# Muslim Scientist & Their Contribution (Complete)

The CSS Point

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# Muslim Scientist & Their Contribution

## ABU AL-QASIM AL-ZAHRAWI
## (936-1013 C.E.)

Abul Qasim Khalaf ibn al-Abbas al-Zahrawi (known in the west as Abulcasis) was born in 936 C.E. in Zahra in the neighbourhood of Cordova. He became one of the most renowned surgeons of the Muslim era and was physician to King Al-Hakam-II of Spain. After a long medical career, rich with significant original contribution, he died in 1013 C.E.

He is best known for his early and original breakthroughs in surgery as well as for his famous Medical Ecyclopaedia called Al-Tasrif, which is composed of thirty volumes covering different aspects of medical science. The more important part of this series comprises three books on surgery, which describe in detail various aspects of surgical treatment as based on the operations performed by him, including cauterization, removal of stone from the bladder, dissection of animals, midwifery, stypics, and surgery of eye, ear and throat. He perfected several delicate operations, including removal of the dead foetus and amputation.

Al-Tasrif was first translated by Gherard of Cremona into Latin in the Middle Ages. It was followed by several other editors in Europe. The book contains numerous diagrams and illustrations of surgical instruments, in use or developed by him, and comprised a part of the medical curriculum in European countries for many centuries. Contrary to the view that the Muslims fought shy of surgery, Al-Zahrawi's Al-Tasrif provided a monumental collection for this branch of applied science.

Al-Zahrawi was the inventor of several surgical instruments, of which three are notable: (i) an instrument for internal examina- tion of the ear, (ii) an instrument for internal inspection of the urethra, and (iii) and instrument for applying or removing foreign bodies from the throat. He specialized in curing disease by cauterization and applied the technique to as many as 50 different operations.

In his book Al-Tasrif, Al-Zahrawi has also discussed the preparation of various medicines, in addition to a comprehensive account of surgical treatment in specialized branches, whose modern counterparts are E.N.T., Ophthalmology, etc. In connection with the preparation of medicines, he has also described in detail the application of such techniques as sublimation and decantation. Al-Zahrawi was also an expert in dentistry, and his book contains sketches of various instruments used thereof, in addition to a description of various important dental operations. He discussed the problem of non-aligned or deformed teeth and how to rectify these defects. He developed the technique of preparing artificial teeth and of replacement of defective teeth by these. In medicine, he was the first to describe in detail the unusual disease, haemophelia.

There can be no doubt that Al-Zahrawi influenced the field of medicine and surgery very deeply and the principles laid down by him were recognized as authentic in medical science, especially

surgery, and these continued to influence the medical world for five centuries. According to Dr. Cambell (History of Arab Medicine), his principles of medical science surpassed those of Galen in the European medical curriculum.

## YAQUB IBN ISHAQ AL-KINDI
## (800-873 C.E.)

Abu Yousuf Yaqub Ibn Ishaq al-Kindi was born at Kufa around 800 C.E. His father was an official of Haroon al-Rashid. Al-Kindi was a contemporary of al-Mamun, al-Mu'tasim and al-Mutawakkil and flourished largely at Baghdad. He vas formally employed by Mutawakkil as a calligrapher. On account of his philosophical views, Mutawakkil was annoyed with him and confiscated all his books. These were, however, returned later on. He died in 873 C.E. during the reign of al-M'utamid.

Al-Kindi was a philosopher, mathematician, physicist, astronomer, physician, geographer and even an expert in music. It is surprising that he made original contributions to all of these fields. On account of his work he became known as the philosopher of the Arabs.

In mathematics, he wrote four books on the number system and laid the foundation of a large part of modern arithmetic. No doubt the Arabic system of numerals was largely developed by al-Khawarizmi, but al-Kindi also made rich contributions to it. He also contributed to spherical geometry to assist him in astronomical studies.

In chemistry, he opposed the idea that base metals can be converted to precious metals. In contrast to prevailing alchemical views, he was emphatic that chemical reactions cannot bring about the transformation of elements. In physics, he made rich contributions to geometrical optics and wrote a book on it. This book later on provided guidance and inspiration to such eminent scientists as Roger Bacon.

In medicine, his chief contribution comprises the fact that he was the first to systematically determine the doses to be adminis- tered of all the drugs known at his time. This resolved the conflic- ting views prevailing among physicians on the dosage that caused difficulties in writing recipes.

Very little was known on the scientific aspects of music in his time. He pointed out that the various notes that combine to produce harmony, have a specific pitch each. Thus, notes with too low or too high a pitch are non-pleatant. The degree of harmony depends on the frequency of notes, etc. He also pointed out the fact that when a sound is produced, it generates waves in the air which strike the ear-drum. His work contains a notation on the determination of pitch.

He was a prolific writer, the total number of books written by him was 241, the prominent among which were divided as follows:

Astronomy 16, Arithmetic 11, Geometry 32, Medicine 22
Physics 12, Philosophy 22, Logic 9, Psychology 5, ar,d Music 7.

In addition, various monographs written by him concern tides, astronomical instruments, rocks, precious stones, etc. He was also an early translator of Greek works into Arabic, but this fact has largely been over-shadowed by his numerous original writings. It is unfortunate that most of his books are no longer extant, but those existing speak very high of his standard of scholarship and contribution. He was known as Alkindus in Latin and a large number of his books were translated into Latin by Gherard of Cremona. His books that were translated into Latin during the Middle Ages comprise Risalah dar Tanjim, Ikhtiyarat al-Ayyam, Ilahyat-e-Aristu, al-Mosiqa, Mad-o-Jazr, and Aduiyah Murakkaba.

Al-Kindi's influence on development of science and philosophy was significant in the revival of sciences in that period. In the Middle Ages, Cardano considered him as one of the twelve greatest minds. His works, in fact, lead to further development of various subjects for centuries, notably physics, mathematics, medicine and music.

## Abu Ja'far Muhammad ibn Musa Al-Khwarizmi

We know few details of al-Khwarizmi's life. We know he worked at an academy where Greek philosophical and scientific works were translated. He and his colleagues also studied, and wrote on, algebra, geometry, and astronomy. Certainly al-Khwarizmi worked under the patronage of the Caliph.

His treatise on algebra, Hisab al-jabr w'al-muqabala, was the most famous and important of all of al-Khwarizmi's works. It is the title of this text that gives us the word "algebra" and, in a sense that we shall investigate more fully below, it is the first book to be written on algebra. In al-Khwarizmi's own words, the purpose of the book is to teach:

what is easiest and most useful in arithmetic, such as men constantly require in cases of inheritance, legacies, partition, lawsuits, and trade, and in all their dealings with one another, or where the measuring of lands, the digging of canals, geometrical computations, and other objects of various sorts and kinds are concerned.

This does not sound like the contents of an algebra text, and indeed only the first part of the book is a discussion of what we would today recognise as algebra. However it is important to realise that the book was intended to be highly practical, and that algebra was introduced to solve real life problems that were part of everyday life in the Islam empire at that time.

After introducing the natural numbers, he discusses the solution of equations. His equations are linear or quadratic and are composed of units (numbers), roots (x) and squares (x2). He first reduces an equation to one of 6 standard forms, using the operations of addition and subtraction, and then shows how to solve these standard types of equations. He uses both algebraic methods of solution and the geometric method of completing the square.

Al-Khwarizmi continues his study of algebra by examining how the laws of arithmetic extend to an arithmetic for his algebraic objects. For example he shows how to multiply out expressions such as (a + bx)(c + dx), although we should emphasise that al-Khwarizmi uses only words to describe his expressions, and no symbols are used.

The next part of al-Khwarizmi's Algebra consists of applications and worked examples. He then goes on to look at rules for finding the area of figures such as the circle, and also finding the volume of solids such as the sphere, cone, and pyramid. This section on mensuration certainly has more in common with Hindu and Hebrew texts than it does with any Greek work. The final part of the book deals with the complicated Islamic rules for inheritance, but require little from the earlier algebra beyond solving linear equations.

Al-Khwarizmi's algebra is regarded as the foundation and cornerstone of the sciences. In a sense, al-Khwarizmi is more entitled to be called "the father of algebra" than Diophantus because al-Khwarizmi is the first to teach algebra in an elementary form and for its own sake, while Diophantus is primarily concerned with the theory of numbers.

Al-Khwarizmi also wrote a treatise on Hindu-Arabic numerals. The work describes the Hindu place-value system of numerals based on 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0. The first use of zero as a place holder in positional base notation was probably due to al-Khwarizmi in this work.

He also wrote an important work on astronomy, covering calendars, calculating true positions of the sun, moon and planets, tables of sines and tangents, spherical astronomy, astrological tables, parallax and eclipse calculations, and visibility of the moon. Although his astronomical work is based on that of the Indians, and most of the values from which he constructed his tables came from Hindu astronomers, al-Khwarizmi must have been influenced by Ptolemy's work too.

Al-Khwarizmi wrote a major work on geography which give latitudes and longitudes for 2402 localities as a basis for a world map. The book, which is based on Ptolemy's Geography, lists with latitudes and longitudes, cities, mountains, seas, islands, geographical regions, and rivers. The manuscript includes maps which on the whole are more accurate than those of Ptolemy.

A number of minor works were written by al-Khwarizmi on topics such as the astrolabe, on which he wrote two works, on the sundial, and on the Jewish calendar. He also wrote a political history containing horoscopes of prominent persons.

# ABU AL - WAFA MUHAMMAD AL-BUZJANI

Abul Wafa Muhammad Ibn Muhammad Ibn Yahya Ibn Ismail al-Buzjani was born in Buzjan, Nishapur in 940 C.E. He flourished as a great mathematician and astronomer at Baghdad and died in 997/998 C.E. He learnt mathematics in Baghdad. In 959 C.E. he migrated to Iraq and lived there till his death.

Abul Wafa's main contribution lies in several branches of mathematics, especially geometry and trigonometry. In geometry his contribution comprises solution of geometrical problems with opening of the compass; construction of a square equivalent to other squares; regular polyhedra; construction of regular hectagon taking for its side half the side of the equilateral triangle inscribed in the same circle; constructions of parabola by points and geometrical solution of the equations: x4 = a and x4 + ax3 = b

Abul Wafa's contribution to the development of trigonometry was extensive. He was the first to show the generality of the sine theorem relative to spherical triangles. He developed a new method of constructing sine tables, the value of sin 30' being correct to the eighth decimal place. He also developed relations for sine (a+b) and the formula:

2 sin2 (a/2) = 1 - cos a , an

sin a = 2 sin (a/2) cos (a/2)

In addition, he made a special study of the tangent and calculated a table of tangents. He introduced the secant and cosecant for the first time, knew the relations between the trigonometric lines, which are now used to define them, and undertook extensive studies on conics.

Apart from being a mathematician, Abul Wafa also contributed to astronomy. In this field he discussed different movernents of the moon, and discovered 'variation'. He was also one of the last Arabic translators and commentators of Greek works.

He wrote a large number of books on mathematics and other subjects, most of which have been lost or exist in modified forms. His contribution includes Kitab 'Ilm al-Hisab, a practical book of arithmetic, al-Kitab al-Kamil (the Complete Book), Kitab al-Handsa (Applied Geometry). Apart from this, he wrote rich commentaries on Euclid, Diophantos and al-Khawarizmi, but all of these have been lost. His books now extant include Kitab 'Ilm al-Hisab, Kitab al- Handsa and Kitab al-Kamil.

His astronomical knowledge on the movements of the moon has been criticized in that, in the case of 'variation' the third inequality of the moon as he discussed was the second part of the 'evection'. But, according to Sedat, what he discovered was the same that was discovered by Tycho Brache six centuries later. Nonetheless, his contribution to trigonometry was extremely significant in that he

developed the knowledge on the tangent and introduced the secant and cosecant for the first time; in fact a sizeable part of today's trigonometry can be traced back to him.

## Abu 'Ali al-Hasan ibn al-Haytham

The Arab physicist, astronomer, and mathematician Abu 'Ali al-Hasan ibn al-Haytham (ca. 966-1039), or Alhazen, established the theory of vision that prevailed till the 17th century. He also defended a theory of the physical reality of Ptolemy's planetary models.

Al-Hasan was born at Basra in southern Iraq, where he must have received all his education. He gained sufficient fame for his knowledge of physics in his youth that he was called to Egypt by the Fatimid ruler al-Hakim to attempt to regulate the flow of the Nile. Failing in this effort, he was disgraced and established himself as a copyist of mathematical manuscripts; there still exists in Istanbul a manuscript of the Banu Musa's version of Apollonius's Conics copied by him in 1024. He continued to practice the scribal art in Cairo for the remainder of his life.

He did not cease to pursue his scientific studies, however, and published a large number of highly original works. He produced two catalogs of his own work, which are preserved by Ibn abi Usaybia. The first of these, compiled in 1027, comprises 25 books on mathematics and 44 on physics and metaphysics, including On the Structure of the World. The second, supplementary catalog was complied in 1028.

### Work in Astronomy

The primary interest of al-Hasan was the explanation of phenomena by both mathematical and physical hypotheses. His interest in astronomy was motivated by the discrepancy between the Aristotelian physical and mechanistic model of the celestial spheres and the Ptolemaic mathematical model. On the Structure of the World, of which only the Latin translation has been published, describes the Aristotelian sublunar world of four elements and the Ptolemaic celestial spheres in all their complexity (his only change is to accept the theory that the solar apogee is fixed with respect to the fixed stars) as if they were material. He inserts a discussion of the perception of lunar and solar eclipses based on the assumption that the moon and sun are solid physical bodies.

This problem al-Hasan takes up again in On the Light of the Moon, in which he refutes the ancient theory that the moon reflects the sun's light like a mirror.

# ABIR IBN HAIYAN
## (Died 803 C.E.)

Jabir Ibn Haiyan, the alchemist Geber of the Middle Ages, is generally known as the father of chemistry. Abu Musa Jabir Ibn Hayyan, sometimes called al-Harrani and al-Sufi, was the son of the druggist (Attar). The precise date of his birth is the subject of some discussion, but it is established that he practised medicine and alchemy in Kufa around 776 C.E. He is reported to have studied under Imam Ja'far Sadiq and the Ummayed prince Khalid Ibn Yazid. In his early days, he practised medicine and was under the patronage of the Barmaki Vizir during the Abbssid Caliphate of Haroon al-Rashid. He shared some of the effects of the downfall of the Barmakis and was placed under house arrest in Kufa, where he died in 803 C.E. Jabir's major contribution was in the field of chemistry. He introduced experimental investigation into alchemy, which rapidly changed its character into modern chemistry. On the ruins of his well-known laboratory remained after centuries, but his fame rests on over 100 monumental treatises, of which 22 relate to chemistry and alchemy. His contribution of fundamental importance to chemistry includes perfection of scientific techniques such as crystalization, distillation, calcination, sublimation and evaporation and development of several instruments for the same. The fact of early development

of chemistry as a distinct branch of science by the Arabs, instead of the earlier vague ideas, is well-established and the very name chemistry is derived from the Arabic word al-Kimya, which was studied and developed extensively by the Muslim scientists.

Perhaps Jabir's major practical achievement was the discovery of mineral and others acids, which he prepared for the first time in his alembic (Anbique). Apart from several contributions of basic nature to alchemy, involving largely the preparation of new compounds and development of chemical methods, he also developed a number of applied chemical processes, thus becoming a pioneer in the field of applied science. His achievements in this field include preparation of various metals, development of steel, dyeing of cloth and tanning of leather, varnishing of water-proof cloth, use of manganese dioxide in glass-making, prevention of rusting, letterring in gold, identification of paints, greases, etc. During the course of these practical endeavours, he also developed aqua regia to dissolve gold. The alembic is his great invention, which made easy and systematic the process of distillation. Jabir laid great stress on experimentation and accuracy in his work.

Based on their properties, he has described three distinct types of substances. First, spirits i.e. those which vaporise on heating, like camphor, arsenic and ammonium chloride; secondly, metals, for example, gold, silver, lead, copper, iron, and thirdly, the category of compounds which can be converted into powders. He thus paved the way for such later classification as metals, non-metals and volatile substances.

Although known as an alchemist, he did not seem to have seriously pursued the preparation of noble metals as an alchemist; instead he devoted his effort to the development of basic chemical methods and study of mechanisms of chemical reactions in themselves and thus helped evolve chemistry as a science from the legends of alchemy. He emphasised that, in chemical reactions, definite quantities of various substances are involved and thus can be said to have paved the way for the law of constant proportions.

A large number of books are included in his corpus. Apart from chemistry, he also contributed to other sciences such as medicine and astronomy. His books on chemistry, including his Kitab-al-Kimya, and Kitab al-Sab'een were translated into Latin and various European languages. These translations were popular in Europe for several centuries and have influenced the evolution of modern chemistry. Several technical terms devised by Jabir, such as alkali, are today found in various European languages and have become part of scientific vocabulary. Only a few of his books have been edited and published, while several others preserved in Arabic have yet to be annotated and published.

Doubts have been expressed as to whether all the voluminous work included in the corpus is his own contribution or it contains later commentaries/additions by his followers. According to Sarton, the true worth of his work would only be known when all his books have been edited and published. His religious views and philosophical concepts embodied in the corpus have been criticised but, apart from the question of their authenticity, it is to be emphasised that the major contribution of Jabir lies in the field of chemistry and not in religion. His various breakthroughs e.g., preparation of acids for the first time, notably nitric, hydrochloric, citric and tartaric acids, and emphasis on systematic experimentation are outstanding and it is on the basis of such work that he

can justly be regarded as the father of modern chemistry. In the words of Max Mayerhaff, the development of chemistry in Europe can be traced directly to Jabir Ibn Haiyan.

## ABU AL-NASR AL-FARABI
## (870-950 C.E.)

Abu Nasr Mohammad Ibn al-Farakh al-Farabi was born in a small village Wasij, near Farab in Turkistan in 259 A.H. (870 C.E.). His parents were originally of Persian descent, but his ancestors had migrated to Turkistan. Known as al-Phrarabius in Europe, Farabi was the son of a general. He completed his earlier education at Farab and Bukhara but, later on, he went to Baghdad for higher studies, where he studied and worked for a long time viz., from 901 C.E. to 942 C.E. During this period he acquired mastery over several languages as well as various branches of knowledge and technology. He lived through the reign of six Abbasid Caliphs. As a philosopher and scientist, he acquired great proficiency in various branches of learning and is reported to have been an expert in different languages.

Farabi travelled to many distant lands and studied for some time in Damascus and Egypt, but repeatedly came back to Baghdad, until he visited Saif al-Daula's court in Halab (Allepo). He became one of the constant companions of the King, and it was here at Halab that his fame spread far and wide. During his early years he was a Qadi (Judge), but later on the took up teaching as his profession. During the course of his career, he had suffered great hardships and at one time was the caretaker of a garden. He died a bachelor in Damascus in 339 A.H./950 C.E. at the age of 80 years.

Farabi contributed considerably to science, philosophy, logic, sociology, medicine, mathematics

and music. His major contributions seem to be in philosophy, logic and sociology and, of course, stands out as an Encyclopedist. As a philosopher, he may be classed as a Neoplatonist who tried to synthesize Platonism and Aristotelism with theology and he wrote such rich commentaries on Aristotle's physics, meteorology, logic, etc., in addition to a large number of books on several other subjects embodying his original contribution, that he came to be known as the 'Second Teacher' (al-Mou'allim al-Thani) Aristotle being the First. One of the important contributions of Farabi was to make the study of logic more easy by dividing it into two categories viz., Takhayyul (idea) and Thubut (proof).

In sociology he wrote several books out of which Ara Ahl al-Madina al-Fadila became famous. His books on psychology and metaphysics were largely based on his own work. He also wrote a book on music, captioned Kitab al-Musiqa. He was a great expert in the art and science of music and invented several musical instruments, besides contributing to the knowledge of musical notes. It has been reported that he could play his instrument so well as to make people laugh or weep at will. In physics he demonstrated the existence of void.

Although many of his books have been lost, 117 are known, out of which 43 are on logic, 11 on metaphysics, 7 on ethics, 7 on political science, 17 on music, medicine and sociology, while 11 are commentaries. Some of his more famous books include the book Fusus al-Hikam, which remained a text book of philosophy for several centuries at various centres of learning and is still taught at some of the institutions in the East. The book Kitab al-lhsa al 'Ulum discusses classification and fundamental principles of science in a unique and useful manner. The book Ara Ahl al-Madina al- Fadila 'The Model City' is a significant early contribution to sociology snd political science.

Farabi exercised great influence on science and knowledge for several centuries. Unfortunately, the book Theology of Aristotle, as was available to him at that time was regarded by him as genuine, although later on it turned out to be the work of some Neoplatonic writer. Despite this, he was regarded the Second Teacher in philosophy for centuries and his work, aimed at synthesis of philosophy and sufism, paved the way forIbn Sina's work.

## ABU RAIHAN AL-BIRUNI
## (973-1048 C.E.)

Abu Raihan Mohammad Ibn Ahmad al-Biruni was one of the well-known figures associated with the court of King Mahmood Ghaznawi, who was one of the famous Muslim kings of the 11th century C.E. Al-Biruni was a versatile scholar and scientist who had equal facility in physics, metaphysics, mathematics, geography and history. Born in the city of Kheva near "Ural" in 973 C.E., he was a contemporary of the well-known physician Ibn Sina. At an early age, the fame of his scholarship went around and when Sultan Mahmood Ghaznawi conquered his homeland, he took al-Biruni along with him in his journeys to India several times and thus he had the opportunity to travel all over India during a period of 20 years. He learnt Hindu philosophy, mathematics, geography and religion from thre Pandits to whom he taught Greek and Arabic science and philosophy. He died in 1048 C.E. at the age of 75, after having spent 40 years in thus gathering knowledge and making his own original contributions to it.

He recorded observations of his travels through India in his well-known book Kitab al-Hind which gives a graphic account of the historical and social conditions of the sub-continent. At the end of this book he makes a mention of having translated two Sanskrit books into Arabic, one called Sakaya, which deals with the creation of things and their types, and the second, Patanjal dealing with what happens after the spirit leaves the body. His descriptions of India were so complete that even the Aein-i-Akbari written by Abu-al- Fadal during the reign of Akbar, 600 years later, owes a great deal to al-Biruni's book. He observed that the Indus valley must be considered as an ancient sea basin filled up with alluvials.

On his return from India, al-Biruni wrote his famous book Qanun-i Masoodi (al-Qanun al-Masudi, fi al-Hai'a wa al-Nujum), which he dedicated to Sultan Masood. The book discusses several theories of astronomy, trigonometry, solar, lunar, and planetary motions and relative topics. In another well-known book al-Athar al-Baqia, he has attempted a connected account of ancient history of nations and the related geographical knowledge. In this book, he has discussed the rotation of the earth and has given correct values of latitudes and longitudes of various places. He has also made considerable contribution to several aspects of physical and economic geography in this book.

His other scientific contributions include the accurate determination of the densities of 18 different stones. He also wrote the Kitab-al-Saidana, which is an extensive materia medica that combines the then existing Arabic knowledge on the subject with the Indian medicine. His book the Kitab-al-Jamahir deals with the properties of various precious stones. He was also an astrologer and is reputed to have astonished people by the accuracy of his predictions. He gave a clear account of Hindu numerals, elaborating the principle of position. Summation of a geometric progression appropos of the chess game led to the number:

$1616^{\circ} - 1 = 18,446,744,073,709,551,619.$

He developed a method for trisection of angle and other problems which cannot be solved with a ruler and a compass alone. Al-Biruni discussed, centuries before the rest of the world, the question whether the earth rotates around its axis or not. He was the first to undertake experiments related to astronomical phenomena. His scientific method, taken together with that of other Muslim scientists, such as Ibn al-Haitham, laid down the early foundation of modern science. He ascertained that as compared with the speed of sound the speed of light is immense. He explained the working of natural springs and artesian wells by the hydrostatic principle of communicating vessels. His investigations included description of various monstrosities, including that known as "Siamese" twins. He observed that flowers have 3,4,5,6, or 18 petals, but never 7 or 9.

He wrote a number of books and treatises. Apart from Kitab-al- Hind (History and Geography of India), al-Qanun al-Masudi (Astro- nomy, Trigonometry), al-Athar al-Baqia (Ancient History and Geography), Kitab al-Saidana (Materia Medica) and Kitab al-Jawahir (Precious Stones) as mentioned above, his book al-Tafhim-li-Awail Sina'at al-Tanjim gives a summary of mathematics and astronomy.

He has been considered as one of the very greatest scientists of Islam, and, all considered, one of the greatest of all times. His critical spirit, love of truth, and scientific approach were combined

with a sense of toleration. His enthusiasm for knowledge may be judged from his claim that the phrase Allah is Omniscient does not justify ignorance.

## IBN AL-BAITAR
## (DIED 1248 C.E.)

Abu Muhammad Abdallah Ibn Ahmad Ibn al-Baitar Dhiya al-Din al-Malaqi was one of the greatest scientists of Muslim Spain and was the greatest botanist and pharmacist of the Middle Ages. He was born in the Spanish city of Malaqa (Malaga) towards the end of the 12th century. He learned botany from Abu al-Abbas al-Nabati, a learned botanist, with whom he started collecting plants in and around Spain. In 1219 he left Spain on a plant-collecting expedition and travelled along the northern coast of Africa as far as Asia Minor. The exact modes of his travel (whether by land or sea) are not known, but the major stations he visited include Bugia, Qastantunia (Constantinople), Tunis, Tripoli, Barqa and Adalia. After 1224 he entered the service of al-Kamil, the Egyptian Governor, and was appointed chief herbalist. In 1227 al-Kamil extended his domination to Damascus, and Ibn al-Baitar accompanied him there which provided him an opportunity to collect plants in Syria His researches on plants extended over a vast area:including Arabia and Palestine, which he either visited or managed to collect plants from stations located there. He died in Damascus in 1248.

Ibn Baitar's major contribution, Kitab al-Jami fi al-Adwiya al- Mufrada, is one of the greatest botanical compilations dealing with medicinal plants in Arabic. It enjoyed a high status among botanists up to the 16th century and is a systematic work that embodies earlier works, with due criticism, and adds a great part of original contribution. The encyclopaedia comprises some 1,400 different items, largely medicinal plants and vegetables, of which about 200 plants were not known earlier. The book refers to the work of some 150 authors mostly Arabic, and it also quotes about 20 early Greek scientists. It was translated into Latin and published in 1758.

His second monumental treatise Kitab al-Mlughni fi al-Adwiya al-Mufrada is an encyclopaedia of medicine. The drugs are listed in accordance with their therapeutical value. Thus, its 20 different chapters deal with the plants bearing significance to diseases of head, ear, eye, etc. On surgical issues he has frequently quoted the famous Muslim surgeon, Abul Qasim Zahrawi. Besides Arabic, Baitar has given Greek and Latin names of the plants, thus facilitating transfer of knowledge.

Ibn Baitar's contributions are characterised by observation, analysis and classification and have exerted a profound influence on Eastern as well as Western botany and medicine. Though the Jami was translated/published late in the western languages as mentioned above, yet many scientists had earlier studied various parts of the book and made several references to it.

# NASIR AL-DIN AL-TUSI
# (1201-1274 C.E.)

Abu Jafar Muhammad Ibn Muhammad Ibn al-Hasan Nasir al-Din al-Tusi was born in Tus (Khurasan) in 1201 C.E. He learnt sciences and philosophy from Kamal al-Din Ibn Yunus and others. He was one of those who were kidnapped by Hasan Bin Sabah's agents and sent to Almut, Hasan's stronghold. In 1256 when Almut was conquered by the Mongols, Nasir al-Din joined Halagu's service. Halagu Khan was deeply impressed by his knowledge, including his astrological competency; appointed him as one of his ministers, and, later on, as administrator of Auqaf. He was instrumental in the establishment and progress of the observatory at Maragha. In his last year of life he went to Baghdad and died there.

Nasir al-Din was one of the greatest scientists, philosaphers, mathematicians, astronomers, theologians and physicians of the time and was a prolific writer. He made significant contributions to a large number of subjects, and it is indeed difficult to present his work in a few words. He wrote one or several treatises on different sciences and subjects including those on geometry, algebra, arithmetic, trigonometry, medicine, metaphysics, logic, ethics and theology. In addition he wrote poetry in Persian.

In mathematics, his major contribution would seem to be in trigonometry, which was compiled by him as a new subject in its own right for the first time. Also he developed the subject of spherical trigonometry, including six fundamental formulas for the solution of spherical right-angled triangles.

As the chief scientist at the observatory established under his supervision at Maragha, he made significant contributions to astronomy. The observatory was equipped with the best possible instruments, including those collected by the Mongol armies from Baghdad and other Islamic centres. The instruments included astrolabes, representations of constellations, epicycles, shapes of spheres, etc. He himself invented an instrument 'turquet' that contained two planes. After the devoted work of 12 years at the observatory and with the assistance of his group, he produced new astronomical tables called Al-Zij-Ilkhani dedicated to Ilkhan (Halagu Khan). Although Tusi had contemplated completing the tables in 30 years, the time required for the completion of planetary cycles, but he had to complete them in 12 years on orders from Halagu Khan. The tables were largely based on original observa- tions, but also drew upon the then existing knowledge on the subject. The Zij Ilkhani became the most popular tables among astronomers and remained so till the 15th century. Nasir al-Din pointed out several serious shortcomings in Ptolemy's astronomy and foreshadowed the later dissatisfaction with the system that culminated in the Copernican reforms.

In philosophy, apart from his contribution in logic and meta- physics, his work on ethics entitled Akhlaq-i-Nasri became the most important book on the subject, and remained popular for centuries. His book Tajrid-al-'Aqaid was a major work on al-Kalam (Islamic Scholastic Philosophy) and enjoyed widespread popularity. Several commentaries were written on this book and even a number of supercommentaries on the major commentaries, Sharh Qadim and Sharh Jadid.

The list of his known treatises is exhaustive; Brockelmann lists 56 and Sarton 64. About one-fourth of these concern mathe- matics, another fourth astronomy, another fourth philosophy and religion, and the remainder other subjects. The books, though originally written in Arabic and Persian, were translated into Latin and other European languages in the Middle Ages and several of these have been printed.

Tusi's influence has been significant in the development of science, notably in mathematics and astronomy. His books were widely consulted for centuries and he has been held in high repute for his rich contributions.

## JALAL AL-DIN RUMI
## (1207-1273 C.E.)

Jalal al-Din Mohammad Ibn Mohammad Ibn Mohammad Ibn Husain al-Rumi was born in 604 A.H. (1207/8 C.E.) at Balkh (now Afghanistan). His father Baha al-Din was a renowned religious scholar. Under his patronage, Rumi received his early education from Syed Burhan-al-Din. When his age was about 18 years, the family (after several migrations) finally settled at Konya and at the age of 25, Rumi was sent to Aleppo for advanced education and later to Damascus. Rumi continued with his education till he was 40 years old, although on his father's death Rumi succeeded him as a professor in the famous Madrasah at Konya at the age of about 24 years. He received his mystical training first at the hands of Syed Burhan al-Din and later he was trained by Shams al-Din Tabriz. He became famous for his mystical insight, his religious knowledge and as a Persian poet. He used to teach a large number of pupils at his Madrasah and also founded the famous Maulvi Order in Tasawwuf. He died in 672 A.H. (1273 C.E.) at Konya, which subsequently became a sacred place for dancing derveshes of the Maulvi Order.

His major contribution lies in Islamic philosophy and Tasawwuf. This was embodied largely in poetry, especially through his famous Mathnawi. This book, the largest mystical exposition in verse, discusses and offers solutions to many complicated problems in metaphysics, religion, ethics, mysticism, etc. Fundamentally, the Mathnawi highlights the various hidden aspects of Sufism and their relationship with the worldly life. For this, Rumi draws on a variety of subjects and derives numerous examples from everyday life. His main subject is the relationship between man and God on the one hand, and between man and man, on the other. He apparently believed in Pantheism and portrayed the various stages of man's evolution in his journey towards the Ultimate.

Apart from the Mathnaui, he also wrote his Diwan (collection of poems) and Fihi-Ma-Fih (a collection of mystical sayings). How- ever, it is the Mathnawi itself that has largely transmitted Rumi's message. Soon after its completion, other scholars started writing detailed commentaries on it, in order to interpret its rich propositions on Tasawwuf, Metaphysics and Ethics. Several commentaries in different languages have been written since then.

His impact on philosophy, literature, mysticism and culture, has been so deep throughout Central Asia and most Islamic countries that almost all religious scholars, mystics, philosophers, sociologists and others have referred to his verses during all these centuries since his death. Most

difficult problems in these areas seem to get simpli- fied in the light of his references. His message seems to have inspired most of the intellectuals in Central Asia and adjoining areas since his time, and scholars like Iqbal have further developed Rumi's concepts. The Mathnawi became known as the interpretation of the Qur'an in the Pahlavi language. He is one of the few intellectuals and mystics whose views have so profoundly affected the world-view in its higher perspective in large parts of the Islamic World.

## IBN AL-NAFIS
## (1213-1288 C.E.)

Ala-al-Din Abu al-Hasan Ali Ibn Abi al-Hazm al-Qarshi al- Damashqi al-Misri was born in 607 A.H. of Damascus. He was educated at the Medical College-cum-Hospital founded by Nur al- Din Zangi. In medicine his teacher was Muhaththab al-Din Abd al- Rahim. Apart from medicine, Ibn al-Nafis learnt jurisprudence, literature and theology. He thus became a renowned expert on Shafi'i School of Jurisprudence as well as a reputed physician.

After acquiring his expertise in medicine and jurisprudence, he moved to Cairo where he was appointed as the Principal at the famous Nasri Hospital. Here he imparted training to a large number of medical specialists, including Ibn al-Quff al-Masihi, the famous surgeon. He also served at the Mansuriya School at Cairo. When he died in 678 A.H. he donated his house, library and clinic to the Mansuriya Hospital.

His major contribution lies in medicine. His approach comprised writing detailed commentaries on early works, critically evaluating them and adding his own original contribution. Hlis major original contribution of great significance was his discovery of the blood's circulatory system, which was re-discovered by modern science after a lapse of three centuries. He was the first to correctly describe the constitution of the lungs and gave a description of the bronchi and the interaction between the human body's vessels for air and blood. Also, he elaborated the function of the coronary arteries as feeding the cardiac muscle.

The most voluminous of his books is Al-Shamil fi al-Tibb, which was designed to be an encyclopaedia comprising 300 volumes, but it could not be completed due to his death. The manuscript is available at Damascus. His book on ophthalmology is largely an original contribution and is also extant. However, his book that became most famous was Mujaz al-Qanun and a number of commentaries were written on this. His own commentaries include one on Hippocrates' book. He wrote several volumes on Ibn Sina's Qanun, that are still extant. Likewise he wrote a commentary on Hunayn Ibn Ishaq's book. Another famous book embodying his original contribution was on the effects of diet on health. entitled Kitab al-Mukhtar fi al-Aghdhiya.

Ibn Al-Nafis' works integrated the then existing medical know- ledge and enriched it, thus exerting great influence on the development of medical science, both in the East and the West. However, only one of his books was translated into Latin at early stages and, therefore, a part of his work remained unknown to Europe for a long time.

## Ibn Sina (Avicenna) -

Ibn Sina was born in 980 C.E. in the village of Afshana near Bukhara which today is located in the far south of Russia. His father, Abdullah, an adherent of the Ismaili sect, was from Balkh and his mother from a village near Bukhara.

In any age Ibn Sina, known in the West as Avicenna, would have been a giant among giants. He displayed exceptional intellectual prowess as a child and at the age of ten was already proficient in the Qur'an and the Arabic classics. During the next six years he devoted himself to Muslim Jurisprudence, Philosophy and Natural Science and studied Logic, Euclid, and the Almeagest.

He turned his attention to Medicine at the age of 17 years and found it, in his own words, "not difficult". However he was greatly troubled by metaphysical problems and in particular the works of Aristotle. By chance, he obtained a manual on this subject by the celebrated philosopher al-Farabi which solved his difficulties.

By the age of 18 he had built up a reputation as a physician and was summoned to attend the Samani ruler Nuh ibn Mansur (reigned 976-997 C.E.), who, in gratitude for Ibn Sina's services, allowed him to make free use of the royal library, which contained many rare and even unique books. Endowed with great powers of absorbing and retaining knowledge, this Muslim scholar devoured the contents of the library and at the age of 21 was in a position to compose his first book.

At about the same time he lost his father and soon afterwards left Bukhara and wandered westwards. He entered the services of Ali ibn Ma'mun, the ruler of Khiva, for a while, but ultimately fled to avoid being kidnapped by the Sultan Mahmud of Ghazna. After many wanderings he came to Jurjan, near the Caspian Sea, attracted by the fame of its ruler, Qabus, as a patron of learning. Unfortunately Ibn Sina's arrival almost coincided with the deposition and murder of this ruler. At Jurjan, Ibn Sina lectured on logic and astronomy and wrote the first part of the Qanun, his greatest work.He then moved to Ray, near modern Teheran and established a busy medical practice. When Ray was besieged, Ibn Sina fled to Hamadan where he cured Amir Shamsud-Dawala of colic and was made Prime Minister. A mutiny of soldiers against him caused his dismissal and imprisonment, but subsequently the Amir, being again attacked by the colic, summoned him back, apologised and reinstated him! His life at this time was very strenuous: during the day he was busy with the Amir's services, while a great deal of the night was passed in lecturing and dictating notes for his books. Students would gather in his home and read parts of his two great books, the Shifa and the Qanun, already composed.

Following the death of the Amir, Ibn Sina fled to Isfahan after a few brushes with the law, including a period in prison. He spent his final years in the services of the ruler of the city, Ala al-Daula whom he advised on scientific and literary matters and accompanied on military campaigns.

Friends advised him to slow down and take life in moderation, but this was not in character. "I prefer a short life with width to a narrow one with length", he would reply. Worn out by hard work

and hard living, Ibn Sina died in 1036/1 at a comparatively early age of 58 years. He was buried in Hamadan where his grave is still shown.

Al-Qifti states that Ibn Sina completed 21 major and 24 minor works on philosophy, medicine, theology, geometry, astronomy and the like. Another source (Brockelmann) attributes 99 books to Ibn Sina comprising 16 on medicine, 68 on theology and metaphysics 11 on astronomy and four on verse. Most of these were in Arabic; but in his native Persian he wrote a large manual on philosophical science entitled Danish-naama-i-Alai and a small treatise on the pulse.

His most celebrated Arabic poem describes the descent of Soul into the Body from the Higher Sphere. Among his scientific works, the leading two are the Kitab al-Shifa (Book of Healing), a philosophical encyclopaedia based upon Aristotelian traditions and the al-Qanun al-Tibb which represents the final categorisation of Greco-Arabian thoughts on Medicine. Of Ibn Sina's 16 medical works, eight are versified treatises on such matter as the 25 signs indicating the fatal termination of illnesses, hygienic precepts, proved remedies, anatomical memoranda etc. Amongst his prose works, after the great Qanun, the treatise on cardiac drugs, of which the British Museum possesses several fine manuscripts, is probably the most important, but it remains unpublished.

The Qanun is, of course, by far the largest, most famous and most important of Ibn Sina's works. The work contains about one million words and like most Arabic books, is elaborately divided and subdivided. The main division is into five books, of which the first deals with general principles; the second with simple drugs arranged alphabetically; the third with diseases of particular organs and members of the body from the head to the foot; the fourth with diseases which though local in their inception spread to other parts of the body, such as fevers and the fifth with compound medicines.

The Qanun distinguishes mediastinitis from pleurisy and recognises the contagious nature of phthisis (tuberculosis of the lung) and the spread of disease by water and soil. It gives a scientific diagnosis of ankylostomiasis and attributes the condition to an intestinal worm. The Qanun points out the importance of dietetics, the influence of climate and environment on health and the surgical use of oral anaesthetics. Ibn Sina advised surgeons to treat cancer in its earliest stages, ensuring the removal of all the diseased tissue. The Qanun's materia medica considers some 760 drugs, with comments on their application and effectiveness. He recommended the testing of a new drug on animals and humans prior to general use Ibn Sina noted the close relationship between emotions and the physical condition and felt that music had a definite physical and psychological effect on patients. Of the many psychological disorders that he described in the Qanun, one is of unusual interest: love sickness! ibn Sina is reputed to have diagnosed this condition in a Prince in Jurjan who lay sick and whose malady had baffled local doctors. Ibn Sina noted a fluttering in the Prince's pulse when the address and name of his beloved were mentioned. The great doctor had a simple remedy: unite the sufferer with the beloved.

The Arabic text of the Qanun was published in Rome in 1593 and was therefore one of the earliest Arabic books to see print. It was translated into Latin by Gerard of Cremona in the 12th century. This 'Canon', with its encyclopaedic content, its systematic arrangement and philosophical plan, soon worked its way into a position of pre-eminence in the medical literature of the age displacing the works of Galen, al-Razi and al-Majusi, and becoming the text book for medical education in the schools of Europe. In the last 30 years of the 15th century it passed through 15

Latin editions and one Hebrew. In recent years, a partial translation into English was made. From the 12th-17th century, the Qanun served as the chief guide to Medical Science in the West and is said to have influenced Leonardo da Vinci. In the words of Dr. William Osler, the Qanun has remained "a medical bible for a longer time than any other work".

Despite such glorious tributes to his work, Ibn Sina is rarely remembered in the West today and his fundamental contributions to Medicine and the European reawakening goes largely unrecognised. However, in the museum at Bukhara, there are displays showing many of his writings, surgical instruments from the period and paintings of patients undergoing treatment. An impressive monument to the life and works of the man who became known as the 'doctor of doctors' still stands outside Bukhara museum and his portrait hangs in the Hall of the Faculty of Medicine in the University of Paris.

## OMAR AL-KHAYYAM
## (1044-1123 C.E.)

Ghiyath al-Din Abul Fateh Omar Ibn Ibrahim al-Khayyam was born at Nishapur, the provincial capital of Khurasan around 1044 C.E. (c. 1038 to 1048). Persian mathematician, astronomer, philosopher, physician and poet, he is commonly known as Omar Khayyam. Khayyam means the tent-maker, and although generally considered as Persian, it has also been suggested that he could have belonged to the Khayyami tribe of Arab origin who might have settled in Persia. Little is known about his early life, except for the fact that he was educated at Nishapur and lived there and at Samarqand for most of his life. He was a contemporary of Nidham al-Mulk Tusi. Contrary to the available opportunities, he did not like to be employed at the King's court and led a calm life devoted to search for knowledge. He travelled to the great centres of learn- ing, Samarqand, Bukhara, Balkh and Isphahan in order to study further and exchange views with the scholars there. While at Samarqand he was patronised by a dignatory, Abu Tahir. He died at Nishapur in 1123-24.

Algebra would seem to rank first among the fields to which he contributed. He made an attempt to classify most algebraic equations, including the third degree equations and, in fact, offered solutions for a number of them. This includes geometric solutions of cubic equations and partial geometric solutions of most other equations. His book Maqalat fi al-Jabr wa al-Muqabila is a master- piece on algebra and has great importance in the development of algebra. His remarkable classification of equations is based on the complexity of the equations, as the higher the degree of an equation, the more terms, or combinations of terms, it will contain. Thus, Khayyam recognizes 13 different forms of cubic equatlon. His method of solving equations is largely geometrical and depends upon an ingenious selection of proper conics. He also developed the binomial expansion when the exponent is a positive integer. In fact, he has been considered to be the first to find the binomial theorem and determine binomial coefficients. In geometry, he studied generalities of Euclid and contributed to the theory of parallel lines.

The Saljuq Sultan, Malikshah Jalal al-Din, called him to the new observatory at Ray around 1074 and assigned him the task of determining a correct solar calendar. This had become necessary in

view of the revenue collections and other administrative matters that were to be performed at different times of the year. Khayyam introduced a calendar that was remarkably accurate, and was named as Al-Tarikh-al-Jalali. It had an error of one day in 3770 years and was thus even superior to the Georgian calendar (error of 1 day in 3330 years).

His contributions to other fields of science include a study of generalities of Euclid, development of methods for the accurate determination of specific gravity, etc. In metaphysics, he wrote three books Risala Dar Wujud and the recently discovered Nauruz- namah. He was also a renowned astronomer and a physician.

Apart from being a scientist, Khayyam was also a well-known poet. In this capacity, he has become more popularly known in the Western world since 1839, when Edward Fitzgerald published an English translation of his Rubaiyat (quatrains). This has since become one of the most popular classics of world literature. It should be appreciated that it is practically impossible to exactly translate any literary work into another language, what to talk of poetry, especially when it involves mystical and philosophical messages of deep complexity. Despite this, the popularity of the translation of Rubaiyat would indicate the wealth of his rich thought.

Khayyam wrote a large number of books and monographs in the above areas. Out of these, 10 books and thirty monographs have been identified. Of these, four concern mathematics, three physics, three metaphysics, one algebra and one geometry.

His influence on the development of mathematics in general and analytical geometry, in particular, has been immense. His work remained ahead of others for centuries till the times of Descartes, who applied the same geometrical approach in solving cubics. His fame as a mathematician has been partially eclipsed by his popularity as a poet; nonetheless his contribution as a philosopher and scientist has been of significant value in furthering the frontiers of human knowledge.

## ABU HAMID AL-GHAZALI
## (1058-1128 C.E.)

Abu Hamid Ibn Muhammad Ibn Muhammad al-Tusi al-Shafi'i al-Ghazali was born in 1058 C.E. in Khorasan, Iran. His father died while he was still very young but he had the opportunity of getting education in the prevalent curriculum at Nishapur and Baghdad. Soon he acquired a high standard of scholarship in religion and philosophy and was honoured by his appointment as a Professor at the Nizamiyah University of Baghdad, which was recognised as one of the most reputed institutions of learning in the golden era of Muslim history.

After a few years, however, he gave up his academic pursuits and worldly interests and became a wandering ascetic. This was a process (period) of mystical transformation. Later, he resumed his teaching duties, but again left these. An era of solitary life, devoted to contemplation and writing then ensued, which led to the authorship of a number of everlasting books. He died in 1128 C.E. at Baghdad.

Ghazali's major contribution lies in religion, philosophy and sufism. A number of Muslim philosophers had been following and developing several viewpoints of Greek philosophy, including the Neoplatonic philosophy, and this was leading to conflict with several Islamic teachings. On the other hand, the movement of sufism was assuming such excessive proportions as to avoid observance of obligatory prayers and duties of Islam. Based on his unquestionable scholarship and personal mystical experience, Ghazali sought to rectify these trends, both in philosophy and sufism.

In philosophy, Ghazali upheld the approach of mathematics and exact sciences as essentially correct. However, he adopted the techniques of Aristotelian logic and the Neoplatonic procedures and employed these very tools to lay bare the flaws and lacunae of the then prevalent Neoplatonic philosophy and to diminish the negative influences of Aristotelianism and excessive rationalism. In contrast to some of the Muslim philosophers, e.g., Farabi, he portrayed the inability of reason to comprehend the absolute and the infinite. Reason could not transcend the finite and was limited to the observation of the relative. Also, several Muslim philosophers had held that the universe was finite in space but infinite in time. Ghazali argued that an infinite time was related to an infinite space. With his clarity of thought and force of argument, he was able to create a balance between religion and reason, and identified their respective spheres as being the infinite and the finite, respectively.

In religion, particularly mysticism, he cleansed the approach of sufism of its excesses and reestablished the authority of the orthodox religion. Yet, he stressed the importance of genuine sufism, which he maintained was the path to attain the absolute truth.

He was a prolific writer. His immortal books include Tuhafut al-Falasifa (The Incoherence of the Philosophers), Ihya al-'Ulum al-Islamia (The Rivival of the Religious Sciences), "The Beginning of Guidance and his Autobiography", "Deliverance from Error". Some of his works were translated into European languages in the Middle Ages. He also wrote a summary of astronomy.

Ghazali's influence was deep and everlasting. He is one of the greatest theologians of Islam. His theological doctrines penetrated Europe, influenced Jewish and Christian Scholasticism and several of his arguments seem to have been adopted by St. Thomas Aquinas in order to similarly reestablish the authority of orthodox Christian religion in the West. So forceful was his argument in the favour of religion that he was accused of damaging the cause of philosophy and, in the Muslim Spain, Ibn Rushd (Averros) wrote a rejoinder to his Tuhafut.

## ABU MARWAN IBN ZUHR
## (1091-1161 C.E.)

Abu Marwan Abd al-Malik Ibn Zuhr was born at Seville in 1091/c. 1094 C.E. After completing his education and specializing in medicine, he entered the service of Almoravides (Al-Murabatun), but after their defeat by the Al-Mohades (Al-Muwahadun), he served under 'Abd al-Mu'min, the first Muwahid ruler. He died in Seville in 1161/c. 1162 C.E. As confirmed by George Sarton, he was not a Jew, but an orthodox Muslim.

Ibn Zuhr was one of the greatest physicians and clinicians of the Muslim golden era and has rather been held by some historians of science as the greatest of them. Contrary to the general practice of the Muslim scholars of that era, he confined his work to only one field medicine. This enabled him to produce works of everlasting fame.

As a physician, he made several discoveries and breakthroughs. He described correctly, for the first time, scabies, the itch mite and may thus be regarded as the first parasitologist. Likewise, he prescribed tracheotomy and direct feeding through the gullet and rectum in the cases where normal feeding was not possible. He also gave clinical descriptions of mediastinal tumours, intestinal phthisis, inflammation of the middle ear, pericarditis, etc.

His contribution was chiefly contained in the monumental works written by him; out of these, however, only three are extant. Kitab al-Taisir fi al-Mudawat wa al-Tadbir (Book of Simplification concerning Therapeutics and Diet), written at the request of Ibn Rushd (Averroes), is the most important work of Ibn Zuhr. It describes several of Ibn Zuhr's original contributions. The book gives in detail pathological conditions, followed by therapy. His Kitab al-Iqtisad fi Islah al-Anfus wa al-Ajsad (Book of the Middle Course concerning the Reformation of Souls and the Bodies) gives a summary of diseases, therapeutics and hygiene written specially for the benefit of the layman. Its initial part is a valuable discourse on psychology. Kitab al-Aghthiya (Book on Foodstuffs) describes different types of food and drugs and their effects on health.

Ibn Zuhr in his works lays stress on observation and experiment and his contribution greatly influenced the medical science for several centuries both in the East and the West. His books were translated into Latin and Hebrew and remained popular in Europe as late as the advent of the 18th century.

## AL-IDRISI
## (1099-1166 C.E.)

Abu Abdallah Muhammad Ibn Muhammad Ibn Abdallah Ibn Idris al-Qurtubi al-Hasani, was bom in Ceuta, Spain, in 1099 C.E. He was educated in Cordova. Later he travelled far and wide in connection with his studies and then flourished at the Norman court in Palermo. The date of his death is controversial, being either 1166 or 1180 C.E.

Biographical notes on him are to be found rathe rarely, and according to F. Pons Boigues the underlying reason is the fact that the Arab biographers considered al-Idrisi to be a renegade, since he had been associated with the court of a Christian king and written in praise of him, in his work. The circumstances which led him to settle in Sicily at the court of Roger II are not on record.

His major contribution lies in medicinal plants as presented in his several books, specially Kitab al-Jami-li-Sifat Ashtat al-Nabatat. He studied and reviewed all the literature on the subject of medicinal plants and formed the opinion that very little original material had been added to this branch of knowledge since the early Greek work. He, therefore, collected plants and data not reported earlier and added this to the subject of botany, with special reference to medicinal plants. Thus, a large number of new drugs plants together with their evaluation became available to the medical practitioners. He has given the names of the drugs in six languages: Syriac, Greek, Persian, Hindi, Latin and Berber.

In addition to the above, he made original contributions to geography, especially as related to economics, physical factors and cultural aspects. He made a planishere in silver for King Roger II, and described the world in Al-Kitab al-Rujari (Roger's Book), also entitled Nuzhat al-Mushtaq fi Ikhtiraq al-Afaq (The delight of him who desires to journey through the climates). This is practically a geographical encyclopaedia of the time, containing information not only on Asia and Africa, but also Western countries.

Al-Idrisi, later on, also compiled another geographical encyclo- paedia, larger than the former entitled Rawd-Unnas wa-Nuzhat al-Nafs (Pleasure of men and delight of souls) also known as Kitab al- Mamalik wa al-Masalik.

Apart from botany and geography, Idrisi also wrote on fauna, zoology and therapeutical aspects. His work was soon translated into Latin and, especially, his books on geography remained popular both in the East and the West for several centuries.

## IBN RUSHD
## (1128-1198 C.E.)

Abu'l Waleed Muhammad Ibn Ahmad Ibn Muhammad Ibn Rushd, known as Averroes in the West, was born in 1128 C.E. in Cordova, where his father and grandfather had both been judges. His grandfather was well versed in Fiqh (Maliki School) and was also the Imam of the Jamia Mosque of Cordova. The young Ibn Rushd received his education in Cordova and lived a quiet life, devoting most of his time to learned-pursuits. He studied philoso- phy and law from Abu J'afar Haroon and from Ibn Baja; he also studied medicine.

Al-Hakam, the famous Umayyad Caliph of Spain, had construc- ted a magnificent library in Cordova, which housed 500,000 books, He himself had studied many of these and made brief marginal comments on them. This rich collection laid the foundation for intellectual study in Spain and provided the background for men like Ibn Rushd, who lived 2 centuries later. Abu Yaqub, the Caliph of Morocco, called him to his capital and appointed him as his physician in place of Ibn Tufail. His son Yaqub al-Mansur retained him for some time but soon Ibn Rushd's

views on theology and philosophy drew the Caliph's wrath. All his books, barring strictly scientific ones, were burnt and he was banished to Lucena. However, as a result of intervention of several leading scholars he was forgiven after about four years and recalled to Morocco in 1198; but he died towards the end of the same year.

Ibn Rushd made remarkable contributions. in philosophy, logic, medicine, music and jurisprudence. In medicine his well- known book Kitab al-Kulyat fi al-Tibb was written before 1162 C.E. Its Latin translation was known as 'Colliget'. In it, Ibn Rushd has thrown light on various aspects of medicine, including the diagnoses, cure and prevention of diseases. The book concentrates on specific areas in comparison of Ibn Sina's wider scope of al-Qanun, but contains several original observations of Ibn Rushd.

In philosophy, his most important work Tuhafut al-Tuhafut was written in response to al-Ghazali's work. Ibn Rushd was criticised by many Muslim scholars for this book, which, neverthe- less, 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 neither in full control of his destiny nor is it fully predetermined for him. He wrote three commenlaries 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 the intermediate 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 Qu'ranic concepts. In the field of music, Ibn Rushd wrote a commentary on Aristotle's book De Anima. This book was translated into Latin by Mitchell the Scott.

In astronomy he wrote a treatise on the motion of the sphere, Kitab fi-Harakat al-Falak. He also summarised 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.

According to Ibn al-Abbar, Ibn Rushd's writings spread over 20,000 pages, the most famous of which deal with philosophy, medicine and jurisprudence. On medicine alone he wrote 20 books. Regarding jurisprudence, his book Bidayat al-Mujtahid wa-Nihayat- al-Muqtasid has been held by Ibn Jafar Thahabi as possibly the best book on the Maliki School of Fiqh. 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, generally in Hebrew script. This reveals his wider acceptance in the West in comparison to the East. The commentary on zoology is entirely lost. Ibn Rushd also wrote commentaries on Plato's Republic, Galen's treatise on fevers, al- Farabi's logic, etc. Eighty-seven of his books are still extant.

Ibn Rushd has been held as one of the greatest thinkers and scientists of the 12th century. According to Philip Hitti, Ibn Rushd influenced Western thought from the 12th to the 16th centuries. His books were included in the syllabi of Paris and other universities till the advent of modern experimental sciences.

# IBN KHALDUN
## (1332-1395 C.E.)

Abd al-Rahman Ibn Mohammad is generally known as Ibn Khaldun after a remote ancestor. His parents, originally Yemenite Arabs, had settled in Spain, but after the fall of Seville, had migrated to Tunisia. He was born in Tunisia in 1332 C.E., where 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. This was followed by a long period of unrest marked by contemporary political rivalries affecting his career. This turbulent period also included a three year refuge in a small village Qalat Ibn Salama in Algeria, which provided him with the opportunity to write Muqaddimah, the first volume of his world history that won him an immortal place among historians, sociologists and philosophers. 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'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 analysed the dynamics of group relationships and showed how group-feelings, al-'Asabiyya, give rise to the ascent of a new civilisation 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 emphasised environmental, sociological, psychological and economic factors governing the apparent events. This revolutionised 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. For instance, Prof. Gum Ploughs and Kolosio consider Muqaddimah as superior in scholarship to Machiavelli's The Prince written a century later, as the forrner bases the diagnosis more on cultural, sociological, economic and psychological factors.

## El Zahrawi - Father Of Surgery

Almost a thousand years ago at a time when Spain (Andulesia) was part of the Islamic empire, there lived near the capital city of Cordoba one of the great, but now largely forgotten, pioneers of surgery. He was known as El Zahrawi, though in European languages his name is written in over a dozen different ways: Abulcases, Albucasis, Bulcasis, Bulcasim, Bulcari, Alzahawi, Ezzahrawi, Zahravius, Alcarani, Alsarani, Aicaravi, Alcaravius, Alsahrawi etc. El Zahrawi is believed to have been born in the city of El-Zahra, six miles northwest of Cordoba, sometime between 936 and 940. It was here that he lived, studied, taught and practised medicine and surgery until shortly before his death in about 1013, two years after the sacking of El-Zahra.

Because El-Zahra was pillaged and destroyed, little is known about its illustrious son El Zahrawi. He was first mentioned by the Andalusian scholar Abu Muhammad bin Hazm (993-1064), who listed him among the great physician- surgeons of Moorish Spain. The first known biography of El Zahrawi, however, appeared in al-Humaydi's Jadhwat al-Muqtabis (On Andalusian Savants), completed six decades after El Zahrawi's death.

It is clear from El Zahrawi's life history and from his writings that he devoted his entire life and genius to the advancement of medicine as a whole and surgery in particular. El Zahrawi wrote a medical encyclopaedia spanning 30 volumes which included sections on surgery, medicine, orthopaedics, ophthalmology, pharmacology, nutrition etc. This book was known as At-Tasrif and contained data that El Zahrawi had accumulated during a career that spanned almost 50 years of training, teaching and practice. He apparently travelled very little but had wide experience in treating accident victims and war casualties.

In At-Tasrif, El Zahrawi expressed his concern about the welfare of his students whom he called "my children". He emphasised the importance of a good doctor patient relationship and took great care to ensure the safety of his patients and win their trust irrespective of their social status. El Zahrawi's clinical methods showed extreme foresight - he promoted the close observation of individual cases in order to establish the most accurate diagnosis and the best possible treatment. He insisted on compliance with ethical norms and warned against dubious practices adopted by some physicians for purposes of material gain. He also cautioned against quacks who claimed surgical skills they did not possess.

At-Tasrif contains many original observations of historical interest. In it, El Zahrawi elaborates on the causes and symptoms of disease and theorises on the upbringing of children and youth and on the care of the aged and convalescent. In the section on pharmacology and therapeutics, he covers areas such as cardiac drugs, emetics, laxatives, cosmetology, dietetics, materia medica, weights and measures and drug substitution.

At-Tasrif was translated into Latin by Gerard of Cremona in the 12th century and alongside Avicenna's Canon, played a major role as a medical text in the universities of Europe from the 12th to the 17th century AD. Two of El Zahrawi's treatises deserve special mention. Firstly his 28th treatise, known in Latin as Liber servitoris de preeparatione medicinarum simplicium, describes chemical preparations, tablet making, filtering of extracts and related pharmaceutical techniques. This treatise was printed in Venice in 1471 by Nicolaus Jensen.

Perhaps the most importance treatise is the one on surgery. This monumental work was the first in Arabic to treat surgery independently and in detail. It included many pictures of surgical instruments, most invented by El Zahrawi himself, and explanations of their use. El Zahrawi was the first medical author to provide illustrations of instruments used in surgery. There are approximately 200 such drawings ranging from a tongue depressor and a tooth extractor to a catheter and an elaborate obstetric device. The variety of operations covered is amazing. In this treatise El Zahrawi discussed cauterisation, bloodletting, midwifery and obstetrics and the treatment of wounds. He described the exposure and division of the temporal artery to relieve certain types of headaches, diversion of urine into the rectum, reduction mammoplasty for excessively large breasts and the extraction of cataracts. He wrote extensively about injuries to bones and joints, even mentioning fractures of the nasal bones and of the vertebrae. In fact 'Kocher's method' for reducing a dislocated shoulder was described in At-Tasrif long before Kocher was born! El Zahrawi outlined the use of caustics in surgery, fully described tonsillectomy, tracheotomy and craniotomy- operations he had performed on a dead foetus. He explained how to use a hook to extract a polyp tiom the nose, how to use a bulb syringe he had invented for giving enemas to children and how to use a metallic bladder syringe and speculum to extract bladder stones.

El Zahrawi was the first to describethe so-called "Walcher position" in obstetrics; the first to depict dental arches, tongue depressors and lead catheters and the first to describe clearly the hereditary circumstances surrounding haemophilia. He also described ligaturing of blood vessels long before Ambroise Pare.

Once At-Tasrif was translated into Latin in the 12th century, El Zahrawi had a tremendous influence on surgery in the West

The French surgeon Guy de Chauliac in his 'Great Surgery', completed in about 1363, quoted At-Tasrif over 200 times. El Zahrawi was described by Pietro Argallata (died 1423) as "without doubt the chief of all surgeons". Jaques Delechamps (1513-1588), another French surgeon, made extensive use of At-Tasrif in his elaborate commentary, confirming the great prestige of El Zahrawi throughout the Middle Ages and up to the Renaissance. (Dr. Monzur Ahmed)

# MOHAMMAD BIN MUSA AL-KHAWARIZMI
## (Died 840 C.E.)

Abu Abdullah Mohammad Ibn Musa al-Khawarizmi was born at Khawarizm (Kheva), south of Aral sea. Very little is known about his early life, except for the fact that his parents had migrated to a place south of Baghdad. The exact dates of his birth and death are also not known, but it is established that he flourished under Al- Mamun at Baghdad through 813-833 and probably died around 840 C.E.

Khawarizmi was a mathematician, astronomer and geographer. He was perhaps one of the greatest mathematicians who ever lived, as, in fact, he was the founder of several branches and basic concepts of mathematics. In the words of Phillip Hitti, he influenced mathematical thought to a greater extent than any other medieval writer. His work on algebra was outstanding, as he not only initiated the subject in a systematic form but he also developed it to the extent of giving analytical solutions of linear and quadratic equations, which established him as the founder of Algebra. The very name Algebra has been derived from his famous book Al-Jabr wa-al-Muqabilah. His arithmetic synthesised Greek and Hindu knowledge and also contained his own contribution of fundamental importance to mathematics and science. Thus, he explained the use of zero, a numeral of fundamental importance developed by the Arabs. Similarly, he developed the decimal system so that the overall system of numerals, 'algorithm' or 'algorizm' is named after him. In addition to introducting the Indian system of numerals (now generally known as Arabic numerals), he developed at length several arithmetical procedures, including operations on fractions. It was through his work that the system of numerals was first introduced to Arabs and later to Europe, through its translations in European languages. He developed in detail trigonometric tables containing the sine functions, which were probably extrapolated to tangent functions by Maslama. He also perfected the geometric representation of conic sections and developed the calculus of two errors, which practically led him to the concept of differentiation. He is also reported to have collaborated in the degree measurements ordered by Mamun al-Rashid were aimed at measuring of volume and circumference of the earth.

The development of astronomical tables by him was a significant contribution to the science of astronomy, on which he also wrote a book. The contribution of Khawarizmi to geography is also outstanding, in that not only did he revise Ptolemy's views on geography, but also corrected them in detail as well as his map of the world. His other contributions include original work related to clocks, sundials and astrolabes.

Several of his books were translated into Latin in the early 12th century. In fact, his book on arithmetic, Kitab al-Jam'a wal- Tafreeq bil Hisab al-Hindi, was lost in Arabic but survived in a Latin translation. His book on algebra, Al-Maqala fi Hisab-al Jabr wa-al- Muqabilah, was also translated into Latin in the 12th century, and it was this translation which introduced this new science to the West "completely unknown till then". He astronomical tables were also translated into European languages and, later, into Chinese. His geography captioned Kitab Surat-al-Ard, together with its maps, was also translated. In addition, he wrote a book on the Jewish calendar Istikhraj Tarikh al-

Yahud, and two books on the astrolabe. He also wrote Kitab al-Tarikh and his book on sun-dials was captioned Kitab al-Rukhmat, but both of them have been lost.

The influence of Khawarizmi on the growth of science, in general, and mathematics, astronomy and geography in particular, is well established in history. Several of his books were readily translated into a number of other languages, and, in fact, constituted the university textbooks till the 16th century. His approach was systematic and logical, and not only did he bring together the then prevailing knowledge on various branches of science, particularly mathematics, but also enriched it through his original contribution. No doubt he has been held in high repute throughout the centuries since then.

## THABIT IBN QURRA
## (836-901 C.E.)

Thabit Ibn Qurra Ibn Marwan al-Sabi al-Harrani was born in the year 836 C.E. at Harran (present Turkey). As the name indicates he was basically a member of the Sabian sect, but the great Muslim mathematician Muhammad Ibn Musa Ibn Shakir, impressed by his knowledge of languages, and realising his potential for a scientific career, selected him to join the scientific group at Baghdad that was being patronised by the Abbasid Caliphs. There, he studied under the famous Banu Musa brothers. It was in this setting that Thabit contributed to several branches of science, notably mathematics, astronomy and mechanics, in addition to translating a large number of works from Greek to Arabic. Later, he was patronised by the Abbasid Caliph al-M'utadid. After a long career of scholarship, Thabit died at Baghdad in 901 C.E.

Thabit's major contribution lies in mathematics and astronomy. He was instrumental in extending the concept of traditional geometry to geometrical algebra and proposed several theories that led to the development of non-Euclidean geometry, spherical trigonometry, integral calculus and real numbers. He criticised a number of theorems of Euclid's elements and proposed important improvements. He applied arithmetical terminology to geometrical quantities, and studied several aspects of conic sections, notably those of parabola and ellipse. A number of his computations aimed at determining the surfaces and volumes of different types of bodies and constitute, in fact, the processes of integral calculus, as developed later.

In astronomy he was one of the early reformers of Ptolemic views. He analysed several. problems related to the movements of sun and moon and wrote treatises on sun-dials.

In the fields of mechanics and physics he may be recognised as the founder of statics. He examined conditions of equilibrium of bodies, beams and levers.

In addition to translating a large number of books himself, he founded a school of translation and supervised the translation of a further large number of books from Greek to Arabic.

Among Thabit's writings a large number have survived, while several are not extant. Most of the books are on mathematics, followed by astronomy and medicine. The books have been written in

Arabic but some are in Syriac. In the Middle Ages, some of his books were translated into Latin by Gherard of Cremona. In recent centuries, a number of his books have been translated into European languages and published.

He carried further the work of the Banu Musa brothers and later his son and grandson continued in this tradition, together with the other members of the group. His original books as well as his translations accomplished in the 9th century exerted a positive influence on the development of subsequent scientific research.

## ALI IBN RABBAN AL-TABARI
## (838-870 C.E.)

This accomplished Hakim was the tutor of the unparalleled physician Zakariya al-Razi. Luck favoured the disciple more than the teacher in terms of celebrity. As compared to Razi people know very little about his teacher Ali.

Ali Bin Rabban's surname was Abu al-Hasan, the full name being Abu al-Hasan Ali Bin Sahl Rabban al-Tabari. Born in 838 C.E. his father Sahl hailed from a respectable Jew family. The nobility and sympathy inherent in his very nature soon endeared him to his countrymen so much so that they used to call him Rabban which implies "my leader".

Professionally Sahl was an extremely successful physician. He had command over the art of calligraphy too. Besides he had a deep insight into the disciplines of Astronomy, Philosophy, Mathematics and Literature. Some complicated articles of Batlemus's book al-Mijasti came to be resolved by way of Sahl's scholarly expertise, translators preceding him had failed to solve the mystery.

Ali received his education in the disciplines of Medical science and calligraphy from his able father Sahl and attained perfection in these fields. He had also mastered Syriac and Greek languages to a high degree of proficiency

Ali hailed from a Israelite family. Since he had embraced Islam, he is classified amongst Muslirn Scholars. This family belonged to Tabristan's famous city Marv.

The fame acquired by Ali Bin Rabban did not simply account for the reason that a physician of the stature of Zakariya al-Razi was amongst his disciple. In fact the main cause behind his exalta- tion lies in his world-renowned treatise Firdous al-Hikmat.

Spread over seven parts, Firdous al-Hikmat is the first ever Medical encyclopaedia which incorporates all the branches of medical science in its folds. This work has been published in this century (20th century) only. Prior to this publication only five of his manuscripts were to be found scattered in libraries the world over. Dr. Mohammed Zubair Siddiqui compared and edited the manuscripts. In his preface he has provided extremely useful information regarding the book and

the author and, wherever felt necessary, explanatory notes have been written to facilitate publication of this work on modern publishing standards.

Later on this unique work was published with the cooperation of English and German institutions. Following are the details of its all seven parts:

1. Part one: Kulliyat-e-Tibb. This part throws light on contempo- rary ideology of medical science. In that era these principles formed the basis of medical science.

2. Part two: Elucidation of the organs of the human body, rules for keeping good health and comprehensive account of certain muscular diseases.

3. Part three: Description of diet to be taken in conditions of health and disease.

4. Part four: All diseases right from head to toe. This part is of profound significance in the whole book and comprises twelve papers

i) General causes relating to eruption of diseases. ii) Diseases of the head and the brain. iii) Diseases relating to the eye, nose, ear, mouth and the teeth. iv) Muscular diseases (paralysis and spasm). v) Diseases of the regions of the chest, throat and the lungs. vi) Diseases of the abdomen. vii) Diseases of the liver. viii) Diseases of gallbladder and spleen. ix) Intestinal diseases. x) Different kinds of fever. xi) Miscellaneous diseases- brief explanation of organs of the body. xii) Examination of pulse and urine. This part is the largest in the book and is almost half the size of the whole book.

5. Part five: Description of flavour, taste and colour.

6. Part six: Drugs and poison.

7. Part seven: Deals with diverse topics. Discusses climate and astronomy. Also contains a brief mention of Indian medicine

Though he wrote Firdous al-Hikmat in Arabic but he simultaneously translated it into Syriac. He has two more compilations to his credit namely Deen-o-Doulat and Hifdh al-Sehhat. The latter is available in manuscript-form in the library of Oxford University. Besides Medical science, he was also a master of Philosophy, Mathematics and Astronomy. He breathed his last around 870 C.E.

## ABU ABDULLAH AL-BATTANI
## (868-929 C.E.)

Abu Abdallah Muhammad Ibn Jabir Ibn Sinan al-Battani al-Harrani was born around 858 C.E. in Harran, and according to one account, in Battan, a State of Harran. Battani was first educated by his father Jabir Ibn San'an al-Battani, who was also a well-known scientist. He then moved to Raqqa, situated on the bank of the Euphrates, where he received advanced education and later on

flourished as a scholar. At the beginning of the 9th century, he migrated to Samarra, where he worked till the end of his life in 929 C.E. He was of Sabian origin, but was himself a Muslim.

Battani was a famous astronomer, mathematician and astrologer. He has been held as one of the greatest astronomists of Islam. He is responsible for a number of important discoveries in astronomy, which was the result of a long career of 42 years of research beginning at Raqqa when he was young. His well-known discovery is the remarkably accurate determination of the solar year as being 365 days, 5 hours, 46 minutes and 24 seconds, which is very close to the latest estimates. He found that the longitude of the sun's apogee had increased by 16° , 47' since Ptolemy. This implied the important discovery of the motion of the solar apsides and of a slow variation in the equation of time. He did not believe in the trapidation of the equinoxes, although Copernicus held it.

Al-Battani determined with remarkable accuracy the obliquity of the ecliptic, the length of the seasons and the true and mean orbit of the sun. He proved, in sharp contrast to Ptolemy, the variation of the apparent angular diameter of the sun and the possibility of annular eclipses. He rectified several orbits of the moon and the planets and propounded a new and very ingenious theory to determine the conditions of visibility of the new moon. His excellent observations of lunar and solar eclipses were used by Dunthorne in 1749 to determine the secular acceleration of motion of the moon. He also provided very neat solutions by means of orthographic projection for some problems of spherical trigonometry.

In mathematics, he was the first to replace the use of Greek chords by sines, with a clear understanding of their superiority.He also developed the concept of cotangent and furnished their table in degrees.

He wrote a number of books on astronomy and trigonometry. His most famous book was his astronomical treatise with tables, which was translated into Latin in the 12th century and flourished as De scienta stellerum — De numeris stellerum et motibus. An old translation of this is available of the Vatican. His Zij was, in fact, more accurate than all others written by that time.

His treatise on astronomy was extremely influential in Europe till the Renaissance, with translations available in several languages. His original discoveries both in astronomy and trigonometry were of great consequence in the development of these sciences.

## AL-FARGHANI
## (C. 860 C.E.)

Abu'l-Abbas Ahmad ibn Muhammad ibn Kathir al-Farghani, born in Farghana, Transoxiana, was one of the most distinguished astronomers in the service of al-Mamun and his successors. He wrote "Elements of Astronomy" (Kitab fi al-Harakat al-Samawiya wa Jawami Ilm al-Nujum i.e. the book on celestial motion and thorough science of the stars), which was translated into Latin in the 12th century and exerted great influence upon European astronomy before Regiomontanus. He accepted Ptolemy's theory and value of the precession, but thought that it affected not only the

stars but also the planets. He determined the diameter of the earth to be 6,500 miles, and found the greatest distances and also the diameters of the planets.

Al-Farghani's activities extended to engineering. According to Ibn Tughri Birdi, he supervised the construction of the Great Nilometer at al-Fustat (old Cairo). It was completed in 861, the year in which the Caliph al-Mutawakkil, who ordered the construction, died. But engineering was not al-Farghani's forte, as transpires from the following story narrated by Ibn Abi Usaybi'a.

Al-Mutawakkil had entrusted the two sons of Musa ibn Shakir, Muhammad and Ahmad, with supervising the digging of a canal named al-Ja'fari. They delegated the work to Al-Farghani, thus deliberately ignoring a better engineer, Sind ibn Ali, whom, out of professional jealousy, they had caused to be sent to Baghdad, away from al-Mutawakkil's court in Samarra. The canal was to run through the new city, al-Ja'fariyya, which al-Mutawakkil had built near Samarra on the Tigris and named after himself. Al-Farghani committed a grave error, making the beginning of the canal deeper than the rest, so that not enough water would run through the length of the canal except when the Tigris was high. News of this angered the Caliph, and the two brothers were saved from severe punishment only by the gracious willingness of Sind ibn Ali to vouch for the correctness of al-Farghani's calculations, thus risking his own welfare and possibly his life. As had been correctly predicted by astrologers, however, al-Mutawakkil was murdered shortly before the error became apparent. The explanation given for Al-Farghani's mistake is that being a theoretician rather than a practical engineer, he never successfully completed a construction.

The Fihrist of Ibn al-Nadim, written in 987, ascribes only two works to Al-Farghani: (1) "The Book of Chapters, a summary of the Almagest" (Kitab al-Fusul, Ikhtiyar al-Majisti) and (2) "Book on the Construction of Sun-dials" (Kitab 'Amal al-Rukhamat).

The Jawami, or 'The Elements' as we shall call it, was Al- Farghani's best-known and most influential work. Abd al-Aziz al-Qabisi (d. 967) wrote a commentary on it, which is preserved in the Istanbul manuscript, Aya Sofya 4832, fols. 97v-114v. Two Latin translations followed in the 12th century. Jacob Anatoli produced a Hebrew translation of the book that served as a basis for a third Latin version, appearing in 1590, whereas Jacob Golius published a new Latin text together with the Arabic original in 1669. The influence of 'The Elements' on mediaeval Europe is clearly vindicated by the presence of innumerable Latin manuscripts in European libraries.

References to it by medieval writers are many, and there is no doubt that it was greatly responsible for spreading knowledge of Ptolemaic astronomy, at least until this role was taken over by Sacrobosco's Sphere. But even then, 'The Elements' of Al-Farghani continued to be used, and Sacrobosco's Sphere was evidently indebted to it. It was from 'The Elements' (in Gherard's translation) that Dante derived the astronomical knowledge displayed in the 'Vita nuova' and in the 'Convivio'

# MOHAMMAD IBN ZAKARIYA AL-RAZI
## (864-930 C.E.)

Abu Bakr Mohammad Ibn Zakariya al-Razi (864-930 C.E.) was born at Ray, Iran. Initially, he was interested in music but later on he learnt medicine, mathematics, astronomy, chemistry and philosophy from a student of Hunayn Ibn Ishaq, who was well versed in the ancient Greek, Persian and Indian systems of medicine and other subjects. He also studied under Ali Ibn Rabban. The practical experience gained at the well-known Muqtadari Hospital helped him in his chosen profession of medicine. At an early age he gained eminence as an expert in medicine and alchemy, so that patients and students flocked to him from distant parts of Asia.

He was first placed in-charge of the first Royal Hospital at Ray, from where he soon moved to a similar position in Baghdad where he remained the head of its famous Muqtadari Hospital for along time. He moved from time to time to various cities, specially between Ray and Baghdad, but finally returned to Ray, where he died around 930 C.E. His name is commemorated in the Razi Institute near Tehran.

Razi was a Hakim, an alchemist and a philosopher. In medicine, his contribution was so significant that it can only be compared to that of Ibn Sina. Some of his works in medicine e.g. Kitab al-Mansoori, Al-Hawi, Kitab al-Mulooki and Kitab al-Judari wa al- Hasabah earned everlasting fame. Kitab al-Mansoori, which was translated into Latin in the 15th century C.E., comprised ten volumes and dealt exhaustively with Greco-Arab medicine. Some of its volumes were published separately in Europe. His al-Judari wal Hasabah was the first treatise on smallpox and chicken-pox, and is largely based on Razi's original contribution: It was translated into various European languages. Through this treatise he became the first to draw clear comparisons between smallpox and chicken-pox. Al-Hawi was the largest medical encyclopaedia composed by then. It contained on each medical subject all important information that was available from Greek and Arab sources, and this was concluded by him by giving his own remarks based on his experience and views. A special feature of his medical system was that he greatly favoured cure through correct and regulated food. This was combined with his emphasis on the influence of psychological factors on health. He also tried proposed remedies first on animals in order to evaluate in their effects and side effects. He was also an expert surgeon and was the first to use opium for anaesthesia.

In addition to being a physician, he compounded medicines and, in his later years, gave himself over to experimental and theoretical sciences. It seems possible that he developed his chemistry independently of Jabir Ibn Hayyan. He has portrayed in great detail several chemical reactions and also given full descriptions of and designs for about twenty instruments used in chemical investigations. His description of chemical knowledge is in plain and plausible language. One of his books called Kitab-al-Asrar deals with the preparation of chemical materials and their utilization. Another one was translated into Latin under the name Liber Experi- mentorum, He went beyond his predecessors in dividing substances into plants, animals and minerals, thus in a way opening the way for inorganic and organic chemistry. By and large, this classification of the three kingdoms still

holds. As a chemist, he was the first to produce sulfuric acid together with some other acids, and he also prepared alcohol by fermenting sweet products.

His contribution as a philosopher is also well known. The basic elements in his philosophical system are the creator, spirit, matter, space and time. He discusses their characteristics in detail and his concepts of space and time as constituting a continuum are outstanding. His philosophical views were, however, criticised by a number of other Muslim scholars of the era.

He was a prolific author, who has left monumental treatises on numerous subjects. He has more than 200 outstanding scientific contributions to his credit, out of which about half deal with medicine and 21 concern alchemy. He also wrote on physics, mathematics, astronomy and optics, but these writings could not be preserved. A number of his books, including Jami-fi-al-Tib, Mansoori, al-Hawi, Kitab al-Jadari wa al-Hasabah, al-Malooki, Maqalah fi al- Hasat fi Kuli wa al-Mathana, Kitab al-Qalb, Kitab al-Mafasil, Kitab-al- 'Ilaj al-Ghoraba, Bar al-Sa'ah, and al-Taqseem wa al-Takhsir, have been published in various European languages. About 40 of his manuscripts are still extant in the museums and libraries of Iran, Paris, Britain, Rampur, and Bankipur. His contribution has greatly influenced the development of science, in general, and medicine, in particular.