Personalities Noble

Glimpses of Renowned Scientists and Thinkers of the Golden Muslim Era

Hakim Mohammed Said
Editor

Islamic Academy of Sciences
Amman, Jordan

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and
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Edited by the IAS Secretariat Staff,
Chief Editor: Moneef R Zou'bi.

Islamic Academy of Sciences
PO Box 830036
Amman 11183
Jordan

Telephone: 552 2104 - 552 3385
Facsimile: 9626 551 1803

E-mail:
ias@go.com.jo
Secretariat@ias-worlwide.org

www.ias-worldwide.org

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Editors of First Edition

Dr M A Kazi
Adviser to the President of Pakistan on Science and Technology
Hakim Mohammed Said
President, Hamdard Foundation Pakistan
Dr Z A Hashmi
Senior Scientist, National Science Council of Pakistan
Dr Raziuddin Siddiqui
Secretary General, Pakistan Academy of Sciences
Dr S M A Shah
National Science Council of Pakistan
Hakim Naimuddin Zubairi
Director of Research (Academic),
Hamdard Foundation Pakistan

Foreword to the Second Edition

I have come across this book "Personalities Noble," some time ago and found it to be most informative and interesting.

The information contained therein is well researched and the various portraits included serve well their intended purpose of reminding us of these eminent scholars of our history. The various biodata underline to us the multi-faceted interests that each and everyone of these scholars had. They indeed were linguists, philosophers, as well as chemists and physicists and most of all, they felt that it was their religious duty to acquire and generate knowledge for the community and for the Ummah.

I am grateful to Hamdard Foundation (Pakistan), and Mrs Sadia Rashid, for approving this re-print and to Dr M D Shami FIAS who liased this undertaking with Hamdard.

I would express my appreciation of the efforts of Moneef R Zou'bi and his staff at the IAS Secretariat for carefully checking the manuscript and to Mr G Anz and Ms A Mizher of the RSS's printing unit for their efforts in the production of the book.

This book is dedicated to the memory of our colleagues at the Islamic Academy of Sciences, Hakim Mohammad Said Hon.FIAS and Dr M A Kazi FIAS, IAS Founding President, both of whom are sadly no longer with us. It was through their joint effort that this publication was first launched in 1983.

Dr Abdel Salam Majali
President
Islamic Academy of Sciences
Amman, Jordan (2000)

Foreword to the First Edition

Every Muslim who has even a brief acquaintance with Islamic History is aware that the Islamic Ideology and world-view provided, during the first few centuries Hijra, a most powerful source of inspiration, especially for the Muslim people's quest for knowledge. The Islamic spirit produced a radical transformation in the Arabian Peninsula, as well as among the countries where Islam took firm root in the immediately succeeding centuries. The rich contributions that Islam made in the various branches of *Science* served as the basis for the development of *Modern Science*. Although many earlier western historians tended to ignore this fact, recent investigations led to a wider recognition of the importance of Muslim contributions, especially to the development of scientific thought and the scientific methods.

The injunctions of the Qur'an and the teachings of the Holy Prophet (peace be upon him) laid great stress on the acquisition of knowledge and developing the spirit of enquiry. Muslims strictly followed these precepts and spared no pains to acquire, preserve and spread knowledge. As a result of their vigorous and dedicated efforts, a truly scientific outlook was developed. This in itself is a most valuable service of the Muslims to human civilisation. But, unfortunately, the achievements of these luminaries faded into oblivion due to our indifference and apathy. There is an urgent need to reclaim these achievements and, as their heirs, it is our duty to hold aloft the torch of knowledge lighted by these illustrious personalities. We must, therefore, bring their works into the limelight once again, so that mankind may benefit from them.

The present volume, which has been brought out by the Hamdard Foundation, in collaboration with the National Science Council of Pakistan, is an attempt in this direction. An effort has been made to present the scientific achievements of the Muslim era at a glance, so that the illuminating contributions of these Muslim scholars may again stand out in all their elegance and grandeur. The twenty-six towering scientific and intellectual personalities of the Muslim era whose portraits appear in this volume are recognised as being some of the most outstanding figures in the history of science and scientific thought. I am sure this book will provide a heart-warming glimpse of a golden period of human history and invite us to develop the glorious traditions of our forefathers. I trust that it will be followed by several other volumes on the contributions of various Muslim scientists and technologists whose work has lain hidden in the libraries of the world.

Dr M A Kazi
Adviser to the President of Pakistan
on Science and Technology
Islamabad, Pakistan (1983)

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ABU ABDULLAH AL-BATTANI

ABU ABDULLAH AL-BATTANI
(858-929 AD)

Abu Abdullah Muhammad Ibn Jabir Ibn Sinan al-Battani al-Harrani was born around 858 AD in Harran, and according to one account, in Battan, a State of Harran. Battani was first educated by his father Jabir Ibn Sinn 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 flourished as a scholar. At the beginning of the ninth century, he migrated to Samarra, where he worked till the end of his life in 929 AD 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 16º, 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 trepidation of the equinoxes, although Copernicus held it.

At-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 twelfth century and flourished as *De scienta stellerum - De numeris stellerum et motibus.* An old translation of this is available at 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 until the Renaissance, with translations available in several languages. His original discoveries both in astronomy and in trigonometry were of great consequence in the development of these sciences.

ABU RAIHAN AL-BIRUNI

ABU RAIHAN AL-BIRUNI
(973-1048 AD)

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 eleventh century AD. Al-Biruni was a versatile scholar and scientist who had equal facility in physics, metaphysics, mathematics, geography and history. Born in the town of Khewa near Khawarizm (present-day Uzbekistan) in 973 AD, 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 Hindi philosophy, mathematics, geography and religion from the Pandits to whom he taught Greek, Arabic science and philosophy. He died in 1048 AD at the age of 75, after having spent 40 years in 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-Fadl 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 with alluvials.

On his return from India, al-Biruni wrote his famous book *Qanun-i-Masoodi (al-Qanun al-Mas'udi, fi al-Hai'a wa al-Nujum),* which he dedicated to Sultan Masood. The book discusses several theorems 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 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 apropos of the chess game led to the number:

$$16^{16}-1=18,44,6,744,073,709,551,619.$$

He developed a method for trisection of angle and other problems that 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* (Astronomy, Trigonometry), *al-Athar al-Baqia* (Ancient History and Geography), *Kitab al-Saidana* (Materia Medica) and *Kitab al-Jamahir* (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 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.*

ABUL WAFA MUHAMMAD AL-BUZJANI

ABUL WAFA MUHAMMAD AL-BUZJANI
(940-997 AD)

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

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

$$x^4 = a \quad \text{and} \quad x^4 + ax^3 = b$$

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 sin (a+b) and the formula:

$$2\sin^2 - \frac{a}{2} - = 1 - \cos a, \text{and}$$

$$\sin a = 2\sin - \frac{a}{2}\cos - \frac{a}{2}$$

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 movements 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 criticised 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 to-day's trigonometry can be traced back to him

ABU AL-NASR AL-FARABI

ABU AL-NASR AL-FARABI
(870-950 AD)

Abu Nasr Mohammad Ibn al-Farakh al-Farabi was born in the small village of Wasij, near Farab in Turkistan in 259 AH (870 AD). His parents were originally of Persian descent, but his ancestors had migrated to Turkistan. Known as al-Phararabius in Europe, Farabi was the son of a general. He completed his earlier education at Farab and Bukhara and, later on, he went to Baghdad for higher studies, where he studied and worked for a long time viz., from 901 AD to 942 AD. 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 the 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 (Aleppo). He became one of the constant companions of the King, and it was there at Halab that his fame spread far and wide. During his early years he was a *Qadi* (Judge), but later on he took up teaching as his profession. During the course of his career, he suffered great hardships and at one time was the caretaker of a garden. He died a bachelor in Damascus in 339 AH/950 AD at the age of eighty.

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, he stands out as an Encyclopaedist. As a philosopher, he may be classed as a Neo-Platonist who tried to synthesise Platonism and Aristotelism with theology. 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. He thus 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 easier 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 Ihsa 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 and 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 it turned out to be the work of some Neo-platonic 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 for Ibn Sina's work.

AL-FARGHANI

AL FARGHANI
(C. 800)*

Abul-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 twelfth 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 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, Sanad 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 Sanad 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).*

* Ninth Century AD.

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 twelfth 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 in mediaeval 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.* 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 Nova' and in the 'Convivio.'

ABU HAMID AL-GHAZALI

ABU HAMID AL-GHAZALI
(1058-1128 AD)

Abu Hamid Ibn Muhammad Ibn Muhammad al-Tusi al-Shafi'i al-Ghazali was born in 1058 AD 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 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 AD 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 Neo-platonic 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 in 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 Neo-platonic procedures and employed these very tools to lay bare the flaws and lacunas of the then prevalent Neo-platonic 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 re-established 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 *Tahafut al-Falasifa* (The Incoherence of the Philosophers), *Ihya al-'Ulum al-Islamia* (The Revival of 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 re-establish 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 Muslim Spain, Ibn Rushd (Averros) wrote a rejoinder to his *Tahafut.*

AL-IDRISSI

AL IDRISSI
(1099-1166 AD)

Abu Abdullah Muhammad Ibn Muhammad Ibn Abdullah Ibn Idriss al-Qurtubi al-Hassani, was born in Ceuta, Spain, in 1099 AD He was educate in Cordoba. 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 a source of controversy, being either 1166 or 1180 AD.

Biographical notes on him are rarely found, and according to F. Pons Boigues, the underlying reason is the fact that the Arab biographers considered al-Idrissi to be a renegade, since he had been associated with the court of a Christian king (Roger II) 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 several of his books, especially *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 gave 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 silver globe weighing around 400 kilograms for King Roger II. He 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-Idrissi, later on, also compiled another geographical encyclopaedia, 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, Idrissi also wrote on fauna, zoology and therapeutical aspects. His works were translated into Latin and, especially, his books on geography remained popular both in the East and the West for several centuries.

IBN AL-BITAR

IBN AL-BITAR
(Died 1248 AD)

Abu Muhammad Abdullah Ibn Ahmad Ibn al-Bitar 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 twelfth 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 Bouaghia, Constantine, 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-Bitar accompanied him there which provided him an opportunity to collect plants from stations located there. He died in Damascus in 1248.

Ibn Bitar'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 sixteenth 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 Arab, and it also quotes about 20 early Greek scientists. It was translated into Latin and published in 1758.

His second monumental treatise *Kitab al-Mughni 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 frequently quoted the famous Muslim surgeon, Abul Qasim Zahrawi. Besides Arabic, Bitar, had given the Greek and Latin names of the plants, thus facilitating transfer of knowledge.

Ibn Bitar'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.

ABU ALI HASSAN IBN AL-HAITHAM

ABU ALI HASSAN IBN AL-HAITHAM
(965-1040 AD)

Abu Ali Hassan Ibn al-Haitham was one of the most eminent physicists, whose contributions to optics and the scientific methods are outstanding. Known in the West as Alhazen, Ibn al-Haitham was born in 965 AD in Basra, and was educated in Basra and Baghdad. Thereafter, he went to Egypt, where he was asked to find ways of controlling the flood of the Nile. Being unsuccessful in this, he feigned madness until the death of Caliph al-Hakim. He also travelled to Spain and, during this period, he had ample time for his scientific pursuits, which included optics, mathematics, physics, medicine and development of scientific methods on each of which he has left several outstanding books.

He made a thorough examination of the passage of light through various media and discovered the laws of refraction. He also carried out the first experiments on the dispersion of light into its constituent colours. His book *Kitab-al-Manathir* was translated into Latin in the Middle Ages, as also his book dealing with the colours of sunset. He dealt at length with the theory of various physical phenomena like shadows, eclipses, the rainbow, and speculated on the physical nature of light. He is the first to describe accurately the various parts of the eye and give a scientific explanation of the process of vision. He also attempted to explain binocular vision, and gave a correct explanation of the apparent increase in size of the sun and the moon when near the horizon. He is known for the earliest use of the camera obscura. He contradicted Ptolemy's and Euclid's theory of vision that objects are seen by rays of light emanating from the eyes. According to him the rays originate in the object of vision and not in the eye. Through these extensive researches on optics, he has been considered as the father of modern optics.

The Latin translation of his main work, *Kitab-al-Manathir,* exerted a great influence upon Western science e.g. on the work of Roger Bacon and Kepler. It brought about great progress in experimental methods. His research in catoptrics centred on spherical and parabolic mirrors and spherical aberration. He made the important observation that the ratio between the angle of incidence and refraction does not remain constant and investigated the magnifying power of a lens. His catoptrics contains the important problem known as Alhazen's problem. It comprises drawing lines from two points in the plane of a circle meeting at a point on the circumference and making equal angles with the normal at that point. This leads to an equation of the fourth degree.

In his book *Mizan al-Hikmah,* Ibn all-Haitham discussed the density of the atmosphere and developed a relation between it and the height. He also studied atmospheric refraction. He discovered that the twilight

only ceases or begins when the sun is 19° below the horizon and attempted to measure the height of the atmosphere on that basis. He also discussed the theories of attraction between masses, and it seems that he was aware of the magnitude of acceleration due to gravity.

His contribution to mathematics and physics was extensive. In mathematics, he developed analytical geometry by establishing linkage between algebra and geometry. He studied the mechanics of motion of a body and was the first to maintain that a body moves perpetually unless an external force stops it or changes its direction of motion. This would seem equivalent to the first law of motion.

The list of his books runs to 200 or so, very few of which have survived. Even his monumental treatise on optics survived through its Latin translation. During the Middle Ages, his books on cosmology were translated into Latin, Hebrew and other languages. He has also written on the subject of evolution a book that deserves serious attention even today.

In his writing, one can see a clear development of the scientific methods as developed and applied by the Muslims and comprising the systematic observation of physical phenomena and their linking together into a scientific theory. This was a major breakthrough in scientific methodology, as distinct from guess and gesture, and placed scientific pursuits on a sound foundation comprising systematic relationship between observation, hypothesis and verification.

Ibn al-Haitham's influence on physical sciences in general, and optics in particular, has been held in high esteem and, in fact, it ushered in a new era in optical research, both in theory and practice.

IBN AL-NAFIS

IBN AL-NAFIS
(1213-1288 AD)

Ala-al-Din Abu al-Hassan Ali Ibn Abi al-Hazm al-Qurashi al-Damashqi al-Misri was born in 607 AH at Damascus. He was educated at the Medical College-cum-Hospital founded by Nur al-Din Zinki. In medicine, his teacher was Muhathab 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 AH. 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. His 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, elaborated the function of the coronary arteries as feeding the cardiac muscle.

The most voluminous of his books in *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. 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 of health, entitled *Kitab al-Mukhtar fi al-Aghdhiya.*

Ibn Al-Nafis' works integrated the then existing medical knowledge 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 KHALDUN

IBN KHALDUN
(1332-1395 AD)

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 AD, 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 Qala'at Ibn Salama in Algeria. It was that period that provided him with the opportunity to write the *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. There, he lived a life of fame and respect, marked by his appointment as the Chief Malekite Judge and lecturing at the Al-Azhar University. 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 the *Muqaddimah* or 'Prolegomena', was based on Ibn Khaldun's unique approach and original contribution. It became a masterpiece on 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 civilisation and the trends of history. In that 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 from. He identified an almost rhythmic repetition of rise and fall in human civilisations, 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 autobiographies. 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 former bases the diagnosis more on cultural, sociological, economic and psychological factors.

IBN RUSHD

IBN RUSHD
(1128-1198 AD)

Abul Waleed Muhammad Ibn Ahmad Ibn Muhammad Ibn Rushd, known as Averroes in the West, was born in 1128 AD in Cordoba, where his father and grandfather had both been judges. His grandfather was well versed in Fiqh (Maleki School) and was also the Imam of the Mosque of Cordoba. The young Ibn Rushd received his education in Cordoba and lived a quiet life, devoting most of his time to learned pursuits. He studied philosophy and law from Abu Ja'afar Haroon and from Ibn Baja. He also studied medicine.

Al-Hakam, the famous Umayyad Caliph of Spain, had constructed a magnificent library in Cordoba, 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. 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 AD. 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 to Ibn Sina's wider scope of *al-Qanun,* but contains several original observations by Ibn Rushd.

In philosophy, his most important work *Tahafut al-Tahafut* was written in response to al-Ghazali's work. Ibn Rushd was criticised by many Muslim scholars for this book, which nevertheless, had a profound influence on European thought, at least until the beginning of modern philosophy and experimental science. His views on fate were that man is neither in full control of his destiny nor is it fully predetermined for him. He wrote three commentaries on the works of Aristotle, as these were known then through Arabic translations. The shortest *Jami* may be considered as a summary of the subject. The intermediate was *Talkhis* and the longest was the *Tafsir.* These three commentaries would seem to correspond to different stages in the education of pupils; the short one was meant for the beginners, then

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 Mitchel 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 writing 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 Ja'afar al-Thahabi as possibly the best book on the Maleki 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 twelfth 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 until the advent of modern experimental sciences.

IBN SINA

IBN SINA
(980-1037 AD)

Abu Ali al-Hussain Ibn Abdullah Ibn Sina was born in 980 AD at Afshana near Bukhara (Central Asia). The young Ibn Sina received his early education in Bukhara, and by the age of ten had become well versed in the study of the Qur'an and various sciences. He started studying philosophy by reading various Greek, Muslim and other books on this subject and learnt logic and some other subjects from Abu Abdallah Natili, a famous philosopher of the time. While still young, he attained such a degree of expertise in medicine that his renown spread far and wide. At the age of 17, he was fortunate in curing Nooh Ibn Mansoor, the King of Bukhara, of an illness in which all the well-known physicians had given up hope. On his recovery, the King wished to reward him, but the young physician only desired permission to use his uniquely stocked library.

On his father's death, Ibn Sina left Bukhara and travelled to Jurjan where Khawarizm Shah welcomed him. There, he met his famous contemporary Abu Raihan al-Biruni. Later he moved to Ray and then to, where he wrote his famous book *Al-Qanun fi al-Tibb.* There he treated Shams al-Dawlah, the King of Hamadhan, for severe colic. From Hamadhan, he moved to Isfahan, where he completed many of his monumental writings. Nevertheless, he continued travelling and the excessive mental exertion as well as political turmoil spoilt his health. Finally, he returned to Hamadhan where he died in 1037 AD

He was the most famous physician, philosopher, encyclopaedist, mathematician and astronomer of his time. His major contribution to medical science was his famous book *al-Qanun,* known as the "Canon" in the west. The *Qanun fi al-Tibb* is an immense encyclopaedia of medical knowledge available from ancient and Muslim sources. Due to its systematic approach, formal perfection as well as its intrinsic value, the *Qanun* superseded Razi's *Hawi*, Ali Ibn Abbas's *Maliki*, and even the works of Galen, and remained supreme for six centuries. In addition to bringing together the then available knowledge, the book is rich with the author's original contribution. His important original contribution includes such advances as recognition of the contagious nature of phthisis and tuberculosis; spread of diseases by water and soil, and interaction between psychology and health. In addition to describing pharmacological methods, the book described 760 drugs and became the most authentic *Materia medica* of the era. He was also the first to describe meningitis and made rich contributions to anatomy, gynaecology and child health.

His philosophical encyclopaedia *Kitab al-Shifa* was a monumental work, embodying a vast field of knowledge from philosophy to science. He classified the entire field as follows: theoretical knowledge; physics,

mathematics and metaphysics, and practical knowledge; ethics, economics and politics. His philosophy synthesises Aristotelian tradition, Neo-platonic influences and Muslim theology.

Ibn Sina also contributed to mathematics, physics, music and other fields. He explained the "casting out of nines" and its application to the verification of squares and cubes. He made several astronomical observations, and devised a contrivance similar to the vernier, to increase the precision of instrumental readings. In physics, his contribution comprised the study of different forms of energy, heat, light and mechanics, and the study of such concepts as force, vacuum and infinity. He made the important observation that if the perception of light is due to the emission of some sort of particle by the luminous source, then the speed of light must be finite. He propounded an interconnection between time and motion, and also made investigations on specific gravity and used an air thermometer.

In the field of music, his contribution was an improvement over Farabi's work and was far ahead of knowledge prevailing elsewhere on the subject. Doubling with the fourth and fifth was a 'great' step towards the harmonic system and doubling with the third seems to have also been allowed. Ibn Sina observed that in the series of consonances represented by (n+1)/n, the ear is unable to distinguish them when n= 45. In the field of chemistry, he did not believe in the possibility of chemical transmutation because, in his opinion, the metals differed in a fundamental sense. These views were radically opposed to those prevailing at the time. His treatise on minerals was one of the "main" sources of geology of the Christian encyclopaedists of the thirteenth century. Besides *Shifa* (Healing), his well-known treatises in philosophy are *al-Nagat* and *Isharat.*

ABU MARWAN IBN ZUHR

ABU MARWAN IBN ZUHR
(1091-1161 AD)

Abu Marwan Abd al-Malik Ibn Zuhr was born at Seville in 1091 or 1094 AD. After completing his education and specialising 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 or 1162 AD. 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 those, 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 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 in the West. His books were translated into Latin and Hebrew and remained popular in Europe as late as the advent of the eighteenth century.

JABIR IBN HAIYAN

JABIR IBN HAIYAN
(Died 803 AD)

Jabir Ibn Haiyan, the alchemist Geber of the Middle Ages, is generally known as the father of chemistry. Abu Musa Jabir Ibn Haiyan, 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 AD. He is reported to have studied under Imam Ja'afar Sadiq and the Ummayed prince Khalid Ibn Yazid. In his early days, he practised medicine and was under the patronage of the Barmaki Vizier during the Abbasid 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 AD.

Jabir's major contribution was in the field of chemistry. He introduced experimental investigation into alchemy, which rapidly changed its character into modern chemistry. Although the ruins of his well-known laboratory remained centuries after him, 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 crystallisation, distillation, calcination, sublimation and evaporation and development of several instruments for the same. The fact of the early development of chemistry as a distinct branch of science by the Arabs, instead of the earlier vague ideas, became well-established and the very name chemistry was 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, lettering in gold, identification of paints, greases, etc. During the course of these practical endeavours, he also developed aqua regia to dissolve gold. The alembic was 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 that vaporise on heating, like camphor, arsenic and ammonium chloride; secondly, metals, for example, gold, silver, lead, cooper, 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. He instead devoted his effort to the development of basic chemical methods and study of mechanism 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 are preserved in Arabic and 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. 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

MOHAMMAD BIN MUSA AL-KHAWARIZMI

MOHAMMAD BIN MUSA AL-KHAWARIZMI
(770?-840 AD)

Abu Abdullah Mohammad Ibn Musa al-Khawarizmi was born at Khawarizm (Khewa) (Uzbekistan), south of the 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 for sure, but it is established that he flourished under Al-Mamun at Baghdad through 813-833 and probably died around 840 AD.

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 mediaeval 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. That established him as the founder of Algebra. The very name Algebra has been derived from his famous book *Hisab 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 introducing 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 the 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 Al-Mamun that 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 revised Ptolemy's views on geography, but also corrected them in detail as well as correcting his map of the world. His other contributions include original work related to clocks, sun-dials and astrolabes.

Several of his books were translated into Latin in the early twelfth century. In fact, his book on arithmetic, *Kitab al-Jam'a a wal-Tafreeq bill Hisab al-Hindi,* was lost in Arabic but survived in the Latin translation. His book on algebra, *Al-Maqala fi Hisab-al Jabr wa-al Muqabilah,* was also translated into Latin in the twelfth 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 book 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 text-books till the sixteenth 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. Not surprising then that he has been held in high repute through the centuries since his death.

OMAR AL-KHAYYAM

OMAR AL-KHAYYAM
(1044-1123 AD)

Ghayath al-Din Abul Fateh Omar Ibn Ibrahim al-Khayyam was born at Nishapur, the provincial capital of Khurasan around 1044 AD (c. 1038 to 1048). A Persian mathematician, astronomer, philosopher, physician and poet, he is commonly known as Omar Khayyam- Khayyam means the tent-maker. 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 Nizam 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 learning, Samarqand, Bukhara, Balkh and Isfahan in order to study further and exchange views with the scholars there. While at Samarqand, he was patronised by a dignitary, 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 equation, including the third degree equations and, in fact, offered solution for a number of them. This includes geometric solutions of cubic equation and partial geometric solutions of most other equations. His book *Maqalat fi al-Jabr wa al-Muqabila* is a master-piece on algebra and had 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 recognized 13 different forms of cubic equation. 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, Malik-shah 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 *Nauruznamah.* He was also a renowned astronomer and 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 the world literature. It should be appreciated that it is practically impossible to exactly translate any literary work into another language, let alone poetry, especially when it involves mystical and philosophical messages of deep complexity. Despite this, the popularity of the translation of *Rubaiyat* would indicate the worth of his rich thought.

Khayyam wrote a large number of books and monographs in the above areas. Out of these, ten 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 until the times of Descartes, who applied the same geometrical approach in solving cubics. His frame 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.

* Prof. Ali Al-Daffa' FIAS disputes the fact that Omar Khayyam was infact responsible for the *Rubaiyat* (quatrains), and quotes Zokofsky who had infact claimed that at least eighty-two verses of the *Rubaiyat* were written by other poets.

YAQUB IBN ISHAQ AL-KINDI

YAQUB IBN ISHAQ AL-KINDI
(800-873 AD)

Abu Yousuf Yaqub Ibn Ishaq al-Kindi was born at Kufa around 800 AD. 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 was 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 AD during the reign of al-Mu'tamid.

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. Because 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. There is no doubt that 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 contribution 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 administered of all the drugs known at his time. This resolved the conflicting 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-pleasant. 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, and 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 highly 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 *Risalat dar Tanjim, Ikhtiyarat al-Ayyam, Ilahyate-e-Aristu, al-Mosiqa, Mad-wa-Jazr,* and *Adwiya 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.

ABUL HASSAN ALI AL-MASU'DI

ABUL HASSAN ALI AL-MASU'DI
(Died 957 AD)

Abul Hassan Ali Ibn Hussain Ibn Ali Al-Masu'di was a descendant of Abdallah Ibn Masu'd, a companion of the Holy Prophet (peace be upon him). An expert geographer, a physicist and historian, Masu'di was born in the last decade of the ninth century AD. His exact date of birth being unknown. He was a Mu'tazilite Arab, who explored distant lands and died at Cairo, in 957 AD

He travelled to Fars in 915 AD and, after staying for one year in Istikhar, he proceeded via Baghdad to India, where he visited Multan and Mansoora before returning to Fars. From there he travelled to Kirman and then again to India. Mansoora in those days was a city of great renown and was the capital of the Muslim State of Sind. Around it, there were many settlements/townships of new converts to Islam. In 918 AD, Masu'di travelled to Gujrat, where more than 10,000 Arab Muslims had settled in the seaport of Chamoor. He also travelled to Deccan, Ceylon, Indo-China and China, and proceeded via Madagascar, Zanjibar and Oman to Basra.

At Basra, he completed his book *Muruj-al-Thahab,* in which he described in a most absorbing manner his experience of various countries, people and climates. He gives accounts of his personal contacts with the Jews, Iranians, Indians and Christians. From Basra he moved to Syria and from there to Cairo where he wrote his second extensive book *Muruj al-Zaman* in thirty volumes. In this book he described in detail the geography and history of the countries that he had visited. His first book was completed in 947 AD. He also prepared a supplement, called *Kitab al-Awsat,* in which he has compiled historical events chronologically. In 957 AD, the year of his death, he completed his last book *Kitab al-Tanbih wa al-Ishraf,* in which he gave a summary of his earlier book as well as an errata.

Masu'di is referred to as the Herodotus and Pliny of the Arabs. By presenting a critical account of historical events, he initiated a change in the art of historical writing, introducing the elements of analysis, reflection and criticism, which was later on further improved by Ibn Khaldun. In particular, in *Al-Tanbih* he makes a systematic study of history against a perspective of geography, sociology, anthropology and ecology. Masu'di had a deep insight into the causes of rise and fall of nations.

With his scientific and analytical approach he has given an account of the causes of the earthquake of 955 AD, as well as the discussions of the water of the Red Sea and other problems in earth sciences. He is the first author to make mention of windmills, which were invented by the Muslims of Sijistan.

Masu'di also made important contributions to music and other fields of science. In his book *Muruj al-Thahab,* he provides important information on early Arab music as well as music of other countries.

His book *Muruj al-Thahab wa al-Ma'adin al-Jawahir* (Meadows of Gold and Mines of Precious Stones) has been held as 'remarkable' because of the 'catholicity of its author, who neglected no source of information and of his truly scientific curiosity.' As mentioned above, it was followed by his treatise *Muruj al-Zaman.* In addition to writing a supplement *Kitab al-Awsat,* he completed *Kitab al-Tanbih wa al-Ishraf* towards the end of his career. It is, however, unfortunate that, out of his 34 books as mentioned by himself in *Al-Tanbih,* only three have survived, in addition to *Al-Tanbih* itself.

Some doubts have been expressed about some claims related to his extensive travelling e.g., up to China and Madagascar, but the correct situation cannot be assessed due to the loss of several of his books. Whatever he has recorded was with a scientific approach and constituted an important contribution to geography, history and earth sciences. It is interesting to note that he was one of the early scientists who propounded several aspects of evolution viz., from minerals to plant, plant to animal and animal to man. His researches and views extensively influenced the sciences of historiography, geography and earth sciences for several countries.

ABU AL-HASSAN AL-MAWARDI

ABU AL-HASSAN AL-MAWARDI
(972-1058 AD)

Abu al-Hassan Ali Ibn Muhammad Ibn Habib al-Mawardi was born at Basra in 972 AD. He was educated at first in Basra where, after completion of his basic education, he learned *Fiqh* (Islamic jurisprudence) from the jurist Abu al-Wahid al-Simari. He then went to Baghdad for advanced studies under Sheikh Abdul-Hamid and Abdallah al-Baqi. His proficiency in jurisprudence, ethics, political science and literature proved useful in securing a respectable career for him. After his initial appointment as *Qadi* (Judge), he was gradually promoted to higher offices, until he became the Chief Justice of Baghdad. The Abbasid Caliph *al-Qaim bi-Amr Illah* appointed him as his roving ambassador and sent him to a number of countries as the head of special missions. In this capacity, he played a key role in establishing harmonious relations between the declining Abbasid Caliphate and the rising power of Buwaihids and Seljukes. He was favoured with rich gifts and tributes by most Sultans of the time. He was still in Baghdad when it was taken over by Buwaihids. He died in 1058 AD.

Al-Mawardi was a great jurist, *mohaddith,* sociologist and an expert in political science. He was jurist in the school of *Fiqh* and his book *Al-Hawi* on the principles of jurisprudence is held in high repute.

His contribution in political science and sociology comprises a number of monumental books, the most famous of which are *Kitab al-Ahkam al-Sultania, Qanun al-Wazarah,* and *Kitab Nasihat al-Mulk.* The books discuss the principles of political science, with special reference to the functions and duties of the caliphs, the chief minister, other ministers, relationships between various elements of public and government and measures to strengthen the government and ensure victory in war. Two of these books, *al-Ahkam al-Sultania* and *Qanun al-Wazarah* have been published and also translated into various languages. He is considered as being the author/supporter of the 'Doctrine of Necessity' in political science. He was thus in favour of a strong caliphate and discouraged unlimited powers delegated to the governors, which tended to create chaos. On the other hand, he has laid down clear principles for election of the caliph and qualities of the voters, chief among which are attainment of a degree of intellectual level and purity of character.

In ethics, he wrote *Kitab A'adab al-Dunya wa al-Din,* which became a widely popular book on the subject and is still read in some Islamic countries.

Al-Mawardi has been considered as one of the most famous thinkers in political science in the middle ages. His original work influenced the development of this science, together with the science of sociology, which was further developed later on by Ibn Khaldun.

MUHAMMAD IBN ZAKARIYA AL-RAZI

MOHAMMAD IBN ZAKARIYA AL-RAZI
(864-930 AD)

Abu Bakr Mohammad Ibn Zakariya al-Razi (864-930 AD) 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. There, he remained the head of its famous Muqtadari Hospital for a long time. He moved from time to time to various cities, especially between Ray and Baghdad, but finally returned to Ray, where he died around 930 AD. His name is commemorated at the Razi Research 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 fifteenth century AD, 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 of 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 Haiyan. 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 Experimentorum.* 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 sulphuric 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-Judari wa al-Hasabah, al-Mulooki, Maqalah fi al-Hasat fi Kulla 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.

JALAL AL-DIN RUMI

JALAL AL-DIN RUMI
(1207-1273 AD)

Jalal al-Din Mohammad Ibn Mohammad Ibn Mohammad Ibn Hussain al-Rumi was born in 604 AH (1207/8 AD) 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 (Turkey). 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 *Madrasa* 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 Tabrizi. 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 *Madrasa* and also founded the famous Mawlawi Order in *Tasawwuf.* He died in 672 AH (1273 AD) at Konya, which subsequently became a sacred place for dancing dervishes of the Mawlawi 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 *Mathnawi,* he also wrote his *Diwan* (collection of poems) and *Fih-Ma-Fih* (a collection of mystical sayings). However, 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 seemed to have inspired most of the intellectuals in Central Asia and adjoining areas since his

time. Scholars like Iqbal have further developed Rumi's concepts. The *Mathnawi* became known as the interpretation of the Qur'an in the Pahlawi 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.

ALI IBN RABBAN AL-TABARI

ALI IBN RABBAN AL-TABARI
(838-870 AD)

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, it seems. As compared to Razi, people know very little about his teacher Al-Tabari.

Ali Bin Rabban's forename was Abu al-Hassan, the full name being Abu al-Hassan Ali Ibn Sahl Ibn Rabban al-Tabari. Born in 838 AD, his father Sahl hailed from a respectable Jewish 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.

Although Ali hailed from an Israelite family, he had embraced Islam, and thus he is classified amongst Muslim Scholars. His family belonged to Tabristan's famous city Marv.

The fame acquired by Ali Ibn Rabban did not simply account for the reason that a physician of the stature of Zakariya al-Razi was amongst his disciples. In fact, the main cause behind his exaltation 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 the last century (twentieth century) only. Prior to that, it used to be found scattered in libraries the world over. Dr. Mohammed Zubair Siddiqui compared and edited the manuscripts. In his preface he has preface he has provided extremely useful information regarding the book and the author and, wherever 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 co-operation of English and German institutions. Following are the details of its all seven parts:

1. **Part one:** *Kulliyat-e-Tibb.* This part sheds light on contemporary 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-wa-Dawlat* and *Hifz al-Seha.* 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 AD.

THABIT IBN QURRA

THABIT IBN QURRA
(836-901 AD)

Thabit Ibn Qurra Ibn Marwan al-Sabi' al-Harrani was born in the year 836 AD 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-Mu'tadid. After a long career of scholarship, Thabit died at Baghdad in 901 AD.

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 the parabola and the 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 Ptolemaic views. He analysed several problems related to the movements of sun and moon and wrote treatises on sundials.

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 ninth century exerted a positive influence on the development of subsequent scientific research.

NASIR AL-DIN AL-TUSI

NASIR AL-DIN AL-TUSI
(1201-1274 AD)

Abu Ja'afar Muhammad Ibn Muhammad Ibn al-Hassan Nasir al-Din al-Tusi was born in Tus (Khurasan) in 1201 AD. He learnt sciences and philosophy from Kamal al-Din Ibn Yunus and others. He was one of those who were kidnapped by Hassan bin Sabah's agents and sent to Almut, Hassan's stronghold. In 1256 when Almut was conquered by the Mongols, Nasir al-Din joined Hulegu's service. Hulegu Khan (Holako) was deeply impressed by his knowledge, including his astrological competency; appointed him as one of his ministers, and, later on, as administrator of Awqaf. 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, philosophers, 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. In addition, he developed the subject of spherical trigonometry, including six fundamental formulae 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 (Hulegu 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 Hulegu Khan. The tables were largely based on original observations, 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 fifteenth 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 metaphysics, 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-'Aqai'd* 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 super commentaries 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 mathematics, 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.

ABU AL-QASIM AL-ZAHRAWI

ABU AL-QASIM AL-ZAHRAWI
(936-1013 AD)

Abul Qasim Khalaf Ibn al-Abbas al-Zahrawi (known in the west as Abulcasis) was born in 936 AD in Zahra in the neighbourhood of Cordoba. 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 AD

He is best known for his early and original breakthroughs in surgery as well as for his famous Medical Encyclopaedia 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 cauterisation, removal of stone from the bladder, dissection of animals, midwifery, styptics, 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 examination 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 specialised in curing disease by cauterisation 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 ENT, 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, haemophilia.

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 recognised as authentic in medical science, especially surgery, and these continued to influence the medical world for five centuries. According to Campbell's (*History of Arab Medicine*), his principles of medical science surpassed those of Galen in the European medical curriculum.

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