. Recitals before medical treatment, to increase the virtue of the remedy.
2. Internal medical diseases. Diseases of the eye.
3. Diseases of the skin (with an appendix of sundries).
4. Diseases of the extremities. Miscellinea (especially diseases of the head, for example, of the tongue, teeth, nose, and ears, and cosmetics).
5. Diseases of women (and matters concerning housekeeping).
6. Information of an anatomic, physiologic, and pathologic nature, and explanation of words.
7. Surgical diseases.

That order is open to many objections, but the author's intention is clear enough. He wanted to put together as well as possible all the information that a physician might need; he wrote a medical treatise, one of the earliest ever written (thirty-six centuries ago!).

## Smith Papyru

The *Smith* papyrus is much shorter. It is 33 cm high and was probably 5 m long, but the beginning has been lost and it now measures 4.70 m. lt is a copy of a much older text, dating back to the Pyramid Age, perhaps even early in that age, let us say the thirtieth century. After it had circulated for some generations it was found that its terms were antiquated.

Toward the end of the Old Kingdom, say in the twenty-sixth century, a learned physician had the idea of rejuvenating it by the addition of glosses (69 in all), explaining obsolete terms and discussing dubious matters. (N.B. the Papyrus Ebers has also some glosses, 26 in all, but they have been badly messed up). These glosses constitute the most valuable part of the papyrus.

The text as we have it now comprises two very distinct parts - 17 columns (377 lines) on the front and 4.5 columns (92 lines) on the back. The latter part contains only recipes and incantations and need not detain us. The main part is a surgical treatise, informed by a scientific spirit far superior to that of the Ebers papyrus.

To be sure, the field of surgery is much less likely than that of internal medicine to be contaminated by irrational ideas, for in most surgical cases dealt with by ancient physicians the cause of the injury was too obvious to require the insertion of magical antecedents. On the contrary, an internal disease is always mysterious and likely to breed superstitious ideas in the patient's mind, even in the physician's mind. The *Smith* papyrus consists not of recipes but of definite cases. It was planned to deal with the ailments in the order of the bodily parts from head to foot, but unfortunately it stops a little below the shoulders, whether because the scribe was interrupted or because the end of the manuscript got 1ost. That order - *eis podas ec cephales, a capite ad calces* -remained the one throughout the Middle Ages, but it was so natural, as a first approximation, that we should not assume it was determined by the Egyptian example.

The forty-eight cases dealt with in the papyrus, as it has come to us, are classified as follows:

The discussion begins with the head and skull, proceeding thence downward by way of the nose, face and ears, to the neck, clavicle, humerus, thorax, shoulders and spinal column, where the text is discontinued, leaving the document incomplete. Without any external indication of the arrangement of the text, the content of the treatise is nevertheless carefully disposed in groups of cases, each group being concerned with a certain region. These groups are as follows:

A. Head (27 cases, the first incomplete): Skull, overlying soft tissue and brain, Cases 1-10. Nose, Cases 11-14. Maxillary region, Cases 15-17. Temporal region, Cases 18-22. Ears, mandible, lips and chin, Cases 23-27.
B. Throat and neck (cervical vertebrae), Cases 28-33
C. Clavicle, Cases 34-35.
D. Humerus, Cases 36-38
E. Sternum, overlying soft tissue, and trueribs, Cases 39-46.
F. Shoulders, Case 47.
G. Spinal Column, Case 48.

The incompleteness of Case 48 confirms our suspicion that the rest of the treatise is lost. The discussion of each case is done systematically in the following way:

1. Title.
2. Examination.
3. Diagnosis.
4. Treatment (unless a fatal case, considered untreatable).
5. Glosses (a little dictionary of obscure terms, if any, employed in the discussion of the case

The title of Case 4 reads, "Instructions concerning a gaping wound in his head, penetrating to the bone, and splitting his skull"; that of Case 6, "Instructions concerning a gaping wound in his head, penetrating to the bone, smashing his skull, and rending open the brain of his skull."
The examination regularly begins thus-. "If thou examinest a man having . . ."
The form adopted is that of a teacher instructing a pupil that he shall do so and so. The methods of observation expressly stipulated or implied are answers elicited from the patient, ocular, olfactory, and tactile observations, movements of parts of the body by the patient as directed by the surgeon. Strange to say, eight out of eleven surgical operations are classified with the examination rather than with the treatment. This would suggest that the surgical work was considered a preparation to the medical treatment, independent of it.
The diagnosis is always introduced by the words: "Thou should say concerning him [the patient] . . ." and ends with one of three statements:

1. An ailment which I will treat.
2. An ailment with which I will contend.
3. An ailment not to be treated.

Three diagnoses consist of this final hopeless verdict and nothing more; but in forty-nine diagnoses in our treatise the three verdicts are preceded by other observations on the case. In thirty-six of these forty-nine diagnoses the other observations are nothing more than a repetition of the title of the case, or of observations already made in the examination; but in the remaining thirteen, the diagnosis adds one or more conclusions based on the facts determined in the examination. These are the earliest surviving examples of observation and conclusion, the oldest known evidences of an inductive process in the history of the human mind.' Parallel with the systematic use of these three verdicts is a similar series of temporal clauses bearing more directly on the condition of the Patient although not so regularly employed, and placed at the end of the treatment. These read:

A. "Until he recovers."
B. "Until the period of his injury passes by."
C. "Until thou knowest that he has reached decisive point."

The matter-of-factness and soberness of those early medical texts is very impressive. The doctor who wrote them down was not only an experienced man but a wise one, whose general point of view sometimes adumbrates that of the Hippocratic writings. For example, he recommends an expectant attitude, trusting in the healing power of nature, or he recommends waiting "until thou knowest that he [the patient] has reached a decisive point"; this reminds us of the Hippocratic notion of crisis.

## Did the Egyptians study Anatomy?

There is no reason to believe that the ancient Egyptians had studied anatomy, by means of deliberate dissections, but they had taken advantage of the accidental experiments falling under their eyes and had accumulated much knowledge. Of course, the mummification of dead bodies of men and animals, which had been practiced from time immemorial, might have taught them many things, but I am rather skeptical about that; the embalmers were too much concerned about their own difficult art to pay attention to irrelevant anatomic details. lt is possible that the practice of mummification made it easier later, much later, in Ptolemaic times, for Greek scientists to undertake systematic dissections, but that is another story. As far as ancient Egypt is concerned there is no evidence of the influence of mummification on anatomic knowledge.

The author whose work is recorded in the Smith papyrus had meditated on anatomic and physiologic questions. He was aware of the importance of the pulse, and of a connection between pulse and heart. He had some vague idea of a cardiac system, though not of course of a circulation, which nobody clearly understood before Harvey (and before him the Muslim physiacin Ibn Al-Nafis). His knowledge of the vascular system was made hopelessly difficult by his inability to distinguish between blood vessels, tendons, and nerves. Yet consider these astounding observations of the brain :

"If thou examines a man having a gaping wound in his head penetrating to the bone, smashing his skull, and rending open the brain of his skull, thou shouldst palpate his wound. Shouldst thou find that smash which in his skull like those corrugations which form in molten copper, and something therein throbbing and fluttering under thy fingers, like the weak place of an infant's crown before it becomes whole- when it has happened there is no throbbing and fluttering under thy fingers until the brain of his [the patient's] skull is rent open and he discharges blood from both his nostrils, and he suffers with stiffness in his neck."

He had observed the meninges, the cerebrospinal fluid, and the convolutions of the brain (compared in the previous quotation to the rippling surface of metallic slag). Moreover, he had realized that the brain was the seat of the control of the body, and that special kinds of control were localized in special parts of the brain.

## Conclusion

To conclude, the *Smith* papyrus, and to a lesser extent the *Ebers* one, give us a very favorable idea of the medicine, anatomy, and physiology of the Egyptians, and of the scientific outlook that they obtained at least two thousand years before Hippocrates.

## Mummification in Ancient Egypt

Preservation of human bodies after death is usually designated by two expressions, namely, "embalming" and "mummification". To embalm literally means "to place in balsam or resin". which is actually one of the last steps of the whole process of the preservation of the body. The word "mummification" is derived from the Latin word (perhaps of Persian origin) "mumia" which was mentioned by Dioscorides (first century A.D.) as a black bitumen found oozing from the earth in certain places. This word was applied at a late date to the embalmed bodies in Egypt, probably due to the fact that from the Twenty-sixth Dynasty onwards, bituminous materials were largely used in the presevation of the body.

Mummification is undoubtedly the most distinctive technique or art which developed in Ancient Egypt. It greatly affected the habits and customs of the ancient Egyptians and, through it, much knowledge was gained in anatomy, chemistry, and many arts and industries.

# Cosmetics in Ancient Egypt

Edited and prepared by Prof. Hamed A. Ead

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## Cosmetics

Cosmetics are as old as vanity. In Egypt their use can be traced back almost to the earlist period of which burials have been found, and continues to the present day.

Cleanliness and personal appearance were highly regarded by the ancient Egyptians. For the priests in the service of the gods cleanliness was strictly prescribed. Not only did they have to wash several times a day, but they also had to be clean shaven all over, to keep at bay parasites, such as lice, eggs of which have been found in the hair of mummies. Water was plentiful, but there is little evidence that the ancient Egyptians used natural soaps or tooth powder. In a hot climate deodorants were much in demand. To repel body odour men and women alike were advised to rub pellets of ground carob(?) into the skin, or to place little balls of incense and porridge where limbs met.
Around 1400 BC three ladies of the court of Tuthmosis III were buried with costly royal funerary equipment, which included cosmetics. Two of the jars contained a cleansing cream made of oil and lime. Some prescriptions for body 'scrub' are given in the medical papyri

The 'red natron' was presumably natron tinted by an iron compound in the earth where the natron was extracted.
An allegedly successful remedy to treat wrinkles consisted of': gum of frankincense I wax I; fresh moringa oil I; cyperus grass I; is ground finely and mixed with fermented plant juice. Apply daily.

A simple remedy of gum applied to the face after cleansing had a similar effect. If' the skin was marred by scars caused by burning, a special ointment was used to treat them and make them less obvious, as for example red ochre and kohl, ground and mixed with sycamore juice. An alternative treatment was a bandage of carob(?) and honey, or an ointment made of frankincense and honey.
Because of 'their healthy diet and the lack of sugar the Egyptians did not suffer from tooth decay, but their bread contained particles of sand from the grain and grit from the grinding stone, which caused their teeth to become excessively worn No evidence has been recovered to suggest that the Egyptians used a toothbrush in the manner of the miswak, a natural brush-cum-toothpaste from Salvadora persica, a tree native to southern Egypt and the Sudan. The root has been used for dental care by the Muslims since the days of the Prophet (PPUH). To improve on their breath the Egyptians chewed herbs, or they gargled with milk. Perhaps they also chewed frankincense like their descendants in the last century
As in other civilizations, the appearance of the hair was of paramount importance not only because of the visual effect, but also because of 'the erotic symbolism conventionally conneted with hair. Men and women alike wore wigs made of 'human hair on festive occasions, but they also tried to keep their natural hair in good condition. Jars of what could be compared with 'setting lotion' have been found to contain a mixture of beeswax and resin. These were remedies for

problems such as baldness and greying hair. To treat the latter, blood of a black ox or calf was boiled in oil to transfer the blackness of the animal to the greying hair, or the black horn of a gazelle was made into an unguent with oil to prevent grey hairs from appearing. These remedies are slightly more agreeable than another consisting of putrid donkey's liver steeped in oil, though they all had the same magic effect. A far more efficient remedy would be an ointment made of juniper berries and two unidentified plants kneaded into a paste with oil and heated. The natural colouring matter in the plants would rub off on the hair, and the astringent properties of juniper stimulate the scalp. In order to make the hair grow, chopped lettuce was placed on a bald patch, if the baldness occurred after an illness, or the head was anointed with equal parts of fir oil and another oil or fat.

The toilet casket of any man or woman would contain a razor for removing body hair, although a number of creams were sometimes used for the purpose. One such consisted of the boiled and crushed bones of a bird, mixed with fly dung, oil, sycamore juice, gum, and cucumber; this mixture would be heated and applied, presumably to be pulled off when cold, with the hair adhering to it.

The almond shape of the black Egyptian eyes was underlined by the application of black kohl or green malachite. Eyepaint was also considered as a treatment to cure or prevent eye diseases. A great number of prescriptions deal with preventing ingrowing eyelashes.

To cool the eyes a finely ground green mineral (jasper or serpentine) mixed with water was applied to the lids. Alternative preparations were ground carob(?) and fermented honey, or emmer grains steeped in water overnight. An eye wash was prepared from ground celery and hemp.

Eyepaint for an overnight treatment made of kohl and goose fat or a paste was mixed from kohl, green eyepaint, lapis lazuli, honey and ochre in equal parts, applied to the lids. The green eyepaint was usually malachite, a green ore of copper; kohl was made of galena, a dark grey ore of lead. It w as kept in lumps in little bags of linen or leather and was ground on a palette to a fine powder. The powder was poured into vases or tube-shaped containers from which it was extracted with a thin stick. It was applied either with the moistened stick, as is done by Egyptian women today, or, for medicinal purposes as quoted above, mixed with some fatty matter.

Malachite was brought to the Nile Valley from the mountainous regions of Sinai, whereas galena was obtained either near Aswan in Upper Egypt or at the Red Sea coast. But both were also imported as luxury commodities from Asia and Arabia.

However, no matter which remedy was employed, the Egyptians knew that nothing made the eyes brighter than falling in love: 'Like eyepaint is my desire. When I see you, it makes my eyes sparkle', says a girl in a love poem.

Some Egyptians appear to have dyed their fingernails, but the nature of the red colour used is unknown. It may have been henna. Red was also required to paint the lips. The lip gloss, possibly made of fat with red ochre or with one of the plants used for dyeing, was applied with a brush or spatula. Red colour was used to give glow to the cheeks. A rouge consisting of red ochre and fiat, possibly with a little gull resin, has survived: it was some four thousand years old. Rouge in the form of powder was marketed a few years ago as a product of ancient Egyptian origin. The recipe which inspired the manufacturers was presumably one of those used for the purpose of camouflaging a burn.

# Alchemy in Islamic Times

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## INTRODUCTION

On 8 June, A.D. 632, the Prophet Mohammed (Peace and Prayers be upon Him) died, having accomplished the marvelous task of uniting the tribes of Arabia into a homogeneous and powerful nation.
In the interval, Persia, Asia Minor, Syria, Palestine, Egypt, the whole North Africa, Gibraltar and Spain had been submitted to the Islamic State, and a new civilization had been established.
The Arabs quickly assimilated the culture and knowledge of the peoples they ruled, while the latter in turn-Persians, Syrians, Copts, Berbers, and others-adopted the Arabic language. The nationality of the Muslim thus became submerged, and the term Arab acquired a linguistic sense rather than a strictly ethnological one.
As soon as Islamic State had been established, the Arabs began to encourage learning of all kinds. schools, colleges, libraries, observatories and hospitals were built throughout the whole Islamic State, and were adequately staffed and endowed.
In the same time, scholars were invited to Damascus and Baghdad without distinction of nationality or creed. Greek manuscripts were acquired in large numbers and were studied, translated and provided with scholarly and illuminating commentaries.
The old learning was thus infused with a new vigor, and the intellectual freedom of men of the desert stimulated the search for knowledge and science.
In early days at least, the Muslims were eager seekers for knowledge, and Baghdad was the intellectual center of the world. Historians have justly remarked that the school of Baghdad was characterized by a new scientific spirit.
Proceeding from the known to the unknown; taking precise account of phenomena; accepting nothing as true which was not confirmed by experience, or established by experiment, such were fundamental principles taught and acclaimed by the then masters of the sciences.

**Cultural Background**

Three of the 'Abbasid Caliphs distinguished themselves greatly in this respect: the second, al-Mansur (754-775), who founded Baghdad, and, even more so, the fifth, Harun-al-Rashid whose fame has been immortalized by many legends and the seventh, Al-Ma'mun (813-833). All of them encouraged the work of the translators who were busily unlocking the treasures of Greek knowledge.
First of all the word 'alchemy', as the article al- indicates, is Arabic (al-klmya'). The origin of the word kimya', pre-Arabic, is arguable. Several more or less plausible or legendary hypotheses have been advanced. For some the word came from the Egyptian kemi (black), whence the Greek kemia which might indicate two things:
Egypt, 'the black land' according to Plutarch - alchemy would be preeminently the science of Egypt; 'the Black', the original matter of transmutation, i.e. the art of treating 'black metal' to produce precious metals.
For others, the word 'chemy' could have come from the Greek khymeia, 'fusion', i.e. the art of melting gold and

silver. A Byzantine text states that Diocletian ordered the destruction of Egyptian books relating to khymeia, to the 'fusion' of gold and silver.

**Islamic Alchemy In Western Writings**

Following the work of French chemist Marcellin Berthelot on alchemy, many researchers on the basis of original texts discovered and published, became interested in the study of alchemy with the Arabs: Lippmann, Wiedemann, Ganzenmuller, Stapleton, Holmyard, Plessner and especially Paul Kraus whose work about Jabir ibn Hayyan is still a classic in this subject. More recently Henry Corbin in his research on Shi'ism has tried to give an esoteric interpretation of the great alchemy texts. His ideas created a school of thought and some contemporary authors, Roger Deladriere and Pierre Lory for instance, did not escape his influence. Arabic alchemy is no longer the 'terra incognita' which, a century ago, challenged the insight of historians of science.

The large quantity of accumulated facts suggested a synthetic presentation to Fuat Sezgin and Manfred Ullmann. The former produced his in the frame of his series *Geschichte des arabischen Schrifttums*; the fourth volume, appearing in 1971, dedicated several pages to alchemy. In his turn, Ullmann, in his book *Die Natur- und Geheimwissenschaften in Islam*, appearing in 1972, presented in about a hundred pages the whole of Arabic alchemic literature studying successively the translations and pseudoepigraphs from Greek authors, Egyptian, Indian, Persian, Jewish and Christian sources, then alchemy theories, the research of the elixir, laboratory experiments and the material employed, and the whole is copiously documented.

# THE SOURCES OF ALCHEMY AMONG MUSLIMS

**Pythagoras (Fithaghurus)**

Pythagoras is often mentioned in Arabic philosophy and in gnomic literature. Jaldaki calls him al-mu'allim al-awwal because he acquired the science from hermetic texts. Jabir refers to him as an alchemic author and speaks of Ta'ifat Fthaghurus, the school of Pythagoras, and of his book *Kitab almu'sahhahat* (Book of Adjustments). Other quotations refer to Pythagoras's theory of numbers. Tughra'i mentions him several times and refers to his treatise about 'natural numbers'. The fragments of texts which are attributed to him could have come either from *Turba philosophorum*, where he is among the participants, or from other texts.

**Archelaos**

Archelaos is mentioned in the *Fihrist* (p. 352, 25) and by al-Kindi in his *Fada'il Misr* (p. 191, 11). He is considered as the disciple of Anaxagoras and the teacher of Socrates. He should not be confused with his Byzantine namesake, author of an alchemic poem of 336 verses. The Arabs consider him as the author of *Turba philosophorum* (Mu.shafal aljama'a) and attribute to him the *Risalat madd al-ba hr dhat al-ru'ya*, a text which had been revealed in a vision about the tide and which was translated into Latin with the title *Visio Arislei*. This text is introduced as the continuation of *Turba philosophorum*.

**Socrates**

Socrates is considered not only as a wise man but also as an alchemist. Jabir calls him 'the father and mother of all philosophers' and considers him as the prototype of the real chemist. From Socrates to Jabir, there is a continuous tradition which attributes entire treatises to him. Jabir affirms that Socrates was opposed to the writing down of alchemic knowledge to avoid its exposition to the ignorance of the masses. Most references to Socrates refer to his arithmetical speculations (theory of the balance) and also to artificial generation.

**Plato (Aflatun)**

Olympiodorus already (at the end of the sixth century) considered Plato as an alchemist and Ibn al-Nadlm mentions him in the list of alchemists. Butrus al-Ilmlml mentions an alchemic device called ,hammam Aflatun (Plato's bath). Among the books attributed to him by the Arabs we can mention the *Summa Platonis* of which we only have the Latin version. There is a commentary to this book - the *Kitab al-Rawabi'* - whose Arabic text was edited by Badawi and whose Latin translation is known by the name *Liber quartorum*. The contents of this work are mainly alchemic but it contains also information on geometry, physiology and astrology. The ancient authors cited are Plato, Aristotle, Ptolemy, Hipparchus, Proclus, the Sophists, Ostanes, Hermes, Asclepius and Hippocrates.

We note also that Plato takes up the story in the forty-fifth discourse in *Turba philosophorum*; this speech ends with the phrase al-tabi'a tulzimu-ltabi'ata wa-l-tabi'atu taqharu-i-tabSata wa-i-tabi'ata tafra hu li-l-tabl'ati (nature necessarily accompanies nature, nature overcomes nature, nature rejoices in nature), an aphorism often mentioned in Arabic alchemic literature under the name of Plato or anonymously. It comes from the *Physika kai Mystika* of Democritus.

**Aristotle (Aristu)**

Aristotle is considered as an alchemist author not so much because of his fourth book *Meteorologica* but because of his reputation as an all-round scholar. He wrote a book on alchemy for his disciple Alexander. In 618, by order of Heraclius, the book was translated into Syriac by the monk Jean, and the Bishop of Nisibis, Eliyya bar Shinaya,

made sure of its orthodoxy. Finally Abdishu' bar Brika, Bishop of Sinjar, and later of Nisibis, made a commentary on it in Syriac of which there still exists an Arabic translation. The text contains an introduction in which Abdlshu reports the legendary history of the text followed by a Ietter from Alexander to Aristotle where the former poses questions to which the latter responds. This dialogue is called *sahifat kanz Allah al-akbar* (Epistle of the Great Treasure of God). it includes three chapters: (1) About the great principles of alchemy; (2) Alchemic operations; (3) The elixir. Pythagoras, Democritus, Asclepiades, Hermes, Plato, Ostanes and Balmas are mentioned in the text.
We also have a dialogue between Aristotle and the Indian Yuhin sent by the Indian king as messenger to Alexander. Ibn al-Nadim reports this dialogue to Ostanes. Finally in the Jabirian corpus there is a *Kitab Musahhaha Aristutalis*.

**Porphyry (d. c. 303)**

Porphyry is often mentioned, especially by Jabir who attributes artificial generation to him. The later alchemists such as Tughra'i and Jaldakl also mention him.

**Galen (Jahnus) (d. c. 199 AD)**

According to a note in *Kitab al-hajar 'ala ra'y Balinas*, Galen was interested in alchemy before dedicating himself to philosophy. In fact, he is sometimes mentioned as an authority on alchemy' and fragments of alchemy texts attributed to Galen can be found in the National Library of Cairo.

**Bolos the Democritean of Mendes**

Bolos the Democritean lived in the second century before Christ. The work of this scholar is varied: alchemy, astrology, medicine. He is probably at the origin of the alchemic tradition transmitted by the work of pseudo-Democritus: *Physika kai Mystika*. He expounds there the four traditional branches of alchemy: gold, silver, precious stones, dyes. One can find the famous formula which aims to synthesize the quintessence of the alchemic art: 'one nature is charmed by another nature, one nature overcomes another nature, one nature dominates another nature'. How can this axiom be explained in practical terms? Zosimus, commentator of the fourth century, explains: 'we can proceed with the transmutation of common metal into noble metal by working alloys or by purifying the metals, basing ourselves on the affinity between metals, knowing their "sympathies and antipathies". Raw material, sympathy, transmutation by qualitative change (of the colours), we have thus the principles that constitute alchemy.' Thus the school of Bolos brings to the Egyptian technique a philosophical reasoning which will open the way to the science of the Great Work. 'Once again', says Festugiere, 'we see the union of the Greek spirit and the Oriental art.' The art exists, from ancient times; the goldsmiths of Egypt work metals, stones and purple. But although they have innumerable recipes transmitted from father to son and kept in temple archives, they lack a reasoning method. No-one has yet joined these practices with the principles which explain and justify them. There is practice but not theory. This is what the Greek spirit provides. The merit of Bolos of Mendes was to join theory and experiment and thus found a pseudoscience which would cross the ages up to modern chemistry.
About the same time alchemy was practiced in most Egyptian towns. This first alchemy is a mixture of hermetic or Gnostic elements and old Greek philosophy: Heraclitus, Empedocles and their speculations about the four elements, Parmenides with his theory on the unity of the whole, the Platonic cosmogony of Timaeus.

**Zosimus**

The most famous character of this time is Zosimus of Panopolis (Akhmim, in Upper Egypt). He probably lived at the end of the third and beginning of the fourth century; he wrote an encyclopedia with twenty-eight books on alchemy which he dedicated to his sister Theosebeia. Some sections are original but most of it reproduces old texts lost to the present time. His name in Arabic, because of the ambiguity of the writing, is often transcribed under different forms: Risimus, Rusim, Rusam. Al-Qifli affirms that he lived before Islam.
Some of his aphorisms and anecdotes are reported by Arab authors such as Jahiz, Ibn Durayd, al-Tawhidi,. Ibn Arfa' Ra's calls him 'the universal wise man and the brilliant flame' (al-hakim aljami' wa-i-shihab al-lami'). Ibn al-Nadlm mentions four books from Zosimus: *Kitab al-mafatih f-l-santa*; *Kitab al-sab'tuna risala*; *Kitab al-'anasir*; *Kitab ila jamb alhukama' fi-lsan'a*.
The epistle from Zosimus to Theosebeia has the title *Mushaf al-suwar* (The Book of Images). The name of Theosebeia is often rendered as Atusabiya, Amtuthasiya, Uthasiya, etc. Zosimus can be placed at the end of an evolution in alchemy. With Bolos, it became philosophical; with Zosimus it becomes a mystical religion where the idea of salvation is predominant. In fact, the period which separates Bolos the Democritean from Zosimus saw intense alchemic activity. Vastly different elements - Egyptian magic, Greek philosophy, neo-Platonism, Babylonian astrology, Christian theology, pagan mythology - can be found in Zosimus' texts. He is full of gnostic and hermetic books, he knows the Jewish speculations about the Old Testament. He gives to alchemy a religious character which will remain forever, at least in its traditional course, since with the Arab alchemists it will retain its concrete technical character before meeting the Ismaeli gnostic speculations.
Zosimus and his contemporaries who collected their predecessors' traditions insist on their connection with the Egypt of the Pharaohs or with the Persia of Zoroastra and Ostanes. We can find texts under the name of

Agathodaimon compared with Hermes. Some written pieces even say that alchemic texts were engraved in hieroglyphs on steles but it was absolutely forbidden to divulge them.
This Greek-Egyptian alchemy survived in Alexandria for several centuries. From here it will go to Constantinople, where several recensions of the 'collection of Greek alchemists' were compiled, and to the Arabs when they conquered Egypt in the seventh century.

**Hermes and Hermetic literature**

According to Ibn al-Nadlm (351, 19) Arab alchemists considered the Babylonian Hermes as the first one to have mentioned the art of alchemy. Exiled by his countrymen, he came to Egypt where he became king. He wrote a certain number of books on alchemy and was equally interested in the study of the hidden forces of nature.
The *Fihrist* gives a list of thirteen books of Hermes about alchemy but in fact some of them are about magic. Other texts have been traced: *Alfalakiyya al-kubra* (The Great Epistle of the Celestial Spheres) by Hermes of Denderah; *Risalat al-sirr*; *Kitab Hirmis ila Tat f-l-santa*; *Risalat harb al-kawakEb al-barbawiyya*; *Tadblr Hirmis al-Haramisa*; *sahlfat Hirmis al'ugma*, commentated by Jaldaki; *Risalat Qabas al-qabis fi tadbir Hirmis al-Haramisa*.

**Sirr al-Khaliqa of Ballnas**

The *Kitab Sirr al-khaliqa wa santat al-tabia* also has the title *Kitab al-'ilal* (The Book of Causes); it was sometimes called simply *li-lashya'*. In the introduction a certain Sajiyus is introduced, a priest from Nablus who commented on the story of Bal.

# Muslim Alchemists

The Arabs appeared in history in the seventh century. Alchemy had by then gone through a long path. The first contacts took place in Egypt, in Alexandria, where the traditions went back several centuries before Christianity. Muslim alchemy was derived from the Greek. The frequency with which Greek authors are quoted, the numerous theories that are common to both Greek and Arabic alchemy, and the large number of Arab technical terms clearly taken over from Hellenic treatises (e.g. hayuli, atisyus, athalia, iksir, qambar,S) prove beyond doubt the affiliation of Muslim and Greek alchemy. The transmission was made partly through direct contact in Egypt, partly through the medium of Syrian Christian translators, and partly by way of Persia. There are unmistakable traces of Persian influence, manifested distinctly by linguistic affinities in technical names and usage and in names of minerals. These traces are sufficiently well marked to render it probable that Persia was, indeed, one of the main channels through which alchemy came to Islam; and it is not without interest to note that many of the principal Muslim alchemists were Persians.
It has already been observed that Chinese alchemy has so much in common with Greek and Arabic alchemy as to afford support to the hypothesis that all three had a common origin; and there is some reason to believe that the Chinese practiced a kind of alchemy long before the days of Islam. The remote origins of Arabic alchemy are therefore still to some extent uncertain, but there is very little to recommend the suggestion that the Arabs received any direct introduction to alchemy from the Chinese. Whatever may be the cause of the similarity between Chinese, Greek and Muslim alchemical ideas.

**JABIR IBN HAIYAN (721-815)**

The greatest chemist of Islam has long been familiar to western readers under the name of Geber, which is the medieval rendering of the Arabic Jabir. Since the work of Paul Kraus we are on more solid ground with Jabir ibn Haiyan.
He is Abu Musa Jabir ibn Haiyan al-Azdl (al-Tusl, al-~artusl, al-Harram meaning that he was a Sabian?; al-Sufi). Flourished mostly in kufa. The most famous Arabic' alchemist; the alchemist Geberu of the Middle Ages. He may be the author of a book on the astrolabe, but his fame rests on his alchemical writings preserved in Arabic: the 'Book of the Kingdom', the 'Little Book of the Balances', the 'Book of Mercury', the 'Book of Concentration', the 'Book of Eastern Mercury', and others. According to the treatises already translated (by Berthelot), his alchemical doctrines were very anthropomorphic and animistic. But other treatises (not yet available in translation) show him in a better light. We find in them remarkably sound views on methods of chemical research; a theory on the geologic formation of metals; the so-called sulphur-mercury theory of metals (the six metals differ essentially because of different proportions of sulphur and mercury in them); preparation of various substances (e.g., basic lead carbonate; arsenic and antimony from their sulphides). Jabir deals also with various applications, e.g., refinement of metals, preparation of steel, dyeing of cloth and leather, varnishes to water-proof cloth and protect iron, use of manganese dioxide in glass making, use of iron pyrites for writing in gold, distillation of vinegar to concentrate acetic acid. He observed the imponderability of magnetic force.
It is possible that some of the facts mentioned in the Latin works, ascribed to Geber and dating from the twelfth century and later, must also be placed to Jabir's credit. It is impossible to reach definite conclusions until all the Arabic writings ascribed to Jabir have been properly edited and discussed. It is only then that we shall be able to

measure the full extent of his contributions, but even on the slender basis of our present knowledge, Jabir appears already as a very great personality, one of the greatest in mediaeval science. Jabir admits the Aristotelian theory about the composition of matter-earth, water, air, fire-but he develops it along a different path. First, there are four elementary qualities, or natures: heat, cold, dryness, humidity. When they get together with a substance they form compounds of the first degree, i.e. hot, cold, dry, wet. The union of two of these qualities gives
hot + dry + substance -------------- fire
hot + wet + substance -------------- air
cold + wet + substance ------------- water
cold + dry + substance ------------- earth

One of his chief contributions to the theory of chemistry lies in his views upon the constitution of metals. To understand his conceptions properly, we must hark back to Aristotle, whose philosophy of nature was universally accepted in its main principles by the scientists of Islam. According to Aristotle, it still be remembered, all substances are composed of the four elements, fire, air, water, and earth, which are themselves interconvertible. The immediate constituents of minerals and metals are two exhalations, one an 'earthy smoke' and the other a watery vapour'; the former consists of small particles of earth on the way to becoming fire, while the latter consists of small particles of water on the way to becoming air. Neither exhalation is ever entirely free from some admixture of the other. Stones and other minerals are formed when the two exhalations become imprisoned in the earth, the dry or smoky exhalation predominating; metals are formed under similar circumstances if the watery exhalation predominates.

Jabir accepted this theory of the constitution of metals, but appears to have regarded it as too indefinite to explain observed facts or to afford a guide to practical methods of transmutation. He therefore modified it in such a fashion as to make it less vague, and the theory he suggested survived, with some alterations and additions, until the beginning of modern chemistry in the eighteenth century. The two exhalations, he believed, when imprisoned in the bowels of the earth, are not immediately changed into minerals or metals, but undergo an intermediate conversion. The dry or smoky exhalation is converted into sulphur and the watery one into mercury, and it is only by the subsequent combination of sulphur and mercury that metals are formed. The reason of the existence of different varieties of metals is that the sulphur and mercury are not always pure, and that they do not always combine in the same proportion. If they are perfectly pure and if, also, they combine in the most complete natural equilibrium, then the product is the most perfect of metals, namely gold. Defects in purity or proportion, or both, result in the formation of silver, lead, tin, iron or copper, but since these metals are essentially composed of the same constituents as gold, the accidents of combination may be removed by suitable treatment. Such treatment is the object of alchemy.

The idea that the transmutation of the metals was possible had the excellent merit of provoking incessant experiment, but unfortunately the alchemists were always prone to theorize to an inordinate extent. Moreover, at Alexandria, the mystical beliefs of the Gnostics and the Neo-Platonists - however admirable and attractive in themselves - had a very detrimental effect upon experimental science. Alchemy thus became less and less a matter for experimental research and more and more the subject of ineffable speculation and superstitious practice, not to say fraudulent deception.

The practical applications of chemistry were not neglected. Jabir describes processes for the preparation of steel and the refinement of other metals, for dyeing cloth and leather, for making varnishes to waterproof cloth and to protect iron, for the preparation of hair-dyes and so on. He gives a recipe for making an illuminating ink for manuscripts from 'golden' marcasite, to replace the much more expensive one made from gold itself, and he mentions the use of manganese dioxide in glass-making. He knew how to concentrate acetic acid by the distillation of vinegar, and was also acquainted with citric acid and other organic substances.

**Abu Bakr Muhammad ibn Zakariyya al-Razi (866-925)**

After the death of Jabir, nearly a century elapsed before Islam produced a worthy successor. History records a few alchemists in the interval, but it is only with the Persian chemist and physician Abu Bakr Muhammad ibn Zakariyya al-Razi (known to the West as Rhazes) that Jabir's great example is successfully followed.

According to one of his biographers, Razi was born in A.D. 866 at Ray, an ancient town on the southern slopes of the Elburz Range that skirts the south of the Caspian Sea. In his early youth he devoted himself to the study of music, literature, philosophy, manichaeism, magic and alchemy.

After his first visit to Baghdad, when he was at least 30 years of age, that he seriously took up the study of medicine under the well-known doctor Ali ibn Sahl (a Jewish convert to Islam, belonging to the famous medical school of Tabaristan or Hyrcania). Razi showed such skill in the subject that he quickly surpassed his master, and wrote no fewer than a hundred medical books. He also composed 33 treatises on natural science (exclusive of alchemy), on mathematics and astronomy, and more than 45 on philosophy, logic and theology. On alchemy, in addition to his *Compendium of Tweltne Treatises* and *Book of Secrets*, he wrote about a dozen other books, two of which were refutations of works by other authors in which the possibility of alchemy had been attacked.

As to the man himself, one of the inhabitants of Ray who recollected Razi described him as a man with a large square head. He used to take his seat in the lecture room, with his own pupils next him, and the pupils of these men behind them, and, behind these again, other pupils. Whenever any one came with a question, he used first to ask the back row. If they could answer, he went away; but, if not, he used to pass on to the others, and they, in their turn, if they could give a correct answer, tried to satisfy him; otherwise Razi would speak on the subject himself. He was a liberal and generous man, and so compassionate to the poor and sick that he used to distribute alms to them freely and even nurse them himself. He was always reading or copying, and "I never visited him" (said the narrator) "without finding him at work on either a rough or a fair copy". His eyes were always watering 'on account of his excessive consumption of beans', and he became blind towards the end of his life. He died in his native town on 26 October, A.D, 925, at the age of 60 years and 2 months.

Razi is of exceptional importance in the history of chemistry, since in his books we find for the first time a systematic classification of carefully observed and verified facts regarding chemical substances, reactions and apparatus, described in language almost entirely free from mysticism and ambiguity.

Razi's scheme of classification of the substances used in chemistry shows such a sound, it is the first time that we find such a systematic classification. The list of these products as mentioned in *Sirr al-asrar* book is as follows:

A. The earthly substances (al-'aqaqtr al-turabiyya) Mineral substances

1. The SPIRITS (al-arwah)

Mercury, sat ammoniac, arsenic sulphate (orpiment and realgar), sulphur

2. The BODIES (al-ajsad)

Gold, silver, copper, iron, lead, tin, Kharsind

3. The STONES (al-ahjar)

Pyrites (marqashita), iron oxide (daws), Zinc oxide (tutiya), azurite, malachite, turquoise, haematite, arsenic oxide, lead sulphate (kohl), mica and asbestos, gypsum, glass

4. The VITRIOLS (al-zajat)

Black, alums (al-shubub), white (qalqadzs), green (qalqand), yellow (qulqutar), red

5. BORAX (al-bawariq)

6. The SALTS (al-amlah)

B. Vegetable substances

Rarely used, they are mainly employed by physicians.

C. Animal substances

Hair, scalp, brain, bile, blood, milk, urine, eggs, horn, shell

To these 'natural substances' we need to add a certain number of artificially obtained substances; al-Razl mentions litharge, lead oxide, verdigris, copper oxide, zinc oxide, cinnabar, caustic soda, a solution of polysulphur of calcium and other alloys.

The insistence of al-Razl in promoting research work in the laboratory brought its fruits in pharmacy.

Razi gives also a list of the apparatus used in chemistry. This consists of two classes: (i) instruments used for melting metals, and (ii) those used for the manipulation of substances generally. In the first class were included the following:

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Blacksmith's hearth
Bellows
Crucible
Descensory
Ladle
Tongs
Shears
Hammer or Pestle
File
Semi-cylindrical iron mould
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The second class included:

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Crucible                        Flasks
Alembic                         Phials
Receiving flask                 Cars
Aludel                          Cauldron
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| | |
|---|---|
| Beakers | Sand-bath |
| Glass cups | Water-bath |
| Shallow iron pan | Large oven |
| Sieve | Hair-cloth |
| Heating-lamps | Filter of linen |
| Cylindrical stove | Potter's Kiln |
| Chafing-dish | Mortar |
| Flat stone mortar | Stone roller |
| Round mold | Glass funnel |

It will be observed that the list was comprehensive, but Razi completes the subject by giving details of making composite pieces of apparatus, and in general provides the same kind of information as is to be found nowadays in manuals of laboratory arts.

Like Jabir, Razi was a firm believer in the possibility of transmutation, and Stapleton describes his scheme of procedure approximately as follows:

**The first stage**: consisted in the cleansing and purification of the substances employed, by means of distillation, calcination, amalgamation, sublimation and other processes. Having freed the crude materials from their impurities,

**The next stage**: was to reduce them to an easily fusible condition. This was done by an operation known as aeration, that resulted in a product which readily melted, without any evolution of fumes, when dropped upon a heated metal plate.

**The third stage**: was to bring the 'berated' products to a further state of disintegration by the process of solution. The solutions of different substances, suitably chosen in proportion to the amount of 'bodies', 'spirits', &c., they were supposed to possess, were brought together by the process of combination.

**Finally**: the combined solutions underwent the process of coagulation or solidification, the product which it was hoped would result, being the Elixir. This, as previously explained, was a substance of which a small quantity, when projected upon a larger quantity of baser metal, would convert the latter into silver or gold.

From a general study of his chemical works, Stapleton says that hence forward Razi must be accepted as one of the most remarkable seekers after knowledge that the world has ever seen - not only 'unique in his age and unequaled in his time', but without a peer until modern science began to dawn in Europe with Galileo and Robert Boyle. The evidence of his passion for objective truth that is furnished by his chemical writings, as well as the genius shown by the wide range of books he wrote on other subjects, force us to the conclusion that - with the possible exception of his acknowledged master, Jabir - Razi was the most noteworthy intellectual follower of the Greek philosophers of the seventh to fourth centuries B.C. that mankind produced for 1900 years after the death of Aristotle. His supreme merit lay in his rejection of magical and astrological practices, and adherence to nothing that could not be proved, by experiment and test, to be actual fact.

Later Arab Alchemists

No account of chemistry in Islam would be even approximately complete which omitted to mention four of Arab Alchemists: Abu'l-Qasim of Iraq, Aidamir al-Jildaki, Al-Tughra‘i and Al-Majriti.

The first of these men lived in the thirteenth century, probably at Cairo, and has left us several books which, apart from their intrinsic interest, serve to indicate the trend of alchemical thought and practice in Islam after the process of transmission to Europe had been in action for some considerable time. It is very obvious that in Abu'l-Qasim's time the reaction of European scientific thought upon Islam had not yet begun, and the contrast between the two intellectual worlds could not be better exemplified than in the persons of Abu'l-Qasim and his contemporary Roger Bacon. The driving force of Islam was beginning to grow weak, while the new stimulus that Arabic learning had given to Europe had resulted in a scientific renaissance which was to reach its full development not long afterwards. Abu'l-Qasim's outlook is that of his predecessors of three or four centuries earlier, and although there was unquestionably some advance in empirical practical chemistry, the theoretical views expressed are supported by quotations not merely from Jabir but from the still earlier alchemists of the Alexandrian school. Abu'l-Qasim himself seems to have been a good experimentalist and a comparatively logical thinker, but his general views often represent a retrograde movement upon those of Jabir.

Aidamir al-Jildaki (?-1342)

Who also lived for part of his life at Cairo, is of importance chiefly on account of his extensive and deep knowledge of Muslim chemical literature. He apparently spent the major portion of his existence in collecting and explaining all the books upon alchemy that he could discover, and labours are now beginning to receive their reward; for writings form an indispensable source of a great deal of our knowledge of chemistry and chemists in Islam. In a few instances it is possible to observe that he must have carried out experimental work himself, but for the most part his books are commentaries upon the works of earlier writers. Thus his great *End of the Search* is a commentary upon

Abu'l-Qasim's book *Knowledge acquired concerning the Cultivation of Gold*, and although his explanations are not seldom more obscure than the passages they are designed to illuminate, he had the admirable habit of making innumerable and lengthy quotations from Khalid, Jabir, Razi and many other authors, and his books are thus a rich storehouse of information upon Muslim chemistry. It is therefore necessary to inquire into the question whether his quotations and historical facts are authentic, and whether his reliability is to be accepted or doubted. Fortunately, it often happens that a book from which he quotes is extant, and his quotations in such cases can of course be checked. A test conducted on these lines has shown that Jildaki was conscientious and although he does not always come through unscathed, his general trustworthiness can be safely assumed. He thus deserves the warmest thanks of all who are interested in the history of chemistry.
Al-Tughra'i (1063-1120)
This alchemist, who was a civil servant under the Seljuks Malik-shah and Muhammad, has great importance as a poet and a writer. His *Lamiyyat al'ajam* is very famous. He was executed in 1121.
In his *Nihaya*, Jaldakl tries to appraise the scientific value of al-Tughra'l: he was the most important alchemist since Jabir; his style has become perfect but his books can only be read by those who are already advanced in the great art. In his *Kitab al-Masabt,h wa-l-maf tech* (The Lamps and the Keys), he reports the teaching of the Ancients; he is more theoretical than practical. He declares in his poem that he has inherited his alchemy knowledge from Hermes. According to Jaldakl, his most important book on alchemy is *MafAti,h al-rahma wa masabl,h al-,hikma*.
Al-Majriti ( -1007)
In Andalusia, under the Caliphat of al-Hakam II (961-76) flourished scholars in all the domains, including alchemy. One of these was Maslama b. Ahmad, from Cordoba, better known under the name al-Majriti because he lived for a long time in Madrid. He assimilated Muslim sciences in the Arab Orient where he seems to have had close contacts with the originators of the famous *Epistles of Ikhwan al-Safa'*. He brought to Spain a new edition of this encyclopaedia. He is known in particular for his astronomical work: a revision of the Persian astronomical tables in Arabic chronology, a commentary on the *Planispherium* of Ptolemy and a treatise on the astrolabe. The last two were translated quite early into Latin and were very successful .
An important alchemy work, *Rutbat' al-Hakzm wa mudkhal al-tathm* (Rank of the Wise Man and Isagoge oh! Teaching), is attributed to him, and an astrological work called *Chayat al-Haklm*. The last was translated into Spanish in 1256 by order of Alfonso the Wise, King of Castile and Leon (from 1252 to 1284), and later it became popular in Latin under the name of *Picatrix*. Rabelais in *Pantagruel* mentions it when he speaks of the "Reverend Father of Devil Picatrix, rector of the diabolic faculty in Toledo". The attribution of the book to al-Majriti was considered false as the internal critique shows that this work could only have been written after 1009, while al-Majriti died in 1007.
Holmyard redeveloped an interest in Rutbat al-Haklm. The author first expresses his views on the way an aspiring alchemist should be educated: by study mathematics, books from Euclid and Ptolemy, natural sciences with Aristotle or Apollonius of Tyana; then he needs to acquire a manual ability and practice precise observation, reasoning about chemical substances and their reactions; in his research he needs to follow the laws of nature, like a physician: a physician diagnoses the disease and administers the medicine, but it is Nature who acts.

## General Review of Muslim Chemistry

Until the time of Jabir, chemistry was 'without form and void'. The solid technical knowledge of the craftsmen was lost in the vapourings of occultists, and if there were any men with a more reasonable view of chemical science, its aims, its objects and its methods, we find no record of them. By the efforts of Jabir and Razi, the two Muslim chemical geniuses, much of the vast accretion of unbridled speculation was cleared away, and chemistry first began to take shape as a true science. Experimental fact was at last informed with the beginnings of reasonable theory, while on the practical side a workmanlike scheme of classification was evolved and a divide range of substances was carefully investigated and systematically characterized. The common laboratory methods of distillation, sublimation, calcination, reduction, solution and crystallization were improved and their general purposes well understood. The refinement of metals, by cupellation and in other ways, was brought to a high degree of perfection, and the careful assay of gold and silver was accompanied by extraordinary accuracy in methods of weighing and in the determination of specific gravity.
On the theoretical side, the idea that 'base' metals could be transmuted into gold or silver overshadowed every other. The generally accepted belief was that elixirs could be prepared which, by an action we should now describe as catalytic, would convert practically unlimited amounts of lead, mercury, tin, copper, or even iron into silver first and then into gold. There were alternative theories as to the means whereby transmutation could be effected, but as we may more conveniently study these in their later developments a mere reference to them in passing may be sufficient at the moment. The philosophical justification for the almost universal credence in the possibility of transmutation is

to be found ultimately in the Aristotelian conception of the Four Elements and proximately in Jabir's theory that all metals are composed of sulphur and mercury. Its practical justification lay in the elegant manner in which it explained numerous phenomena and stimulated unceasing research.

Chemistry, in the work of the great chemists from Jabir to the time of Avicenna, was concerned chiefly not so much with alchemy but with concrete technical matters such as the development of apparatus, the preparations of, and the study of their reactions. The development of chemistry in the period, although almost entirely empirical, was of great importance in that a new high level was attained in the accumulation of chemical data. The previous period of such great growth had taken place long before 3000-500 B.C., in Mesopotamia. In many ways, Muslim chemistry grew in the same manner as it did in Mesopotamia with the difference that the Arabs were more careful in their larger number of experiments, made careful notations of their laboratory results, and developed their laboratory apparatus to a high point of perfection. This was the real beginning of scientific method in the science of chemistry. Not only did the Muslims organize their scientific knowledge as did ancient Mesopotamians before them, but they used experiments to gain scientific data. Because of this accent on experiment in later times, there is much more practical discussion of the categories of matter in the Muslim literature than may be found in the Mesopotamian literature where appearances were of prime consideration.

Alongside experiment, logical speculation took its place in chemical science as an important adjunct. Although Muslim theorizing was grossly inadequate, it was, however, carried out by important chemists in an effort to explain results of laboratory work and not necessarily to add to the so-called 'natures'. This was a distinct Muslim advancement over their Greek, Egyptian, and Mesopotamian predecessors.

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# Alchemy in Ibn Khaldun's *Muqaddimah*

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# **Alchemy in Ibn Khaldun's *Muqaddimah***

Edited and prepared by Prof. Hamed A. Ead, Cairo University, Giza

## (1332-1395 C.E.)

**Abd al-Rahman Ibn Mohammad Ibn Khaldun** was born in Tunis in 732 A.H. (1332 C.E.) to an upper class family that had migrated from Seville in Muslim Spain. His ancestors were Yemenite Arabs who settled in Spain in the very beginning of Muslim rule in the eighth century, but after the fall of Seville, had migrated to Tunisia.

He received his early education and where, still in his teens, he entered the service of the Egyptian ruler Sultan Barquq. His thirst for advanced knowledge and a better academic setting soon made him leave this service and migrate to Fez. During his formative years, Ibn Khaldun experienced his family's active participation in the intellectual life of the city, and to a lesser degree, its political life. This was followed by a long period of unrest marked by contemporary political rivalries affecting his career.

The uncertainty of his career still continued, with Egypt becoming his final abode where he spent his last 24 years. Here he lived a life of fame and respect, marked by his appointment as the Chief Malakite Judge and lecturing at the AL-Azhar University, but envy caused his removal from his high judicial office as many as five times.

Ibn Khaldun led a very active political life before he finally settled down to write his well known masterpiece on history. He worked for rulers in Tunis and Fez (in Morocco), Granada (in Muslim Spain) and Biaja (in North Africa). In 1375, Ibn Khaldun crossed over to Muslim Spain (Granada) as a tired and embittered man solely for the reasons of escaping the turmoil in North Africa. Unfortunately, because of his political past, the ruler of Granada expelled him.

Ibn Khaldun's chief contribution lies in philosophy of history and sociology. He sought to write a world history preambled by a first volume aimed at an analysis of historical events. This volume, commonly known as Muqaddimah or 'Prolegomena', was based on Ibn Khaldun's unique approach and original contribution and became a masterpiece in literature on philosophy of history and sociology. The chief concern of this monumental work was to identify psychological, economic, environmental and social facts that contribute to the advancement of human civilization and the currents of history. In this context, he analyzed the dynamics of group relationships and showed how group feelings, al-'Asabiyya, give rise to the ascent of a new civilization and political power and how, later on, its diffusion into a more general civilization invites the advent of a still new 'Asabiyya in its pristine form. He identified an almost rhythmic repetition of rise and fall in human civilization, and analysed factors contributing to it. His contribution to history is marked by the fact that, unlike most earlier writers interpreting history largely in a political context, he emphasized environmental, sociological, psychological and economic factors governing the apparent events. This revolutionized the science of history and also laid the foundation of Umraniyat (Sociology).

Apart from the Muqaddimah that became an important independent book even during the lifetime of the author, the other volumes of his world history Kitab al-I'bar deal with the history of Arabs, contemporary Muslim rulers, contemporary European rulers, ancient history of Arabs, Jews, Greeks, Romans, Persians, etc., Islamic History, Egyptian history and North-African history, especially that of Berbers and tribes living in the adjoining areas. The last volume deals largely with the events of his own life and is known as Al-Tasrif. This was also written in a scientific manner and initiated a new analytical tradition in the art of writing autobiography A book on mathematics written by him is not extant.

Ibn Khaldun's influence on the subject of history, philosophy of history, sociology, political science and education has remained paramount ever since his life. His books have been translated into many languages, both in the East and the West, and have inspired subsequent development of these sciences.

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# Alchemy in Ibn Khaldun's *Muqaddimah*

Definition: Ibn Khalddun defines alchemy as "the science that studies the substance through which the generation of gold and silver may be artificially accomplished, and comments on the operation leading to it". The alchemists acquire knowledge of the tempers and powers of all created things, and they hope that they may come upon the substance that is prepared to produce gold and silver. They even investigate the waste matter of animals, such as bones, feathers, hair, eggs, and excrement, not to mention minerals.

Alchemy in Ibn Khalddun's opinion, comments on the operations through which such a substance may transformed from potentiality into actuality, as for example, by the dissolution of bodies (substances) into their natural components through sublimation and distillation, by the solidification of meltable substances through calcification, by the pulverization of solid materials with the help of pestles and mullers and similar things, the alchemists assume that all techniques lead to the production of a natural substance which they call "the elixir", and when some mineral substance, such as lead, tin or copper is heated in fire and some quantity of the elixir is added to it, the substance turns into pure gold. The alchemists used special terms for the purpose of mystification - they give the cover name of 'spirit' to the elixir and that of 'body' to the substance to which the elixir is added.

The science that comments on this technical terminology and on the form of the technical operation by which proposed substances are turned into the form of gold and silver, is the science of alchemy.

The chief systematic writer on alchemy, according to alchemists, is Jabir ibn Hayyan. Alchemists even consider Jabir's alchemy a special preserve and call it "the science of Jabir". He wrote seventy treatises on alchemy, all of them read like puzzles. It is thought that only those who know all that is in Jabir Ibn Hayyan's treatises can unlock the secrets of alchemy.

Al-Tughrai, a recent Eastern philosopher, wrote systematic works on alchemy and disputations with alchemists and philosophers.

Maslamah al-Majriti, a spanish philosopher, wrote on alchemy in the *Rutbat al-Hakim*. He wrote the *Rutbah* as a counterpart to his work on sorcery and talismas entitled *Ghayat al-Hakim*. He thought that the two arts (alchemy and sorcery) were both the results and fruits of philosophy and science, and that those who were not acquainted with them would miss the fruit of scholarship and philosophy altogether.
Maslamah's discussion in the Rutbah and the discussions of all (alchemists) in their respective works employ puzzling means of expression which are difficult to understand for those who have not familiarized themselves with the technical terminology of alchemists.
Works on alchemy are attributed to al-Ghazzili, but this attribution is not correct, because al-Ghazzali's lofty perceptions would not have permitted him to study, or, eventually, to adopt the errors of alchemical theories.
Some alchemical theories and opinions are occasionally attributed to Khalid b. Yazid b. Mu'iwiyah, a stepson of Marwan ibn al-Hakam.
Ibm Khaldun passes on here an epistle on alchemy written by Bakr b. Bishrun to Ibn as-Samh. Both were pupils of Maslamah. The discussion of (Ibn Bishrun) will show Ibn Khaldun's attitude toward alchemy.

## Ibn Bishrun's Treatise - [Extracts]

*Ibn Bishrun said that: "The premises of this noble craft were mentioned by the ancients. All of them were reported by the philosophers. Such premises are knowledge of the generation of minerals, of the creation of rocks and precious stones, and of the different natures of regions and localities."*
*Ibn Bishron explains what one needs to know of this craft?*
*"It has been said: The students of this science must first know three things: (1) whether exists, (2) what brings it into being, and (3) how it comes into being. If the student of alchemy knows these three things well, he achieves his object and knows as much as can be known about this science."*
*As to the problem of the existence of alchemy and the proofs for the (forces) that bring alchemy into existence, the elixir that we have sent to you is a satisfying answer. "The question of what brings alchemy into being implies, according to alchemists, search for the stone that makes the (alchemical) operation possible."*
*Potentially, the operation may be performed with any (conceivable) thing, because the (potentiality to perform the operation) comes from the four natures (elements). It originated from their composition at the beginning and will revert to them at the end.*
*However, there are things that might be used for the operation (only) potentially, not actually. This comes about as follows: There are some things that can be decomposed. There are others that cannot be decomposed. Those that can be decomposed can be processed and treated. They are the things that can be transformed from potentiality into actuality.*
*On the other hand, the things that cannot be decomposed cannot be processed and treated, because they have nothing but potentiality in them. They cannot be decomposed, in order to give some of the elements they contain an advantage over the others and to have the power of the bigger (elements) predominate over the lesser ones.*
*You - may God give you success - must therefore know the most suitable of the decomposable stones that can be used for the operation. You must know its genus, power, action, and which kind of dissolution or solidification, purification, calcification, absorption, or transformation it may be able to effect. People who do not know these basic principles of alchemy will never be successful or achieve any good results.*
*You must know whether (the stone) can be aided by something else or is sufficient by itself, and whether it is one (thing by itself) at the beginning or is associated with something else and becomes one (thing by itself) during the treatment, and is therefore called 'stone'. You must also know how it works; how much its components must weigh and what times need for it; how the spirit is inserted and the soul made to enter into it; whether fire can separate (the soul) from (the stone) after it has been inserted; if not, why (not), and what makes it necessary that it be that way.*
*It should be realized that all philosophers have praised the soul and thought that it is the soul that governs, sustains, and defends the body and is active in it. For, when the soul leaves the body, the body dies and gets cold. It cannot move or defend itself, because there is no life in it and no light. I have mentioned the body and the soul only because this alchemy almost is similar to the body which is built up by regular foods and which persists and is perfected by the living, luminous soul, which enables the body to do the great and mutual things that only the living power of the soul can do. Man suffers from the differences of his component elements. If these elements were in complete harmony, it will not affected by accidents and contradictions, so the soul would not be able to leave his body, as a result man would then live endless. Praised be He who governs all things, He is exalted.*
*It should be realized that the natures (elements) producing the (alchemical) operation constitute a quality that pushes forward at the beginning, and must reach end. When they have reached this limit, they cannot be*

*transformed (back) into the (state) that (formed the starting point of) their composition, as we stated at the out-set with regard to man.*
*The natures of the substance had been separate, but now they adhere to each other and have become one thing, similar to the soul in power and activity, become one and similar to the body in having composition and pulse.*
*An early alchemists has said that: "Decomposition and division mean life and duration, as far as the alchemical operation is concerned, while composition means death and non being." This statement has a subtle meaning. The philosopher meant by 'life and duration' its transformation from nonexistence into existence. As long as it remains in (the state of) its first composition, it is, no doubt, non being. But when the second composition takes place, non being no longer exists.*
*Now, the second composition comes about only after decomposition and division. Thus, decomposition and division are peculiar to the (alchemical) operation. If it is applied to the soluble body (substance), it spreads in it, because it has no form, since it has come to take in the body the place of the soul which has no form. This is because it has no weight as far as (the substance) is concerned.*
*You must know that mixing a fine thing with another fine thing is easier than mixing a coarse thing with another coarse thing. This similarity in form among spirits (on the one hand) and bodies (substances, on the other hand),because things related to their forms.. I mention this to you, so that you may know that the alchemical operations is more easier and simpler if it is undertaken with fine spiritual elements than if it is undertaken with coarse substances. It is logical that stones are stronger in their resistance to fire than spirits. Likewise, gold, iron, and copper are observed to offer more resistance to fire than sulphur, mercury, and other spirits.*
*Therefore, I say: The substances were spirits at the beginning. When the heat of the natural process affects them, they are transformed by it into coarse, coherent substances and fire is not able to consume them, because they are exceedingly coarse and coherent. When an exceedingly great amount of fire is applied to them, it turns them again into spirits, as they had been when they were first created. If fire (then again) affects the fine spirits, they flee and are not able to endure it. Thus, you must know what brought the substances to their particular condition and (what) brought the spirits to theirs. That is the most important knowledge you can have.*
*I say: The spirits are burned, because of their combustibility and fineness. They became combustible because of their great share of humidity. When fire notices humidity, it attaches itself to it, because humidity is airy and similar to fire, which does not stop eating it until is consumed. The same applies to the substances when, they approach of fire, they flee, because they have little coherence and are coarse. But they are not combustible, because they are composed of earth and water which offers resistance to fire, in that the fine components of water unite with its coarse components through a long cooking which softens and mixes things.*
*"We are now going to speak about the stone that makes the alchemical operation possible, as mentioned by the philosophers. They have held different opinions about it. Some have thought that it is found in animals; some have thought, in plants; some have thought, in minerals; and, according to some, in everything. We do not have to examine these claims and enter into a dispute concerning them with the people who make them, because that would be a very long discussion.*
*I have already stated that the alchemical operation might potentially be performed with anything, because the elements exist in every thing. This is so. "We want to know what produces the (alchemical) operation (both) potentially and actually. Therefore, we turn to the statement of al-Harrini that all dyeing "' consists of two types. One may use a substance such as saffron, which is used to dye a white garment. The (saffron) eventually changes in it, vanishing and being decomposed. While the second dyeing is transformation of the substance of one thing into the substance and color of something else. Thus trees, for instance, transform the soil into themselves, and animals the plants, so that eventually the soil becomes plants, and the plants animals. This can come about only with the help of the living spirit and the active nature (kiyan) which has the ability to generate substances and change essences.*
**Ibn Khaldun continues........**
Here ends the discussion by Ibn Bishrun, one of the great pupils of Maslamah al-Maj'riti, the Spanish authority on alchemy, letter magic, and sorcery, for the third [ninth] century and later (times). One can see how all the expressions used by (alchemists) tend to be secret hints and puzzles,difficult to explained or understood. This is a proof of the fact that alchemy is not a natural craft.
The truth with regard to alchemy, which is to be believed and which is supported by actual fact, is that alchemy is one of the ways in which the spiritual souls exercise an influence and are active in the world of nature. (It may) belong among the (miraculous) acts of divine grace, if the souls are good. Or it may be a kind of sorcery, if the souls are bad and wicked.
It is obvious that (alchemy may materialize) as a (miraculous) act of divine grace. It may be sorcery, because the sorcerer, as has been established in the proper place, may change the identity of matter by means of his magic power. People think that a (sorcerer) must use some substance (in order) for his magical activity to take place. Thus,

certain animals may be created from the substance of earth, of hair, or of plants, or, in general, from substances other than their own. That, for example, happened to the sorcerers of Pharaoh with their ropes and sticks. It also is reported, for instance, of the Negro and Indian sorcerers in the far south and of the Turks in the far north, that by sorcery they force the air to produce rain, and other things.
Now, since alchemy is the creation of gold in a substance other than that of (gold), it is a kind of sorcery. The famous sages who discussed the subject, men such as Jabir, Maslamah, and other non Muslim predecessors, followed this line.Therefore, they used puzzling expressions. They wanted to protect alchemy from the disapproval that religious laws express for the various kinds of sorcery. It was not because they were reluctant to communicate it (to others), as was thought by people who did not investigate the matter thoroughly. One may compare the fact that Maslamah called his book on alchemy *Rutbat al-hakim*, while he called his book on sorcery and talismans *Ghayat al-hakim.* He wanted to intimate that the subject of the Ghayah is a general one, whereas the subject of the Rutbah is a restricted one, for final goal is a higher (stage in research) than rutbah degree, rank. The problems of the Rutbah are in a way part of the problems of the Ghayah, or deal with the same subjects. (Maslamah's) discussion of the two disciplines clarifies what we have said. Later on, we shall explain that those who assume that the achievements of alchemy are the result of a natural craft are wrong.
(Based on the English translation of the "Muqaddimah" by F. Rosenthal)

# Arab Medical Schools during the 12th and 13th centuries

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# -I-

## The status of Medicine in the Islamic World

The Scientific movement in the early Islamic centuries has various aspects. One of them is the contribution of the early Arab Scientists, which took different forms, their role in scientific progress, the theories they have provided us with, and their methods and influence on the western world which started, as a result, viewing science in a new light during the middle ages.
In fact it is not easy to divide the whole unity of science, and claim that this science belongs completely to the Greeks or the Arabs or the West. It is not possible to divide science because it does not belong to one nation, nor to one race. It is the result of co-operation, and communication, among scientists and many other factors. This paper considers the case of medicine in the Arab Islamic World and investigates its nature and schools.
To understand the nature of Arab medical schools in the Arabic Islamic World, we have to deal with the status of medicine before the 12th century; the Bimaristans: their system and different purposes; medical educational assemblies: their role in configurating physicians' minds and the method that was followed and then conclude with the results. It is worth noticing that examples have been provided.
Medicine was the first science that the Muslims knew in their environment. The ancient Arabic sources mention Al-Harith Ibn Keladah (d. 634 A.D), the Arabian who travelled from the Arab peninsula to Persia to study medicine in Jundisabur where there was a well known Bimaristan (hospital). After he had finished his studies in Jundisabur, Al-Harith returned home to practise his science and to treat those who were in need of his knowledge.
The ancient sources inform us about Al-Harith especially Ibn Golgol , the most famous historian in the fourth century of Hijra (10th century), who said that Al-Harith «studied medicine in Persia and Yemen and was alive in the days of the Prophet**(1). According to other sources (2) , the Prophet advised Saad Ibn Abi Waq'qas when he was sick to consult Al-Harith, the physician.**
**The power and authority of physicians began to increase during the rule of Mu'awiyah (660-680), who founded the Umayyad state. Mu'awiyah ordered his men to bring the best physicians from Jundisabur to care for his health, specially that he was afraid his enemies (3) might poison his food.**
**No doubt the successive physicians made great contributions and were the pioneers of medicine during the rule of Mu'awiyah and his sons. During the rule of Umayyad Caliph Marawan Ibn al-Hakam (d. 685), the**

**Persian physician Masarjawayh played a vital and effective role, when he started, by order of Marawan, to translate the Medical Encyclopaedia of the Alexandrian priest Ahrun, from Syriac into Arabic. Masarjawyh's translation of Ahrun's book is considered to be the first translation of a medical book in Islam from a foreign language into Arabic (4) .**

**The Abbasids represent a very strong and important stage in the development of science, because they encouraged scientists, and tried to establish a solid scientific movement in the Islamic world, especially after they chose Baghdad to be the new capital, instead of Damascus. As we know the Abbasids were rationalistic. Most of the Caliphs were among the "Mutazilah scientists. The adoption of rationalism led to the flourishing of the sciences through the Islamic academy of science "Bayet al-Hikma" (5) (the House of Wisdom).**

**Practising medicine in Baghdad during the Abbasids rule was the responsibility of two families: (1) The family of Bukhtishu, and (2) the family of Masaway.**

**The Bukhtishu family came to Baghdad by the order of the Caliph Al-Mansour who was sick and suffering from pain in his stomach. He sent his men to bring Georges b. Jibril b. Bukhtishu to treat him in the year (148H. / 765). Georges was the chief physician (rais al atibba) in Jundisabur (6) .**

**When Georges left to Jundisabur after four years he ordered his son to stay in Baghdad to continue his mission. Both father and son wrote medical books in Syriac which were later translated into Arabic by Hunain b. Ishaq .**

**Hunain b. Ishaq (194-264 H.) who took the lead in the official movement of translation, was one of the most important figures both in translation and medicine. He translated the books of Hippocrates and Galen, and wrote down many medical books among which is his famous one about the eye (Al Ashr Maqalat fi al-'Ayn) *The Ten Treatise on the Eye* - Max Meyerhof verified and studied it critically (7) . The book of Hunain is considered the first scientific attempt towards Ophthalmology.**

**While the process of translation was going on, The Arabs began to organise Medicine as a profession, especially the bimaristans (hospitals) and practicing medicine among people.**

**Ancient Arabic sources - like al-Qifti (8) and Ibn Usaibi'ah (9) - mentioned that the real organisation of medicine took place by the order of al-Muqtadir who wrote to Sinan Ibn Thabit b. Qurrah to examine those who want to practice medicine and give them Ijaza (certificate). This was in the tenth century.**

**No doubt we have some good knowledge about the contribution of the Arab Muslim physicians who took part in the process of developing medicine (10) , such as al-Razi (Rhazes 850-923), Ibn Sina (Avicenna 980-1037), al-Zahrawi (Abulcasis 1013) and Ibn an-Nafis. let us look at the case of al-Razi and Ibn Sina, and their effect in medicine.**

**1- Al-Razi was one of the well known Muslim physicians in the West during the Middle Ages. Ibn al-Nadim enumerated the works of al-Razi among which are these major works: (1) Kitab al-Asrar *The Book of Secrets*, (2) Kitab al-Tib al-Mansuri *Liber Almansouris*, (3) Kitab al-Hawi (11) *The Comprehensive Book*, and (4) A Treatise on al-Judari wa al-Hasbah *Small pox and measles*.**

**Kitab al-Asrar was first translated into Latin by Gerard of Cremona (d. 1187), while Kitab al-Tib al-Mansouri appeared in the Latin translation in Milan in 1480, and so did the treatise on al-Judari wa al-Hasbah. As for al-Hawi (Continens) its translation had been made by Faraj Ibn Salim in 1279, and reprinted many times in Latin. This book had a great influence in Europe. Montgomery Watt, while dealing with al-Razi said "His greatest work is one translated into Latin as the Continens, *The Comprehensive Book*. It was an encyclopedia of all medical science up to that time, and had to be completed by his disciples after his death. For each disease he gave the views of Greek, Syrian, Indian, Persian and Arab authors, and then added notes on his clinical observations and expressed a final opinion." (12)**

**2- Ibn Sina was known as a philosopher and physician. His fame in these two fields was the cause of his influence in the West. Here we are dealing with his medical contribution that became so evident in his famous work Kitab al-Qanun fi al-Tib. *The Organon in Medicine*. This book was translated by Gerard of Cremona into Latin and published in Europe several times. The importance of al-Qanun came from two things:**

**a) Its well organized data, its method and scientific style. This is because Ibn Sina was a good philosopher and had an organized logical mind.**

**b) His description of some diseases such as mediastinitis and pleurisy. Also he mentioned the nature of phthisis and the spreading of diseases by water and soil, and gave the right diagnosis of ankylostomiasis (13) .**

# -II-

# Bimaristans in the Islamic World

Those who learn and study medicine and practice it as a profession must work in hospitals to get experience and practice the medical profession, so that they gain this experience from the cases they examine under the supervision of master scientists. Von Grunebaum says about the necessity of hospital visits for medical students "The medical student must always visit the hospitals and must be very careful of the conditions and situations of the persons found there, while he is accompanied by the most intelligent medical teachers, and must ask about patients' conditions, their symptoms, remembering what he read about changes and their significance whether good or bad. If he understands these things he will achieve a high rank in his profession **(14)** .

So, it is evident that the medical - teaching in that time - had bases and rules and was practiced in the Bimaristans. To be acquainted with the rules of the process of medical teaching that dominated. The Islamic world, we have to study first the origin of the Bimaristans and their development in order to know their importance for medical teaching generally.

Ibn Abi Usaibia'h said: "Hippocrates cared greatly about his patients and their treatment. It is said that he was the first to invent and build the Bimaristan and the first to renew it, by allocating - near his house - part of his garden for the patients and assigned some servants to perform the treatments. He called this the «Akhssendokin», i.e. a patient complex. Also the word Bimaristan-which is of Persian origin-has the same meaning as (Bimar) in Persian means disease and (stan) is location or place, i.e. location or place of disease **(15)**. This is the text we find in the «Uyun al-Anba» of Ibn Abi Usaibi'ah about the historical development of the Bimaristans or hospitals. But Max meyerhof **(16)** mentioned that the first hospital to be built in the Islamic world is that which was based in Baghdad by the order of Harun al-Rashed; then hospitals were built successively everywhere. Does Meyerhof's opinion present the absolute truth, or does this opinion contain some clear fallacies?

Ibn Qutayibah al-Dainuri was interested in his book ***Leadership and Politics*** **(17)** in throwing light on some important matters relating to Islamic history. He mentioned that the first Bimarastan or hospital was built for the Muslim army-after Abdallah Ibn al-Zoubair when he was blockaded in Mecca, built a tent on one side of the Mosque, so that when one of the Sahaba (Prophet's followers) was wounded he would be brought inside the tent to be treated and to be cared for by skilled persons. That is how the first type of Bimarastan (hospital) was built in Islam. This is the Arab Bimarastan (hospital).

Moreover we find other proofs in (Ibn al-Atheer) in ***al-Kamel*** **(18)** and al Maqrizi in ***Maqrizi Plans*** **(19)** which denote that al-Waleed ibn Abdel Malik was the first to build a Bimaristan it the real meaning of the word in Islam in 88 Hijri. Noushirawy **(20)** in his new book on ***Islamic Brimaristans in the Middle Ages*** seemed to adopt this opinion and he mentioned that the first Bimaristan built in Islam was in Damascus, by al-Waeed b. Abdel Malik (705-715 A.D) and built in 86 Hijri (706-707 A.D.). The aim of its building was treating patients and the care of affected chronic patients-as lepers and blind people... etc. The leprotics were imprisoned, treated freely and given money. In the Bimaristan there were more than one physician. It is obvious that Noushirawy adopted what was mentioned in ***(al-kamel)*** of Ibn AL-Atheer on this poing specifically. A person has great importance and consideration on this subject, is Ahmed Bey Issa **(21)** who was the first to write clearly about the development of the Bemaristan and its history in Islam, and he mentions that the Prophet Mohamed (may peace and prayer be upon him) was the first to order the establishment of mobile military Bimaristans. It is natural that this last opinion has its importance and consideration, because Muslims were rushed in many invasions in which they were attacked and injured. There was lots of chaos, and men were wounded or killed here and there. It was normal that there should be those who cared for these people and looked after their treatment, and hence complete care was provided for the fighters. This last opinion agrees with what Ibn Qutaiba al-Daynuri mentioned.

**1- The Bimaristan system:** The people who are interested in establishing any institution must set an administrative or technical system to be followed. Of course the physicians in the Islamic world put in mind to follow a precise system inside the hospitals so that it would be based upon academic graduation which fulfills two amis: First, the welfare of the patients to be dealt with their treatment according to the updated rules of medical treatment. Second, Bimaristans used for teaching medicine to the newly graduated physicians responsible to treat patients successfully. Therefore the Bimaristans in the Islamic world were followed all the technical rules that fulfilled the two purposes together.

Ibn Jubair **(22)** mentioned what he observed in the hospitals concerning work. Also Ahmed Bey Issa mentioned in his book **(23)** ***Bimaristans in Islam*** Amin Assaad Khayrallah **(24)** in his book ***Arab Medicine*** and Nushirawy **(25)** in his book ***Islamic Bimaristans in Middle Ages*** mentioned the administrative, technical and teaching organization existing in that period in the hospitals.

Concerning the technical choice of bimaristanic site they used to choose the best location with regard to the health conditions. They preferred to build the Bimaristans over hills or by rivers. Al Adoudi's bimaristan is a good example

of this; it was built by Adoud al-Dawla b. Bawaih **(26)** in Baghdad by the River Deglah and the water of the river flowed through its courtyard and halls and returned to pour into Deglah.
Concerning organization, it was natural that the physicians comprehended the necessity of separating men and women, therefore they took into consideration as much as possible to divide the Bimaristan into two sections, one for men and the other for women. Each section was independent, each having large halls for the patients.
Concerning the administrative organization of the Bimaristan, it was as follows: each section contained a hall for each type of disease, while each hall had one physician or more and each group of doctors in a section had a chief doctor. The halls were specialized: a hall for internal diseases another for splinted patients, another for oculists, and another one for delivery a special hall for each type of disease including communicable diseases **(27)** .
Ibn Abi Usaibi'ah discribed in his book Uyun al-Anba **(28)** , the halls of internal medicine which frequently included a section for the patients affected by fever and another one for patients having mania. All sections of the Bimaristan were equipped with all the medical instruments and apparatuses necessary for the physician.
Ibn Abi Usaibi'ah tells us **(29)** that Adoud al Dawla set a test for a hundred physicians, when he decided to build the Adoudian Bimaristan on the Western side of Baghdad, and he chose twenty four physicians out of the hundred to work in the Bimaristan.
The chief of all physicians in the hospital was called (AI Saoor). The administrative and medical system in the hospital was based upon using boys who worked as employees or health workers, assistants or dressers; some of them were servants and they cleaned the Bimaristan and cared after the patients when necessary.
According to this order and system the Bimaristan was performing its medical job from a diagnostic point of view, disease definition and prescription of treatment. Moreover, they understood the necessity of adjoining a pharmacy to the Bimaristan to give out the drugs, which were given according to the physician's prescription, and the pharmacy was called «Al Sharabkhana» **(30)** .
And as it is the case today, they used to inspect the Bimaristan. This was the responsibility of an employee assigned by the minister or the Caliph and given the authority to enter the hospital to be acquainted with the patients' status and the care offered to them, the food given to them and whether the boys were serving them or not. Whether the physician is performing his duty perfectly or he neglecting it. This system assured the stay and continuity of the Bimaristan in a serious way that allowed it to work with a high competence technically, scientifically and administratively.
It is worth mentioning that each patient had his own card on which the physician recorded his observations while treating the patient. Also the phsician had his own special register to record his observations on the diseases he was treating. The physician performed his experiments and tests according to his observations. If the physician faced any problem in any matter of diagnosis, he went to the head of his division or the chief physician. Frequently the physicians held meetings to discuss cases. Undoubtedly these discussions and consultations were considered as a small scientific conference of physicians. We do the same today.
We notice that the historians of Arab medicine wrote special long pages on the medical personalities about whom discussions were held to set the work system in the hospital, or the Bimaristan between the physicians. There were shifts for the doctors, some worked in the morning and others at night, some worked a certain time in the morning and another period at night, so that they cared for the patient. At the same time they could get enough rest to allow them to continue working in the Bimaristan, supervise the treatment system and medical care of the patients.
Al-Maqrizi mentioned in his plans **(31)** that the patients were registered at the admission in the Bimaristan, their clothes were taken away and their money put in trust by the Bimaristan guardian. The patients received clean clothes instead of those taken from them, and they were given drugs and food under the supervision of the physicians freely till they were cured.
Ibn al-Okhowa described in his book (al-Hisba) the entrance of the patient to the outpatient clinic to see the physician. He said in a very important text «the physician asks the patient about the cause of his illness and the pain he feels. He prepares for the patient syrups and other drugs, then he writes a copy of the prescription to the parents attending with the patient. Next day he re-examines the patient and looks at the drugs and asks him if he feels better or not, and he advises the patient according to his condition. This procedure is repeated on the third day and the fourth... till the patient is either cured or dead. If the patient is cured, the physician is paid.
If the patient dies, his parents go to the chief doctor, they present the prescriptions written by the physician. If the chief doctor judges that the physician has performed his job perfectly without negligence, he tells the parents that death was natural; if he judges otherwise, he tells them: take the blood money of your relative from the physician; he killed him by his bad performance and negligence. In this honorable way they were sure that medicine is practiced by experienced well trained persons **(32)** .

**2- Bimaristan Varieties according to different Purposes**

In the early Islamic state, Muslims comprehended the different form and purposes that should be considered in Bimaristans. Normally, they should deal with this point seriously, precisely due to its importance to the patient and the physician as well as the desired degree of care for the patient. Certainly the Bimaristan established to serve the fighters in the battle field during the hustle of the battle must differ from that built for the patients affected by mental disease who do not have to hustle, but doctors might hustle away from them but this is different, or those built for a commercial caravan or the pilgrimage to Al-Kaaba.... and so on.

Each type of diseases might require a special Bimaristan for a group of patients. This can be noticed at least by specialization of Bimaristans for leprotics and mentally affected patients.

**a) Mental Disease Bimaristan**

Muslims realised the importance of the care for mentally affected patients. They frequently added to the big Bimaristans special places isolated by iron bars, specially for patients with mental diseases **(33)** , to avoid the aggression of these patients on the others.

Muslim physicians knew that psychiatric and mental diseases required a special type of care and that the physician must be acquainted with the etiology of the disease from which the patient is suffering.

It is worth mentioning that Ibn Abi Usaibi'ah **(34)** tells us in his book (Uyun al-Anba) about some cases of this type of disease and how the skilled doctor Waheed al-Zambian could treat them. One of the patients thought that he had a tun over his head that never leaves him; he was afraid that the tun might break while he was walking, therefore he walked carefully to avoid breaking it. Some doctors tried to treat him but they failed. Lastly he saw Waheed al-Zaman who realized that the man was suffering from illusions. He told his family: «bring him to the hospital. Waheed al-Zaman ordered one of his boys to bring a big stick and hit the head of the patient-while Waheed al-Zaman talks to him-as if he wants to break the tun that the patient pretends having on his head, in the same time he asked another boy to throw a tun- that he prepared for him-from the house top, the moment the first boy hits above the head of melancholic patient, to the ground. When the patient came, Waheed al-Zaman started to talk to him, disapproved he was carrying the tun, he gave the boy a signal and he started to hit over the head of the patient with the woody stick, in this moment the other boy threw the tun from the house top which caused a great noise and broke to many pieces. When the patient saw what happened to him and saw the broken tun he did not doubt that it was the tun he was carrying -in his imagination - this influenced him and he was cured from his illness.

**b) Leprotic Bimaristan:**

This was built specially for leprotics. At the start of our talk about Bimaristans we referred to what Nushirawy mentioned about al-Waleed b. Abd al-Malek saying that he was the first who was interested in establishing such types of Bimaristans.

According to Ibn al-Qifi **(35)** , the first who wrote a book on «Leprosy» was Yohan b. Masaway. The cause of interest in such a disease arises from the Muslim's idea of isolating the patients who had communicable diseases from the rest of the society. We find the same behaviour with the doctors of today towards such liseases.

**c) Road Bimaristan:**

Arabs knew this type of Bimaristans and they realized its importance, because the pilgrimage to Holy places or the commercial caravans that travailed for long distances required care for the travelers, such as treating wounded persons or saving a person asking for help.

Therefore, they equipped the caravans with medical missions where physicians worked and had boys to help them. Ibn al Qifti presented to us an important test while he was talking about «Al-Hakam b. Ali al-Hakam al-Damaski», he said «he was a doctor in the beginning of «Al Abbassid state», Mu'awiyah b. Abi Sofian sent him as a doctor with his son Yazeed to Mecca when he sent Yazeed as Emeer of the pilgrimage in that epoch. Al-Hakam said: He is the doctor my father sent with Yazeed when he went to Mecca and I was the doctor who went with Abd al Samad b. Ali b. Abd Alla b. Abbas to Mecca **(36)** .

Undoubtedly, Ibn al-Qifti's text we just mentioned kept the oldest idea about this type of Bimaristans. Ibn Katheer **(37)** pointed out in his book (The Beginning and the End) that road Bimaristans were conducted by a wise director who knew how to give treatment: The rich people, who had the ability to equip the caravans with medical missions supported those Bimaristans financially.

**d) Prison Bimaristan:**

The Muslims cared medically for the imprisoned the same way they did for people outside the prison. This is clear from the letter the minister, Issa b. Ali al-Garrah **(38)** Minister of al-Moktader, to Sanan b. Thabit al-Tabeib al-Natassi who was distinguished in Arab medicine and who embraced Islam at the hands of Al-Qaher. After Issa b. Ali had visited the prisons, he found it was necessary to treat the patients and preserve their humanity so, he sent his famous letter to Sanan in which he said: «I thought-May God prolong your life-of the imprisoned and they are exposed, due to their big number and their hard situation, to diseases; they are incapable to deal with their excretions or to meet doctors to seek their advice about diseases. You have - May God grant you honor - to assign physicians to visit them daily and they should carry with them drugs and syrups and all they need to treat the patients and cure illnesses with God's will. Sinan followed this advice» Also according to what Ibn al-Qifti mentioned al moktader asked Sinan b. Thabit to build a Bimaristan and give it his name. He ordered one at Bab Al-Sham and called it The Moktader Bimaristan and financed it with 200 Dinars monthly **(39)** This was in 306 Hijri and Sanan b. Thabit was assigned as chief doctor. When al-Moktader was told that one of his physicians had killed a man by mistake, he ordered Sinan to perform a test for the physicians. So, they were tested in Baghdad and their number became eight hundred physicians **(40)** .

It was Sinan b. Thabit who financially supported al-Sayeda Bimaristan, according to what Ibn al-Qifti said «On the first of Moharam 306 Hijri, Sinan b. Thabit inaugurated Bimaristan al-Sayeda in the Yahia Market and he stayed in it and he organized the work of physicians in it. Each month 600 Dinars were spent on the Bimaristan by Youssef b. Yahia al-Monajem because Sinan did not contribute to the expenditure of the bimaristan **(41)** .

**e) The Mobile Bimaristan:**

This type of Bimaristan visited villages, peripheries and cities caring for the health of people who lived away from the state capital and allowed the state services to reach anyone who needed treatment in the state.

Ali b. Issa al-Garrah - al Muqtadir's minister - ordered the first state physician Sinan b. Thabit, in a written letter, to let doctors travel to the peripheries of the state. He said in his letter «I thought of people who live in the peripheries and that among them are patients who do not receive any medical care because there are no doctors there. So, assign - May God prolong your life-some physicians to visit the peripheries; also a pharmacy containing drugs and syrups. They have to travel all through the peripheries and stay in each region enough time to perform treatment of patients, then they move to another one **(42)** .

It was the state's responsibility to care for the Bimaristans. The senior physicians were aware of establishing work rules and bases to teach the students who came to learn medicine from everywhere. Therefore, medicine schools were established in the Islamic world, in which teaching was performed by two methods:

1- The theoretical method in the medical schools, and 2- A practical method for training and practice where students gathered around the doctor in chier to see and examine the patients and the treatment he prescribed. When the students finished the studying period they applied for an exam, took an oath and got their certificates. When they started to practice medicine, they always worked under the state's supervision. This means of course that the Bimaristans were institutes for teaching medicine and to complete the study for junior doctors **(43)** . From a practical point of view, the professors prescribed the treatment for the patients, they examined them in the presence of the students who received their learning through professors, they writing their instructions. They performed these instructions in an organized way and they did a follow up to the patients and hence they acquired the necessary practical experience for a medical student. Muslim contribution in the field of medicine can be exposed throughout three main points which are, (1) the medical assemblies, (2) Al-bimaristan, and (3) the method that they followed.

# -III-
# Medical Educational Assemblies

Educational assemblies spread throughout the Islamic world through a methodological system. They were sometimes sponsored by the state but most often by the scientists. This has always been their system. We know that a scientist is known by his assembly, his students, and followers, as well as by the influence he has on the following generations, as each of his pupils reflects him; therefore scientist are always careful to teach pupils in their assemblies in a special way different from other teachers.

The Arab Historian Ibn Abi Usaibi'ah, recognized and wrote down many things related to science and scientists in his book (Uyun al-Anba Fi Tabaqat al-Atibba) ***Sources of Information on the Classes of Physicians***. He mentioned many characteristics concerning scientists assemblies. The medical assembly of Amin al-Dawla b. al-Thalmeed who knew many languages specially Syriac and Pahlavy as well as Arabic **(44)** , devoted himself to teach new generations, with the condition that they should master the Arabic language, and if any of his students committed grammar mistakes or if his Arabic seemed not good in construction he sent him to a grammarian to take care of and examine him after that. The assembly of Amin al-Dawla b. al-Thalmeed was probably the biggest assembly of science held at that time. Ibn Abi Usaibi'ah mentions a quotation by Mowafak al-Deen Abdel Latif b. Youssef to have said: «A man entered upon him bleeding in summer time so he asked his pupils who were approximately fifty and they did not know the illness» **(45)** .

Scientifc assemblies between physicians sometimes were held in the Bimaristans, we find Zahed al-Ulama who established al-Farki Bimaristan assembling his pupils there to answer their queries **(46)** .

Most educational assemblies acquired the form of a debate. Seif al-Deen al-Amidi's assembly adopted this form and eventually people praised «his eloquence in debating and research» **(47)** . So did the assembly of Shams al-Deen Ibn Al-Laboudi who «became strong in arguments, good at debating» **(48)** .

Sometimes during science assemblies, a physician wrote books for the students who had graduated under his teaching and who had become themselves teachers of science. The writing of books in this case was not meant for teaching or dictating but they were meant to urge the students to more studies and comprehension **(49)** .

Arab physicians' way of teaching had its characteristics and Abou Bakr al-Razi, maybe the physicians' leader and one of the best physicians of his time to preserve for us in their writings the essentials that a physician should know well, and that teachers should engrave in the pupils mind.

These teachings were not just theoretical, but they came out of experience and practice, Abou Bakr al-Razi was the best clinical physician, had no competitor in this field, beside being a good teacher of medicine and its writing. His book (The Guide or al-Fusul) is a good example. During his teaching sessions pupils crowded around him in circles according to the precedence of their joining these sessions. He used to present them patients and let them ask about the illness and try to diagnose it; if they failed he would intervene and give the final decision» **(50)** .

This quotation refers to many things in the field of medical education by these professors and their assemblies either in the Bimaristans or outside them. Al-Razi's educational assembly was of two kinds, one for theoretical teaching the other for the practical one **(51)** . Theoretical teaching took the form of debates between three groups of students; the group in the circle nearest to him were the more advance in learning and practice. Next came the second group of those with less experience and last came the third circle in which new students were grouped. He read to them, explained, argued and listened to their debates answering their queries. Whenever he detected an intelligent pupil he moved him to a circle nearer to him in which he had to spend three years. So he spent one year in each circle. During this period he was taught anatomy, physiology or organ properties and pathology.

As for the practical teachings, like during his theoretical ones, students placed themselves in circles around the patient's bed in the hospital. He explained to them rare cases one after the other. In this way al-Razi used the patient as a book to be read daily and continuously to be able to understand the symptoms of his illness **(52)** .

The most important thing in this matter, is that the teacher explained to his pupils in the assemblies each case he examined and noted his questions and his observations in a special page. He started by asking the patient, and the pupils around him, asking his name, age, country of origin, trips and his illness, the date it started, place of pain and symptoms. He assured that the patient was the best person to explain the extent of what he feels. He also asked the patient about his family and its members, and whether they felt the same symptoms.

To achieve all that, al-Razi examined his pupils and graduates. He asked first in the field of anatomy, and if the pupils failed to answer, he did not continue the clinical examination because their failure in this subject made them unworthy even if they passed the clinical exam **(53)** .

Mohazb al-Deen abd Al-Rahim b. Ali al-Dakhwar's assembly in the second half of the sixth century Hijri and the first quarter of the seventh century Hijri, was the same. Students used to gather around him in the Bimaristans while he examined patients. He taught them and explained the cases in front of them. One of his students, Ibn Abi Usaibi'ah, says: «I saw him once in the hall of the fevered; doctors felt the pulse of one patient and diagnosed weakness and prescribed chicken soup to give him strength, he said that his speech and the look of his eyes denoted weakness, then he felt the pulse of his right hand then of the other and said: Feel the pulse of his left hand, we found it strong, he then said: look at his right hand and how near his elbow the vein divides in two branches one remains and can be felt the other moves over the ulna towards the fingers, which we found true. He then said: this is a rare case but some people show this phenomena, and many physicians diagnose it wrong as weak pulse but it is just that they are feeling half the vein **(54)** . This is the scientific point of view of al-Dakhwar he had inherited from his medical ancestors who had laid the foundation of medical practice in the Islamic world. This is not strange, as al-Dakhwar studied al-Razi's writings and understood it well. He absorbed the instructions and descriptions of clinical cases that al-Razi mentioned in his book (Al-Hawi).

When al-Dakhwar finished in the Bimaristan he devoted his time first to transcription, studying and reading, then to his pupils. He asked them in «They came in and so did groups of doctors and practitioners, each read his lesson, discussed it with him explained it as much as he could then if there was need for further explanation or if there was a problem he would discuss it with the best of the attendants **(55)** . This was his system, and he explained the introduction of medicine in the same way, explaining its meanings and construction facilitating it to students.

Al-Dakhwar's system in theoretical teaching had a special character. He scrutinized the next he had, and tried as much as possible to bring out a text without mistakes, whenever someone read to him, "he would have a copy of the text in his hands, he looked at it, and compared it, if he found a mistake in the copy being read he would order its correction" **(56)** . Al-Dakhwar persisted in the accuracy and precision of the copy, Ibn Abi Usaibi'ah says: Sheikh Mohazab al-Deen's copies that were read to him were very accurate, most of them were in his hand writing. He surrounded himself with all he needed of medical books language books Abou Hanifa al-Danoury's botany book **(57)** . These are the tools that a scientist needs to perfect his research. After Al-Dakhwar's assembly was over and the attedants left, he returned to his private life ate something then spent the rest of the day studying and reading and stayed a good part of the night working **(58)** .

This was al-Dakwar's scientific assembly, where, he taught many pupils and physicians. He wanted scientists to remember him and commemorate him, therefore he transformed his home into a school for medicine, and it was considered one of the best known schools in Damascus, and was known in the history of Arab medicine as the Dakhwarian school the reputation of which in the seventeenth century Hijri spread all over the world. And from it graduated many well known doctors who spread all over the world presenting mankind their knowledge and studies. Al Dakhwar succeeded in inspiring his students with the correct scientific doctrines which he himself had learned in his teacher, Tag al-Deen al-Kindi's assembly. This was very clear in his other interests besides medicine.

Actually, Ibn Abi Usaibi'ah preserved for us a great treasure in his book (Uyun al-Anba fi Tabaqat al-Atiba). In this book he deals with physicians not history, but at the same time he praises the interest in history, al-Dakhwar was not only a great figure in medicine during Ibn Usaibi'ah lifetime, nor was he only a Sheikh who taught this historian doctor, nor only did he establish a school well known in the Islamic world, and that became a true science institute attracting researches from all places, but he also wrote the history of medicine in consecutive periods, relating to his pupils among whom was Ibn Abi Usaibi'ah what he remembered, and what he heard from his elders about the science and views of his predecessors. This is not strange as al-Dakhwar the scientist and doctor was a descendant of Tag al-Deen al-Kanadi, who taught him how to look for the truth and seek its origin, this is the characteristic of a true scientist who ascribes sayings to their owners and not take the credit himself for science and learning and diminish others' abilities, as some ignorant people do nowadays pretending to know everything and deny the merit to others.

We have many examples of what Ibn Abi Usaibi'ah wrote, which show al-Dakhwar's views who connected good ideology to good morals and so spoke truthfully and honestly **(59)** .

# -IV-
# The Fundamentals of Method

The method is considered to be the core idea that characterizes any science. Scientists who work without a method will never achieve a scientific discovery and will never get the chance for any scientific addition and hence will repeat opinions of others. Arab scientists and physicians realized the importance of concluding the ideas after following a clear method in their researches and following certain rules. Therefore they brought both sense and reason (intellect), they discussed intellectually and logically what sense exposed in the light of what previous scientists had recorded.

Though it is difficult to claim that Muslims had clearly written about method - as it is the case today - it is obvious from their writings that they followed a precise scientific method in studying and teaching when they talked about the topics they wrote and wanted people to learn.

Scientists and physicians in the period of the flourishing Islamic state achieved brilliant scientific results, which - for certain - were transmitted to the Western world, to Latin Europe, and European science benefited from them, during the Renaissance epoch. This made Ali Sami al-Nashar, when speaking about influence of the Islamic method on the West, assert while writing his introduction "I knew for sure that I am in front of the greatest discovery that the European world had ever known which is the discovery of experimental methods of the Islamic world in its most perfect form" **(60)** .

The talk about method could be divided into two parts:

A- The steps followed during research and study.

B- The characteristic and general features that characterized the method and allowed it to serve the purposes of scientific research and reflection upon the scientific works, the character and the nature of genuiness and seriousness, and hence allowed them to achive important scientific discoveries by which they went ahead of the European world for many centuries.

**A- The steps followed in the research:**

As previously mentioned, the method is the core of scientific research so that if you start the study of any topic without following a specific method to treat the topic through it, or without following a specific plan during your research, you will achieve nothing, i.e. you will not get any useful research result to be used theoretically and practically.

Though scientists in the capital of the Islamic state and in its peripheries did not have specialized clear writings - which we call method - the rules and regulations and the steps were clear in their minds and they used to draw the attention of the reader and the student to its importance from time to time.
We can conclude from their several writings, the general rules followed in the medical researches that led to the flourishing of that science in a way that astonished the Latin world.

**1- Observation and Description**

It is familiar to find some diseases that have similar symptoms to the extent that makes the distinction between them require a highly skilled physician. Muslim physicians have dealt frequently with such matters. We know this through several examples and observations found in the history of Arab Medicine. Here is al-Razi **(61)** who was known by his medical and scientific skills an intellect whom European medicine acknowledged before even Arabic medicine. He described in his study (Small Pox and Measles) the symptoms of small pox - which he saw himself - as follows: "the appearance of small pox is preceded by a continuous fever that causes back ache and itching in the nose and shivering during sleep".
Scientists have comprehended the steps of observation, description, comparison and detection of points of similarities and differences. They realized that there are qualitative observations that explain to us the different sides of what we are studying.
**Example 1: Qualitative Observation** Al-Bughdady was interested in the study of Diabetes Mellitus symptoms. He mentioned in two successive paragraphs "while examining the urine you must observe the amount whether a little or a lot, the colour of urine, its taste, and consistency i.e. whether it is thin or thick...". In another paragraph he said «while examining the urine we should examine three things: the colour, the consistency and weight, in addition we have to examine the odour, the temperature by putting your finger in it, as well as its sour taste» **(62)** .
**Example 2: Comparative observation and the relation between sensation and intellect** Al-Bughdady did not stop following his observation. He proved that Galen committed mistakes. Galen mentioned that the lower jaw in human beings consists of two parts attached together by a joint at the chin, but al-Bughdady could - through his precise observation - describe the real situation which is: the lower jaw in the mammalians consists of two parts which unite together sooner or later, the degree of union increases or decreases to form strong symphysis at the middle of the chin in different types of mammalians. In high mammalians and human beings the union of bone at the middle of the chin occurs strongly immediately after the delivery so that the lower jaw forms a single bone **(63)** .
Al-Bughdady was acquainted with the reasons of Galen's opinion on this point, but his observations contradicted what Galen assumed and hence he could, through concentrating his attention on what he observed, realise the point of similarities and differences of what he had in front of him, being provided with an ability of precise distinction and understanding.
Al-Bughdady found in a certain place near Cairo a Tomb full of human bones where he counted more than two thousands skulls. When he examined the shape of the bones and joints and the way of their articulation, he proved that the lower jaw is formed of one piece rather than two as Galen assumed in the sixth chapter of his book «The Children Bones» where he said that: «The lower jaw is formed of two parts which is proved by the fact that it can be cracked at its middle when it is crumbled».
But according to the precise observations of al-Bughdady «if the lower jaw was formed of two attached parts by a joint, we could see that joint at least in the brittle decayed bones, because the crumbling of bones starts firstly at the joints» **(64)** .
We can notice from all these examples, the importance of the step of precise scientific observation to the Arab scientists and the degree of correlation between the observation and the continuous description directly from reality, and the extent of their thinking to correlate between the parts of the observed subjects that they describe. This is proved by the example given by al-Bughdady which was just mentioned, that shows how just one empirical observation acquainted him with a wrong opinion that dominated for a long period and was adopted by the physicians since Galen. We will ascertain more precise observations while we review some important points.
But we are concerned mostly to demonstrate that al-Bughdady-and other scientists also-did not rely upon Galen and other persons sayings. This will become evident in case of Ibn al-Nafis. The sensational observations of those scientists were accompained with good works of mind in what the sense was exposed to. The sense might be wrong but the mind should correct this mistake.

**2- Experimental and Testing:**

Muslim physicans were concerned with referring to experiment because it is the best witness to the correctness of an opinion. That is why al-Razi mentioned in his book (The Characteristics of Things) many texts on experiment, "we add what we know by experiment and people know that we do not give our confidence to anything except after its test and experimentation" **(65)** .

Al-Razi believes also that the skilled physician must have two characteristics together "one, he should be skilled in the scientific art of medicine and the other, he must have at the same time a lot of experiences" **(66)** .

From this point of view, we find that al-Razi was committed always to experiment as it is considered the principal criterion in judging things. As long as experiment is the criterion that the physician always resorts to "to distinguish between the truth and the falsehood in what concerns these caracteristics that might be submitted to the denial of those who could not understand the aims of science" **(67)** .

Such texts and others reveal to what extent, the scientists of that epoch were concerned with the establishing of science upon correct scientific basis. It is impossible to use standards through which the science works today in the twentieth century as a basis to judge a science produced by the Islamic mind more than a thousand years ago approximately.

Muslims were skilled in the art of medicine and they achieved important achievements, they attributed in the way of distinction between one disease and another and the definition of many of communicable diseases which can be called epidemics. They did not only distinguish between communicable diseases, but they described each disease separately from the observations they made and the signs of disease occurrence and progress. There are many examples to demonstrate this fact. For example, al-Razi was the first to describe precisely and clearly small pox and measles **(68)** . Ibn Zahr was the first to describe mediastinal puncture, dry peritonitis and peritoneal effusion" **(69)** .

We can notice the precision of that description which al-Razi presented in the distinction between small pox and measles where he says "the appearance of small pox is preceded by a continuous fever which causes backache and itching in the nose and shivering during sleep. The important symptoms that denote its occurrence: backache with fever and burning pain all over the body, facial congestion and sometimes facial contractions, acute redness of the cheeks, eyes pressure sensation in the body which extends to the muscles, throat and chest pain accompanied with difficulty of breathing, cough and restlessness. Irritability, nausea, anxiety are more pronounced in measles than in small pox **(70)** . Al-Razi mentioned the cough of hereditary infections. The opinions presented by al-Razi were not only the results of his own efforts, but when he talked about many of the diseases, he gathered, first the opinions mentioned on the disease, by the Greeks, Syriac, Indians, Persians and Arabs, then he presented his own opinion and the experiment he performed and the observations he achieved after the process of diagnosis and treatment. In surgeries, he was a head of his contemporaries because he treated renal and bladder stones surgically. As Hitti descriped him in the field of surgery he was one of the first to use the seton.

Among other examples we find Avicenna who "distinguished between pneumonia and pleurisy, acute and secondary meningitis, intestinal and renal colics" **(71)** . Also, there were some important additions presented by Avicenna, where we find" the first description of anthrax which the Arabs called "The Persian Fire **(72)** . Avicenna mentioned that the infection occurs through water and dust. He described the life cycle of Ankylostomiasis **(73)** and he showed its effect on the body. Anatomically, Avicenna described all the organs, even the anatomy of teeth and jaw bones. When talking about the nerves and muscles he included the nerves of the face, forehead, eye globe, eye lids, cheeks, lils, tongue as well as the nerves of the marrow and chest. When he talked about "the nerves", he studied cases of paralysis. He described hemiplegia and distinguished between two main types: the first is the facial palsy resulting from a central cause in the brain and the second due to a local or peripheral cause **(74)** . It seems that the treatment of the causes of paralysis were familiar to the physicians of the Islamic world of that epoch. This was the result of their interest in treating skillfully mental diseases. They specified particular words in the Bimaristans - as for example they used one of three methods to treat such cases (we mean caes of paralysis and neurogenic diseases). In cases of paralysis they resorted to cooling drugs in contradiction with the familiar Greek method, which used the hot methods of treatment; or they resorted to methods similar to electricial shocks used in our days, as we have been told by some contemporary historians. Muslims were the first to use electricity to treat epilespy and neurogenic diseases by using a certain type of fish called Torpedo or cramp fish, which was put alive in water which was then connected to two straps of steel. When the patient held them, which he could not do but for a short time, he shivered and would throw them to the ground. After some days of this treatment he was cured from epilepsy **(75)** . The third method was based on psychiatric treatment and there are many examples for this. Harun al-Rashed had a slave maid attained by a certain type of hysterical paralysis. When she raised her hand upwards, the hand stayed hanging up. The physicians were perplexed in her treatment, therefore al-Rushed brought Gabriel Ibn Bachtishou to treat her. He asked for his safety while he performed the treatment in front of him and he said "if the Caliph will not be angry with me I have some tricks for her" al-Rashed said" and what are they?" the doctor said "the slave must come here in the presence of everyone till I do what I want and you must give me time and not be angry with me quickly. Al-Rashed ordered to bring her, when Gabriel saw her, he walked quickly towards her and bent her head and caught the tail of her dress as if he wanted to undress her in front of all the people; she was shocked and worried by this behaviour and her shyness obliged her to drop her hand downwards to hold her dress and to cover her body. At this moment, the physician turned towards the Caliph and said: "She is cured now" **(76)** .

These three examples reveal the intelligence of the physicians in the Islamic World and their insight about the cases presented to them and the way of giving successful treatment to such diseases after they examined them carefully and recognized its etiology and the facts and the way of its progress through scientific observations.
We find also that Muslims knew in detail other important diseases whose diagnosis was not known in the old medicine **(77)** . They were "the first to write about leprosy and the repair of the not known in the old medicine. They were " the first to write about leprosy and the repair of the teeth closure defects and tooth arches. They correlated piles with gastric contraction and recommended plant foods for its treatment". They were also "the first to draw attention to the shape of the nails of the tuberculous; they described treatment of jaundice and cholera, they used opium in certain doses to treat haemorrhage, and they treated shoulder disclocation by the surgical method known as sudden resistance reduction **(78)** . Moreover, al-Tabari was the first to discover the insect causing scabies.
Among the medical features of Muslims worth mentioning is Surgery. They were the first to use anaesthesia in surgical operations **(79)** . Abu al-Kaseem al-Zahrawi (Abulcasis) is considered "the greatest one to perform manual works skillfully in surgical operations and to use surgical instruments. His book presentation to those who failed to write consists of three parts: the first in medicine, the second in pharmacology and chemistry, and the third in surgery **(80)** . The previously mentioned reference of al-Zahrawi is considered to be one of the most important text books in the description of instruments used in performing surgical operations and the way to use them, kwith the detailed description of each instrument through illustrations and he acquired a great importance because he was the first in this subject **(81)** . Al-Zahrawi was the first to succeed in tying arteries to stop haemorrhage **(82)** . The Arabs knew in this epoch the anatomy of pulmonary arteries and veins. Not only this but Iban al-Nefis presented to us for the first time in history a complete description of the blood circulatory system.
The belief that predominated since the epoch of Galen till the time when Ibn al-Nafis first appeared was that blood originates in the liver from which it is transported to the right ventricle in the heart, then it flows in the veins to the different body organs to nourish them, some of the blood enters the left ventricle through pores in the diaphragm, where it is mixed with the air coming from the lungs. But, Ibn al-Nafis found that the process of blood purification occurs in the lungs due to its union with the air and hence it is purified, then it is transported to the left ventricle hence the small blood circulation discovered by Ibn al-Nafis. As the historians of science assert «Ibn al-Nafis, described precisely the blood circulation eight hundred years before the Portuguese Servit to which this discovery is attributed **(83)** . Muslims were skilled also in another medical branch which is Ophthalmology. The nature of hot environment of their countries encouraged them to study this branch of medical specialities and to contribute to it in an evident way which called for astonishment. The book of Salah Ibn Yousif al Kahhal on the eye might be the greatest reference that gathers all eye diseases. He wrote chapters on: eye description, sight description, eye diseases and their etiology, their symptoms, the care for the eye, eyelid diseases and diseases of the cornea and iris, and those diseases far from the senses, also eye treatments» **(84)** .

**B- The Characteristics of the Methods**

There were general characteristics ascribed to the method used by the different scientists and physicians, during the flourishing of Islamic development. These characteristics can be described as follows **(85)** :

1- Debating and not accepting ideas without proof.
2- Conscious and accurate analysis.
3- Scientific honesty. This feature characterised the books written by Arab scientists through the ages. Scientific honesty can be put in the following order:
a) Refer opinions to their owners.
b) Not to take credit for others' creativity.
c) Arab scientists used some statements that indicated complete uncertainty such as: «Some physicians told me» or «Aleppo citizens told me» or «I copied from some history books» or «I found in some books».
4- Freedom of opinion and stating observations without adhering to ancient theories.
5- Arab scientists were self confident and esteemed the bold scientific opinion, and their writings were characterized by fluent style and accuracy of presentation and being free of contracdictions and they sometimes depended on using equivocations.

# Results

It cannot be said that the study of the history and development of Arab medicine has been completed, as we cannot also say that Arab physicians were just copiers from the Greek medicine heritage they had studied and understood. In reality they were aware of the details of medical theories specially those reached by Hippocrates and Galen. This did not stop them from having their own participation, and of correcting some mistakes in old theories.
Although many Orientalist studies deprived Arab and Islamic share in the medical heritage from its seriousness and originality in relation to theory and application, this opinion was mainly due to racism or misunderstanding.

This study we cannot be considered to have covered all aspects of the problem, or to have defined the development in a decisive manner. We cannot ascertain that. But this study gave us some important results, which if added to the results of other studies could help in better writting the history of the development of Arab medicine theoretically and from the view point of application.

The indications of this study could be stated in the following points.

1- Scientists throughout the Islamic world understood the Greek medical heritage, first they translated it magnificently by the care of Hunain b. Ishaq who travelled the nations in all directions searching for manuscripts and lost pieces (shreds of them. Ibn Al-Nadim, Ibn Golgol, Ibn al-Qifti, and Ibn AbiUsaibi'ah, confessed that Hunain's translations and his school played a great role in understanding this heritage. These writings also transferred to us some of Hunain's pupils translations, details of the translations and whether translated from Greek or Syriac. It is clear that there were medical assemblies, the most famous of which was that of «Yuhanna b. Massoyweh» Hunain b. Ishaq's teacher. These asemblies played a good role in increasing the growth of medical knowledge. Al Razi's assembly was a real school for teaching pupils. These assemblies of teaching medicine, were propagated between the fifth and the seventh century of the Hijri. After the translation era, started a period of flourishing and development as physicians had the opportunity to study from text books and to make clinical observations.

2- The period between the twelfth and thirteenth century was characterized by the propagation of medical assemblies. These assemblies were usually held in physician's homes. These can seen by the assemblies of Ibn al-Thalmeed and al-Dakhwar, students read with their professors important books and teachers explained the difficult parts.

3- The practical side of the study took place in the Bimaristan under the supervision of great physicians. In this light the bimaristans could be considered as true faculties for medicine paractical study.

4- In different periods of Islamic development, physicians encouraged Caliphs and men of influence and power to build hospitals which were called Bimaristans. From what we reviewed, we see that the building of Bimaristans started in an early stage of the history of the Islamic nation. They were built in all parts of the Islamic world. Physicians also understood, in those times, that medicine needed to be practiced in hospitals with precise organization both in management and treatment. New physicians were subject to pass an examination, and the profession itself was controlled by the government, through a man called Al-Mohtasib (Health Inspector). They had to pass examinations and get certificates. This proves the precision used in the practice of medicine in the Islamic world. The Bimaristans were of different types differing according to the type of disease treated in each, this shows us the precise understanding of the nature of diseases.

5- Study in the bimaristan meant the presence of clinical cases (the patient) in front of the student who osculated him and noted the course of the illness and observed any change in the symptoms. There were different kinds of bimaristans throughout the Islamic world, and these were under strict control.

6- Students attended physicians' teaching sessions in the bimaristans, after having completed the studies. They were examined theoretically and practically by the physician and were given certificates of graduation but had to practice medicine in the bimaristans under the professors' supervision.

7- Physicians taught in a scientific way, so, for the theoretical part of the study, there were certain books a student had to read and understand under the surpervision of his teacher, these books were those of Hippocrates, Galen, Hunain, al-Razi and Ibn Sina. The student also had to note the teacher's lectures, and that, led to the many versions for one writing. For the practical part, the students watched the teacher's way of diagnosis, and also attended the debates between the professors on some diseases.

8- Scientific method was systematically the most important pillar for medical practice and for understanding it in a scientific way. The different writings of physicians of that time show this clearly, as we find them following the trial rules of scientific method in its best form even before this method was discovered or created in the West. In this field the study points out that the many participations had special common characteristics that could be summarized as follows:

a) Medical study depended on observing and describing, as we found detailed descriptions of illnesses that physicians teated.

b) Physicians made comparisons between different illnesses specially that some of these had similar manifestations.

c) Cases were diagnosed after a meticulous clinical examination of the patient and after a proper understanding of the illness.

d) Physicians often turned to experiments, and we met many texts refereing to this fact.

e) Descriptive comparison of some studies showed mistakes made by the Greek physicians, specially Galen, and this drove Muslim physicians to correct them.

f) They used instruments and tools in the many surgeries they performed.

g) Physicians studied and criticized the Greek heritage.
h) We, often, find that physicians followed the meticulous analytic system in using the heritage they came about.
i) The studies that were done in the Islamic world were strictly scientifically honest. Never did any physician claim the merit for another's work, but always quoted other's ideas using precision in referring them to their owner, this gave them greater self confidence and a free courageous opinion.
9- The Arabic writings and inventions were transferred from the Arab world to Latin Europe. This genuine and diversified transferred heritage, led to the development of medicine in Latin Europe.

# Footnotes

**(1) Ibn Golgol, Tabaqat al-'atiba' wal-hukama' (The Generations of Physicians and Wise Men) ed. by Fu'ad Sayyid, Imprimerie de L'Institut Français d'Archéologie Orientale, Le Caire, 1955, P. 54.**
**(2) Ibn Golgol mentioned some stories about the advice of the Prophet to some men to visit physicians when they become ill. But Fu'ad Sayyid who edited the book of Ibn Golgol and verified it refuted-these stories, Ibid, P. 54.**
**(3) Some historians such as Ibn Abi Usaibi'ah used to say that Mu'awiyah used his physician Ibn Athal to get rid of his enemies. Ibn Abi Usaibi'ah *Uyun al Anba*, ed. by Nazar Reda, Dar Al-Hayat Publishing House, Beirut, 1965. P. 171.**
**(4) Max Meyerhof stated that "It was a Persian Jew, Massarjawaih, who translated Ahron's *Pandects* into Arabic and was responsible for what was probably the earliest scientific book in that language". Meyerhof, M., 'Science And Medicine', in *The Legacy of Islam*, ed. by Sir Thomas Arnold & Alfred Guillaume, Oxford University Press, 1952. P. 314 -5.**
**As Ibn Abi Usaibi'ah stated: Ahrun was an Alexandrian Physician and Christian priest. He devoted himself to medicine and wrote his main Encyclopedia of Medicine. Massarjawiayh translated the book of Ahrun from Syriac into Arabic, and after that Hunain b. Ishaq made corrections to the book. See: - Ibn Abi Usaibi'ah, "Uyun al-anba". P. 232.**
**(5) When al-Ma'mun established Bayt al-Hikma (The House of Wisdom) he stipulated that the rulers of the countries he conquered must submit the books instead of the Jiziah. The ancient sources mentioned that when al-Ma'mun achieved his great victory over the Rum (830 A.C.) he knew that they used to collect the Philosophy books in the cellars. Al-Ma'mun asked their king to give him these books instead of the Jiziah. Teofils (ÊíæÝíá) the king accepted and considered it a great gain for him, but al Ma'mun considered it a great blessing for him. see: Faroukh, O., *The History of Arab Science*, Dar al-Ilm Li-Al-Malayeen, Beirut, 1977, P. 113.**
**(6) Jundisabur was the famous centre of medical sciences before Islam. Its hospital (bimaristan) was founded to absorb the Graeco - Alexandrian medical sciences. Many physicians , especially the Syriac-speaking Christians, contributed in developing medicine in that hospital, also they took part in the early medical movement in Islam.**
**Maurice Gaudefroy - Demombynes while he was comminting and descriping the status of Arab physicians informed us that "like the theologians, they profit by the Greek heritage, but not by its teaching of the art of reasoning; they make use of the whole range of Greek learning, first through Syriac translations, and later, directly from the originals. The Monophysite medical centre at Gundeshapur was, from the 5th century, both a university and a school of medicine, to which the "Abbasid Caliphs turned for their physicians, and which gradually migrated altogether to Bagdad." P.204.**
**Maurice Gaudefroy - Demombynes, *Muslim Insitutions*, trans. from the French by John P. Macgregor, George Allen & Unwin LTD, London, 2nd impression, 1954.**
**Also we find Professor Max Meyerhof considers "The academy of Jundeshapur continued as the scientific centre of the new Islamic empire."**
**Meyerhof, M., "Science And Medicine". P. 314.**
**(7) Hunain b. Ishaq, Kitab al-Ashr Maqalat fi al-Ayn, *The Ten Treatises on the Eye* , Arabic-English edition by Max Mayerhof, Al-Maktaba al-Amiriyya, Cairo, 1928. This book influenced both the Arab and European medicine in the middle ages.**
**(8) Al-Qifti, Ta'rikh al-Hukama *The History of Wise Men*, Dar Al-Athar, Beirut, p.p. 132 -133.**
**(9) Ibn Abi Usaibi'ah, *Uyun al Anba*, ed. By Nazar Reda, the library of Dar al-Hayat, Beirut, 1965. Also, A.Muller edition, Cairo - Konisberg, 1882.**
**(10) Professor Hamarneh noted as a result of his investigation in the field of Arabic Medicine that "medicine and allied sciences, for example, were first imported but soon improved upon and greatly enriched by**

**significant additions, investigations, and intelligent personal observation, experience, and experiments". See: Hamarneh, S., "Arabic Histrography as related to the Health Professions in medieval Islam", P.23, in, *SUDHOFFS ARCH IV*, Band 50. Heet 1, Marz 1966.**

**(11) Max Mayerhof notes that "The greatest medical work of Rhazes, and perhaps the most extensive ever written by a medical man, is his al-Hawi, i.e. 'Comprehensive Book', which includes indeed Greek, Syriac, and early Arabic medical knowledge in their entirety".**

**Mayerhof, M., 'Science And Medicine', P. 324.**

**While Hitti mention that "true to its name al-Hawi was a veritable medical encyclopedia summing up what the Arabs knew of Greek, Syriac, Persian, and Hindi medicine and enriched by the addition of the author's experiments and experiences" P.116.**

**"The book was first translated into Latin (1279) under the auspices of Charles, king of Naples and Sicily by the Jewish physician Faraj ben Salim, translator of other Arabic medical works" P.116.**

**See: Hitti, P., *Islam: Away of life*, University of Minnesota Press, Minneapolis, 1970.**

**(12) Watt, W. M., *The Majesty that was Islam*, PP. 227-228.**

**(13) Professor Watt emphasized the effect of Ibn Sina (Avicenna) in the West by saying "His Vast Canon of Medicine was translated into Latin in the twelfth century and was used much more than the works of Galen and Hippocrates. It dominated the teaching of medicine in Europe until at least the end of the sixteenth century". Watt, W.M., *The Majesty that was Islam*, P 228.**

**(14) Von Grunebaum, G.E., *The Civilization of Islam*, Arabic Translation by A. Gaweid, P. 424.**

**(15) Ibn Abi Usaibi'ah, *Uyun al Anba*, P. 45.**

**(16) Max Mayerhof, "Science and Medicine", in *The Legacy of Islam* by T. Arnold, The Arabic translation by Gorgeis Fathallah, Dar al-Taleia, Beirut, 1972, P.423.**

**(17) Ibn Qutayibah, Al-Emama We'll-Seyasa, *Leadership and Politics*, Cairo, 1328 H., V.2, P 12.**

**(18) Ibn Al-Atheer, Al-Kamel Fi al-Tareikh, *The perfect in History*, Cairo, 1290 H. V. 4P. 219.**

**(19) Al Maqrizi, Kitab al-Mawa'ez wa al-Eitbar, *The Book of Wisdom and Consideration - Maqrizi Plans*, Dar Sader, Beirut, V. 2, P 405.**

**(20) Noshrawy, A.R., *The Islamic Bimaristans in the Middle Ages*, Arabic Translation by M. Kh. Badra, The Arab Legacy Bul. No. 21, P 202.**

**(21) Isa, A., *The History of Bimaristans in Islam*, Damascus, 1939, P. 9.**

**(22) Ibn Joubir, Rehlat Ibn Jouber, *The Journey of Ibn Jouber*, Cairo, 1358 H.**

**(23) Isa Bey, A., *The History of the Bimaristans in Islam*, PP. 20, 40.**

**(24) Khayrallah, A., *Outline of Arabic Contributions to Medicine and Allied Sciences*, Beirut, 1946, PP.63-68.**

**(25) Noushirawy, A.R., *The Islamic Bimaristan*, P. 201.**

**(26) Ibn Abi Usaibi'ah, *Uyun al Anba*, P. 415.**

**(27) Ibid, P 732.**

**(28) Ibid, PP. 732, 733.**

**(29) Ibn Abi Usaibi'ah, *Uyun al Anba*, PP. 415.**

**(30) Ibid.**

**(31) Al Maqrizi, Kitab, *al-Mawa'es Wa al-Eitbar*, V. 2, P. 405.**

**(32) Ibn al Okhwa, Ma'alem al-Qurba fi Talab al-Hisba, *The Features of Relations in al-Hisba*, Cambridge, 1937, P. 167.**

**(33) Noshrawy, A.R., *The Islamic Bimaristans*, P.202.**

**(34) Ibn Abi Usaibi'ah, *Uyun al-Anba*, P. 337.**

**(35) Al-Qifti, *Tarikh al-Hukama*, P. 249.**

**(36) Ibid, P. 123.**

**(37) Ibn Katheer, Al-Bidaya wa al-Nihaya, *The beginning and the End*, The Library of knowledge, Beirut, 1966, Vol. 12 P. 188.**

**(38) Al-Qifti, *Tarikh al Hukama*, P. 132.**

**(39) Ibid, P. 133.**

**(40) Ibid, P. 130.**

**(41) Ibid, P. 133.**

**(42) Ibid, P. 132.**

**(43) Marhaba, A. R., *The Course in the History of Arab Science*, The Lebanese Publishing House, Beirut, 1970, P. 50.**

**(44) Ibn Abi Usaibi'ah, *Uyun al-Anba*, P. 349.**

**(45) Ibn Abi Usaibi'ah, *Uyun al-Anba*, P. 353.**
**We can understand that Arabic was really a scientific language in studying medicine and other science. We also notice that characteristic in every other field of science.**
**(46) Ibid, P. 353.**
**(47) Ibid, P. 350.**
**(48) Ibid, P. 341.**
**(49) Al-Samarai, K., 'Who is Abou Bakr al-Razi', P. 15.**
**Ibn Abi Usaibi'ah who preserved for us Ibn Abi al-Ashaat on *The Book of Single Medication* he had written says: "Ahmed Ibn Mohamed al-Baladi asked me to write this book, and before him Mohamed b. Thawab, so in this book I wrote about them and their standings, and I started in the month of Rabii al-Awal of the year three hundred and fifty three, and they had reached a high rank in learning medicine, and became experts in its practice, to them and to my pupils and those interested in by writings, you should study, enlarge your knowledge and develop it".**
**See: Ibn Abi Usaibi'ah, Uyun al-Anba, P. 354.**
**(50) Nagi, K., "al-Razi the Pioneer of Clinical Medicine" P. 30, 35.**
**(51) Ibid, P. 25.**
**(52) Al-Samarai, K., "Who is Abou Bakr al-Razi?", P. 19.**
**(53) Ibn Abi Usaibi'ah, op.cit. P. 732.**
**(54) Ibid. P. 732.**
**(55) Ibn Abi Usaibi'ah, op.cit. P. 732.**
**(56) Ibid. P. 732.**
**(57) Ibid. P. 732, 733.**
**(58) Ibid. P. 733.**
**(59) When Ibn Abi Usaibi'ah was researching some sides of Amin al-Dawla Ibn al-Talmeed, he asked al-Dakhwar who repeated to him what he had heard of stories with their references. These were repeated by Ibn Abi Usaibi'ah as he heard it from his master he says: "Al Hakim Mohazab al-Deen b. Ali, he says: Sheikh Mowafak al-Deen b. Ilias b. al-Motran say: my father told me: Ismail Ibn Rashid said: Abou al-Farag b. Thoma and Abou al-Farag the Christian said: We were gathered in the presence of Amin al-Dawla b. al-Talmeed when a woman asked to enter with a young boy, he allowed her, when he saw the boy he told her that the son is suffering from burning while urinating and urinated sand. She said yes. He then prescribed medication and she left. We asked the symptoms on which he based his diagnosis, and that if the problem was in liver or the spleen his colour would be the same. He said: when he came in he was scratching himself and I found his fingers cracked and dry, I understood that the scratching was because of the sand and that the substance that made him scratch must have come in touch with his hands and caused their cracking and dryness, and my diagnosis was right". Al-Dkhwar was always very accurate in stating what he heard and from whom he heard it, to his pupil Ibn Abi Usaibi'ah, the authenticity of the story depends on the truth of its narrator Al-Dakhwar understood fully this point when he went to Tag al-Deen al-Kanadi's assembly to acquire knowledge and benefit and later to pass it along to his own students. We also find this virtue in Abi Usaibi'ah's book *Uyun al-Anba'a*.**
**See: Ibid. P.**
**(60) Al-Nashar, A. S., *Methods of Research in Islam*, Al-Nahda Al-Arabia Publishing House, Beirut, 1978, P.11.**
**(61) When Ibn Abi Usaibi'ah was researching some sides of Amin al-Dawla Ibn al-Talmed, he asked al-Dakhwar who repeated to him what he had heard of stories with their references. These were related by Ibn Abi Usaibi'ah as he heard it from his master he says: "Al Hakim Mohazab al-Deen Abdel Rahman b. Ali, he says: Sheikh Mowafak al-Deen b. Ilias b. al-Motran say: my father told me: Ismail Ibn Rashid said: Abou al-Farag b. Thoma and Abou al-Farag the Christian said: We were gathered in the presence of Amin al-Dawla b. al-Talmeed when a women asked to enter with a young boy, he allowed her, when he saw the boy he told her that the son is suffering from burning while urinating and urinated sand. She said yes. He then prescribed medication and she left. We asked the symptoms on which he based his diagnosis, and that if the problem was in liver or the spleen his colour would be the same. He said: when he came in he was scratching himself and I found his fingers cracked and dry, I understood that the scratching was because of the sand and that the substance that made him scratch must have come in touch with his hands and caused their cracking and dryness, and my diagnosis was right. "Al-Dakhwar was always very accurate in stating what he heard and from whom he heard it, to his pupil Ibn Abi Usaibi'ah, the authenticity of the story depends on the truth of its narrator Al-Dakhwar understood fully this point when he went to Tag al-Deen al-Kanadi's assembly to**

**acquire knowledge and benefit and later to pass it along to his own students. We also find this virtue in Abi Usaibi'ah's book "Uyun al Anba'a".**
**(62) Al-Nashar, A.S., *Methods of Research in Islam*, Al-Nahda Al-Arabia Publishing House, Beirut, 1978, P.11.**
**(63) Olman, M., *Islamic Medicine*, Arabic Translation by Y. Al-Kilani, Kuwait, P.125.**
**(64) Ibid. P. 125.**
**(65) Ibid. P. 126.**
**(66) Ibid.**
**(67) Galal, M., *The Arab Methodology of Scientific Research in Natural and Cosmological Sciences*, The Lebanese Publishing House, Beirut, 1972, P. 128.**
**(68) Ibid. P. 187.**
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**(70) Hitti, P., *Islam: A way of life*, P. 116.**
**(71) Ashour, S.A., *Islamic Civilization and its influence upon Europe*, The Arabic Renaissance House, Cairo, 1963, P. 154.**
**(72) Marhaba, A., *The Concise History of Arab Sciences*, P. 96.**
**(73) Ibid.**
**(74) Toukan, K. H., *The History of Arab Sciences*, P. 20.**
**(75) Ibn Al-Ibri, *The Abridged History of the States*, (Tarikh Moukhtasar al-Dowal), Beirut, P. 131.**
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**(77) Toukan, K. H., *The Arab Sciences*, P. 20.**
**(78) Ibid.**
**(79) Toukan, K. H., *The Arab Sciences*, P. 20.**
**(80) Ibid., P. 21.**
**(81) Ibid., P. 21.**
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**<ABU'L cauterization.**
**(83) Toukan, K. H., *The Arab Sciences*, P. 24.**
**Concerning Ibn al-Nafis see:**
**a) Aly, M., *Studies in Arab Medicine*, Dar al-Maarifa al-Gameya, Alexandria, 1990.**
**b) Aly, M. *An Introduction to the History of Arab Medicine*, Dar al-Ulum al-Arabia, Beirut, 1987.**
**c) Aly, M. & Zaydan, J., Kitab Sharh Fusul Hippocrates Li Ibn Al-Nafis, Al-Dar al-Misrya al-Libnanya, Cairo, 1991.**
**(83) Ashour, S. A., *Islamic Civilization*, P. 158.**
**(84) Aly, M., *The Muslim Contribution in Civilization*. The House of University Knowledge, Alexandria, 1983, Pp. 113-114.**

# Arabic (or Islamic) Influence On the Historical Development of Medicine

Edited and prepared by Prof. Hamed A. Ead

These pages are edited by Prof. Hamed Abdel-reheem Ead, Professor of Chemistry at the Faculty of Science - University of Cairo, Giza, Egypt and director of the Science Heritage Center
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# Arabic (or Islamic) Influence On the Historical Development of Medicine

Edited and Prepared By Prof. Hamed A. Ead, Professor of Chemistry, Cairo University

[8th August 1998, Heidelberg, Germany]

## Definition:

***Arabic, or what we may be called Islamic, science in terms of location in space and time denotes the scientific activities of individuals who lived in a region that might extended chronologically from the eighth century A.D. to the beginning of the modern era, and geographically from the Iberian Peninsula and north Africa to the Indus valley and from the Southern Arabia to the Casian Sea that is, the region covered for most of that period by what we call Islamic Civilization, and in which the results of the activities referred to were for the most part expressed in the Arabic Language. [A. I. Sabra, Isis, 1996, 87:654-670]***

## Introduction:

**The west has not done justice to the the influence of the Muslim on the historical development of medicine. Western writers have given little prominence to Islamic' Scientific and intellectual contributions to this field. But the fact is that the Muslims carried the torch of science and thought in an age when no other civilization was cabbala of doing so. At one time, learning was regarded as heresy, and the Eastern Christian Church persecuted all scientists. They fleeing from persecution, found no refuge but the Islamic empire, which look them in and acquired from them the scientific heritage of the time. They were given a great deal of veneration and respect by the Muslims, who endeavored to ensure for them a congenial atmosphere in which to work and to develop learning. That was the beginning of a universal cultural revolution which enlightened the ancient world, and which the West later embraced, inheriting from the Muslims their scientific and intellectual achievements.**

## Medical Knowledge Pre Islamic Times:

**The medical knowledge in the pre Islamic times was negligible, due to the unsettled, nomadic, desert environment the Arabs lived in. It is understandable that the only the only settlement was in towns such as Mecca, Medina and Al-Ta' if, in the vicinity of oases. The only contact of Arabs with the civilization of other countries came by the way of the trade caravans which made bi-annual trips from Mecca, traveling to Syria in the north and to Yamen in the south.**

**There were some medical practitioners in pre-Isalmic times, such as Ibn Huzeem, Harith Ibn Kalda al-Thaqafi, Ndr ibn Harith and others.**

**The only drugs the Arabs knew at that time came from plants and the leaves of trees, certain pods, animal bones, and spice and incense. By and large, they tended to live frugally, and to eat a simple diet, and this may well have protected them against many diseases. It is happened that in the first days of Islam, the ruler of the Copts in Egypt once sent presents, including an Egyptian doctor, to the Prophet Mohammed. The Prophet kept the presents but sent the doctor back, with this message: "We have no need of doctors, for we are people who eat only when we are hungry, and when we eat it is never to excess".**

## The Sources of Medical Knowledge for the Arabs:

**The Arabian peninsula was bounded by several states which had ancient civilizations, such as Egypt and the Byzantine and Persian empires:**

- **Physicians among the ancient Egyptians had certain specialties: ophthalmology, gynecology, surgery and internal medicine. There were also medical schools attached to ancient Egyptian temples, and the physicians used to combine medicine with the priesthood. Medical knowledge was not all written down, and there were parts of it which were considered secret, not permitted to be revealed, and each generation used to inherit this secret knowledge. In museums and in the drawings on tombs and in papyri, much has been discovered of what the ancient Egyptians knew about the practice of medicine. Physi-cians used to be attached to temples and used to examine and treat ordinary people without fee, and the state rewarded the physician for his services. The pharaohs had physicians attached to their courts. Medical knowledge flourished in ancient Egypt, and some of the drugs which were used then are still used now. There are in the medical papyri accurate descriptions of some of the drugs which were used then are still used now. There are in the medical papyri accurate descriptions of some diseases, their progress and method of treatment.**

- **Among the ancient Greeks the first physician of prominence was Hippo crates, he considered to be the father of medicine; his descriptions of disease and his clinical talents earned him that title. Hippo crates was held to be the model physician, and the ethics practiced by him are reflected in the so-called "Hippocratic Oath" that doctors swear on starting their medical careers.**
- **Egypt was the center of medical learning once again from the year 271 BC when the School of Alexandria was set up. Here Herophilus and Erasistratus taught, dissected, and investigated the functions of organs; they were particularly interested in the central nervous system, and they were able to distinguish the sensory from the motor nerves.**
- **Greek medicine did not make its appearance in Italy until 124 BC, and this was largely due to Asclepiades, who became famous for his interest in mental diseases. Galen (AD131 to 201) is considered to be, without exception, the greatest of the Greek physicians after Hippo crates. It is said of him that he was the initiator of experimental physiology, and he was known to be widely traveled. He became the chief physician in Rome in AD164 and was renowned as a skilled physician and as a scholar. He built a medical system which allowed him to suggest an answer to every question and an explanation for every phenomenon. The comprehensiveness of this system, and possibly also of Galen's teleology, were very appealing to the generations who succeeded him. As a result, there was a tendency for later physicians to neglect original investigation and to rely solely an the authority of Galen instead. For instance, Galen taught that blood passed from the right to the left ventricle of the heart through invisible pores, and was unaware. of the pulmonary circulation; this, Ibn al-Nafis was to describe much later.**
- **The Nestorian sect, founded in AD428 by Nestorius, the Patriarch of Constantinople, was an heretical sect. The Nestorians were persecuted and so they emigrated to the Syrian city of Al-Ruha (Edessa), where they founded their medical school. But persecution followed them, and the Byzantine Emperor expelled them in AD489. So they emigrated to Persia, where they were welcomed and treated well by the emperor, and they settled there and penetrated eastwards until they reached Jundi-Shapur. And so it was that the Nestorian center of learning moved from Syria to Jundi-Shapur in Persia, and there the Nistorians established a large hospital. Jundi-Shapur became the most prominent cultural center at the time of the Persian Emperor Kisra Anushirawan, who attracted to the city the most famous Indian, Jewish, Syrian and Persian physicians. Kisra used to send his physicians to India to look for medical books to translate from Sanskrit to Persian and Syriac, also the Greek books were translated; and so Jundi-Shapur acquired a large scientific library.**

**This is merely a brief sketch of the development of ancient times and of how medical knowledge was transferred to the lands bording on the Peninsula, from which the Arabs were to draw their Medical knowledge when Islam appeared.**

## Development of Medicine in Islam:

- **Islam spread and the Muslims were keen to collect all that was available to them of manuscripts and books of the ancients; such things were frequently the only booty they prized as conquerors.**
- **When the phase of active conquest was over, the Arabs directed their energies to various branches of learning with great eagerness, and they translated all that they acquired of Greek, Persian and Indian manuscripts. The Christians, Jews, and Nestorians played a large part in this work.**
- **Within one and a half centuries of the appearance of Islam, Baghdad came under the rule of the Abbassids and Cordova under the Umayyads, and these became world centers for learning and particularly for medicine. Among the famous physicians of Ummayyad times were *Ibn Uthal* and *Abu al-Hakam al-Dimashqi*. Ibn Uthal was a Christian, and physician to the first Umayyad caliph, Mu'awiyah. He was skilled in the science of poisons, and during the reign of Mu'awiyah many prominent men and princes died mysteriously. Ibn Uthal was later killed in revenge. *Abu al-Hakam al-Dimashqi* was a Christian physician skilled in therapeutics. He was the physician to the second Umayyad caliph, Yazid.**
- **Translation into Arabic began under the rule of the Umayyads in the time of Prince Khalid ibn Yazid. Prince Khalid was interested in alchemy, and so he employed the services of Greek philosophers who were living in Egypt. He rewarded them lavishly, and they translated Greek and Egyptian books on chemistry, medicine and the stars.**
- **A contemporary of prince Khalid was the great Arab chemist Jabir Ibn Hayan (Geber), who was born in AD705 and died sixty-four years later. He became expert in chemical and al-chemical procedures, and was the first to discover mercury.**

- **Another medical achievement during the rule of the Umayyads was the hospital for lepers which was built in Damascus. This was the first of its kind and enjoyed many endowments. This should be contrasted with European practice which, even six centuries later, condemned lepers to be burnt to death by royal decree.**
- **The Umayyad Caliphate lasted for about ninety years, and during that time Islam spread from China in the east to Spain in the west. Translation of scientific books into Arabic had already begun, but under the Abbassids, who succeeded the Umayyads, it was greatly accelerated. An important factor which facilitated the work of translation was the flexibility of the Arabic language, the richness of its terminology, and its capacity for expression.**
- **The center of the world in all the arts and sciences became Baghdad, which the first Abbassid Caliph, Al-Mansur, took for his capital. The age of Haroun al-Rashid, the ninth-century Caliph renowned in the Arabian Nights, was among the most golden of historical ages. He surrounded himself with the fore-most physicians of the age, who had studied Persian, Greek and Indian medicine.**
- **It is said that the Caliph Al-Abbas asked his physician Isa ibn Yusuf to prepare an examination of medical competence. Those doctors who did not pass the examination were debarred from medical practice. Some 860 men were successful, and hundreds of charlatans were thus expelled from the profession.**
- **The Caliph Al-Mansur invited Jurjis ibn Jibrail, a Syrian physician and the head of the hospital in Jundi-Shapur, to attend him. This man was a member of the family of Bakhtyishu which produced many famous physicians through several generations. They served at the Abbassid court for about three centuries, where they attained great wealth and positions which were sometimes higher than those of princes or ministers. Some of them were translators of scientific texts and authors of a number of books on medicine.**
- **Yuhannah ibn Masawayh was a physician at the time of Haroun al-Rashid. At the Caliph's request, he translated Greek medical books purchased in Byzantium and was himself the author of books on fevers, nutrition, headache, and sterility in women. Al-Mu'tasim the successor to Harnoun al-Rashid, was so interested in Yuhannah's work on dissection that he made a special dissection room available for his use, and he used to have apes specially brought for hirn from Nubia in Africa.**
- **Hunain ibn Ishaq (Johanitius), was probably the greatest translator in Arab history. He had a superlative knowledge of Syriac, Greek, and Arabic, and carried out a large number of translations from Greek scientific and philosophical manu-scripts into Arabic. These included most of the works of Hippo crates and Galen. After his death, much of this work was continued by his pupils and by his nephew Hubaish. This man Hubaish also wrote books on medicine, among which was a treatise on nutrition.**
- **There are many other translators who were prominent writers and philosophers. Thabit ibn Qurrah, who wrote many books on a variety of medical topics as well as on philosophy and astronomy; Qusta ibn Luqa, a contemporary of AI-Kindi, who translated many books into Arabic. There was also Mankah the Indian, who translated from Sanskrit into Arabic, and translated a treatise on poisons written by the Indian physician Shanaq.**
- **The Abbassid Caliphs were not only concerned with translation. They were also interested in public health, and it was an Abbassid minister, Ali ibn Isa, who requested the court physician, Sinan ibn Thabit, to organize regular visiting of prisons by medical officers. The first hospital in the Muslim empire was built in the ninth century in Baghdad, by the Abbassid Caliph Haroun al-Rashid; after that many other hospitals were built in the Muslim world. The first hospital to be built in Cairo was at the time of the governor of Egypt, Ibn Tulun, in AD872. These hospitals were remarkably advanced in design, for they contained pharmacies, libraries, lecture-rooms for medical students, and separate wards for men and women.**
- **The age of translation paved the way for the age of composition and innovation. The latter half of the ninth and the tenth centuries form the most creative period in the history of Muslim science and learning.**
- **Al-Tabari was a native of Tabaristan who was physician to two of the Abbassid Caliphs. He wrote an encyclopedic work on medicine, philosophy, zoology, and Astronomy, and was greatly influenced by the writings of Aristotle and Galen.**
- **Ai-kazi (Rhazes), AD865 to 925, was a Persian and the pupil of Al-Tabari. He was one of the greatest of Muslim physicians and a most prolific writer. He took a great interest in chemistry and is said to**

**have prepared absolute alcohol from fermented sugars, and to have invented a scale for measuring the specific gravity of fluids. But his great farme rests on his supreme abilities as a clinician, and his descriptions of the clinical signs of many illnesses were unsurpassed. He investigated women's diseases and midwifery, hereditary diseases, and eye diseases. He wrote an account of smallpox and measles, and books on chemistry and pharmacy, but the most famous of his bnoks is Al-Hawi, "the Continence", aq large encycopaedia on medicine in 24 volumes. It was translated into Latin by Sicilian Jewish, it made a great mark on the European thinking in medicine.**

- **Al-Majusi was also born in Persia. He wrote a medical book called Al-Maliki, known as *Liber Regius* in Latin translation. It was widely used as a reference work in the Middle Ages. Al-Majusi was the first physician to explain that the foetus does not leave the uterus by its own efforts, but rather that it is extruded by the contractions of the uterus.**
- **Ibn Sina (Avicenna) was born in 980 and died aged fifty-three. He wrote copiously and on many subjects, but the most famous of his books was The Canon of Medicine. This is an encyclopedic work in fourteen volumes, and embodies the combination of Greek and Arabic medical systems, with the addition of Ibn Sina's personal experience. It deals with diseases, their classification, description, and causes; with therapeutics and the classification of simple and compound medicines; with hygiene, the functions of parts of the body, and with many other topics. In particular, Ibn Sina noted the fact that pulmonary tuberculosis was contagious, and he thought that it spread through soil and water. He also described accurately the symptoms of diabetes mellitus and some of its complications. He was very interested in the effect of the mind on the body, and wrote a great deal on psychological disturbance. The Canon was translated into Latin and published many times. It had the most fundamental influence in Europe during the Middle Ages, and was a standard reference book in universities right up until the seventeenth century.**
- **The other major cultural center of the Muslim world was Cordova in Spain. The library was reputed to have over 600,000 books. Among the greatest men whom Spain produced was Abu al-Qasim al-Zahrawi (Albucasis), who was born in Al-Zahra in AD936. He is regarded as the most famous of the Arab surgeons, but he was also skilled in the use of simple and compound remedies, and was thus sometimes described as "the pharmacist surgeon". He wrote the famous manual on surgery, called Al-Tasrif, although it also includes sections on the preparation and dosage of drugs, nutrition, public health, and anatomical dissection. The celebrated sections on surgery are illustrated with drawings of about one hundred surgical instruments. There are descriptions of techniques for operating to relieve various conditions, including the amputation of limbs, the removal of foreign bodies, and the crushing of bladder stones. He invented many of the instruments in his book, and in particular ge devised a pair of forceps for use in midwifery. Al-Zahrawi was no mean dentist either; it is said that he per-formed cosmetic operations to correct dental irregularities. His book became famous in the universities of Europe in the Middle Ages. It was translated into Latin by Gerard of Cremona in 1187, and it was the chief reference work for surgery in the universities of Italy and France.**
- **Ibn Rushd (Averroes) was a twelfth-century physician, philosopher, and astronomer of Cordova. He was primarily concerned with philosophy and wrote an extensive commentary on the philosophical works of Aristotle. But he also practiced medicine and wrote a medical work entitled Al-Kulliyat, which became known in the Latin West as *Colliget*. Among his many original contributions was the observation that smallpox can only infect once.**
- **The family of Ibn Zuhr produced through six consecutive generations a number of famous physicians, men and warnen. The most celebrated of them was Ibn Marwan ibn Zuhr (Aven-zoar). He was a contemporary of Ibn Rushd and an extremely able clinician. His book Al-Teisir was among those which were translated early on into Latin and thus passed into Europe.**
- **Two other physicians who belonged neither to Baghdad nor to Cordova are worthy of note in this survey. Ibn Abi Usaybi'ah was born in Syria and practiced medicine for a while in Cairo. His major contribution to medicine was his large biographical work on the physicians who had preceded him. The second physician of note is Ibn al-Nafis, also born in Syria; he too practiced medicine in Cairo. He refuted what Galen had said about the passage of blood through invisible pores in the septum which separates the right and left ventricles of the heart. He described the lesser (pulmonary) circulation for the first time in history before the English Harvy. It is a regrettable fact that this signal achievement of Ibn al-Nafis received very little notice through the ages and his views were ignored for centuries.**

**This has been a brief survey of the medical contributions made by some of the most prominent people in Arabic Muslim cultural history.**

# Averroes As A Physician

## Edited and prepared by Prof. Hamed A. Ead

These pages are edited by Prof. Hamed Abdel-reheem Ead, Professor of Chemistry at the Faculty of Science - University of Cairo, Giza, Egypt and director of the Science Heritage Center
Web site: http://www.frcu.eun.eg/www/universities/html/hamed2.htm

## On the occasion of the 800th Anniversary of the Muslim Scientist "Averroes":

# Averroes As A Physician
# (Abul Walid Muhammed Ibn Ahmed Ibn Rushd)
## (1126-1198)

Edited and prepared by Prof. Hamed A. Ead
(During the DAAD fellowship hosted by Heidelberg University, July-October, 1998)

## Introduction:

> The medical school of the western Caliphate was both medically and philosophically antagonistic to Ibn Sina (1037) Avicenna, who is usually regarded as the chief representative of Islamic Medicine. The Arabic physician that emanated from the Cordova center of Islam showed a modification, owing to its intimate contact with the Christian West, and the medical and philosophical literature issued by the Christians and Jews of Moslem Spain is based more on the practical realities and attach less importance to dialectic vanities.
> The eminent Arabic writers of the western Caliphate are small in number as compared to those of the Eastern, but their influence on the Latin West was far-reaching. The most of the Western Moslem physicians who reached any degree of eminence date long after Razes and Avicenna: the four most eminent of these were Albucasis, Avenzear, Averoes and Maimonides, all of whom exercised a great influence over the Scholastics of the Latin West.

Muslim Spain has produced some of the brightest intellectual luminaries of the Middle Ages. One of them was Ibn Rushd known in the West as Averroes, who is universally aknoweldge as the great philosopher of Islam and one of the greatest of all times. George Sarton in his introduction of history of science said that " Averroes was great because of the tremendous stir he made in the minds of men for centuries. A history of Averroism would include up to the end of the sixteenth-century, a period of four centuries which would perhaps deserve as much as any other to called the Middle Ages, for it was the real transition between ancient and modern methods."
Abul Waleed Muhammed Ibn Ahmed Ibn Muhammed Ibn Rushd

- He was born in Cordova, the metropolis of Moslem Spain in 520 A.H. (1126 C.E.). Both his father and grand father were prominent judges. His family was well known for scholarship and it gave him fitting environment to excel in learning. He studied religious law, medicine, mathematics, and philosophy and (according to Leo Africanus) he was a friend of Avenzoar, the great Moslem clinician. He studied medicine, philosophy and law from Abu J'afar Harun and from Ibn Baja (1138) and he learned 'Fiqh' (Islamic jurisprudence) from Hafiz Abu Muhammed Ibn Rizq.

- Ibn Rushd under Islamic protection centered on the masterworks of Plato and Aristotle as preserved by an evolving series of lengthy and often innovative commentators, ideas that by now had been banned for centuries and virtually forgotten in the adjoining Holy Roman Empire.
- Like his father and his grandfather, he too became a judge, first in Seville and then Cordova, though his main love was philosophy. Supposedly, one night over dinner, he entered into a discussion with Almohad prince Abu Ya'qub Yusuf over the origin of the world and the nature of the mind.
- Averroes' ruminations on Aristotle's account of existence and the nature of the soul so impressed the ruler that he commissioned Averroes to write an entire set of commentaries. A few years later the prince appointed Averroes as his personal physician; under his auspices, Averroes spent the rest of his life writing commentaries on virtually all of Aristotle's works, producing detailed and original reconstructive commentaries on Aristotle's Metaphysics, Physics, Posterior Analytics, De Caelo, and De Anima, as well as Plato's Republic.
- Ibn Rushd was a genius of encyclopedic scope. He spent a great part of his fruitful life as a judge and as a physician. Yet he was known in the West for being the grand commentator on the philosophy of Aristotle, whose influence penetrated the minds of even the most conservative of Christian Ecclesiastes in the Middle Ages, including men like St. Thomas Aquinas. People went to him for consultation in medicine just as they did for consultation in legal matters and jurisprudence.
- At the age of twenty-seven, Ibn Rushd was invited to the Movahid Court at Marrakesh (in Morocco) to help in establishing Islamic educational institutions. Upon the ascendancy of Yousuf, he was introduced to him by another great Muslim philosopher Ibn Tufail to help in translating, abridging and commenting on some works of Aristotle (in 1169 C.E.).
- Ibn Rushd was appointed a judge (Qaadi) in Seville at the age of forty-four. That year he translated and abridged Aristotle's book "de Anima" (Animals). This book was translated into Latin by Mitchell the Scott. Two years later he was transferred to Cordova, his birthplace where he spent ten years as judge in that town. During those ten years Ibn Rushd wrote commentaries on the works of Aristotle including the Metaphysics. He was later called back to Marrakesh to work as a physician for the Caliph there, before his return to Cordova as Chief Judge.
- Ibn Rushd was well versed in the matters of the faith and law, which qualified him for the post of Qaadi (judge), but he was also keenly interested in philosophy and logic. So he tried to reconcile philosophy and religion in many of his works. Besides this area of study, he was deeply interested in medicine as well, as was his predecessor Ibn Sina (Avicenna). According to the French philosopher Renan Paris 1866), Ibn Rushd wrote seventy-eight books on various subjects.
- A careful examination of his works reveals that Averroes was a deeply religious man. As an example, we find in his writing, "Anyone who studies anatomy will increase his faith in the omnipotence and oneness of God the Almighty."
- In his medical and philosophical works we see the depth of his faith and knowledge of the Qur'an and Prophetic traditions, which he often quotes in support of his views in different matters.
- Ibn Rushd said that true happiness for man can surely be achieved through mental and psychological health, and people cannot enjoy psychological health unless they follow ways that lead to happiness in the hereafter, and unless they believe in God and His oneness.
- Ibn Rushd commented that Islam aims at true knowledge, which is knowledge of God and of His creation. This true knowledge also includes knowing the various means that lead to worldly satisfaction and avoidance of misery in the Hereafter. This type of practical knowledge covers two branches: (1) Jurisprudence which deals with the material or tangible aspect of human life and (2) the spiritual sciences which deal with matters like patience, gratitude to God, and morals. He compared spiritual laws to medicine in their effect on human beings physically on one hand, and morally and spiritually on the other. He pointed out that spiritual health is termed 'Taqwa' (righteousness and God-fearing) in the Qur'an.
- Ibn Rushd made remarkable contributions in philosophy, logic, medicine, music and jurisprudence. Ibn Rushd's writings spread more than 20,000 pages, the most famous of which deal with philosophy, medicine and jurisprudence. He wrote 20 books on medicine.

## In Philosophy:

- His most important work *Tuhafut al-Tuhafut* was written in response to al-Ghazali's work. Ibn Rushd was criticized by many Muslim scholars for this book, which, nevertheless, had a profound influence on European thought, at least until the beginning of modern philosophy and experimental science. His views on fate were that man is in neither full control of his destiny nor it is fully predetermined for him.
- He wrote three commentaries on the works of Aristotle, as these were known then through Arabic translations. The shortest Jami may be considered as a summary of the subject. The intermediate was *Talkhis* and the longest was the *Tafsir*. These three commentaries would seem to correspond to different stages in the education of pupils; the short one was meant for the beginners, then thintermediate for the students familiar with the subject, and finally the longest one for advanced studies. The longest commentary was, in fact, an original contribution as it was largely based on his analysis including interpretation of Qur'anic concepts.
- Ibn Rushd wrote many books on the question of theology, where he tried to use his knowledge of philosophy and logic. It is not surprising then that his works greatly influenced European religious scholarship, though Averroes is innocent of many views of Western so-called Averroism.
- Professor Bammate in his booklet "Muslim Contribution to Civilization" quotes Renan: St. Thomas Aquinas was "the first disciple of the Grand Commentator (i.e., Averroes). Albert Alagnus owes everything to Avicenna, St. Thomas owes practically everything to Averroes." Professor Bammate continues: "The Reverend Father Asin Palacios, who has carried out intensive studies of the theological Averroism of St. Thomas and, in no way classifies Averroes with Latin Averroists, takes several texts of the Cordovan philosopher and compares them with the Angelic Doctor of (St. Thomas). The similarity in their thought is confirmed by the use of expressions similar to that of Ibn Rushd. It leaves no room for any doubt about the decisive influence that the Muslim Philosopher (Averroes) had on the greatest of all Catholic theologians.

## In Medicine:

- The philosophical, religious, and legal works of Ibn Rushd have been studied more thoroughly than his medical books, since he was primarily a theologian-philosopher and scholar of the Koranic sciences.
- Among his teachers in medicine were Ali Abu Ja'lfar ibn Harun al-Tarrajjani (from Tarragona) and Abu Marwan ibn Jurrayul (or Hazbul, according to al-Safadi).
- Ibn Rushd's major work in medicine, *al-Kulliyyat* ("Generalities"), was written between 1153 and 1169.
- Its subject matter leans heavily on Galen, and occasionally Hippocrates' name is mentioned. It is subdivided into seven books: *Tashrih al-a'lda*' ("Anatomy of Qrgans"), *al-Sihha* ("Health"), *al-Marad* ("Sickness"), *al-'Alama*t ("Symptoms"), *al-Adwiya wa 'l-aghdhiya* ("Drugs and Foods"), *Hifz al-sihha* ("Hygiene"), and *Shifa al-amrad* ("Therapy")
- Ibn Rushd requested his close friend Ibn Zuhr to write a book on al-Umur al-juz'iyya (particularities, i.e., the treatment of head-to-toe diseases), which he did, and called his book al-Taisir fi 'l-muddawat wa 'l-tadbir ("An Aid to Therapy and Regimen").
- Ibn Rushd's *al-Kulliyyat* and Ibn Zuhr's *al-Taisir* were meant to constitute a comprehensive medical textbook (hence certain printed Latin editions present these two books together), possibly to serve instead of Ibn Sina's al-Qanun, which was not well received in Andalusia by Abu '1-,Ala' Zuhr ibn Abd al-Malik ibn Marwan ibn Zuhr (Ibn Zuhr's grandfather).
- Two Hebrew vesions of al-Kulliyyat are known, one by an unidentified translator, another by Solomon ben Abraham ben David.
- The Latin translation, Colliget, was made in Padua in 125 5 by a Jew, Bonacosa, and the first edition was printed in Venice in 1482, followed by many other editions.
- Ibn Rushd wrote a talkhis (abstract) of Galen's works, parts of which are preserved in Arabic manuscripts.
- He showed interest in Ibn Sina's Urjuza fi 'I-tibb ("Poem on Medicine," Canticum de medicina . . . ), on which he wrote a commentary, Sharh Urjuzat Ibn Sina.
- It was translated into Hebrew prose by Moses ben Tibbon in 1260; a translation into Hebrew verse was completed at Beziers (France) in 1261 by Solomon ben Ayyub ben Joseph of Granada.
- Further, a Latin translation of the same work was made by Armengaud, son of Blaise, in 1280 or 1284, and a printed edition was published at Venice in 1484.
- Another revised Latin translation was made by Andrea Alpago, who translated Ibn Rushd's Maqala fi '1-Tiryaq ("Treatise on Theriac," Tractatus de theiaca).
- Ibn Rushd's unsuccessful attempts to defend philosophers against theologians paved the way for a decline in Arabic medicine.

- The great image of the Hakim (physician-philosopher), which culminated in the persons of al-Razi and Ibn Sina, has been superseded by that of faqih musharik fi "l- ulum (a jurist who participates in sciences), among whom were physician-jurists and theologian-physicians.
- Because Ibn Rushd'frame as a physician was eclipsed by his frame as a philosopher, his book *Kitab al-Kulyat fi al-Tibb* stands no comparison to *'Continents*' of Rhazes and *'Canon'* of Avicenna.
- Averroes wrote a commentary on Avicenna's poem *Canticum de Medicina* (translated into Latin by Armengaud). and also mentioned the *Philosophia Orientalis* of the latter.
- His commentary of the Canticum was published at Vinice in 1484 under the title *Incipit translatio Canticor. Avi. cum commento Averrhoys facta ab Arabico in Latinum a mag. Armegando blassi de Montepesulaano.*
- The German physician Max Meyerhof remarked that: "In Spain, the philosophical bias predominated among medical men. The prototypes of this combination are the two Muslims, Ibn Zuhr (Avenzoar) and Ibn Rushd (Averroes).

## In Astronomy:

- He wrote a treatise on the motion of the sphere, Kitab fi-Harakat al-Falak.
- According to Draper, Ibn Rushd is credited with the discovery of sunspots. He also summarized Almagest and divided it into two parts: description of the spheres, and movement of the spheres. This summary of the Almagest was translated from Arabic into Hebrew by Jacob Anatoli in 1231.
- His book on jurisprudence 'Bidayat al-Mujtahid wa-Nihayat-al-Muqtasid' has been held by Ibn Jafar Zahabi as possibly the best book on the Maliki School of Fiqh.

## General:

- Ibn Rushd's writings were translated into various languages, including Latin, English, German and Hebrew.
- Most of his commentaries on philosophy are preserved in the Hebrew translations, or in Latin translations from the Hebrew, and a few in the original Arabic.
- His commentary on zoology is entirely lost. Ibn Rushd also wrote commentaries on Plato's Republic, Galen's treatise on fevers, al-Farabi's logic, and many others. Eighty-seven of his books are still extant.
- Ibn Rushd has been held as one of the greatest thinkers and scientists of the twelfth century.
- According to the Western writers, Ibn Rushd influenced Western thought from the twelfth to the sixteenth centuries.
- His commentaries were used as standard texts in preference to the treatises of Aristotle in the fourteenth and fifteenth centuries.
- His books were included in the syllabi of Paris and other Western universities till the advent of modern experimental sciences. Ibn Rusd was studied in the University of Mexico until 1831.
- The intellectual movement initiated by Ibn Rushd continued to be a living factor in European thought until the beginning of modern expermintal science.

# History of Islamic Science

Based on the book

*Introduction to the History of Science*by George Sarton

(provided with photos and portraits)

## Edited and prepared by Prof. Hamed A. Ead

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*George Sarton's Tribute to Muslim Scientists in the "Introduction to the History of Science,"*
*"It will suffice here to evoke a few glorious names without contemporary equivalents in the West: Jabir ibn Haiyan, al-Kindi, al-Khwarizmi, al-Fargani, al-Razi, Thabit ibn Qurra, al-Battani, Hunain ibn Ishaq, al-Farabi, Ibrahim ibn Sinan, al-Masudi, al-Tabari, Abul Wafa, 'Ali ibn Abbas, Abul Qasim, Ibn al-Jazzar, al-Biruni, Ibn Sina, Ibn Yunus,*

*al-Kashi, Ibn al-Haitham, 'Ali Ibn 'Isa al-Ghazali, al-zarqab, Omar Khayyam. A magnificent array of names which it would not be difficult to extend. If anyone tells you that the Middle Ages were scientifically sterile, just quote these men to him, all of whom flourished within a short period, 750 to 1100 A.D."*

# Preface

On 8 June, A.D. 632, the Prophet Mohammed (Peace and Prayers be upon Him) died, having accomplished the marvelous task of uniting the tribes of Arabia into a homogeneous and powerful nation.

In the interval, Persia, Asia Minor, Syria, Palestine, Egypt, the whole North Africa, Gibraltar and Spain had been submitted to the Islamic State, and a new civilization had been established.

The Arabs quickly assimilated the culture and knowledge of the peoples they ruled, while the latter in turn - Persians, Syrians, Copts, Berbers, and others - adopted the Arabic language. The nationality of the Muslim thus became submerged, and the term Arab acquired a linguistic sense rather than a strictly ethnological one.

As soon as Islamic state had been established, the Arabs began to encourage learning of all kinds. Schools, colleges, libraries, observatories and hospitals were built throughout the whole Islamic state, and were adequately staffed and endowed.

In the same time, scholars were invited to Damascus and Baghdad without distinction of nationality or creed. Greek manuscripts were acquired in large numbers and were studied, translated and provided with scholarly and illuminating commentaries.

The old learning was thus infused with a new vigor, and the intellectual freedom of men of the desert stimulated the search for knowledge and science.

In early days at least, the Muslims were eager seekers for knowledge, and Baghdad was the intellectual center of the world.

Historians have justly remarked that the school of Baghdad was characterized by a new scientific spirit.

Proceeding from the known to the unknown; taking precise account of phenomena; accepting nothing as true which was not confirmed by experience, or established by experiment, such were fundamental principles taught and acclaimed by the the masters of the sciences.

The Islamic Empire At Its Greatest Extent 750 c

George Sarton in his introduction, marks the time from the 2nd half of eighth century to the 2nd half of the eleventh century into:

- The time of Jabir Ibn Haiyan which covers the 2nd half of eighth century
- The time of Al-Khwarizmi which covers the 1st half of ninth century
- The time of Al-Razi which covers the 2nd half of ninth century
- The time of Al-Mas'udi which covers the 1st half of tenth century
- The time of Abu-l-Wafa which covers the 2nd half of tenth century
- The time of Al-Biruni which covers the 1st half eleventh century
- The time of Omar Khyyam which covers the 2nd half of eleventh century

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# The Time of Jabir Ibn Haiyan

Second half of Eighth Century

The intellectual relaxation which characterized the second half of the seventh century and the first half of the eighth was followed by a period of renewed activity which was entirely due to Muslim initiatives, that is why this period gave an Arabic name marking the beginning of Muslim science. The name Jabir Ibn Haiyan came from the highly important contributions by him in this period. Jabir's texts, whether in Arabic or Latin, are one of the most urgent and promising tasks of scholarship. He will remain a very impressive personality.

Imaginative portrait of Jabir Ibn Haiyan

(Photograph, A. Chelazzi, Florence,...*Makers of Chemistry*, E. L. Holmyard)

# Cultural Background of this Period in the East

Two rulers of the Abbasid caliphs used their authority to promote the intellectual welfare and progress of the peoples, and distinguished themselves greatly in this respect; the second, al-Mansur (founded Baghdad) and the fifth, Harun-al-Rashid (whose fame has been immortalized by many legends). Both caliphs encourage the work of translators who were busily unlocking the treasures of Greek knowledge.

**Abu Ja'far 'Abdallah al-Mansur**, i.e. the victorious. Died in 775 at Bir Maimun, near Mecca, at the age of 63 - 68 Muslim years (Hegra), i.e. 61-66 Christian years. He was the second 'Abbasid caliph and ruled from 754 to his death.

He was a great statesman and the founder of Baghdad. Memorable because of the many translations from the Syriac, Persian, Greek, and Hindu languages into the Arabic which were accomplished in his reign.

**Harun al-Rashid**, born in 763 or 766 at al-Ray; died at Tus in 809. Caliph from 786 to his death; the fifth and one of the greatest 'Abbasid monarchs. Magnificent patron of science, art, and literature. Many more Greek works were translated by his order. In 807 he presented a very remarkable water-clock to Charlemange (King of the Franks since 768; crowned Emperor of the West on Christmas 800 by Leo III in Rome)

# Islamic Mathematics and Astronomy

All of the mathematical and astronomical work of this period was done by Muslims. It is interesting to recall that the mathematical work of the previous period had been done almost exclusively by Chinese. Some amount of stimulation had come from India. In addition to transmission of some Hindu mathematics.

Ibrahim al-Fazari is said to have been the first Muslim to construct astrolabes.

**Ya'qub ibn Tariq** and **Muhammad, son of Ibrahim al-Fazari**, are the first to be mentioned in connection with Hindu mathematics: Ya'qab met at the court of al-Mansur, a Hindu astronomer called Kankah (?), who acquainted him with the *Siddhanta*, and Muhammad was ordered to translate it. The physician al-Batriq translated Ptolemy's *Quadripartitum*. Two astrologers, one of them a Jew named Mashallah, the other a Persian called al-Naubakht, worked together to make the measurements necessary for the building of Bagdad. Al-Naubakht's son, al-Fadl, wrote astrological treatises and translations from the Persian into Arabic.

**Ibrahim al-Fazari**

Abu Ishaq Ibrahlm ibn Habib ibn Sulaiman ibn Samura ibn Jundab. Died c. 777.

Muslim astronomer. The first to construct astrolabes, he wa the author of a poem (qasida) on astrology and of various astronomical writings (on the astrolabe, on the armillary spheres, on the calendar). H. Suter: *Die Mathematiker und Astronomer der Araber* (3, 208, 1900)

**Ya'qub Ibn Tariq**

Probably of Persian origin, flourished in Baghdad, c.767-778 died c. 796. One of the greatest astronomers of his time. He probably met, c. 767, at the court of al-Mansur, the Hindu Kankah (or Mankah?), who had brought there the *Siddhanta*. He wrote memoirs on the sphere (c. 777), on the division of the kardaja; on the tables derived from the *Siddhanta*. H. Suter: *Die Mathematiker und Astronomer der Araber* (p. 4, 1900)

**Muhammad Ibn Ibrahim Al-Fazari**

Abu 'Abdallah Muhammad ibn Ibrahim al-Fazari. Son of the astronomer Ibrahim dealt with above, for whom he is sometimes mistaken (he may be the author of the astrological poem ascribed to his father). Died c. 796 to 806. Muslim scientist and astronomer. He was ordered by the Caliph al-Mansur in 772/3 to translate the Sanskrit astronomical work Siddhanta. This translation was possibly the vehicle by means of which the Hindu numerals were transmitted from India to Islam.

H. Suter: *Die Mathematiker und Astronomen der Araber* (p. 4,1900).

Cantor: *Geschichte der Mathematik* (I, 3rd ed., 698, 1907).

D. E. Smith and L. C. Karpinski: *The Hindu-Arabic Numerals* (p.92, Boston, 1911)

**Mashallah**

His real name was probably Manasseh (in Arabic, Misha). Latin translators named him Messahala (with many variants, as Macellama, Macelarma). Mashallah is a contraction of ma'aha Allah meaning "What wonders Allah has willed." (What hath God wrought.) Flourished under al-Mansur, died c. 815 or 820. One of the earliest astronomers and astrologers in Islam, himself an Egyptian (?) Jew. Only one of his writings is extant in Arabic, but there are many mediaeval Latin and Hebrew translations. The Arabic text extant deals with the prices of wares and is the earliest book of its kind in that language. He took part with the Persian astrologer al-Naubakht in the surveying preliminary to the foundation of Baghdad in 762-63. His most popular book in the Middle Ages was the 'De scientia motus orbis', translated by Gherardo Cremonese.

Text and Translation. The *De scientia motus orbis* is probably the treatise called in Arabic "the twenty-seventh;" printed in Nuremberg 1501, 1549. The second edition is entitled: 'De elementis et orbibus coelestibus', and contains 27 chapters. The De compositione et utilitate astrolabii was included in Gregor Reisch: *Margarita phylosophica* (ed. pr., Freiburg, 1503; Suter says the text is included in the Basel edition of 1583). Other astronomical and astrological writings are quoted by Suter and Steinsehneider.

An Irish astronomical tract based in part on a mediaeval Latin version of a world by Messahalah. Edited with preface, translation, and glossary, by Afaula Power (*Irish Texts Society*, vol. 14, 194 p., 1914. A relatively modern translation of the *De scientia motus orbis*, the preface is uncritical).

## Islamic Alchemy

It is noteworthy that the earliest alchemical texts in Arabic and Latin are contemporaneous, that is, if our dating of them is correct. The most famous alchemist of Islam, Jabir Ibn Haiyan, seems to have had a good experimental knowledge of a number chemical facts; he was also an able theoretician.

## Jabir ibn Haiyan

Abu Musa Jabir ibn Haiyan al-Azdi (al-Tusi, al-Tartusi; al-Harrani meaning that he was a Sabian?; al-Sufi). Flourished mostly in Kufa, c. 776, he was the most famous Arabic alchemist; the alchemist Geber of the Middle Ages. He may be the author of a book on the astrolabe, but his fame rests on his alchemical writings preserved in Arabic: the "Book of the Kingdom," the "Little Book of the Balances," the "Book of Mercy," the "Book of Concentration," the "Book of Eastern Mercury," and others. According to the treatises already translated (by Berthelot), his alchemical doctrines were very anthropomorphic and animistic. But other treatises (not yet available in translation) show him in a better light. We find in them remarkably sound views on methods of chemical research; a theory on the geological formation of metals; the so-called sulphur-mercury theory of metals (the six metals differ essentially because of different proportions of sulphur and mercury in them); preparation of various substances (e.g. basic lead carbonate; arsenic and antimony from their sulphides). Jabir deals also with various applications, e.g. refinement of metals, preparation of steel, dyeing of cloth and leather, varnishes to water-proof cloth and protect iron, use of manganese dioxide in glass making, use of iron pyrites for writing in gold, distillation of vinegar to concentrate acetic acid. He observed the imponderability of magnetic force.

It is possible that some of the facts mentioned in the Latin works, ascribed to Geber and dating from the twelfth century and later, must also be placed to Jabir's credit. It is impossible to reach definite conclusions until all the Arabic writings ascribed to Jabir have been properly edited and discussed. It is only then that we shall be able to measure the full extent of his contributions, but even on the slender basis of our present knowledge, Jabir appears already as a very great personality, one of the greatest in mediaeval science.

Text and Translations:- M. Berthelot: *La chimie au moyen age* (vol. 3, L'alchimie arabe, Paris,1893. The Arabic text of a few of Jabir's writings is edited by Octave Houdas. French translation, p. 126-224. See E. J. Holmyard's criticism in *Isis*, XI, 479-499, 1924). Ernst Darmstaedter: *Die Alchemie des Geber* (212 p., 10 pl.; Berlin, 1922. German translation of the Latin treatises ascribed to Geber; reviewed by J. Ruska in *Isis*, V, 451-455, concluding that these Latin treatises are apocryphal); Liber misericordiae Geber. Eine lateinisehe ubersetzung des grosseren Kitab al-rahma (Archive fur Geschichte der Medizin, vol. 17, 181-197, 1925; *Isis*, VIII, 737).

# History of Islamic Science 2

Based on the book

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(provided with photos and portraits)

Edited and prepared by Prof. Hamed A. Ead

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Web site: http://www.frcu.eun.eg/www/universities/html/shc/index.htm

## **The Time of Al-Khwarizmi**

**"First Half of Ninth Century"**

The ninth century was essentially a Muslim century. To be sure, intellectual work did not cease in other centuries; but the activity of the Muslim scholars and men of science was overwhelmingly superior. They were the real standard-bearers of civilization in those days. Their activity was superior in almost every respect. To consider only the first half of the century, the leading men of science, al-Kindi, the sons of Musa, Al-Khwarzmi, al-Farghani, were all Muslims; Ibn Masawaih, it is true, was a christian, but he wrote in Arabic.

## Cultural Background

The seventh Abbasid caliph, al-Ma'mun (813-833), was even a greater patron of letters and science than Harun al-Rashid. He founded a scientific academy in Bagdad, tried to collect as many Greek manuscripts as possible, and ordered their translation; he encouraged scholars from all kinds, and an enormous amount of scientific work was done under his patronage.

# al-Ma'mun

'Abdallah al-Ma'mun. Born in Baghdad in 786, died near Tarsus in 833. The seventh and greatest 'Abbasid caliph (813-833). His mother and wife were Persians, which explains his Persian and 'Alid proclivities. He was an ardent Mu'tazil, tried to enforce his views by means of violence. He wrote four long letters to explain the Qur'an was created, and he cruelly punished those who dared entertain different views (e.g., Ibn Hannibal). He thus combined in a remarkable way free thought and intolerance. While persecuting those who objected to Mu'tazilism, Jews and Christians were very welcome at his court. He was even a greater patron of letters and science than Harun al-Rashid. He took considerable pains to obtain Greek manuscripts and even sent a mission to the Byzantine Emperor Leon the Armenian (8l3 to 890) for that purpose. He ordered the translation of these manuscripts. He organized at Baghdad a sort of scientific academy called the House of Wisdom (Bayt al-hilkma), which included a library and an observatory. This was the most ambitious undertaking of its kind since the foundation of the Alexandrian Museum (q. v. first half of third century B. C.). He built another observatory on the plain of Tadmor (Palmyra). The inclination of the ecliptic was found by his astronomers to equal 23o 33' and tables of the planetary motions were constructed. He ordered two degree-measurements to be made to determine the size of the earth one of them near Tadmor (a degree = 6,500 miles) hence circumference of the earth = 20,400 miles; diameter=6,500 miles). A large map of the world was drawn for him. He encouraged philosophers, philologists, traditionalists, and other jurists mathematicians, physicians, astrologers and alchemists.
Fihrist (116, 24.3 and passim). Gustav Weil: Gesehichte (ler Chalifen (vol.2 198-994). J. T. Remaud: Geographie d'Aboulfeda (vol. 1, 269 sq. 1848). J. L. E. Dreyer: History of the Planetary System from Thales to Kepler (p. 245, 249 278 Cambridge, 1906) R. A. Nicholson: Literary History of the Arabs (359 1907).

# An Encyclopedic Scientist.... Al-Kindi

Abu Ysuf Ya'qub ibn Ishaq ibn al-Sabbah al-Kindi (i. e., of the tribe of Kinda) Latin name, Alkindus. Born in Basra at the beginning of the ninth century, flourished in Bagdad under al-Ma' mun and al-Mu'tasim (8l3 to 849), persecuted during the orthodox reaction led by al-Mutawakkil (841 to 861); died c. 873. "The philosopher of the Arabs;" so-called probably because he was the first and only great philosopher of the Arab race. His knowledge of Greek science and philosophy was considerable.
He made a deep study of Aristotle from Neoplatonic point of view. Relatively few of his numerous works (270?) are extant. They deal with mathematics, astrology , physics, music, medicine, pharmacy, and geography. He wrote four books on the use of the Hindu numerals. Many translations from the Greek into Arabic were made or revised by him or under his direction. He considered a1chemy as an imposture. Two of his writings are especially important: "De aspectibus," a treatise on geometrical and physiological optics (largely based on Euclid, Heron, Ptolemy; no dioptrics), which influenced Roger Bacon, Witelo, etc.; "De medicinarum compositarum gradibus," an extraordinary attempt to establish posology on a mathematical basis. He is the earliest Muslim .writer on music whose works have come down to us; they contain a notation for the determination of pitch. Many writings of his were translated into Latin by Gherardo da Cremona. His influence was long felt and Cardano considered him as one of the twelve greatest minds.
Text and Translation - The De medicinarum compositarum gradibus investigandis libellus was published in Strassburg (1531) Die philosophischen Abhandlungen des al-Kindi. Zum ersten Male hrg . von Albino Nagy (Beitr. zur Gesch. d. Philos. des Mittelalters, II, 5, 118 p., Munster, 1897.

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# Islamic Mathematics and Astronomy

A very large amount of mathematical and astronomical work was done during third period. chiefly by Muslims. It is practically impossible to separate mathematics from astronomy, for almost every mathematician was an astronomer or an astrologer, or both. Some of the most important steps forward were made in the field of trigonometry in the course of computing astronomical tables. Thus it is better to consider mathematicians and astronomers at one and the same time, but they are so numerous that G.Sarton have divided them into five groups, as follows: the geometers, the arithmeticians and algebraists, the translators of the "Almagest," the astronomers and trigonometricians, the astrologers. It is hardly necessary to say that these groups are not exclusive, but overlap in various ways.

**Geometers** Al-Hajjaj ibn Yusuf was the first translator of Euclid's "Elements 'into Arabic . Al-'Abbas wrote commentaries upon them . Abu Sa'id al-Darir wrote a treatise on geometrical problems. Two of the Banu Musa, Muhammad and Hasan, were especially interested in geometry; the third, Ahmad, was a student of mechanics. Books on the measurement of the sphere, the trisection of the angle, and the determination of two mean proportionals between two given quantities are ascribed to them. They discovered kinematical methods of trisecting angles and of drawing ellipses.

**Arithmeticians and Algebraists** The Jewish astrologer Sahl ibn Bishr wrote a treatise on algebra. The greatest mathematician of the time, and, if one takes all circumstances into account, one of the greatest of the times was al-Khwarazmi. He combined the results obtained by the Greeks and the Hindus and thus transmitted a body of arithmetical and algebraic knowledge which exerted a deep influence upon mediaeval mathematics. His works were perhaps the main channel through which the Hindu numerals became known in the west. The philosopher al-Kind1 wrote various mathematical treatises, including four books on the use of Hindu numerals. This may have been another source of Western knowledge on the subject. In any ease, the Arabic transmission eclipsed the Hindu origin, and these numerals were finally known in the West as Arabic numerals.

**Translators of the "Almagest"** The earliest translator of the "Almagest" into Arabic was the Jew Sahl al-Tabari. Another translation was made a little later (in 829), on the basis of a Syriae version, by al-Hajjaj ibn Yusuf.

**Astronomers and Trigonometricians** Ahmad al-Nahawandi made astronomical observations at Jundishapur and compiled tables. The Caliph al-Ma'mun built an observatory in Baghdad and another in the plain of Tadmor. His patronage stimulated astronomical observations of every kind. Tables of planetary motions were compiled, the obliquity of the ecliptic determined, and geodetic measurements carefully made.

Al-Khwarizmi was one of the first to compute astronomical and trigonometrical tables. Habash al-Hasib seems to have been one of the greatest astronomers working for al-Ma'mun. He edited three astronomical tables, seems to have been the first to determine the time by an altitude, and introduced the notion of shadow (umbra versa) corresponding to our tangent.

He compiled a table of tangents, probably the earliest of its kind. Sanad ibn 'Ali was the chief of al-Ma'mun's astronomers. Astronomical tables were compiled by him and by Yahya ibn abi Mansur, it is probable that those tables (and those of Habash already quoted) were due to the cooperative efforts of many astronorners. Observations were made by the geometers al-'Abbas, 'Ali ibn 'Isa al-Asturlabi, Yahya ibn abi Mansur, al-Marwarrudhi, and al-Khwarizmi; also the observations made by al-Dinawari in 845-50 in Ispahan.

The geometer Abu Sa'id al Darir wrote a treatise on the drawing of the meridian.

'Al. ibn 'Isa al-Asturlabi was a famous maker of instruments; he wrote 3 treatise on the astrolabe. But by far the most notable of that distinguished company was al-Fargham (Alfraganus). He was apparently the first Muslim to write a : comprehensive treatise on astronomy. That treatise was very popular until the fifteenth century; it influenced not only the Muslim, but also, through Latin and Hebrew translations, the Christian and Jewish astronomers.

**Astrologers** It is safe to assume that every astronomer was also, incidentally an astrologer. There are a few popular men, throughout the Middle Ages, who were chiefly if not exclusively concerned with astrology, they contributed powerfully to its debasement, The main astrologers of this period were 'Umar ibn al-Farrukhan and his son Muhammad Abu Ma'shar (Albumasar), Sahl ibn Bishr, and Abu 'Ali al-Khaiyat.

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# Muslim Mathematics and Astronomy

## Al-Hajjaj ihn Yusuf

Al-Hajjaj ihn Yusuf ibn Matar. Flourished some time between 786 and 833. probably in Baghdad. The first translator of Eucelid's "Elements" into Arabic and one ef the first translators of the "Almagest." kitab al-mijisti, hence our word almagest). Al-Hajjaj's translation of the Almagest was made in 829-8.90 on the basis of a Syriac version (by Sergios of Resaina" (first half of sixth century). A later adaptation of the Almagest was made by Abu-l-Wafa' (second half of tenth century) .

He twice translated the "Elements" of Euclid, first under Harun al-Rashid then again under al-Ma'mun.

## Al-'Abbas ibn Sa'id

al-'Abbas ibn Sa'id al-Jauhari. Flourished under al-Ma mun. Muslim mathematician and astronomer. He took part in the astronomical observations organized at Baghdad in 829.30 and at Damaseus in 832-833. He wrote commentaries on Euclid's Elements.
H. Suter: :Mathematiker (12, 1900)

## Abu Sa'id al-Darir

Abu Sa'id al-Darir al-Jurajani. who died in 845/6; thus he flourished in the first half of the ninth century. Muslim astronomer and mathematician. He wrote a treatise on geometrical problems and another on the drawing of the meridian.
H. Suter: :Mathematiker (12, 1900).

## Al.-Khwarizmi

Abu 'Abdallah Muhammad ibn Musa al-Khwarizmi. The last-mentioned name (his nisba) refers to his birthplace, Khwarizm, modern Khiva, south of the Aral Sea. It is under that name that he was best knoxvn, as is witnessed by the words algorism and augrim (Chaucer) derived from it. Flourished under al-Ma'mun, caliph from 813 to 833, died c. 850. Muslim mathematician, astronomer, geographer. One of the greatest scientists of his race and the greatest of his time. He syneretized Greek and Hindu knowledge. He influenced mathematical thought to a greater extent than any other mediaeval writer. His arithmetic (lost in Arabic; Latin translation of the twelfth century extant) made known to the Arabs and Europeans the Hindu system of numeration. His algebra, Hisab al-jabr wal-muqabala, is equally important. It contains analytical solutions of linear and quadratic equations and its author may be called one of the founders of analysis or algebra as distinct from geometry. He also gives geometrical solutions (with figures) of quadratic equations, for ex., X2 + 1OX = 39, an equation often repeated by later writers. The Liber ysagogarum Alchorismi in artem astronomicam a magistro A. [Adelard of Bath ?] compositus!' deals with arithmetic, geometry. music, and astronomy; it is possibly a summary of al-Khwarzmi's teachings rather than an original work. His astronomical and trigonometric tables, revised by Maslama al-Majrti (Second half of tenth century), were translated into Latin as early as l126 by Adelard of Bath. They were the first Muslim tables and contained not simply the sine function but also the tangent (Maslama's interpolation). Al-Khwarizmui probably collaborated in the degree measurements ordered by al-Ma'nun. He improved Ptolemy's geography, both the text and the maps (Surat al-ard, "The Face of the Earth").
General Studies Fihrist (p. 274 and comm.). H. Suter: Die Mathematiker und Astronomen der Araber (l0, 1900); Nachtrage (158-160, 1902). L. C. Karpinski's edition of the Algebra (1915.)

## Sahl Al-Tabari

Also called Rabban al-Tabari, meaning the Rabbi of Tabaristan. Flourished about the beginning of the ninth century. Jewish astronomer and physician. The first translator of the Almagest into Arabic.
H. Suter: Die Mathematiker und Astronomen der Araber (l0, 1900); M. Steinschneider: Die arabische Literatur der Juden (23-34, Frankfurt, 1902).

## Ahmed Al-Nahawandi

Ahmad ibn Muhammad al-Nahawandi. Flourished at Jundishapur at the time of Yahva ibn Khalid ibn Barmak, who died in 802-3; he himself died c. 835 to 845. Muslim astronomer. He made astronomical observations at Jundishapur and compiled tables called the comprehensive (Mushtamil).
H. Suter: Die Mathematiker und Astronomen der Araber (l0, 1900)

## Habash Al-Hasib

Ahmad ibn 'Abdallah al-Marwazi (i. e., from Merv) Habash al-Hasib (the calculator). Flourished in Baghdad; died a centenarian between 864 and 874. Astronomer under al-Ma'mun and al-Mu'tasim. (He observed from 825 to 835) He compiled three astronomical tables: the first were still in the Hindu manner; the second, called the 'tested" tables, were the most important; they are likely identical with the "Ma'munic" or "Arabic" tables and may be a collective work of al-Ma'mun's astronomers; the third, called tables of the Shah, were smaller. Apropos of the solar eclipse of 829, Habash gives us the first instance of a determination of time by an altitude (in this case, of the sun); a method which was generally adopted by Muslim astronomers. He seems to have introduced the notion of "shadow," umbra (versa), equivalent to our tangent, and he compiled a table of such shadow which seems to be the earliest of its kind.

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# Islamic Alchemy, Physics, and Technology

The astronomer *Sanad ibn 'Ali* is said to have made investigations on specific gravity. *Al-Kindi* wrote a treatise on geometrical and physiological optics; he criticized alchemy. His writings on music are the earliest of their kind extant in Arabic; they contain a notation for the determination of pitch. Among the works ascribed to the *Banu Musa*, is one on the balance.

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# Islamic Geography, and Geology

Al-Ma'mun ordered geodetic measurements, to determine the size of the earth, and the drawing of a large map of the world. The mathematician al-Khwarizmi wrote a geographical treatise, entitled the Face of the Earth, which was essentially revised edition of Ptolemy's geography; it included maps. *Sulaiman* the Merchant traveled to the coast-lands of the Indian Ocean and to China; an account of his journeys was published in 851.

Some idea of Muslim views on minerals may be obtained in the so called "Lapidary" of Aristotle. That compilation is probably of Syriac and Persian origin, and one may tentatively place the Arabic version in the first half of the ninth century. 'Utarid's lapidary, the earliest work of its kind in Arabic, dates probably from the same time.

# Arabic Medicine

There is nothing to report in this time on either Latin or Chinese medicine, and that my account of Byzantine medicine is restricted to a reference to Leon of Thessalonica. Practically all the medical work of this period was due either to Japanese or to Arabic-speaking physicians. To consider the latter first, I said advisedly "Arabic speaking" and not "Muslim," because out of the eight physicians whom G. Sarton mentioned as the most important, six were Christians, most probably Nistorians. Of the two remaining, one was a true Arab, the other a Persian. A great part of the activity of these men was devoted to translating Greek medical texts, especially those of Hippocrates and Galen, into Syriac and into Arabic. All of these translators were Christians, the most prominent being *Ya'hya ibn Batriq, Ibn Sahda, Salmawaih ibn Bunan, Ibn Masawaih, and Ayyub al-Ruhawi.*

***Jibril ibn Bakhtyashu*' collected Greek manuscripts and patronized the translators, but he also wrote some medical works. *Salmawaih ibn Bunan* showed that the use of aphrodisiacs, always so popular in the East, was dangerous. The greatest of all these physicians was the Christian *Ibn Masawaih (*Mesue Major). He dissected apes and composed various anatomical and medical writings, notably the earliest ophthalmological treatise extant in Arabic and a collection of aphorisms. The philosopher *al-Kindi* wrote medical works also, the most important being one wherein he tried to establish posology on a mathematical basis. The Persian '*Ai al-Tabari* completed, in 850, a medical encyclopaedia entitled Paradise of Wisdom.**

# Ibn Sahda

Flourished at al-Karkh (a suburb of Baghdad), probably about the beginning of the ninth century. Translator of medical works from Greek into Syriac and Arabic. According to the Fihrist he translated some works of Hippocrates into Arabic. According to Hunain ibn Ishaq, he translated the "De sectis" and the "De pulsibus ad tirones" of Galen into Syriac.

Max Meyerhof: New Light on Hunain ibn Ishaq (Isis, VIII, 704, 1926).

# Jabril Ibn Bakhtyshu

Grandson of Jirjis ibn JibriI, q. v., second half of eighth century; physician to Ja'far the Barmakide, then in 805-6 to Harun al-Rashid and later to al-Ma'mun; died in 828-29; buried in the monastery of St. Sergios in Madain (Ctesiphon). Christian (Nestorian) physician, who wrote various medical works and exerted much influence upon the progress of science in Baghdad. He was the most prominent member of the famous Bakhtyashu' family. He took pains to obtain Greek medical manuscripts and patronized the translators.

F. Wustenfeld: Arabische Aerzte (15-16, l840). L. Leclere: Medecine arabe (vol. 1, 99-102, 1876). M. Meyerhof: New Light on Hunain (Isls, VIII, 717, 1926).

# Salmawaih Ibn Buan

Christian (Nestorian) physician, who flourished under al-Ma'mun and al-Mu'tasim and became physician in ordinary to the latter. He died at the end of 839 or the beginning of 840. He helped Hunain to translate Galen's Methodus medendi and later he patronized Hunain's activity. He and Ibn Masawaih were scientific rivals. Salmanwaih realized the perniciousness of aphrodisiacs.

Leclerc: Medecine arabe (vol. 1, ll8, 1876). M. Meyerhof: New Light on Hunain (Isis, VIII, 71S, 1926).

# Ibn Masawaih

Latin name: Mesue, or, more specifically, Mesue Major; Mesue the Elder. Abu Zakariya Yuhanna ibn Masawaih (or Msuya). Son of a pharmacist in Jundishapur; came to Baghdad and studied under Jibrll ibn Bakhtyashu'; died in Samarra in 857. Christian physician writing in Syriac and Arabic. Teacher of Hunain ibn Ishaq. His own medical writings were in Arabic, but he translated various Greek medical works into Syriac. Apes were supplied to him for dissection by the caliph al-Mu'tasim c. 836. Many anatomical and medical writings are credited to him, notably the "Disorder of the Eye" ("Daghal al-ain"), which is the earliest Systematic treatise on ophthalmology extant in Arabic and the Aphorisms, the Latin translation of which was very popular in the Middle Ages.
Text and Translation Aphorismi Johannis Damnseeni (Bologna, 1489. Translation of the al-nawadir al-tibbiya). Many other editions. In the early editions of this and other works, Joannes [Janus] Damascenu is named as the author.

# History of Islamic Science 3

Based on the book

*Introduction to the History of Science*by George Sarton

(provided with photos and portraits)

## Edited and prepared by Prof. Hamed A. Ead

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# The Time of Al-Razi

## Second Half of Ninth Century

The whole ninth century was essentially a Muslim century. This more clear in the second half than of the first, since all the scientific leaders were Muslims, or at any rate were working with and for Muslims and wrote in Arabic.

## Cultural Background

Abbasid Caliph Al-Mutawakkil (847-861) continued to protect men of science, chiefly the physicians, and he encouraged the school of translators headed by Hunain ibn Ishaq.
Da ud al-Zahiri founded a new school of theology, based upon a more literal interpretation of the Qur'an; however, did not survive very long. Muslim published a new collection of traditions, arranged according to legal topics, like Bukhari's, but more theoretical.
The Egyptian Dhul-Nun is generally considered the founder of Sufism, that is, of Muslim mysticism.

## Arabic Mathematics and Astronomy

G. Sarton clarify that when he said "Arabic" instead "Muslim" he means that some of the most important work accomplished under Muslim tutelage was actually done by non-Muslims but in Arabic language.
There were so many mathematical and astronomers in Islam that is necessary to divide them into four groups as he did before: geometers; arithmeticians; astronomers and trigometricians; astrologers.
**Geometers**: Al-Mahani wrote commentaries on Euclid and Archimedes, and tried to vain and divide a sphere into two segments, being in a given ratio. Archimedian problem became a classical Muslim problem; it led to a cubic equation which was called al-Mahani's equation. Hilal al-Himsi translated the first four books of Apolloinos into Arabic. Ahmed ibn Yusuf wrote a book on proportions which are of special importance, because through it Western mathematicians became acquainted with the theorem of Menelaos. Al-Nairizi wrote commentaries on Ptolemy and Euclid. Thabit ibn Qurra made very remarkable measurements of parabolas and paraboids, but is best known as the leader of a school of translators which produced Arabic versions of some of the mathematical classics: Euclid, Archimedes, Apollonios, Theodosios, Ptolemy, Thabit himself was the foremost translator and revised some of the translations made by others. The two most important translators of his school, outside of himself, were Yusuf al-

Khuri and Ishaq ibn Hunain. A comparison of this brief account with the similar section in the previous chapter will show that much progress had already been made in geometry since the beginning of the century.
**Arithmeticians**: I mentioned in the previous chapter the writings of al-Kindi and al-Khwarizmi were in probability the main channels through which the Hindu numerals known in Islam and later in the West. The earliest Muslim documents bearing such numerals date from 874 and 888. The propagation of these numerals may have been accelerated by the fact that the Muslim trade was exceedingly active in those very days and reached every part of the world.
Thabit ibn Qurra developed the theory of amicable numbers. Qusta ibn Luqa translated Diophantos.
**Astronomers and Trigonometricians**: Al-Mahani made a series of astronomical observations from 855 to 866. Al-Nairizi compiled astronomical tables and wrote an elaborate treatise on the spherical astrolabe; he made systemic use of the tangent. Hamid ibn Ali became famous as a constructor of astrolabes. Thabit ibn Qurra published solar observations; he tried to improve the Ptolematic theory in planetary motions by the addition of a ninth sphere to account for the (imaginary) trepidation of the equinoxes. Qusta ibn Luqa wrote a treatise on the spherical astrolabes. Jabir ibn Sinan, of whom we know nothing, but who may have been al-Battani's father, constructed astronomical instruments, notably a spherical astrolabe.
The greatest astronomer of the age and one of the greatest of Islam was al-Battani (Albategnius). He made a number of observations from 877, on, compiled a catalogue of stars for the year 880, determined various astronomical coefficients with great accuracy, discovered the motion of the solar apsides, and made an elaborate astronomical treatise which remained authoritative until the Sixteen Century. That treatise included naturally a trigonometical summary wherein not only sines, but tangents and cotangents, are regularly used. It contains a table of contangents by degrees and theorem equivalent to our formula giving the cosine of a side of a spherical triangle in function of the cosine of the opposite angle and of the sines and cosines of the other side.
**Astrologers**: The most famous astrologers were Abu Bakr (Albubather), Ahmed ibn Yusuf, and Ibn Qutaiba.
The whole mathematical and astronomical work was far more original than in the first half of the century and on a relatively high level. It is true, Thabit ibn Qurra introduced an unfortunate error of which a great many later astronomers (including Copernicus!) remained prisoners, but original research always implies the possibility of error. Thabit's error was no discreditable. The elaboration of trigonometry was continued with great skill and originality. Much attention was paid to astronomical instruments and especially to a new one, the spherical astrolabe, al-Battani's masterly work was a fitting climax to this wonderful activity.
So much for Islam. What was being done at the same time at the rest of the World? Nothing.

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# Muslim Alchemy and Physics

Al-Jahiz seems to have some chemical knowledge, for instance, he knew how to obtain ammonia from animal offals by dry distillation, but it would be absurd to call him a chemist. On the other hand, the great physician Al-Rhazi was undoubtedly a genuine chemist: he wrote various chemical treatises, described a number of chemical instruments, attempted to classify mineral substances, and even tried to apply his chemical knowledge to medical purposes. He may be considered a distant ancestor of the iatrochemists of the Sixteenth Century. He was also a physicist; he used the hydrostatic balance to make investigations on specific gravity. The mathematician al-Nairizi wrote a treatise on atmospheric phenomena.
**Muslim Biology:** The Muslims had little interest in natural history; they were certainly not tempted to study it for its own sake, but many of their current views on biological subjects may be found in their literary and historical compilations. The most remarkable example is "The Book of Plants" composed by the historian al-Dinawari. The purpose of that book was primarily philological, but contains much valuable information for the historian of botany. Al-Jahiz's "Book of Animals" is also a mine of information though most of it is folkloric rather than zoological.

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# Muslim Medicine

So much medical work was accomplished in Islam that is expedient to divide the physicians into two groups: those who were primarily practitioners and those who were primarily scholars and those who were engaged in translating the Greek medical classics into Syriac and Arabic. Of course, those of the second group were, all of them were for foreigners, non Muslims,; but even in the first group, one-half of the physicians was christians. thus the activity was christian rather than Muslim, but we must not forget that by far the greatest of all of them, al-Razi, was a Muslim.
The Persian al-Razi was simply the greatest clinician of Islam and of the whole middle ages; he was also, as we have

seen, a chemist and physicist. It would be difficult to choose between him and his contemporary al-Battani: both were very great scientist who would have been conspicuous in any age. I decide to call this period "The Time of al-Razi" because the physician is known to the larger public than the astronomer, and also because his influence can be traced more directly throughout many centuries of human effort, East and West. I have already remarked that al-Razi might be considered to be one of the forerunners of the iatrochemists of the Renaissance. He wrote an immense medical encyclopaedia called Al-hawi ("Continens") and a monograph on measles and smallpox which is the masterpiece of Muslim medicine. Ya'qub ibn akhi Hizam was the author of a treatise on horsemanship, which contains some rudiments of veterinary art, the earliest work of its kind in Arabic.

The greatest of the translators was Hunain ibn Ishaq (Joannitius). He collected great medical manuscripts, translated many of them, supervised the activities of other scholars, and revised their translations. His role as regard to medical literature was very similar to that of Thabit ibn Qurra with regard to the mathematical and astronomical texts. The school of nestorian translators beaded by Hunain must have been quite considerable, for between them they managed to translate the greatest part of the Hippocratic and Galenic writings into Syriac and into Arabic. Hunain wrote also original works, notably a treatise on ophthalmology and the introduction to Galen's Ars parva which was immensely medical writings: Hunain's son Ishaq, Hubaish ibn al-Hassan, Isa ibn Yahia, Stephen son of Basil, Musa ibn Khalid, Thabit ibn Qurra, Yusuf al-Khuri. Hunain was a very great man, but he was more of a scholar than a scientist proper and his activity, which already had begun in the middle of the previous period, ended in the middle of this one; in other words al-Razi and al-Battani were one generation ahead of him. The time of Hunain, extending from 826 to 877, falls just between that of al-Khawarizimi and that of al-Razi.

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## AL-MAHANI

Abu Abdallah Mohammed ibn Isa al-Mahani, that is, from Mahana, Kirman, Persia. Flourished c. 860, died c. 874 to 884. Mathematician, astronomer. A series of observations of lunar and solar eclipses and planetary conjunctions, made by him from 853 to 866, was used by Ibn Yunus. He wrote commentaries on Euclid and Archimedes, and improved Ishaq ibn Hunain's translation of Menelaos's spherics. He tried vainly to solve an Archimedian problem: to divide a sphere by means of a plane into two segments being in a given ratio. That problem led to a cubic equation, $x^3 + c^2b = cx^2$, which Muslim writers called al-Mahani's equation.

*H. Suter: Die Mathematiker und Astronomen der Araber (26, 1900. His failure to solve the Archimedian problem is quoted by 'Omar al-Khayyami'). See Fr. Woepcke: L'algebra d'Omar Alkhayyami (2, 96 sq., Paris, 1851).*

## AHMED IBN YUSUF

Abu Ja'far Ahmed ibn Yusuf ibn Ibrahim al-Daya al Misri, i.e., the Egyptian. Flourished in Egypt in the second half and died about the Third Century H., c. 912. Mathematician. Secretary of the Tulunids, who ruled in Egypt from 868 to 905. He wrote a book on similar arcs (De Similibus arcubus), commentary on Ptolemy's Centiloquium, and a book on proportions ("De proportione et Proportionalitate"). The latter book is important because it influenced mediaeval thought through Leonardo de Pisa and Jordanus Nemorarius (theorem of Menelaos about the triangle cut by a transversal; al-qatta, sector; hence figura cata, regula catta).

*M. Cantor: Ahmed und sein Buch Uber die Proportionen (Bibliotheca Mathematica, 7-9, 1888).*

## AL-NAIRIZI

Latin name: Anaritius. Abu-l-Abbas al-Fadl ibn Hatim al-Nairizi (i.e., from Nairiz, near Shiraz). Flourished under al-Mu'tadid, Caliph from 892 to 902, died c. 922. Astronomer, Mathematician. He compiled astronomical tables and wrote for al-Mu'tadid a book on atmospheric phenomena, He wrote commentaries on Ptolemy and Euclid. The latter were translated by Gherardo da Cermona. Al-Nairizi used the so-called umbra (versa), the equivalent to the tangent, as a genuine trigonometric line (but he was anticipated in this by Habash, q. v., first half of ninth century). He wrote a treatise on he spherical astrolabe, which is very elaborate and seems to be the best Arabic work on the subject. It is divided into four books: (1) Historical and critical introduction; (2) Description of the spherical astrolabe; its superiority over plane astrolabes and all other astronomical instruments; (3 and 4) Applications.

*H. Suter: Die Mathematiker und Astronomen der Araber (45, 1900); Nachtrage (164, 1902).*

## THABIT IBN QURRA

Abu Hassan Thabit ibn Qurra Marawan al-Harrani, that is, from Harran, Mesopotamia, born 826-27 (or 835-36), flourished in Bagdad, died in 901. Harranian physician, astronomer, mathematician. one of the greatest translators from Greek and Syriac into Arabic; the founder of a school of translators, in which many of his own family we remembers. apollonios (Books 5 to 7), Archimedes, Euclid, Theodosios, Ptolemy (geography), Galen, Eutocios were translated by him or under his direction, or translations made by others (e.g., Ishaq ibn Hunain) were revised by him.

He published solar observations, explaining his methods. to the eight Ptolemaic spheres he added a ninth one (primum mobile) to account for the imaginary trepidation of the equinoxes (he is chiefly responsible for the introduction of this erroneous theory). His mensurations of parabolas and paraboloids are very remarkable. He improved the theory of amicable numbers (if $p = 3.2^n - 1; q = 3.2^{n-1}-1; r = 9.2^{2n-1}-1$; and if $p$, $q$, and $r$ are prime together, $2^n pq$ and $2^n r$ are amicable numbers). Many mathematical, astronomical, also anatomical and medical, writings are ascribed to him (most of them in Arabic, some in Syriac).
*Fihrist (272, and comment. by index). F. Wustenfled: Geschichte der arabischen Aerzte (34-36, 1840. Followed by notices on other members of the same family).*

## YUSUF AL-KHURI

Joseph the Priest. Also called Yusuf al-Qass (same meaning) or al-Sahir (the vigilant). He was still living under the caliphate of al-Muqtafi (902 to 908). Physician and mathematician. Translator from Syriac into Arabic. He translated Archimedes's lost work on the triangles and Galen's "De simlicium temperamentis et facultatibus." That the first translation was revised by Sinan ibn Thabit ibn Qurra (q. v., first half of first century), the second by Ishaq.
*H. Suter: Die Mathematiker der Araber (52, 224, 1900). Max Meyerhof: NewLight on Hunain ibn Ishaq (Isis, VIII, 704, 1926).*

## HAMID IBN ALI

Abu-l-Rabi Hamid ibn Ali al-Wasiti. From Waist in Lower Mesopotamia. Flourished in the ninth century, probably toward the end. Muslim astronomer. According to Ibn Yunus, Ali ibn Isa and Hamid were the foremost constructors of astrolabes. Ibn Yunus compares them to Ptolemy and Galen! This proves the importance which Muslims attached to good instruments.
*H. Suter: Mathematiker (40, 1900).*

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# MUSLIM (OR ARABIC) MEDICINE

## SABUR IBN SAHL

Flourished at Jundishapur. Died Dec. 3, 860. Christian physician. He wrote an antidotary (Aqrabadhin), divided into 22 books, which was possibly the earliest of its kind to influence Muslim medicine, and other medical works. This antidotary enjoyed much popularity until it was superseded Ibn al-Tilmidh's new one (q. v., first half of twelfth century).
*F. Wustenfled: arabische Aerzte (25, 1840).*

## YAHYA IBN SARAFYUN

Separion the elder. Yahya ibn Sarafyun. Flourished in Damascus in the second half of the ninth century. Christian physician who wrote in Syriac two medical compilations (Kunnash, pandects), one in 12 books, the other in 7 books. the latter was translated into Arabic by various writers and into Latin by Gherardo da Cermona (Practica sive breviarium). It was very popular during the middle ages. Its last book deals with antidotes. Ibn Srarfyun attached great importance to venesection and gave subtle prescriptions concerning the choice of the veins to be opened.
*Fihrist (29; 303,1. 3; and comm. 296, note 1). Wustenfeld: Geschichte der arabischen Aerzte (49, 1840).*

## AL-RAZI

In Latin: Rhazes. Abu Bakr Mohammed ibn Zakaria al Razi. Born in Ray, near Tehran, Persia, about the middle of the ninth century. Flourished in Ray and in Bagdad. died 923-24. Physician, physicist, alchemist. The greatest clinician of Islam and middle ages. Galenic in theory, he combined with his immense learning true Hippocratic wisdom. His chemical knowledge was applied by him to medicine; he might be considered an ancestor of the iatrochemists. Of his many writings, the most important are the "Kitab al Hawi" (Continens), an enormous encyclopaedia containing many extracts from Greek and Hindu authors and also observations of his own; the "Kitab al Mansuri" (Liber Almansoris), a smaller compilation in ten books based largely on Greek science, and finally his famous monograph on smallpox and measles "Kitab al-jadari wal-hasba" (De variolis et morbiliis; de peste, de pestilentia), the oldest description of variola and the masterpiece of Muslim medicine. many contributions to gynaecology, obstetrics, and ophthalmic surgery can be traced back to him.
He made investigations on specific gravity by means of the hydrostatic balance, which he called al-mizan al-tabi'i. Various chemical treatises are ascribed to him, and one of them (Arcandorum liber, apocryphal?) contains a list of 25 pieces of chemical apparatus. He also made an attempt to classify chemical substracts.
*The al-Hawi has not been published, and there is not even a single complete manuscript in existence. A latin*

*translation, Liber dictus Elhavi, appeared in Brescia (1486), followed by various Ventian editions. The liber ad Almansurem, in ten books was first published in Milano (1481) and was frequently republished.*

# HUNAIN IBN ISHAQ

In Latin, Joannitius. Abu Zaid Hunain ibn Ishaq al-Ibadi. Born in Hira, 809-10. Flourished at Jundishapur, then in Bagdad, where he died in October 877. Famous Nestorian physician; one of the greatest scholars and of the noblest men of his tome. Pupil of Ibn Masawiah. Employed by the Banu Musa to collect Greek manuscripts and translate them into arabic, he became the foremost translator of medical works. These translations were made partly with the assistance of other scholars.

It is reported that the Abbasid caliph al-Mutawakkil created (or endowed) a school where translations were made under Hunain's supervision. It is not too much to say that the translations made by Hunain and his disciplines marked a considerable progress in the history of scholarship. He took infinite pains to obtain manuscripts of the Greek medical texts; he collated them, examined the existing Syriac and Arabic versions, and translated them as accurately and as well as possible. His methods remind one of modern methods. to appreciate more the value of his efforts, one must realize that the Syriac versions were very unsatisfactory and the Arabic versions already available were hardly better. Hunain carefully compared these versions with the great text to prepare his new arabic translations. His activity was prodigious; it began as early as c.826 and lasted till the end of his days. It is typical of his scientific honesty that he very severely criticized the translations made by himself early in life. As his experience increased, his scientific ideal became more exacting. He translated a great many of Galen's works, also various writings of Hippocrates, Plato, Aristotle, Dioscordies, and Ptolemy's Quadripartitum. The importance of his activity can be measured in another way by stating that the translations prepared by Hunain and his school were the foundation of that Muslim canon of Knowledge which dominated medical thought almost to modern times.

Various medical and astronomical writings are ascribed to him (e. g., on the tides, on meteors, on the rainbow). His most Important work is his introduction to Galen's "Ars prava" ("Isagoge Johannitii ad Tegni Galeni") which was mensly popular during the Middle Ages and played the same part in the teaching of medicine as Porphyry's "Isagoge" in that of logic. Galenic classification extended and elaborated.

*Fihrist (294 f and by index). Ferdinand Wustenfeld: Geschichte der arabischen Aerzte und Naturforscher.*

# QUSTA IBN LUQA

Qusta ibn Luqa al-Ba'labakki, i. e. from Baalbek or Heliopolis, Syria. Flourished in Bagdad, died in Armenia about the end of the third century H., i. e., c. 912. A Christian of Greek origin. Philosopher, Physician, mathematician, astronomer, Translations of Diophantos, Theodosios, Autolycos, Hypsicles, Aristarchos, Heron were made or revised by him, or made under his direction, He wrote commentaries on Euclid and a treatise on the spherical astrolabe.

*Fihrist (295 and by index). C. Brockelmann : Geschichte der arabischen Litteratur (Vol. I, 204-205, 512, 1898).*

# JABIR IBN SINAN

Jaber ibn Sinan al-Harrani is one of the makers of astronomical instruments mentioned in the Fihrist at the end of the mathematical section. Nothing else is said of him, but al-Battani's full name suggests that this Jaber may have been his father. According to al-Biruni, this Jaber was the first to make a spherical astrolabe.

*Fihrist (p. 284). Sutre's translation (p. 41). H. Suter : Die Mathematiker (68, 224, 1900).*

# AL-BATTANI

In Latin: Albategnius, Albatenius. The origin of that nisba is unknown. Abu Abdallah Mohammed ibn Jabir ibn Sinan al-Battani, al-Harrani, al-Sabi, born before 858 in or near Harran. Flourished at al-Raqqa, in the Euphrates, died in 929 near Samarra. Of Sabin origin, though himself a Muslim. The greatest astronomer of his race and time and one of the greatest of Islam. Various astrological writings, including a commentary on Ptolemy's "Tetrabiblon" are ascribed to him, but his main work is an astronomical treatise with tables ("De scientia stellarum," " De numeris stellarum et motibus") which was extremely influential until the Renaissance. He made astronomical observations of remarkable range and accuracy from 877 on. His tables contain a catalogue of fixed stars for the years 880-81 (not 911-12). He found that the longitude of the sun's apogee had increased by $16^{o}47$` increase since Ptolemy, that implied the discovery the motion of the solar apsides and of a slow variation in the equation of time. He determined many astronomical coefficients with great accuracy: precession 54.5`` a year; inclination of the ecliptic, $23^{o}35$`. He did not believe in the trepidation of the equinoxes. (Copernicus believed in it!)

The third chapter of his astronomy is devoted to trigonometry. He used sines regularly with a clear consciousness of their superiority over the Greek chords. He completed the introduction of the functions umbra extensa and umbera versa (hence our contangents and tangents) and gave a table of contangents be degrees. He knew the relation between the sides and angles of a spherical triangle which we express by the formula

*cos a = cos c cos c + sin b sin c cos A.*
*H. Suter : Die Mathematiker und Astronomen der Araber (45-47, 1900).*

## ABU BAKR

In Latin: Albubather. Abu Bakr al-Hassan ibn al-Khasib. Of Persian origin. Flourished probably in the third quarter of the ninth century. astrologer who wrote in Persian and arabic and would hardly deserve to be quoted but for the importance given to him in the middle ages. The work he is best known by ("De nativitatibus") was translated into Latin by one canonicus Salio in Padua 1218; it was also translated into Hebrew.
*Fihrist (p. 276 and Commentary, p. 131). H. Suter : Die Mathematiker und Astronomen der Araber (32, 1900); Nachtrage (162, 1902); encycl. of Islam, II, 274, 1916.*

# History of Islamic Science 4

Based on the book
*Introduction to the History of Science*by George Sarton
(provided with photos and portraits)

## Edited and prepared by Prof. Hamed A. Ead

These pages are edited by Prof. Hamed Abdel-reheem Ead, Professor of Chemistry at the Faculty of Science - University of Cairo, Giza, Egypt and director of the Science Heritage Center
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# The Time of Al-Mas'udi

## First Half of Tenth Century

The overwhelming superiority of Muslim culture continued to be felt throughout the tenth century. Indeed, it was felt more strongly than over, not only the foremost men of science were Muslims, but also because cultural influences are essentially cumulative. By the beginning, or at any rate by the middle of the century, the excellence of muslim science was already so well established, even in the West, that each new arabic work benefited to some extent by the prestige pertaining to all. To be sure, other languages, such as Latin, Greek, or Hebrew were also used by scholars, but the works written in those languages contained nothing new, and in the field of science, as in any other, when one ceases to go forward, one already begins to go backward. All the new discoveries and the new thoughts were published in arabic. strangely enough, the language of the Qur'an had thus become the international vehicle of scientific progress.
The development of Muslim culture was fostere in Spain by the eighth Umayyad caliph of the west, Abd al-Rahman II, the advances of Muslim science continued to take place almost extensively in the east.

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## Muslim Mathematics and Astronomy

Practically all the writings of this period were arabic. Let us consider these Arabic writings first. The mathematical production of this period was less abundant and on whole less brilliant than that of the previous one, but it was, for the first time exclusively Muslim, and there were at least two very distinguished mathematicians, Abu Kamil and Ibrahim ibn Sinan. Ibn al-Adami and Ibn Amajur compiled astronomical tables; the latter was said to be one of the best Muslim observers; he made a number of observations between 885 and 933, being aided by his son Ali and a slave called Moflih. Abu Kamil perfected al-Khwarizmi's algebra; he made a special study of the pentagon and decagon and of the addition and subtraction of radicals; he could determine and construct the two (real) roots of a quadratic equation. Abu Othman translated Book X of Euclid, together with Pappos's commentary upon it. Al-Balkhi and the physician Sinan ibn Thabit wrote various treatises on mathematical, astronomical, and astrological subjects. Al-Hamdani compiled astronomical tables for Yemen, and his great work on archaeology of his country contains much information on the scientific views of the early Arabs. Ibrahim ibn Sinan was primarily a geometer; he wrote commentaries on Apollonios and on Almagest and his determination of the area of a parabola was one of the greatest achievements of Muslim mathematics. Al-Imrani wrote astrological treatise and a commentary on Abu Kamil's algebra.

# Muslim Physics and Alchemy

Ibn Wahshiya who will be dealt with more fully below, was primarily an alchemist and an occultist. His works do not seem to have any chemical importance, but they may help to understand alchemical symbolism.

# Muslim Medicine

The newer medical ideas were, all of them, published in Arabic, but not necessarily by Muslims. The greatest physician of the age was a Jew, Ishaq al-Isra'ili (Isaac Judaeus). We owe him, for instance, the main mediaeval treatise on urine.
Two of the Muslim mathematicians dealt with above, Abu Othman and Sinan ibn Thabit, became famous as organizers of hospitals; Sinan took pains to raise the scientific standards of the medical profession; Abu Othman translated Galenic writings into Arabic.

# Muslim Mathematicians

## IBN AL-ADAMI

Mohammed ibnal-Husain ibn Hamid. Flourished at the end of the ninth century or the beginning of the tenth. Muslim astronomer. He compiled astronomical tables which were completed after his death by his pupil al-Qasim ibn Mohammed ibn Hisham al-Madani. They appeared in 920-21 under the title Nazm al-iqd (Arrangement of the Pearl Necklace"), together with a theoretical introduction (lost!).
*H. Suter: Mathematiker (44, 1920).*

## IBN AMAJUR

Abul-Qasim Abdallah Ibn Amajur (or Majur?) al-Turki. He originated from Fargana, Turkestan, and flourished c. 885-933. Muslim astronomer. One of the greatest observers among the Muslims. He made many observations between 885 and 933, together with his son Abu-Hasan Ali and emancipated slave of the latter, named Muflih. Father and son are often called Banu Amajur. Some of their observations are recorded by Ibn Yunus. Together they produced many astronomical tables: the Pure (alkhalis), the Girdled (al-Muzannar), the Wonderful (al-badi), tables of Mars according to Persian chronology, etc.
*H. Suter: Mathematiker (49, 211, 1900; 165, 1902).*

## ABU KAMIL

Abu Kamil Shuja ibn Aslam ibn Mohammed ibn Shuja al-hasib al-Misri, i. e., the Egyptian calculator. He originated from Egypt and flourished after al-Khwarizmi, he died c. 850, and before al-Imrani, who died 955. We place him tentatively about the beginning of the tenth century. Mathematician. He perfected al-Khawarizimi's work on algebra. Determination and construction of both roots of quadratic equations. Multiplication and division of algebraic quantities. Addition and subtraction of radicals (corresponding to our formula

$$(a) \pm (b) = [\ a + b \pm (2ab)\ ]$$ ).

Study of the pentagon and decagon (algebraic treatment). His work was largely used by al-Kakhi and Leonardo de Pisa.
*H. Suter: Die Mathematiker und Astronomen der Araber (43, 1900; Nachtrage, 164, 1902).*

## ABU OTHMAN

Abu Othman Sa'id ibn Ya'qub al-Dimashqi, (i. e., the Damascene). Flourished at Bagdad under al-Muqtadir, Khalifa from 908 to 932. Muslim physician and mathematician. He translated into Arabic works of Aristotle, Euclid, Galen (on temperaments and on the pulse), and porphyry. His most important translation was that of Book X of Euclid, together with Pappos's commentary on it which is extant only in Arabic. The supervision of hospitals in Bagdad, Mekka, and Medina was intrusted to him in 915.

*L. Leclerc: Medicine arabe (vol. 1, 374, 1876. Only a few lines). H. Suter: Die Mathematiker und Astronomen der Araber (49, 211, 1900).*

## AL-BALKHI

Abu Zaid Ahmed ibn Sahl al-Balkhi. Born in Shamistiyan, province of Balkh, died in 934. Geographer, mathematician. A member of the Imamiya sect; disciple of al-Kindi. Of the many books ascribed to him in the Fihrist, I quote: the excellency of mathematics; on certitude in astrology. His "Figures of the Climates" (Suwar al-aqalim) consisted chiefly of geographical maps.

The "Book of the Creation and History" formerly ascribed to him was really written in 966 by Mutahhar ibn Tahir al-Maqdisi (q. v., next chapter).

*M. J. de Goeje: Die Istakhri-Balkhi Frage (Z. d. deutschen morgenl. Ges., vol. 25, 42-58, 1871). H. Suter: Die Mathematiker und Astronomen der Araber (211, 1900).*

## IBRAHIM IBN SINAN

Abu Ishaq Ibrahim ibn Sinan ibn Thabit ibn Qurra. Born in 908-9, died in 946. Grandson of Thabit ibn Qurra (q. v. second half of ninth century); his father Sinan, who embraced Islam and died in 943, was also a distinguished astronomer and mathematician (see medical section below). Muslim mathematician and astronomer. He wrote commentaries on the first book of "Conics" and on the "Almagest", and many papers on geometrical and astronomical subjects (for example, on sundials). His Quadrature of the parabola was much simpler than that of Archimedes, in fact the simplest ever made before the invention of the integral calculus.

*H. Suter: Die Mathematiker und Astronomen der Araber (53, 1900).*

## Al-IMRANI

Ali ibn Ahmed al-Imrani. Born at Mosul in Upper Mesopotamia; he flourished there and died in 955056. Muslim mathematician and astrologer. He wrote a commentary on Abu Kamil's algebra and various astrological treatises. One of these, on the choosing of (Auspicious) days, was translated by Savasodra at Barcelona in 1131 or 1134 (De electiobus) (q. v. first half of twelfth century).

*H. Suter: Mathematiker (56, 1900; 165, 1902).*

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# Muslim Agriculture

## IBN WAHSHIYA

Abu Bakr Ahmed (or Mohammed) ibn Ali ibn al-Wahshiya al-Kaldani or al-Nabati. Born in Iraq of a Nabataean family, flourished about the end of the third century H., i. e., before 912. Alchemist. Author of alchemistic and occult writings (quoted in the Fihrist). He wrote c. 904 the so-called "Nabataean agriculture" (Kitab al-falaha al-nabatiya), an alleged translation from ancient Babylonain sources, the purpose of which was to extol the Babylonian-Aramean-Syrian civilization (or more simply the "old" civilization before the hegira) against that of the conquering Arabs. It contains valuable information on agriculture and superstitions.

This forgery became famous because the great Russian orientalist Khvolson was entirely deceived by it. Of course, Ibn Wahshiya was as unable to read the cuneiform texts as the Egyptian Arabs the hieroglyphic.

*Fihrist (311-312, 358).*

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# Arabic Medicine

## ISHAQ AL-ISRA'ILI

Isaac Judaeus. Isaac Israeli the elder. (Not to be mistaken for the Spanish astronomer Isaac Israeli the younger; q. v., first half of fourteenth century.) Isaac ibn Solomon. Abu Ya'qub Ishaq ibn Sulaiman al-Isra'ili. Born in Egypt; flourished in Qairawan, Tunis, where he died, a centenarian, about the middle of the tenth century (c. 932?). Jewish physician and philosopher. One of the first to direct the attention of the jews to Greek science and philosophy. Physician to the Fatimid caliph "Ubaid Allah al-Mahdi" (909 to 934), he composed at his request many medical writings in Arabic. Translated into Latin in 1087 by Constantine the African, Into Hebrew, and into Spanish, their influence was very great. The main medical writings are: on fevers (Kitab al-Hummayat); the book of simple drugs and nutriments (Kitab al-adwiya al-mufrada wal-aghdhiya; diaetae universales et particulares); on urine (Kitab al-Baul, by far the most elaborate mediaeval treatise on the subject); on deontology, the "Guide of the physician" (lost in Arabic, extant in Hebrew under the title of Manhag (or Musarha-rofe'im). He wrote also a medico-philosophical treatise on the elements (Kitab al-istiqsat), and another on definitions. Isaac was the earliest jewish philosopher (or

one of the earliest) to publish a classification of the sciences. This was essentially the Aristotelian one as transmitted and modified by the Muslims.
*Wustenfeld: Geschichte der arabischen Aerzte (51-52, 1840).*

# History of Islamic Science 5

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# The Time of Abu-l-Wafa

## Second Half of Tenth Century

The period which we have just tried to analyze, and then to reconstruct, was on the whole one of comparative rest. There was no retrogression, but the advance of mankind, which had been so vigorously accelerated during the ninth century through the youthful energy of Islam, was then distinctly slowed up. It is not the first time that we thus witness a momentary quieting down of human activity; on the contrary, we have already had occasion to observe many such periods of fallow. e. g., the first half of the second century B. C., the second half of the fifth, the second half of the sixth, the second half of the seventh, the first half of the eighth. But in each case the slowing up was followed by a new acceleration.
In other words, when we study the creative activity of the mankind as a whole, we find that humanity behaves very much as an individual man would do, that period of unusual achievements are generally followed by depressions, and periods of rest and fallow by new efforts. The intellectual progress of mankind would not be correctly represented by a constantly increasing function, but rather by a sort of sinusoidal curve moving steadily upward. But how do we account for human tiredness, considering that the burden is periodically taken up by new generations? Leaving out of the question political and other external factors which must necessarily influence human energy, we may explain the periodical slowing up in two ways. In the first place, the original flame of enthusiasm, which stimulates intellectual advance, is bound to die out gradually unless new men of genius appear from time to time to keep it alive; of course, there are no means of predicting when and where such men will appear. In the second place, the very progress of knowledge is certain to fill the more conservative minds with a growing anxiety, and finally to determine an orthodox reaction. For example, in the first half of the tenth century an intellectual reaction was led, very successfully, by al-Ash'ari. Man kind does not go forward as a united body; on the contrary, each advance has to be paid a protracted struggle between those who long for more light and those who are afraid of it. The latter are far more numerous than the former, but less intelligent, and thus bound to be beaten in the end, this accounts at once for the sinusoidal advance and its upward tendency, or, in other words, for the slowness, but also for the continuity of human progress.
To come back to the second half of the tenth century, we shall see presently that it was a period of renewed activity in almost every field; the partial fallowness of the first half of the century was thus amply rewarded by more abundant crops and mankind was able to make a few more leaps forward.
Cultural background: Mohammed ibn Ahmed al-Khwarizmi wrote "The Key of the Sciences."
**Muslim Mathematics and astronomy:** All of the creative work was done in Islam. Muslim mathematicians were so numerous that, for the sake of clarity, I must divide them into three groups - arithmeticians, algebraists, and geometers; astronomers and trigonometricians; astrologers.
**Arithmeticians, algebraists, and geometers:** It is well to begin this section with a brief account of the progress of the Hindu numerals. By the middle of the tenth century a special form of them, the so called dust (ghubar) numerals, was already used in Muslim Spain. The eastern Arabic form was represented in an Egyptian grafitto, dated 960-61.

Mutahhar ibn Taher wrote a number of 10 figures by their means. The earliest Latin example of these numerals is found in a manuscript written in 976 near Logrono, in the Christian part of Spain.
Abu Ja'far al-Khazin wrote commentaries on the tenth book of Euclid and other works and solved al-Mahani's cubic equation. Al-Shaghani investigated the trisection of the angle. Nazif ibn Yumn translated the tenth book of Euclid. The great astronomer Abu-l-Wafa wrote commentaries on Euclid, Diophantos, and al-Khwarizmi, arithmetical and geometrical treatises, and solved a number of geometrical and algebraical problems. Abu-l-Fath improved the Arabic translation of Apollonios's Conics and commented upon the first five books. Al-Kuhi was especially interested in the Archimedian and Apollonian problems leading up to higher equations and discovered some elegant solutions. which he discussed. Al-Sijzi worked along the same lines; he made a special study of the intersections of conics and found a geometrical means of trisecting angles. Al-Khujandi, better known as an astronomer, proved that the sum of two cubic numbers can not be a cubic number. Maslama ibn Ahmed composed a commercial arithmetic and studied an amicable number. (This would confirm that he was acquainted to the writings of the Brethren of Purity, for these were very much interested in the theory of numbers - a natural consequence of their Neoplatonic tendencies.)

**Astronomical and trigonometricians:** At the very beginning of this period we meet one of the best Muslim astronomers: Abd al-Rahman al-Sufi, who compiled an illustrated catalogue of stars, based upon his own observations. Ibn al-A'lam was also a famous observer and published astronomical tables. Al-Shaghani invented and constructed astronomical instruments. The Buwayhid rulers, especially Sharaf al-dawla, were deeply interested in astronomy; Sharaf built a new observatory in Bagdad. The instruments were probably made by al-Shaghani, and the great mathematician, al-Kuhi, was the leader of the astronomers.

The foremost of the astronomers employed by Sharaf was the Persian Abu-l-Wafa. It is true he was once believed to be; he did not discover the variation of the moon, but he continued in a masterly way the elaboration of trigonometry. Taken all in all, the fame of Abu-l-Wafa is more solidly based upon his mathematical than upon his astronomical contributions, but I placed him here because, in those days, trigonometry was considered a branch of astronomy.

Al-Khujandi made astronomical observations in Ray. Abu Nasr improved the Arabic text of Menelaos's Spherics and dealt with trigonometrical subjects. Maslama ibn Ahmed edited and revised al-Khwarizmi's astronomical tables, and wrote a commentary on Ptolemy's Planisphere.

**Astrologers:** The main astrologers were al-Qabisi in Syria and Rabi ibn Zaid in Spain; the latter was a Christian, Bishop of Cordova under al-Hakam II.

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# Muslim Alchemy and Technology

The earliest scientific treatise in modern Persian (hitherto the Muslim Persians had written in Arabic) happens to be one of the most chemical works written by a Muslim until that time. It is really a treatise on materia medica, but it contains abundant information upon the preparation and properties of mineral substances. It is obvious that its author; Abu Mansour Muwaffak, was unusually stepped in chemistry. More may be learned about the chemical knowledge of those days, in the Eastern Caliphate, in the encyclopaedic works dealt with in Section III.

As to the Muslim West, the medical treatise of Abu-l-Qasim contains also various items of chemical interest; it explains the preparation of drugs by sublimation and distillation. two important alchemic writings have been ascribed to Maslama ibn Ahmed, but they are possibly a little later.

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# Muslim Medicine

The subtitle of this section is a little misleading, for the many adjectives tend to be the fact that everything was done by the Muslims alone.

Muslim physicians were so numerous that it is necessary to divide them into groups, and the most expedient division is, this time, a regional one. Thus I shall deal successively with the physician who flourished in the Eastern Caliphate (reserving a separate place for one of them who wrote in Persian), in Egypt, in Spain, and in North Africa. The first group is the most numerous, as we would expect it. Ahmed al-Tabari wrote a medical treatise called Hippocratic treatments. Ali ibn Abbas (Hally Abbas), who flourished a little later, was one of the greatest physicians of Islam. He compiled a medical encyclopedia, "The Royal Book", which was very valuable but superseded by Avicenna's Qanun. It contains a number of original observations, under the patronage of Adud-al-Dawla, a new hospital was established in Bagdad in 979. Al-Husain ibn Ibrahim improved the Arabic text of Dioscorides. Abu Sahl al-Masihi, who was, as his name indicates, a Christian, wrote a number of medical treatises. He shares with al-Qumri the fame of having been one of the teacher of Avicenna, the prince of mediaeval physicians. It is even

possible that one of Abu Sahl's treatises gave Avicenna the first idea of composing his Qanun.
Note that all of those were Persians, but all wrote, as far as we know, in Arabic. Another Persian, Abu Masour Muwaffak, had the idea of compiling a great medical treatise in Persian. That treatise dealt with materia medica and contains a general outline of pharmacological theory. Its intrinsic value is great, but it has also a considerable extrinsic importance, because it is the oldest prose work in modern Persian.
Two distinguished physicians of that time flourished in Egypt, al-Tamimi and al-Baladi. The former is chiefly known because of his medical guide (Murshid), the latter wrote a treatise on the hygiene of pregnancy and infancy.
Medical activity in Muslim Spain, was almost of the same level as that which obtained in the Eastern Caliphate; in some respects it was even superior. One of the most distinguished of the Spanish physicians, however, was not a Muslim, but a Jew, the great Hasdia ibn Shaprut. He translated Dioscorides into Arabic with the aid of the Greek monk Nicholas. Arib ibn Sa'd wrote a treatise on gynecology, obstetrics, and pediatrics. Abu-lQasim (Abulcasis) was the greatest Muslim surgeon; he exerted a very deep influence upon he development of the European surgery down to the Renaissance. Ibn Juljul wrote a commentary on Dioscorides and added a supplement to it, and he compiled a history of the Hispano-Muslim physicians of his time.
The last Muslim country to be considered, Tunis, nutured also a great physician, Ibn al-Jazzar (Algizar), author of a medical vade-mecum which obtained considerable success throughout the Middle Ages.

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# Muslim Mathematics and Astronomy

## MUTAHHAR IBN TAHIR

Mutahhar ibn Tahir al-Maqdisi (or al-Muqaddasi), i. e., the native or inhabitant of the Holy City. From Jerusalem, flourished in Bust, Sijistan, c. 966. Encylcopaedist. Author of the book of the Creation and of History (*Kitab al-bad'wal-tarikh*), a summary of the knowledge of his day based not simply on Muslim, but also on Iranian and jewish sources. He quoted as a curiosity a very large number, 4,320,000,000 (representing the duration of the world in years according to the Hindus), in Hindu or Devanagari numerals.
*Cl. Haurt: Leveritable auteur du Libre de la creation et de lhistoire (Journal Asiatique (9), vol. 18, 16-21, 1901. Concludind that Mutahhar was the author); Arabic literature (284, 291, London, 1903).*

## ABU JA'FAR AL-KHAZIN

Alkhazin means the treasurer or the librarian. Born in Khurasan, died between 961 and 971. Mathematician, astronomer. Author of a commentary on the Tenth book of Euclid and of other mathematical and astronomical writings. He solved by means of conic sections the cubic equation which had baffled al-Mahani's efforts, the so-called al-Mahani's equation (q. v., second half of the ninth century.)
*Fihrist (p. 266, 282); Suter's translation (p. 17, 39).*

## NAZIF IBN YUMN

Nazif ibn Yumn (or Yaman?) al-Qass means the priest (particularly, the Christian priest). Flourished under the Buwayhid sultan Adud al-dawla; died c. 990. Mathematician and translator from Greek into Arabic. He thus translated the Tenth book of Euclid. *H. Suter: Mathematiker (68, 1900).*

## ABU-L-FATH

Abu-l-Fath Mahmud ibn Mohammed ibn Qasim ibn Fadl al-Isfahani. From Ispahan, flourished probably c. 982. Persian mathematician. He gave a better Arabic edition of the Conics of Apollonios and commented on the first books.
The Conics had been translated a century before by Hilal al-Himsi (books 1-4) and Thabit ibn Qurra (books 5-7) (see second half of ninth century).
*H. Suter: Die Mathematiker und Astronomen der Araber (98, 1900).*

## AL-KUHI

Abu Sahl Wijan (or Waijan) ibn Rustam al-Kuhi. Of Kuh, Tabaristan, flourished in Bagdad c. 988. Mathematician, astronomer. Many mathematical and astronomical writings are ascribed to him. He was the leader of the astronomers working in 988 at the observatory built of the Buwayhid Sharaf al-dawla. He devoted his attention to those Archimedian and Apollonian problems leading to equations of a higher degree than the second; He solved some of them and discussed the conditions of solvability. These investigations are among the best of Muslim geometry.
*M. Steinschnieder: Lettere intorno ad Alcuhi a D. Bald. Boncompagni (Roma, 1863). Suter: Die Mathematiker und Astronomen der Araber (75-76, 1900).*

# AL-SIJZI

Abu Sa'id Ahmed ibn Mohammed ibn Abd al-Jalil al-Sijzi (short for al-Sijistani). Lived from c. 951 to c. 1024. Mathematician who made a special study of the intersections of conic sections and circles. He replaced the old kinematical trisection of an angle by a purely geometric solution (intersection of a circle and an equilateral hyperbola.)

*Suter: Die Mathematiker und Astronomen der Araber (80-81, 224, 1900).*

# ABD AL-RAHMAN AL-SUFI

Abu-l-Husan Abd al-Rahman ibn Omar al-Fufi al-Razi. Born in Ray 903, died 986. One of the greatest Muslim astronomers. Friend and teacher of the Buwayhid sultan Adud al-dawla. His main work is the "Book of the Fixed Stars" illustrated with figures "Kitab al-kawakib al-thabita al-musawwar", one of the three masterpieces of Muslim observational astronomy (the two others being due to Ibn Yunus, first half of the eleventh century, and Ulugh Beg, first half of the fifteenth century).

*Fihrist (284). Suter: Die Mathematiker und Astronomen der Araber (62, 1900).*

# IBN AL-A'LAM

Abu-l-Qasim Ali ibn al-Husain al-Alawi, al-Sharif al-Hisaini. Flourished at the Buwayhid court under Adud al-dawla (q. v.,); died at Bagdad in 985. Muslim astronomer. The accuracy of his observations was praised; he compiled astronomical tables which obtained much favor during at least two centuries.

*H. Suter: Die Mathematiker der Araber (62, 1900).*

# AL-SAGHANI

Abu Hamid Ahmed ibn Mohammed al-Saghani al-Asturlabi, i. e., the astrolabe maker of Saghan, near Merv, flourished in Bagdad, died 990. Mathematician, astronomer, inventor and maker of instruments. He worked in Sharaf al-dawla's observatory and, perhaps, constructed the instruments which were used there. Trisection of the angle.

*Suter: Die Mathematiker und Astronomen der Araber (p. 65, 1900).*

# ABU-L-WAFA

Abu-l-Wafa Mohammed ibn Mohammed ibn Yahya ibn Isma'il ibn al-Abbas al-Buzjani. Born in Buzjan, Quhistan, in 940, flourished in Bagdad, where he died at 997 or 998. Astronomer and one of the greatest Muslim mathematicians. One of the last Arabic translators and commentators of Greek works. He wrote commentaries on Euclid, Diophantos, and al-Khwarizimi (all lost); astronomical tables (zij al-wadih) of which we have possibly a later adaptation; a practical arithmetic; "the complete book" (Kitab al-kamil), probably a simplified version of the Almagest. The book of applied geometry (Kitab al handasa) is probably in its present form, the work of a disciple. His astronomical knowledge was hardly superior to Ptolemy's. He did not discover the variation, the third inequality of the moon. He simply spoke of the second eviction, the Ptolematic, essentially different from the variation discovered by Tycho Brahe.

Solution of the geometrical problems with one opening of the compass. Construction of a square equivalent to other squares. Regular polyhedra (based on Pappos). Approximative construction of regular heptagon (taking for its side half the side of the equilateral triangle inscribed in the same circle). Constructions of parabola by points. Geometrical solution of

$$x^4 = a \text{ and } x^4 + ax^4 = b.$$

Abu-l-Wafa contributed considerably to the development of trigonometry. He was probably the first to show the generality of the sine theorem relative to spherical triangles. He gave a new method for constructing sine tables, the value of sin 30` being correct to the eighth decimal place. He knew relations equivalent to ours for $\sin(a \pm b)$ (though in an awkward form) and to

$$2\sin^2 a/2 = 1 - \cos a \quad \sin a = 2 \sin a/2 \cos a/2.$$

He made a special study of the tangent; calculated a table of tangents; introduced the secant and cosecant; knew those simple relations between the sic trigonometric lines, which are now often used to define them.

*Fihrist (I, 266, 283, Suter's translation, p. 39).*

# AL-KHUJANDI

Abu Muhamid Hamid ibn al-Khidr al-Khujandi. Of Khujanda, on the jax artes, or Sir Daria, Transoxania, died c. 1000. Astronomer, mathematicain. He made astronomical observations, including a determination of the obliquity of the ecliptic, in Ray in 994. He proved (impefectly) that the sum of two cubic numbers cannot be a cubic number> He may be the discoverer of the sine theorem relative to spherical triangles.

*Suter : Die Mathematiker und Astronomen der Araber (74, 213, 1900).*

## ABU NASR

Abu Nasr Mansur ibn Ali ibn Iraq. Teacher of al-Bairuni; still active in 1007. Muslim mathematician and astronomer; one of three to whom the discovery of the sine theorem relative to spherical triangles is ascribed. He gave in 1007-8 an improved edition of Menelaos's Spherica. Various other writings on trigonometry are ascribed to him.

*H. Suter : Die Mathematiker und Astronomen der Araber (81, 255, Leipzig, 1900).*

## MASLAMA IBN AHMED

Abu-l-Qasim Maslam ibn Ahmed al-Majriti. Of Madrid, flourished in Cordova, died in or before 1007. Astronomer, mathematician, occulist. The earliest Hispano-Muslim scientist of any importance. He edited and corrected the astronomical tables of al-Khwarizmi, replacing the Persian by the Arabic chronology. He wrote a treatise on the astrolabe (translated into Latin by Joan. Hispalensis); a commentary on Ptolemy's Planisphaerium translated by Rudolph of Bruges (q. v., first half of twelfth century); a commercial arithmetic (al-mu'amalat); a book on the generation of animals (?). He may have introduced into Spain the writings of the Prethren Purity, or else this was done later by one of his disciples, al-Karmani. He spoke of the erotic power of amicable numbers (220, 284). Two alchemic writings, the "Sage's step" (Rutbat al-hakim) and the "Aim of the Wise", (Ghayat al-hakim), are ascribed to him. The second is well known in the Latin translation made in 1252 by order of King Alfonso under the title *Picatrix*; the original Arabic text dates probably from the middle of the eleventh century.

*Ibn Khaldun: Prolegmenes. F. Wustenfeld: Geschichte der arabischen Aerzte (61, 1840).*

## AL-QABISI

Abu-l-Saqr Abd al-Aziz ibn Uthman ibn Ali al-Qabisi. Pupil of al-Imrani (q. v. , first half of tenth century) in Mosul; after the latter's death in 955-56 he was patronized by the Hamdanid sultan Sayf al-dawla, who died in 966-67. Famous Muslim astrologer. His main writings are his introduction to the art of astrology (*al-madkhal ila sina'at (ahkam) al-nujum*) and treatise on the conjunctions of planets; both were translated into Latin by Joannes Hispalensis (first half of twelfth century). He, or his patron Sayf al-dawla, wrote a poem on the rainbow.

*H. Suter : Die Mathematiker und Astronomen der Araber (60, 1900; Nachtrag, 165, 1902).*

## RABI IBN ZAID

Rabi ibn Zaid al-Usquf. Meaning the bishop (from the Greek). He was Bishop of Cordova and Elvira under al-Hakam II. Flourished at Cordova c. 961. Spanish Christian writing n Arabic. He coposed various astronological treatises and dedicated to Hakam II a calendar (*Kitab al-anwa', liber anoe*) entitled "The Division of times and the Good of bodies."

*Suter : Mathematiker (96, 212, 1900).*

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# Muslim Alchemy and Technology

See notes on Abu-l-Qasim

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# Muslim Medicine

## AHMED AL-TABARI

Abu-l-Hasan Ahmed ibn Mohammed al-Tabari. Of Tabaristan; was physician to the Buwwayhid Rukn al-dawla, c. 970. Persian Physician. Author of compendium of medicine, called Hippocratic treatments, in ten books. Was it written in Persian or in Arabic? It is extant only in Arabic, *Kitab al-mu'alaja al-buqratiya.*

*F. Wustenfeld: Arabschen Aerzte (56, 1840).*

## ALI IBN ABBAS

Ali ibn Abbas al-Majusi, that is, the Magian, which means that he, or his father was of the Zoroastrian faith. Latin name: Ali Abbas or Hall Abbas. Born in Ahwaz, southwestern Persia; flourished under thw Buwayhid Adud al-dawla; died in 994. One of the three greatest physicians of the Eastern Caliphate. He wrote for Adud aldawla a medical encyclopedia called "the Royal Book" (*Kitab al-Maliki*, Liber regius, regalis dispositio; also called *Kamil al-sana 'a al-tibbiya),* which is more systematic and consice than Razi's Hawi, but more practical than Avicenna'a Qanun, by which it was superseded. The Maliki is divided into 20 discourses, of which the first half deal with theory and the other with the practice of medicine. the best parts of it are those devoted to dietetics and to materia medica. Rudimentary conception of the capillary system. Interesting clinical observations. Proof of the motions of the womb during parturition (the child does not come out; it is pushed out).

*Wustenfeld: Geschichte der arabischen Aerzte (59, 1840).*

## AL-HUSAIN IBN IBRAHIM

Al Husain ibn Ibrahim ibn al-Hasan ibn Khurshid al-Tabari al-Natili. Flourished c. 900-91. Translator from Greek into Arabic. He dedicated, in 990-91, an improved translation of Dioscorides to the Prince Abu Ali al-Samjuri.
*C. Brockelmann: Arabische Litteratur (189, 207).*

## AL-QUMRI

Abu Masur al-Hasan ibn Nuh al-Qumri. From Qum in Jibal. Flourished probably at Bagdad, about the end of the tenth century, and the begining of the eleventh. Muslim Physician. Teacher of Avicenna. He wrote a treatise on medicine, largely based upon al-Razi, called the book of life and death (*Kitab Ghina wa mana'*), divided into three parts (internal diseases, external diseases, fevers).
*C. Brockelmann: Arabische Litteratur (vol. 1, 239, 1808).*

## ABU SAHL AL-MASIHI

Abu Sahl Isa ibn Yahya al-Masihi al-Jurjani, i. e., the Christian, from Jurjan, east of the Caspian Sea; died at the age of fourty in 999-1000. Christian physician writing in Arabic. Teacher of Avicenna. He wrote an encyclopaedic treatise on medicine in a hundred chapters (*al-Kutub al-mi'a fi-l-sana'a al-tibbiya*), which is one of the earliest Arabic works of its kind and may have been in some respects the model of the Qanun. He wrote a various smaller treatises: on measles, on the plague, on the pulse, demonstration of God's wisdom as evidenced in the creation of man, etc.
*C. Brockelmann: Arabische Litteratur (vol. 1, 138, 1898).*

## ABU MANSUR MUWAFFAK

Abu Mansur Muwaffak ibn Ali al-Harawi. Flourished in Herat under the Samanid prince Mansur I ibn Nuh, who ruled from 961 to 976. Persian pharmacologist. He was apparently the first to think of compiling a treatise on materia medica in Persian; he travelled extensively in Persia and India to obtain necessary information. He wrote between 968 and 977, the "Book of the Remedies" (Kitab al-abnyia 'an Haqa'iq al-adwiya), which is the oldest pose work in modern Persian. It deals with 585 remedies (of which 466 are derived from plants, 75 from minerals, 44 from animals), classified into four groups according to their action. Outline of a general pharmacological theory. Abu mansur distinguished between sodium carbonate (natrun) and potassium carbonate (qli); he had some knowledge abot arsenious oxide, cupric oxide, silicic acid, antimony; he knew the toxilogical effects of copper and lead compounds, the depilatory vertue of quicklime, the composition of plaster of Paris and its surgical use.
*E. G. Browne: Arabian Medicine (92, Cambridge, 1921).*

## AL-TAMIMI

Abu Abdallah Muhammed ibn Ahmed ibn Sa'id al-Tamimi al-Muqaddasi (meaning, the native or the inhabitant of the Holly City). Born in Jerusalen; he moved, c. 970, to Egypt and was still living there in 980. Palastinian physician. He made pharmaceutical experiments and wrote various medical works, chiefly on materia medica. His main work is a guide (Murshid) on materia medica, which contains valuable information on plants, minerals, etc. *Kitab al-murshid ila jawahir al-aghdhiya wa quwa-lmufradat*; guide toward (the understanding of) the substances of food-stuffs and (of) the simple drugs.
*C. Brockelmann: Arabische Litteratur (vol. 1, 237, 1898).*

## AL-BALADI

Ahmed ibn Mohammed ibn Yahya al-Baladi. Flourished in Egypt under the Wazir Ya'qub ibn Kils, who died in 990-91. Egyptian physician. Author of a treatise on the hygiene of pregnant women and the babies (*Kitab Tadbir al-habala wal-atfal*).
*C. Brockelmann: Arabische Litteratur (vol. 1, 237, 1898).*

## HASDAI IBN SHAPRUT

Alias shaprut, Shafrut, Bashrut, Shaprot. Abu Yusuf Isaac ibn Izra. Born c. 915 at Jaen, Andalus; flourished at Cordova at the court of Abd al-Rahman III; died in 970 or 990 at Cordova. Hispano-Jewish physician, translator of Greek into Arabic, Patron of science. Physician to the caliph. He discovered a panacea called al-faruq (the best).
A manuscript of Dioscorides having been presented in 948-49 to Abd al-Rahman III by the emperor Constantinos VII, Hasdai undertook to translate it with the assistance of the Greek monk Nicholas. This monk had been sent to Cordova by the emperor upon the caliph's request, in 951.
He wrote a Hebrew letter to the King of the Khazars discribing Andalus. He was a great patron of jewish science and it was partly due to his initiative and activity that the intellectual center of Israel was finally transfered from academies of Babylonia to Spain.
*Article by Rabbi Meyer Kayserling in Jewish encyclopaedia, vol. 6, 248, 1904.*

## ARIB IBN SA'D

Arib ibn Sa'd al-Khatib (the secretary) al-Qurtubi. Flourished at Cordova at the court of Abd al-Rahman IIi and al-Hakim II, who died in 976. Hispano-Mislim historian and physician. Originally Christian. He wrote a chronicle of Muslim Spain and Afric some time between 961-976. This chronicle was extensively used by Ibn al-Idhari (q. v., second half of thirteenth century). He wrote also a treatise on gynaecology, hygiene of pregnant women and infants, and on obstetric (*Khalq al-janin*, Creation of the embryo, in 964-65), and a calender (*Kitab al-anwa'*).

*C. Brockelmann: Arabische Litteratur (vol. 1, 236, 1898).*

## ABU-L-QASIM

Latin names: Abulcasis, Albucasis, Alsaharavius. Khalaf ibn Abbas al-Zahrawi, from Zahra, near Cordova, where he flourished and died c. 1013. The greatest Muslim surgeon. Physician to al-Hakam II (961 to 976). His great medical encyclopedia in 30 sections, *al-Tasrif* (Vade-mecum) contains interesting methods of preparing drugs by sublimation and distillation. but its most important part is the surgical, in three books, largely based upon Paulos Aegineta. Great importance attached to cauterization and styptics. Parts of the surgery are devoted to obstetrics and to the surgical treatment of the eyes, ears, and teeth. This work was illustrated with views of the surgical instruments. It was early translated into Latin (by Gherardo Cremonese), Provencal and Hebrew. Muslim prejudices against surgery stifled Abu-l-Qasim's fame in Islam, but in the Christian world his prestigue was soon immense.

*Wustenfled: Geschichte der Arabischen Aerschen (p. 85, 1840).*

## IBN JULJUL

Abu Da'ud Suliman ibn Hasan ibn Juljul. Physician to the Spanish Umayyad Hisham II, Mu'aiyad billah, caliph from 976 to 1009. Hispano-Muslim physician. He wrote, at Cordova, in 982, a commentary on Dioscorides, and later a supplement to it, and a history of the physicians and philosophers of his time in Spain (*Ta'rikh al-atibba wal-falasifa*), often quoted by Ibn abi Usaibi'a (q. v., first half of the thirteenth century).

The aim of the commentary was to determine the drugs dealt with by Dioscorides; the supplement was a list of drugs not mentioned by Dioscorides. As to the origin of these Dioscoridian studies, see my notes on Hasidai ibn Shaprut. It would seem that Ibn Juljul and others assisted in the translation of Dioscorides into Arabic.

*C. Brockelmann: Arabische Litteratur (t. 1, 237, 1898).*

## IBN AL-JAZZAR

In Latin: Algizar, AlJazirah. Abu Ja'far Ahmed ibn Ibrahim Ibn Abi Khalid Ibn alJazzar. Flourished in Qairawan, Tunis, died in 1009, being more than 80 years old. Physician. Pupil of Ishaq al-Isra'ili (q. v., first half of the tenth century). Of his many writings, the most important because of its enormous popularity, was his "Traveller's Provision" (*Zad al-Musafir*) which was translated into Latin by Constantinus Africanus, into Greek by Synesios, and into Hebrew - the titles of these translations being: *Viaticum pergrinantis*; *Zedat al-Derachim*. It contains remarkable descriptions of smallpox and measles. He wrote also on the coryza, on the cuases of plague in Egypt, etc.

*C. Brockelmann: Arabische Litteratur (vol. 1, 238, 1898).*

# History of Islamic Science 6

Based on the book

*Introduction to the History of Science*by George Sarton

(provided with photos and portraits)

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# The Time of Al-Biruni

## First Half of Eleventh Century

The great leaders were so many - Ibn Yunus, Ibn al-Haitham, Al-Biruni, Ibn Sina, Ali ibn Isa, al-Karkhi, Ibn Gabirol (all Muslim except the last, who was Jewish) - that, for a moment at least, the historian is bewildered. Yet, however distinguished all of those men, and many others who will be named presently, two stand out head and shoulders above the others: al-Biruni and Ibn Sina (Avicenna). It was chiefly because all of them that this period was one of such excellence and distinction. These two men, who by the way, knew one another, were extremely different. Al-Biruni represents the more adventurous and critical spirit, Ibn Sina the synthetic spirit, al-Biruni was more of a discoverer, and in that respect he came nearer to the modern scientific ideal; Ibn Sina was essentially an organizer, an encyclopedist, a philosopher. Both, even the latter, were primarily men of science, and it would be difficult to choose between them but the accidental fact that al-Biruni's life covered more fully the present period and thus may be said to represent it more completely. Ibn Sina was only 20 at the beginning of the century, and his life was ultimately cut short in 1037. Al-Biruni's first important work appeared about 1000 and he lived until 1048. Thus his time of activity and the first half of the eleventh century are not identical periods, and we are fully justified (more fully so than in almost every short case) in calling it the Time of al-Biruni.

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# Muslim Mathematics and astronomy

It is almost like passing from the shade to the open sun and from a sleepy world into one tremendously active. For the sake of convenience, I divide Muslim mathematicians into three groups: those of the West, those of Egypt, who occupied, so to speak, an intermediate position, and those of the East. This is also a logical division, for though communications between the eastern and western ends of the Islam were frequent (there were a number of itinerant scholars to whom the universality of Islam seems to have been a continual provocation to move on from place to place), it is clear that local influences were felt more constantly and to greater advantage.

The greatest astronomer and trigonometrician of the time was Ibn Yunus, who lived in Cairo. Every thing considered, he was perhaps the greatest Muslim astronomer, and the Fatimid rules of Egypt gave him magnificent opportunities. Indeed, under the sixth Fatimid, al-Hakim, a sort of academy of science (Dar al-Hikma) had been established in Cairo, and, had been the case for the academy founded by al-Ma'mun in Bagdad two centuries earlier, an observatory was an essential part of it. Ibn Yunus made excellent use of these exceptional facilities to measure more accurately the number of astronomical constants and to compile improved tables named after his patron, the Hakemite tables. He contributed his share to the development of trigonometry, discovering new solutions of spherical problems and introducing the first of the prosthaphaeretical formulas. His colleague in al-Hakim's academy, Ibn al-Haitham, better known as a physicist, was also a great astronomer and mathematician. He made a curious attempt to measure the height of the atmosphere on the basis of his knowledge and of the length of twilight. He solved al-Mahani's equation and the so-called Alhazen's problem by means of intersecting conics.

The mathematicians of the East were so numerous, and though they could boast no man comparable in his branch of learning to Ibn Yunus, their work was generally on a very high level and full of originality. Kushyar ibn Labban especially interested in trigonometry, he made a deeper study on the tangent function and compiled new astronomical tables which were sooner translated into Persian. He also wrote on astrology and arithmetic. Ibn al-Husain investigated the classical problems of the Greek geometry (for example, the duplication of the cube) and tried to solve them by purely geometrical means. Abu-l-Jud was also a geometer; he made a special study on the regular heptagon and enneagon and of those problems which can not be solved by means of ruler and compass alone; he tried to classify equations with reference to conic sections, he is one of the mathematicians who prepared the work of Omar al-Khayyam in the following period. The greatest of them all, al-Karkhi was chiefly an arithmatician and algebraist. He solved a number of Diophantine problems and invented a series of new one. His work contains many of the original features, but the most extra-ordinary of these is the systematic neglect of Hindu numerals. No numerals are used, the names of the numerals being written in full. It is as if al-Karkhi had considered the use of Hindu numerals as vulgar and non-scientific. Al-Nasawi wrote a practical arithmetic in Persian and later translated it into Arabic. He explained the Hindu methods and applied them to difficult numerical problems; in these computations the sexagesimal fractions introduced by astronomical measurements were replaced by decimal fractions. Ibn Tahir wrote also arithmetical book of a practical nature; he showed how to solve the complicated inheritance problems entailed by the Muslim fondness for juridical niceties. To al-Biruni we owe the best mediaeval account of Hindu numerals. He composed an astronomical encyclopedia and a general treatise on mathematics , astronomy, and astrology. He was deterred neither by formidable computations nor by the most difficult geometrical problems of his time, those called after him Albirunic problems. He introduced a simplified method of stereographic projection. As we would expect, the philosophical aspects of mathematics were more to ibn Sina than the more technical details. We already know that in spite of his encyclopedic activities Ibn Sina found time to carry on a

number of astronomical observations and to improve the observational technique.
I named these Eastern mathematicians, as well as possible, in chronological order. This does not, perhaps, bring out with sufficient clearness the full complexity of their activities. In the first place, observe that, I did not mention a single astrologer; only one named in this section flourished not in the East, but in the orthodox Tunis, where there was much less freedom of thought. In the second place, if we leave out of account the astronomical work, which was determined by practical necessities, we find that there were two distinct streams of mathematical thought: the one theoretical represented by Ibn al-Husain, Abu-l-Jud, and al-Karkhi, the other, more practical, represented by al-Nasawi and Ibn Tahir. Al-Biruni and Ibn Sina can not be included in that classification, for they were equally in the most abstruse and in the most practical questions; they had no contempt for humble means, for there are no small matters for great minds.

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# Muslim Physics, Chemistry and Technology

Contemporary accounts of Muslim achievements must be started with Ibn al-Haitham, who flourished in Cairo at the beginning of the century. He was not only the greatest Muslim physicist, but by all means the greatest of mediaeval times. His researches on geometrical and physiological optics were the most significant to occur between ancient times and the sixteenth century. His description of the eye and his explanation of vision were distinct improvements.
Muslim scientists had developed a great interest in the determination of specific gravity. Al-Biruni continued that tradition and measured the density of 18 precious stones and metals with remarkable accuracy. He observed that the speed of light is incomparably greater than the of sound. Ibn Sina investigated all the fundamental questions of physics which could be formulated finite. His study of music was especially important and far ahead of the contemporary Latin work. He described the doubling with octave, the fourth and the fifth, and even with the third.
A college of Ibn al-Haitham in the Cairo academy, Masawaih al-Mardini, explained the preparation empyreumatic oils. Ibn Sina intertained original views on chemistry; he did not share the common belief of Muslim alchemists that the coloring or bronzing of metals affected their substance, he thought that the differences between metals were to deep to permit their transmutation. An important alchemical treatise was composed in 1034 by al-Kathi.

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# Muslim or Arabic Medicine

There are so many that I must again divide them into three groups. Those of Spain, those of Egypt, and those of the East.
**Spain:** Al-Karmani has already been mentioned. He was at once a mathematician and a surgeon. Ibn al-Wafid composed a treatise on simple drugs, which is partly extant in Latin, and a treatise on Balneography. To these two Muslims may be added the Jew, Ibn Janah, who flourished in Saragossa and wrote there in Arabic, a book on simple remedies.
**Egypt:** Not less than four great Physician enjoyed the patronage of the Fatimid rulers of Egypt. Masawaih al-Mardini (Mesue the Younger) compiled a large dispensatory which was immensely popular in mediaeval Europe. For centuries it remained the standard work on the subject. Ammar was perhaps the most original oculist of Islam, but his work was superseded by that of the Eastern contemporary, Ali ibn Isa. The surgical part of Ammar's ophthalmologic treatise is particularly important. The third of these physicians, Ibn al-Haitham (Alhazen) has already been dealt with many times; he must be remembered her because of his studies in physiological optics. Ali ibn Ridwan wrote various commentaries on Greek medicine, of which the best known was one on Galen's Ars prava; he also wrote a treatise on hygiene with special reference to Egypt. It should be noted that Masawaih was a monophysite Christian; the others were Muslims.
**East:** The greatest physician of the time and one of the greatest of all times was Ibn Sina (Avicenna). His enormous medical encyclopedia, the Qanun (Canon), remained the supreme authority, not simply in Islam but also in Christendom, for some six centuries. It contained a number of original observations, but its hold on the people was chiefly due to its systematic arrangement and its very dogmatism. Ibn Sina was not as great a physician as Galen, but he had very much the same intellectual qualities and defects and his ascendancy was largely based upon the same grounds. He had the advantage over Galen being able to take into account the vast experience of Muslim physicians.
Ibn al-Taiyib wrote commentaries on Greek medicine. Abu Sa'id Ubaid Allah, of the famous Bakhtyashu family, wrote treatise on love-sickness and discussed the philosophical terms used by physicians. Ibn Butlan compiled the so-called Tables of Health, a medical summary, divided into 15 vertical columns; he is perhaps the originator of that typical form of synopsis. Finally Ali ibn Isa (Jesu Haly) was the author of the most famous ophthalmologistical

treatise written in Arabic, it is very remarkable that not than three of these physicians, that is more than half of them, were Christians living in Bagdad: Ibn al-Taiyib, Abu Sa'id Ubaid Allah, and Ibn Butlan. This testifies for the faithfulness of the Christian community of Bagdad and the toleration of the Muslim rulers. It should be added that the other physicians, i.e., the Muslims, were far more important.

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# Muslim Mathematics and Astronomy
# Muslim Mathematics of the West

## AL-KARMANI

Abu Hakam Amr (or Omar) ibn Abd al-Rahman ibn Ahmed ibn Ali al-Karmani (that is of Carmona). Born in Cordova, died in Saragossa. Spanish-Muslim mathematician and surgeon. Disciple of Maslam ibn Ahmed (q. v., second half of tenth century). It is he (or else the latter) who introduced the writings of the Brethren of Purity into Spain.
*Suter: Die Mathematiker und Astronomen der Araber (105, 1900).*

## IBN AL-SAMH

Abu al-Qasim Asbagh ibn Mohammed ibn al-Samh. Flourished at Granada; died May 29, 1035, at the age of 56. Hispano-Muslim mathematician and astronomer. He wrote treatises on commercial arithmetic (*al-mu'amalat*), on two mental calculus (*hisab al-hawa'i*), on the nature of numbers, two on geometry, two on astrolabe, its use and construction. His main work seems to have been the compilation of astronomical tables, according to the Siddhanta method (for which see my notes on Mohammed ibn Ibrahim al-Fazari second half of eighth century), together with theoretical explanations (c. 1025).
*H. Suter: Mathematiker (85, 1900; 168, 1902).*

## IBN ABI-L-RIJAL

In Latin, Abenragel (also Albohazen, Alboacen, which was more correct, for Abenragel was his father's name, rather than his own). Abu-l-Hasan Ali ibn Abi-l-Rijal al-Saibani al-Katib al-Maghribi. Born in Cordova or else where in Spain or in northern Africa, flourished in Tunis some time about 1016 to 1040, died after 1040. Muslim astrologer. His main work is the "distinguished book on horoscopes from the constellations" (*al-bari fi ahkam al-nujum*). It was translated by Judah ben Moses from Arabic into Castilian, then from Castilian into Latin by Aegidius de Tebaldis and Petrus de Regio. He wrote a physiognomic treatise on Naevi.
*H. Suter: Die Mathematiker und Astronomen der Araber (100, 1900; Nachtrage, 172, 1902); encyclopedia of Islam (vol. 2, 356, 1916).*

## IBN AL-SAFFAR

Abu-l-Qasim Ahmed ibn Abdallah ibn Omar al-Ghafiqi, best known under the name of Ibn al-Saffar, meaning son of coppersmith. Flourished at Cordova, toward the end of his life he retired in Denia and died there in 1035. Hispano-Muslim mathematician and astronomer. He wrote a treatise on the astrolabe and compiled tables according to the Siddhanta method.
*H. Suter: Mathematiker (86, 225, 1900; 169, 1902).*

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# Muslim Mathematics of Egypt

## IBN YUNUS

Abu Hasan Ali ibn abi Sa'id Abd al-Rahman ibn Ahmed ibn Yunus (or Ibn Yunus) al-Sadafi al-Misri. Died in Cairo, 1009 (not 1008). The date of his birth is unknown, but his father died in 958-59. Perhaps the greatest Muslim astronomer. A well equipped observatory in Cairo enabled him to prepare improved astronomical tables. Begun c. 990 by order of the Fatimid caliph al-Aziz (975-996), they were completed in 1007 under the latter's son al-Hakim (996-1020) and are called after him the Hakemite Tables (al-zij al-kabir al-Hakimi). They contain observations of eclipses and conjunctions, old and new, improved values of astronomical constants (inclination of the ecliptic, 23º 35`; longitude of the sun's apogee, 86º 10`; solar parallax reduced from 3` to 2`; precession, 51.2`` a year, no allusion to trepidation) and accounts of the geodetic measurements carried on order by al-Ma'mun (q. v., first half of ninth century.)
His contributions to trigonometry, though less important than those of Abu-l-Wafa; are considerable. He solved many problems of spherical astronomy by means of orthogonal projections. He introduced the first of those

prosthapheretical formulae which were indispensable before the invention of the logarithms, namely, the equivalent of

$$\cos\alpha\cos\beta = 1/2\ [\cos(\alpha-\beta) + \cos(\alpha+\beta)].$$

Approximate value of $\sin 1^o = 1.8/3.9 \sin (9/8)^o + 2.16/3.15 \sin(15/16)^o$

Ibn Yunus's observatory was a part of Hall of Wisdom (Dar al-hikma, abode of wisdom) founded in Cairo by the Fatimids. This institution, which lasted from 1005 to the end Fatimid regime (1171), might be considered the second Muslim academy of science, the first being that founded by al-Ma'mun in Bagdad almost two centuries earlier.

*Suter: Encyclopaedia of Islam (vol. 2, 428, 1918).*

## IBN AL-HAITHAM

See notes in the physical section, below.

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# Muslim Mathematics of East

## AL-BIRUNI

Abu-Raihan Mohammed ibn Ahmed al-Biruni. Born in Khwarizm (Khiva) in 973 sojourned a considerable time in India; died in 1048, probably at Ghazna in Sijistan (Afghanistan). He was by birth a Persian and a Shi'ite; his religion was tempered with agonistic tendencies, but his national, anti-Arabic feelings remained very strong until the end. Traveler, mathematician, philosopher, astronomer, geographer, encyclopedist. One of the very greatest of Islam, and, all considered, one of the greatest of all times. His critical spirit, toleration, love of truth, and intellectual courage were almost without parallel in mediaeval times. He claimed that the phrase "Allah is omniscient" does not justify ignorance.

He wrote, in Arabic, a number of books on geographical, mathematical, and astronomical subjects. His main works were: (1) the "Chronology of ancient nations" or "Vestige of the past" (*Kitab al-athar al-baqiya ani-l-qurun al-khaliya*), written in 1000 and dealing chiefly with the calendars and ears of various peoples; (2) an account on India (*Ta'rikh al-Hind*) composed in Ghazna c. 1030; (3) an astronomical encyclopedia, the Mas,udic canon (*al-qanon al-Mas'udi fi-l-hai'a wal-nujum*), so-called because it was dedicated in 1030 to the Ghaznawid sultan Mas'ud; (4) a summery on mathematics, astronomy, and astrology (*Al-tafhim li-awa'il sina'at al-tanjim*). His description of Brahmanical India was based upon a deep study of the country and its people. He had been charmed by Hindu philosophy, especially by the Bhagavadgita. He translated from Sinskrit into Arabic (e. g., two of Varahamihira's works, q. v., first half of sixth century), and on the other hand, transmitted Muslim knowledge to the Hindus.

He gave a clear account (the best mediaeval account) of Hindu numerals (principle of position). Sum a geometric progression apropos of the chess game; it led to the following number: $16^{16} -1$ = 18, 446, 744, 073, 709, 551, 916. Trisection of the angles and other problems which can not be solved with ruler and compass alone (Albirunic problems). Simplified stereographic projection, similar to that first published by G.B. Nicolosi di Paterno in 1600 (Isis, V, 498).

Accurate determination of latitudes. Determination of longitudes. Geodetic measurements. Al-Biruni discussed the question whether the earth rotates around its axis or not, without reaching a definite conclusion.

Investigations on specific gravity. Remarkably accurate determination of the specific density of 18 precious stones and metals. As compared to the speed of sound, that of light is immense. The work of natural springs and "artesian" wells is explained by the hydrostatic principle of communicating vessels.

Description of monstrosities, including what we call "Siamese" twins.

The Indus valley must be considered as ancient sea basin filled up with alluvions.

*H. Suter and E. Wiedemann: Uber al-Biruni (Erlangen, 1920. Quoted above). Carra de Vaux: Penseur de l'Islam (vol. 2, 1921, passim).*

## KUSHYAR IBN LABBAN

Abu-l-Hasan Kushayr ibn Labban ibn Bashahri al-Jili (i. e., from Jilan, south of the Caspian Sea). Flourished c. 971-1029; his main work was probably done about the beginning of the eleventh century. Persian mathematician and astronomer, writing in Arabic. He seems to have taken an important part in the elaboration of trigonometry. For example, he continued the investigations of Abu-l-Wafa, the devoted much space to this in his tables, al-zij al-jami wa-l-baligh (the comprehensive and mature tables), which were translated into Persian before the end of the century. He wrote also an astrological introduction and an arithmetic treatise (extant to Hebrew).

*H. Suter: Mathematiker und Astronomen der Araber (83, 235, 1900; 168, 1902).*

## IBN AL-HUSAIN

Abu Ja'far Mohammed ibn al-Husain. Flourished not long after al-Khujandi (q. v., second half of the tenth century). Mathematician. He wrote a memoir on rational right angled triangles and another on the determination of two mean proportionals between two lines by a geometrical method (vs. kinematic method), i. e., by the use of what the Muslims called "fixed geometry", al-handasa al-thabit. Solution of the equation

$$x^2 \pm a = y^2.$$

*Suter: Die Mathematiker und Astronomen der Araber (80, 1900; Nachtrage, 168, 1902).*

## ABU-L-JUD

Abu-l-Jud Mohammed ibn al-Lith, contemporary of al-Biruni. Mathematician. Solution of al-Birunic problems by means of intersecting conics. Regular heptagon and enneagon. Classification of equations and their reduction to conic sections.

*Suter: Die Mathematiker und Astronomen der Araber (79, 1900).*

## AL-KARKHI

Abu Bakr Mohammed ibn al-Hassan (or Husain) al-Hasib (the calculator) al-Karkhi, meaning of Karkh, a suburb of Bagdad. Flourished in Bagdad during the vizierate of Abu Ghakib Mohammed ibn Khalaf Fakhr al-mulk (glory of the realm), who died in 1016; he died himself c. 1019 to 1029. One of the greatest Muslim mathematicians. His book on arithmetic (the sufficient on calculation, *alkafi fi-l-hisab*) is based chiefly of the Greek and Hellenistic knowledge. No numerals of any kind are used, the names of the numbers being written in full. Casting out of the nines and elevens.

**If** $r < (2a + 1), [(a^2 + r)] \sim a + r/(2a + 1).$

His algebra called (*al-fakhri*) in honor of the vizier is largely based on Diophantos. Complete solutions of quadratic equations (with proofs; two roots considered if positive and if not null). Reduction of equations of the type *ax2p + bxp = c* to quadratic equations. Addition and subtraction of radicals. Summation of series. Solution of Diophantine equations (including 25 problems not found in Diophantos). Al-Karkhi's neglect Hindu mathematics was such that it must have been systematic.

*H. Suter: Encyclopaedia of Islam (vol. 2, 764, 1925. Very little).*

## AL-NASAWI

Abu-l-Hasan Ali ibn Ahmed al-Nasawi. From Nasa, Khurasan. Flourished under the Buwayhid sultan Majd al-dawla, who died in 1029-30, and under his successor. Persian mathematician. He wrote a practical arithmetic in Persian, before 1030, and later under Majd al-dawla's successor an Arabic translation of it, entitled the "Satisfying (or Convincing) on Hindu Calculation" (*al-muqni fi-l-hisab al hindi*). He also wrote on Archemedes's lemnata and Menelaos's theorem (Kitab al-ishba, satiation). His arithmetic explains the division of fractions and the extraction of square and cubic roots (square root of 57,342; cubic root of 3, 652, 296) almost in the modern manner. It is remarkable that al-Nasawi replaces sexagesimal by decimal fractions, e. g.,

*Suter: Die Mathematiker und Astronomen der Araber (96, 1900) Uber das Rechenbuch des Ali ben Ahmed el-Nasawi (Bibliotheca Mathematica, vol. 7, 113-119, 1906).*

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# Muslim Physics, Chemistry and Technology

## IBN AL-HAITHAM

Latin name: Alhazen. Abu Ali al-Hasan ibn al-Hasan (or al-Husain) ibn al-Haitham. Born c. 965 in Basra, flourished in egypt under al-Hakim (996 to 10200 died in Cairo in 1039 or soon after. The greatest Muslim physicist and one of the greatest students of optics of all the times. He was also an astronomer, a mathematician, a physician, and he wrote commentaries on Aristotle and Galen.

The Latin translation of his main work, the Optics (*kitab al-manazir*), exerted a great influence upon Western science (R. Bacon; Kepler). It showed a great progress in the experimental method. Research in catoptrics: spherical and parabolic mirrors, spherical aberration; in dioptrics: the ratio between the angle and incidence and refraction does not remain constant; magnifying power of a lens. study of atmospheric refraction. The twilight only ceases or begins when the sun is $19^o$ below the horizon; attempt to measure the height of the atmosphere on that basis. Better description of the eye, and better understanding of vision, though ibn al-haitham considered the lens as the sensitive part; the rays originate in the object seen, not in the eye. Attempt to explain binocular vision. Correct explanation of the apparent increase in the size the sun and the moon when near the horizon. earliest use of the camera obscura.

The catoptrics contain the following problem, known as Alhazen's problem: from two points of the plane of a circle to draw lines meeting at point of the circumference and making equal angles with the normal at that point. It leads to

an equation of the fourth degree. Alhazen solved it by the aid of an hyberpola intersecting a circle. He also solved the so-called al-Mahani's (cubic) equation (q. v., second half of the ninth century) in a similar (Archimedian) manner.
*Suter: Die Mathematiker und Astronomen der Araber (91-95, Nachtrage, 169, 1902).*

## AL-KATHI

Abu-l-Hakim Mohammed ibn Abd al-Malik al-Salihi al-Khwarizmi al-Kathi. Flourished in Bagdad c. 1034. Muslim Chemist, he wrote, in 1034, a treatise on alchemy entitled "Essence of the Art and Aid to the Workers" (*Ain al-san'a wa awn-al-sana'a*), strikingly similar in some respects to the "Summa perfectionis magisterii" of the Latin Geber (for which see my notes on Jabir, second half of eighth century).
*H. E. Stapleton and R. F. Azo: Alchemical Equipments in the Eleventh century (Memories of Asiatic Society of Bengal, vol. 1, 47-70, 1 pl., Calcutta, 1905. Containing Arabic text, an analysis of it, and an introduction; very important).*

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# Muslim (or Arabic) Medicine

## Arabic-Writing physicians of the West

## AL-KARMANI

See notes in mathematical section

## IBN AL-WAFID

Latin name: Abenguefit. Abu-l- Mutarrif abd al-Rahman ibn Mohammed ibn Abd al-Karim ibn Yahya ibn al-Wafid al-Lakhmi. From Toledo, where he flourished; born 997, died c. 1074. Hispano-Muslim physician, Pharmacologist. His main work, on simple drugs (*Kitab al-adwaiya al-mufrada*), based on Galen and Discorides and also on personal investigations, is partly extant in a Latin translation. He preferred to use dietetic measures, and, if drugs were needed, to use the simplest ones. He advised a method of investigating the action of the drugs. He also wrote a balneotherapy.
*C. Brocklmann: Arabischen Litteratur (vol. 1, 485, 1898. Two Arabic manuscripts mentioned).*

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## Arabic-Writing physicians of Egypt

## MASAWIAH AL-MARDINI

Mesue the Younger. Masawaih al-Mardini, from Mardin in Upper Mesopotamia. Flourished in Bagdad, later at the court of the Fatimid caliph al-Hakim in Egypt, where he died in 1015 at the age of ninety. Physician. Jacobite Christian. He wrote book on purgatives and emetics (*De medicins laxativis*) and on the complete pharmacopoeia in 12 parts called the *Antidotarium sive Grabadin medicamentorum*, based on Muslim knowledge. The last-named work was immensely popular. It remained for centuries the standard text-book of pharmacy in the West, and Mesue was called "pharmacopoeorum evabgelista". Distillation of empyreumatic oils.
There is still a third Mesue (q. v., first half of thirteenth century), author of a treatise on surgery.
*Neuburger: Geschichte der Medizin (vol. 2, 226-227, 1911).*

## AMMAR

Latin name: Canamusali. Abu-l-Qasim Ammar ibn Ali al-Mawsili. From Mawsil in Iraq; flourished in Egypt in the reign of al-Hakim, who ruled from 996-1020. Physician. The most original of Muslim oculists, His work was eclipsed by that of his contemporary Ali ibn Isa, which was more comprehensive. His summary on the treatment of the eye (*Kitab al-muntakhab fi ilaz al-ain*) contains many clear descriptions of diseases and treatments, arranged in logical order. The surgical part is especially important.
*E. Mittwoch: Encyclopaedia of Islam (vol. 1, 332, 1910).*

## IBN AL-HAITHAM

See notes in physical section, above.

## ALI IBN RIDWAN

Abu-l-Hasan Ali ibn Radwan ibn Ali ibn Ja'far al-Misri. Born in Jiza near Cairo, c. 998. Flourished in Cairo and died there in 1061 or in 1067. Astrologer. physician. The author of many medical writings of which the most

popular was his commentary on Galen'a Ars prava, which was translated by Gerardo Cremonese. I may still quote his treatise on hygiene with special reference to Egypt (*fi daf mudar al-abdan bi-ard Misr*). He wrote various other commentaries on Hippoctates and Galen and on Ptolemy's astrological books.
*C. Brocklmann: Arabischen Litteratur (vol. 1, 484, 1898).*

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# Arabic-Writing physicians of the East

## IBN SINA

Abu Ali al-Hassan ibn Abdallah ibn Sina. Hebrew, Aven Sina; Latin, Avicenna. Born in 980 at Afshana, near Bukhara, died in Hamadhan, 1037. Encyclopaedist, philosopher, physician, mathematician, astronomer. The most famous scientist of Islam and one of the most famous of all races, places, and times; one may say that his thought represents the climax of mediaeval philosophy. He wrote a many great treatises in prose and verse; most of them in Arabic, a few in Persian. His philosophical encyclopedia (*Kitab al-shifa, sanatio*) implies the following classification: theoretical knowledge (subdivided, with regard to increasing abstraction, into physics, mathematics, and metaphysics), practical knowledge (ethics, economy, politics). His philosophy roughly represents the Aristotelian tradition as modified by Neoplatonic influences and Muslim theology. Among his many other philosophical works, I must still quote a treatise on logic, *Kitab al-isharat wal-tanbihat* (The Book of Signs and Adonitions). As ibn Sina expressed his views on almost any subject very clearly, very forcible, and generally more than once, his thought is, or at any rate can be, known with great accuracy.
His most important medical works are the Qanun (Canon) and a treatise on cardiac drugs (hitherto unpublished). The *Qanun fi-l-tibb* is an immense encyclopedia of medicine (of about a million words), a codification of the whole ancient and Muslim knowledge. Being similar in many respects to Galen, Ibn Sina elaborated to a degree the Galenic classifications (for example, he distinguished 15 qualities of pain). Because of its formal perfection as well as its intrinsic value, the *Qanun* superseded Razi's Hawi, Ali ibn Abbas's *Maliki*, and even works of Galen, and remained supreme for six centuries. However the very success of Ibn Sina as an encyclopedist caused his original observations to be correspondingly depreciated. Yet the *Qanun* contains many examples of good observation - distinction of mediastinitis from pleurisy; contagious nature of phthitis; distribution of diseases by soil and water; careful description of skin troubles, of sexual diseases; and supervisions; of nervous ailments (including love sickness); many psychological and pathological facts clearly analyzed if badly explained.
Ibn Sina's interest in mathematics was philosophical rather than technical and such as we would expect in a late Neoplatonist. He explained the casting out of nines and its application to the verification of square and cubes. Many of his writings were devoted to mathematical and astronomical subjects. He composed a translation on Euclid. He made astronomical observations, and devised a contrivance the purpose of which was similar to that of the vernier, that is, to increase the precision of instrumental readings.
He made a profound study of various physical questions - motion, contact, force, vacuum, infinity, light, and heat. He observed that if the perception of light is due to the emission of some sort of particles by the luminous source, and speed of light must be finite. He made investigations on specific gravity.
He did not believe the possibility of chemical transmutation, because in his opinion the differences of the metals were not superficial, but much deeper; coloring or bronzing the metals does not affect their essence. It should be noted that these views were radically opposed to those which were then generally accepted.
Ibn Sina's treatise on minerals was the main source of the geological ideas of the Christian encyclopedist of the thirteenth century.
Ibn Sina wrote an autobiography which was completed by his favorite disciple al-Juzajani.
His triumph was too complete; it discouraged original investigations and sterilized intellectual life. Like Aristotle and Vergil, Avicenna was considered by the people of later times as a magician.
*C. Brocklmann: Geschichte der arabischen Litteratur (vol. 1, 452-458, 1898. With list of 99 works).*

## IBN AL-TAIYIB

Abu-l-Faraj Abdallah Ibn al-Taiyib al-Iraqi. Latin name : Abulpharagius Abdalla Benattibus. Died in 1043-44. Nestorian physician. Secertary to Elias I, Nestorian Catholics from 1028 to 1049. Physician at the Adudite hospital in Bagdad. He had many commentaries on Greek medicine, and original memories on various medical topics, also a translation of the pseudo-Aristotelian *De plantis*, with additional excerpts from ancient literature.
From Arabic translation of the Diatessaron ascribed to him.
*Brocklmann: Arabischen Litteratur (vol. 1, 482, 1898).*

## ABU SA'ID UBAID ALLAH

Abu Sa'id Ubaid Allah ibn Bakhtyashu. Flourished in Maiya-fariqin, Jazirah; friend of Ibn Butlan; died in 1058.

Physician. The last and possibly the greatest representative of the Bukhtyashu, a syrian family of physicians which emigrated from Junsishapur to Bagdad in 765. His main works are the Reminder of the Homestayer, dealing with the philosophical terms used in medicine, and a treatise on lovesickness.
*C. Brocklmann: Encyclopaedia of Islam (t. 1, 601, 1911).*

## IBN BUTLAN

Abu-l-Hasan al-Mukhtar ibn al-Hasan ibn Abdun ibn Sa'dun ibn Butlan. Latin name: Elluchasem Elimither. Flourished in Bagdad; died, probably in Antioch, in or soon after 1063. Christian physician. He wrote synoptic tables of hygiene, dietetics, domestic medicine, called the Tables of Health. He probably originated that form of synopsis, which was developed by ibn Jazla (q. v., second half of eleventh century). Medical polemic with Ali ibn Ridwan.
*C. Brocklmann: Arabischen Litteratur (vol. 1, 483, 1898).*

## ALI IBN ISA

Ali ibn Isa or Jesu Haly. flourished in Bagdad in the first half of the eleventh century. He is said to have been a christian. The most Famous Arabic oculist. His "Manual" in three books, *Tadhkirat al-kahhalin*, is the oldest Arabic work on ophthalmology of which the original text is completely extant. It is based partly on ancient knowledge, partly on personal experience. It is at once very detailed and very comprehensive. The first book deals with the anatomy and physiology of the eye; the second with the diseases externally visible; the third with hidden diseases, dietetics, and general medicine from the oculistic standpoint; 130 eye diseases are carefully described; 143 drugs characterized.
*J. Hirschberg: Die arabischen Lehrbucher der Augenheilkunde (Abhd. der preuss. Ak. der Wiss., 117 p., Berlin, 1905)*

# History of Islamic Science 7

Based on the book
*Introduction to the History of Science*by George Sarton
(provided with photos and portraits)

## Edited and prepared by Prof. Hamed A. Ead

These pages are edited by Prof. Hamed Abdel-reheem Ead, Professor of Chemistry at the Faculty of Science - University of Cairo, Giza, Egypt and director of the Science Heritage Center
Web site: http://www.frcu.eun.eg/www/universities/html/hamed2.htm

# The Time of Omar Khayyam

## (Second Half Of Eleventh Century)

The most original creations of this time were made in the field of mathematics by Muslims, and the most original genius among those to whom we owe these creations was the Persian Omar Khayyam. It is thus very appropriate to call this time the Time of Omar Khayyam, as Omar is already very well known to a large number of readers. It is probable that his name is more familiar to them than that of any other Muslim scientist. It will thus be relatively easy to remember the title, and I trust that this remembrance will reach to some extent the contents of the following pages. The time of Omar Khayyam was the end of the golden age of Muslim science.

A new Muslim sect, that of the Assassins, an off-shoot of the Ismailiya movement, originated in Cairo about 1080. They took possession of the fortress of Alamut, which remained their main stronghold for a century and a half. Alamut seems to have been also a center of learning.
The Muslim philosopher who has obtained the largest following in the West, in fact the only one who has become at all popular, is the persian poet and sufi Omar Khayyam. On the other hand, one of Omar's contemporaries, al-Ghazzali, was the greatest theologian of Islam. He might be compared to Thomas Aquinas, to whom he was in many

ways superior. Al-Ghazzali was also a Persian and spent part of his life in Omar's native place, Nishabur. While Omar Khayyam is the most popular fingure of mediaeval times, al-Ghazzali is probably the noblest.

# Muslim Mathematics and Astronomy

Important astronomical work was done at Cordova. Ibn Said, aided by other Muslim and Jewish astronomers, made a number of observations. These observations were used by al-Zarqaili (Arzachel), for the compilation of new tables, the so-called Toledan tables, which obtained considerable authority in western Europe. Al-Zarqaili invented a new kind of astrolabe and proved the movement of the solar apogee; unfortunately, he confirmed the erroneous theory of the "trepidation" of the equinoxes. His tables were preceded, as usual, by an elaborate trigonometrical introduction.

The philosopher al-Ghazzali wrote a treatise on the motion and nature of stars and an astronomical summary; he had some knowledge of magic squares. The Bagdadite Muhammad ibn Àbd al-Baqí wrote a commentary on the tenth book of Euclid.

The activity of Muslim geographers, which had been so intense during the ninth and tenth centuries, abated during the present century. For the second half of this century two men will be recorded, one in the West and the other in the East. The western one, al-Bakri, is of special importance, become the road-book which the compiled in the traditional manner is the oldest one of its kind due to a Spaniard. He also compiled a dictionary of ancient (i.e., Arabian) geography. The Eastern one is also a very arresting personality. Nasir-I-Khusraw was an Ismaili missionary who, starting from Egypt, traveled extensively in the Near East and as far east as Persia. He wrote in Persia an account of his travels, which is equally valuable from the geographical and from the historical point of view.

The contributions of Islam may seem small, but they were still of a very high quality.

In spite of Anselm, Psellos, and Constantine, in spite of the Chanson de Roland, in spite of Alfasi, Rashi, and Nathan, Islam was still at the vanguard of humanity. There was nowhere else in the world, in those days, a philosopher who could at all compare with al-Ghazzali, neither an astronomer like al-Zarqali, neither a mathematician like Omar Khayyam. These men were to towering far above their contemporaries.

If we proceed to examine more carefully the intellectual condition of Islam, we discover, in the first place, that some of the most important contributions were due to Persians; this was not novelty, but what is more starting, they were written in Persian.

Al-Ghazzali was the only Persian who wrote in Arabic; al-Hasan ibn al-Sabbah, Omar Khayyam, Nasir-I-Khusraw, Zarrin Dast, Nidham al-Mulk, and Asadi wrote in Persian.

The city of the caliphs gave us still a number of scientists but none of great distinction - Muhammad ibn Àbd al-Baqí, Ibn Jazla (of Christian origin), Sa'íd ibn hibat Allah, al-Khatíb al-Baghdadí, and al-Mawardí. The only center of intellectual progress in Islam was Spain, but the heyday of Cordova was already over. Indeed, of the seven scientists and scholars who make us think of the Muslim Spain of those days with gratitude, only one can be connected with Cordova, the geographer al-Bakrí.

The greatest of them all, al-Zarqali, flourished in Toledo, and so did the original historian Ibn Sa'íd. Yusuf al-Mutamin lived in Saragossa; Abu 'Umar ibn Hajjaj in Seville. Ibn Sída, was born in Murcia and died in Denia.

But the development of astronomy by al-Zarqal and of algebra by Omar Khayyam were definite steps forward.

A great orientalist went so far as to say : "The fourth century is the turning-point in the history of the spirit of Islam".

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# MUSLIM MATHEMATICS AND ASTRONOMY

## AL-ZARQALI

In Latin : Arzachel. Abu Ishaq Ibrahim ibn Yahya al-Naqqash, the engraver. Better known as Ibn al-Zarqali. From Cordova, lived from c.1029 to c.1080. Astronomer. The best observer of his time (observations dated 1061, 1080). He invented an improved astrolabe called safiham (saphaea Arzachelis); his description of it was translated into Latin, Hebrew, and many vernaculars. He was the first to prove explicitly the motion of the solar apogee with reference to the stars; according to his measurements it amounted to 12.04" per year (the real value being 11.8").

On the other hand, comparing his observation of the obliquity of the ecliptic with previous ones, he concluded that it oscillated between 23o 33' and 23o 53', thus reenforcing the erroneous belief in the "trepidation" of the equinoxes.

He edited the so-called Toledan Tables, planetary tables based upon the observations made by him and probably other Muslim and Jewish astronomers in Toledo (notably Ibn Sa'íd).
These tables were translated into Latin by Gherardo Cremonese and enjoyed much popularity. The trigonometrical introduction (*Canones sive regulae tabularum astronomiae*) was al- Zarqali's own work; it explains the construction of the trigonometrical tables.

## YUSUF AL-MUTAMIN

Of the tribe of the Banu Hud; king of Saragossa from 1081 to 1085. His father, Ahmed al-Muqtadir Billah, king from 1046 to 1081, was also a student and a patron of students. Hispano-Muslim mathematician and patron of science.
He wrote a mathematical treatise, *Istikmal* (Bringing to perfection), of which it was said that it should be studied together with Euclid, the *Almagest*, and the "middle books."p
No copy of Yusuf's treatise is known; it is strange that a work believed to be so important and written by a king should be lost.
Stanley Lane Poole: *Mohammedan Dynasties* (26,1893)
H.Suter: *Mathematiker* (108,1900).

## OMAR KHAYYAM

Abu-l-Fath 'Umar ibn Ibrahím al-khayyamí - the tentmaker - Ghiyath al-dín. Born in or near Níshabur c. 1038 to 1048, died there in 1123-24.
Persian mathematician, astronomer, and poet. One of the greatest mathematicians of mediaeval times. His *Algebra* contains geometric and algebraic solutions of equations of the second degree; an admirable classification of equations, including the cubic; a systematic attempt to solve them all, and partial geometric solutions of most of them (he did not consider negative roots and his failure to use both branches or halves of a conic caused him to miss sometimes one of the positive roots). His classification of equations is very different from our own; it is based on the complexity of the equations (the number of different terms which they include).
Of course the higher the degree of an equation the more different terms, or combinations of terms, it can contain. Thus Omar recognizes 13 different forms of cubic equation. (The modern classification based primarily upon the degree dates only from the end of the sixteenth and the beginning of the seventeenth century).
Binomial development when the exponent is a positive integer. Study of the postulates and generalities of Euclid.
In 1074-75 the saljuq sultan Malikshah, Jalal al-dín, called him to the new observatory of Ray (or Níshabur, or Isfahan?) to reform the old Persian calendar:
(30x12)d.+5d.=365 d. The latter had been temporarily replaced by the Muslim calendar after the conquest. Omar's calendar was called al-ta'rikh al-Jalal.
Its era was the 10th Ramadan 471=16 March 1079. There are many interpretations of Omar's reform and to each corresponds a certain degree of accuracy, but at any rate, Omar's calendar was very accurate, probably more so than the Gregorian calendar.
The correct interpretation is probably one of the three following, the second being the most probable of them. I quote for each, the authority, then the gist of the change, and finally the resulting error:
According to al-Shirazi (d.1449), 15 intercalary days in 62 years; error, 1 day in about 3,770 years.
Moden interpretation, 8 intercalary days in 33 years; error, 1 day in about 5,000 years.
(The Gregorian calendar leads to an error of 1 day in 3,330 years).
Methods for the determination of specific gravity.
It is impossible not to mention the *Ruba'iyat* (quatrains) of Omar Khayyam, which have become, especially since 159 (when Edward Fitzgerald published the first instalment of his English paraphrase), one of the most popular classics of the world literature. Omar Khayyam was probably not a sufi, but rather an agnostic.
Comparisons of his thought with that of Lucretius and that of Voltaire are suggestive but indaequate.

## MUHAMMAD IBN' ABD AL-BAQI

Abu Bakr(?) Muhammad ibn 'Abd al-Baghdadi. Flourished c. 1100.
Possibly the author of a commentary on the tenth book of Euclid, which was very popular because of its numerical

applications. It is entitled "Liber judei super decimum Euclidis" in the translation by Gherardo Cremonese.

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# MUSLIM MEDICINE

## IBN JAZIA

Abu 'ali Yahya ibn Isa Ibn Jazla. Latin forms: Bengesla, Buhahylyha, Byngezla, etc.
Flourished in Bagdad, died in 1100. Christian physician, who embraced Islam in 1074. His most important work is a medical synopsis, wherein 44 tables of two pages each contain the description and outline the treatment of 352 diseases (8 in each table); it was probably modeled upon similar work of Ibn Butlan (q .v; first half of eleventh century) and is called "Tables of the Bodies with regard to their constitutions" (Taqwim al-abdan fi tadbir al-insa; dispositio corporum de constitutions hominis). He wrote for al-Muqtadi (caliph from 1075 to 1094) an alphabetical list of simple and compound medicines called "The Pathway of Explanation as to that which Man Uses" (Minhaj al-bayan fi ma yasta 'miluhu al-insan; methodica dispositio eorum, quibus homo uti solet).

## SA'ID IBN HIBAT ALLAH

Abu-I-Hassan Sa'id ibn Hibat Allah ibn al-Hasan. Flourished in Bagded under al-Muqtadi, caliph from 1075 to 1094, died in 1101-2. Physician and philosopher.
Author of a synopsis of medicine, *Al-mughni fi tadbir al-amrad wa ma 'rifat al-'ilal wal-a'rad* (Sufficiens de cura morborum et eognitione causarum et symptomarum) and of a treatise on physiology and psychology called "Discourse on the creation of Man", *Maqala fi khalq al-insan* (De constitutione hominis), dealing with such subjects as reproduction, gestation, parturition, growth, decay, survival of the soul, etc.

## ZARRIN DAST

Abu Ruh Muhammad ibn Mansur ibn abi 'Abdallah ibn Mansur al-Jamani (or al-Jurjani). Zarrin Dast means the Golden Hand, a good name for an eye surgeon.
Flourished under the Saljuq sultan Abu-l-Fath Malikshah ibn Muhammad, ruling from 1072-73 to 1092-93. Persian oculist. He completed in 1087-88, a very comprehensive and very remarkable treatise on ophthalmology entitled "The Light of the Eyes" (*Nur al-ayun*) (in Persian).
Hirschberg: *Geschichte der Augenheilkunde bei den Arabern* (57 sq., Leipzig, 1905).
Adolf Fonahn: *Quellenkunde der persischen Medizin* (38-41, 1910. Includes summary of the treatise, based upon Hirschberg).

# Timeline of Islamic Scientists

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## Timeline of Islamic Scientists (700-1400)

### This chart depicts the lifes of key Islamic Scientists and related writers, from the 8th to the end of the 13th century. By placing each writer in a historical context, this will help us understand the influences and borrowing of ideas.

**701 (died) - Khalid Ibn Yazeed - Alchemy**

**721 - Jabir Ibn Haiyan (Geber) - (Great Muslim Alchemist)**

**740** - Al-Asmai - (Zoology, Botany, Animal Husbandry)
**780** - Al-Khwarizmi (Algorizm) - (Mathematics, Astronomy)
**787** - Al Balkhi, Ja'Far Ibn Muhammas (Albumasar) - Astronomy, Fortune-telling
**796** (died) - Al-Fazari,Ibrahim Ibn Habeeb - Astronomy, Translation
**800** - Ibn Ishaq Al-Kindi - (Alkindus) - (Philosophy, Physics, Optics)
**808** - Hunain Ibn Is'haq - Medicine, Translator
**815** - Al-Dinawari, Abu-Hanifa Ahmed Ibn Dawood - Mathematics, Linguistics
**836** - Thabit Ibn Qurrah (Thebit) - (Astronomy, Mechanics)
**838** - Ali Ibn Rabban Al-Tabari - (Medicine, Mathematics)
**852** - Al Battani ABU abdillah (Albategni) - Mathematics, Astronomy, Engineering
**857** - Ibn MasawaihYou'hanna - Medicine
**858** - Al-Battani (Albategnius) - (Astronomy, mathematics)
**860** - Al-Farghani (Al-Fraganus) - (Astronomy,Civil Engineering)
**884** - Al-Razi (Rhazes) - (Medicine,Ophthalmology, Chemistry)
**870** - Al-Farabi (Al-Pharabius) - (Sociology, Logic, Science, Music)
**900** - (died) - Abu Hamed Al-ustrulabi - Astronomy
**903** - Al-Sufi (Azophi - ( Astronomy)
**908** - Thabit Ibn Qurrah - Medicine, Engineering
**912** (died) - Al-Tamimi Muhammad Ibn Amyal (Attmimi) - Alchemy
**923** (died) - Al-Nirizi, AlFadl Ibn Ahmed (wronge Altibrizi) - Mathematics, Astronomy
**930** - Ibn Miskawayh, Ahmed Abuali - Medicine, Alchemy
**932** - Ahmed Al-Tabari - Medicine
**936** - Abu Al-Qasim Al-Zahravi (Albucasis) - (Surgery, Medicine)
**940** - Muhammad Al-Buzjani - (Mathematics, Astronomy, Geometry)
**950** - Al Majrett'ti Abu-alQasim - Astronomy, Alchemy, Mathematics
**960** (died) - Ibn Wahshiyh, Abu Baker - Alchemy, Botany
**965** - Ibn Al-Haitham (Alhazen) - Physics, Optics, Mathematics)
**973** - Abu Raihan Al-Biruni - (Astronomy, Mathematics)
**976** - Ibn Abil Ashath - Medicine
**980** - Ibn Sina (Avicenna) - (Medicine, Philosophy, Mathematics)
**983** - Ikhwan A-Safa (Assafa) - (Group of Muslim Scientists)

**1019** - Al-Hasib Alkarji - Mathematics

**1029** - Al-Zarqali (Arzachel) - Astronomy (Invented Astrolabe)

**1044** - Omar Al-Khayyam - (Mathematics, Poetry)

**1060** - (died) Ali Ibn Ridwan Abu'Hassan Ali - Medicine

**1077** - Ibn Abi-Sadia Abul Qasim - Medicine

**1090** - Ibn Zuhr (Avenzoar) - Surgery, Medicine

**1095** - Ibn Bajah, Mohammed Ibn Yahya

**1097** - Ibn Al-Baitar Diauddin (Bitar) - Botany, Medicine, Pharmacology

**1099** - Al-Idrisi (Dreses) - Geography, World Map (First Globe)

**1091** - Ibn Zuhr (Avenzoar) - ( Surgery, Medicine)

**1095** - Ibn Bajah, Mohammad Ibn Yahya (Avenpace) - Philosophy, Medicine

**1099** - Al-Idrisi (Dreses) - (Geography -World Map, First Globe)

**1100** - Ibn Tufayl Al-Qaysi - Philosophy, Medicine

**1120** - (died) - Al-Tuhra-ee, Al-Husain Ibn Ali - Alchemy, Poem

**1128** - Ibn Rushd (Averroe's) - Philosophy, Medicine

**1135** - Ibn Maymun, Musa (Maimonides) - Medicine, Philosphy

**1140** - Al-Badee Al-Ustralabi - Astronomy, Mathematics

**1155** (died) - Abdel-al Rahman AlKhazin - Astronomy

**1162** - Al Baghdadi, Abdellateef Muwaffaq - Medicine, Geography

**1165** - Ibn A-Rumiyyah Abul'Abbas (Annabati) - Botany

**1173** - Rasheed AlDeen Al-Suri - Botany

**1184** - Al-Tifashi, Shihabud-Deen (Attifashi) - Metallurgy, Stones

**1201** - Nasir Al-Din Al-Tusi - (Astronomy, Non-Euclidean Geometry)

**1203** - Ibn Abi-Usaibi'ah, Muwaffaq Al-Din - Medicine

**1204** (died) - Al-Bitruji (Alpetragius) - (Astronomy)

**1213** - Ibn Al-Nafis Damishqui - (Anatomy)

**1236** - Kutb Aldeen Al-Shirazi - Astronomy, Geography

**1248** (died) - Ibn Al-Baitar - ( Pharmacy, Botany)

**1258** - Ibn Al-Banna (Al Murrakishi), Azdi - Medicine, Mathematics

**1262** (died) - Al-Hassan Al-Murarakishi - Mathematics, Astronomy, Geography

**1273** - Al-Fida (Abdulfeda) - ( Astronomy, Geography)

**1306** - Ibn Al-Shater Al Dimashqi - Astronomy, Mathematics

**1320** (died) - Al Farisi Kamalud-deen Abul-Hassan - Astronomy, Physics

**1341** (died) - Al-Jildaki, Muhammad Ibn Aidamer - Alchemy

**1351** - Ibn Al-Majdi, Abu Abbas Ibn Tanbugha - Mathematics, Astronomy

**1359** - Ibn Al-Magdi,Shihab-Udden Ibn Tanbugha - Mathematic, Astronomy