

## CULTURAL ATTAINMENTS DURING THE MEDIEVAL MUSLIM (ABBASID) PERIOD

The year 750 A.D., which witnessed the replacement of the Umayyad dynasty by the Abbasids, not only heralded a new era in the history of Islam, but also proved a turning point in the course of world history. The Abbasid dynasty was established by the descendants of Hazrat Abbas, one of the much honoured uncles of the Holy Prophet, belonging to the Prophet's clan of Banu Hashim of the Quraish. The Abbasid victory was generally hailed as representing the substitution of the true concept of the Caliphate for the secular state of the Umayyads. Although in practice there remained much to be desired in the fulfillment of this requirement, the Abbasids succeeded to win the confidence of the orthodoxy and, true to their promise to the bulk of their supporters who were mainly Persian Muslims, they accorded equal treatment of all the new converts with the Arabs. From then on, the non-Arabs assumed, as common subjects of the state, their proper place as citizens of the Caliphate, were admitted to the highest employment of the state, and enjoyed equal consideration with their Arab brothers.

A greater revolution than this has scarcely been witnessed, either in ancient or modern times (excepting the period of the Pious Caliphate). It gave practical effect to the democratic enunciation of the equality and brotherhood of man. This great revolution was due to the extraordinary vitality of the Abbasid Caliphate and the permanence of its spiritual supremacy, even after it had lost its temporal authority. The acceptance of this fundamental principle of racial equality among all their subjects helped the early sovereigns of the house of Abbas to build up an empire which endured without a rival for over five centuries from 750 to 1258 A.D. and fell only before the barbarian attack of the Mongol hordes from without.

As advocates of the Islamic State, the Abbasid modelled their government on the fundamentals of Islam, which are: equality, liberty, fraternity, social justice and toleration of other faiths. After establishing their government, the Abbasid Caliphs took energetic steps toward the promotion of Islamic culture and civilization. They invited learned scholars from all over the Empire and patronised them so that these scholars would collect all the religious literature,

particularly the traditions of the Prophet, and also codify the Muslim Law.

After the Romans, the Arabs were the only medieval people who cultivated the science of jurisprudence and evolved therefrom an independent legal system. Their legal system, *Fiqh*, as they called it, was primarily based on the Quran and the traditions of the Prophet Muhammad (peace be upon him). *Fiqh* was the science through which the canon Law of Islam (Shariah), the totality of Allah's commandments as revealed in the Quran and elaborated in the traditions, was communicated to later generations. The commandments embrace regulations relating to morality, ritual and worship, civil and legal obligations and punishments. After the Quran, the basic source of Muslim Law is the Sunnah, which embodies the sayings and doings of the Holy Prophet and is found in the works of Ahadith. The Sunnah supplements, elaborates and explains the basic principles laid down in the Holy Quran.

The second and third Muslim centuries saw the compilation of the various collections of traditions (Ahadith) into six books which have since become standard. Of the six books the first and most authoritative is that of Muhammad Ibn Ismail al Bukhari (810-70). Out of the 600,000 traditions, he collected from 1,000 sheikhs in the course of sixteen years of travel and labours in Persia, al-Iraq, al Hijaz and Egypt, some 7,275 traditions which he classified according to subject matter, such as prayer, pilgrimage, holy war, etc.<sup>1</sup>

Next in importance comes the collection of Muslim ibn al-Hajjaj (875) of Naysapur, a work on which Muslims have conferred the same title, al-Shahih, the genuine collection. Next to these two genuine books come four others which Muslims have elevated to canonical rank. These are the Sunan of Abu Dawud of al-Basra (888), the Jani of al-Tirmidhi (892), the Sunan of Ibn Majah of Qazwia (886) and the Sunan of al-Nassi who died at Makkah in 915. A.D.

It may be noted here that among the six collections of Traditions mentioned above, which are known as the six reliable

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<sup>1</sup>This does not mean that the traditions not included in the compilation were spurious. In fact, most of them are genuine, only they did not come up to the standard set by Imam Bukhari.

collections, al-Bukhari holds the first place in several respects. For one thing, al-Bukhari has the unquestioned distinction of being first, all the others modelling their writings on his. Secondly, he is the chronologically most critical of all. He did not accept any tradition unless all its transmitters had actually met the first; the mere fact that the two were contemporaries did not satisfy him. Thirdly, in his acumen, he surpasses all. Fourthly, he heads the more important of his chapters with a text from the Quran, and thus shows that Tradition is only an explanation of the Quran, and as such is a secondary, though undoubtedly essential source of teachings of Islam.

There is no doubt that the collectors of traditions attached the utmost importance to the trustworthiness of the narrators. As Guillaume says: "Inquiries were made as to the character of the narrators, whether they were morally and religiously satisfactory, whether they were tainted with heretical doctrines, whether they had a reputation for truthfulness and had the ability of transmit that they had themselves heard. Finally, it was necessary that they should be competent witnesses whose testimony would be accepted in a court of civil law. More than this, they tried their best to find out that the report was traceable to the Prophet through the various necessary stages. Nay, they went beyond the narrators, and they had rules of criticism which were applied to the subject matter of Tradition."

In the eighth century of the Christian era came the great jurists who codified the Islamic Law according to the need of their time. The first of these, and the one who claims the allegiance of the greater part of the Muslim world, was Abu Hanifa Numan ibn Thabit (80-150 A.H.). The basis of his analogical reasoning (Qiyas) was the Quran. He accepted Tradition only when he was fully satisfied as to its authenticity. He also laid down the principle of equity, whereby not only could new laws be made, but even logical conclusions could be controverted when they proved to be inequitable. He recognized the importance of customs and usages, and utilized them so much in forming independence of judgement that he and his followers were called upholders of private judgement.

The second, Imam Malik ibn Anas (93-173 A.H.) limited himself almost entirely to the Traditions which he found in Medina, relating more especially to the practice which prevailed there. As such his system of jurisprudence is based entirely on the Traditions and practices of the people of Medina. He was scrupulously careful in

giving judgement.

The third, Imam Abu Abd allah Muhammad ibn Idris al-Shafi'i, took immense pains in studying the Traditions, travelling from place to place in search of information. He was intimately acquainted with the Hanifi and Maliki system, but that which he himself founded was based largely on Traditions: it had the advantage that the Traditions made use of by Shaf'i were more extensive, and were collected from different centres, while Imam Malik contented himself only with what he found at Medina.

The last of the four great Imams, was Ahmad ibn Hanbal who, too, made a very extensive study of Traditions and made very little use of reasoning as he depended almost entirely on Traditions.

It was not only in the religious field that marked progress was made. The Abbasid period is noted for intellectual awakening in all fields of knowledge. It witnessed the most momentous intellectual awakening in the history of Islam and one of the most significant in the whole history of thought and culture.

The host of literatures and savants who flourished during this long period directed their minds to every branch of human study. They wrote on grammar, belles lettres, rhetoric, philology, geography, the Traditions, and travels: they compiled lexicons and biographies, and enriched the world with thoughtful histories and beautiful poetry; they added to the sum total of human knowledge by their discoveries in science, an impetus to the movement of thought by their philosophical discussions.

When we consider the immense range over which the Muslim Arabs exercised their intellect from the eighth to the thirteenth century, Sedillot can scarcely be said to be exaggerating. He says: "The vast literature which existed during this period, the multifarious production of genius, the precious inventions, all of which attest to a marvelous activity of intellect, justify the opinion that the Arabs were our masters in everything. They furnished us, on the one hand, with inestimable materials for the history of the Middle Ages, with travels, with the happy idea of biographical dictionaries; on the other, an industry without equal, architecture, magnificent in execution and thought, and important discoveries in art."

The intellectual activities of these early Muslims are generally classified into two groups; firstly, activities evoked by the predilections of the Arab's genius — namely, theology, jurisprudence,

philosophy and history and secondly, activities evoked by an instinctive human desire for knowledge, which are philosophy, mathematics, astronomy, astrology, medicine, natural science, literature and geography. Impelled by the immediate necessity of building up a gigantic socio-political order for Muslimdom in accordance with the principles of the Holy Quran and the Prophetic traditions, the Muslim scholars at first addressed themselves to the first group of subjects, in which they attained a distinctive greatness. But the fabulous prosperity of Baghdad brought in its train also the need for enjoyment, the love of beauty and, as Joseph Hell says, the noblest and highest of all the craving for knowledge, the search after truth. Indeed for the Muslims all knowledge was sacred, a gift of God and in it nothing was profane. It, therefore, goes to the credit of Islam, that it neither slighted nor ignored the second group of subjects, but, as Joseph Hell further adds, "it offered the very same home to them as it did to theology — a place in the mosque." This leads us to a consideration of the system of education that was prevalent under the Abbasid rule.

### **Educational System**

Early in the time of the pious Caliphs schools were established in different parts of Arabia as well as in the conquered provinces for teaching the Holy Quran. The later curriculum included also grammar and calligraphy. Under the Abbasids, these elementary schools were generally housed in prominent mosques, spread like a network throughout the Caliphate. Demands for learning had become so universal that even without any initiative of the state, a sort of compulsory school system grew up. Boys and girls usually joined these schools at the age of six and the teachers were paid by the community.

As a logical development of the intellectual activities, there also sprang up several universities in important cities of the empire such as Basrah, Kufah, Damascus, Baghdad, Nayshapur, Herran, Marv etc. It is generally recognised that until the eleventh century of the Christian era principal seats of the universities were the mosques which ensured perfect freedom to the teachers to express their views on the one hand and the facility of free admission to every Muslim on the other. This public character of teaching coupled with the fact

that no reliance was put on the diploma or formal certificates but on the personal competence of the teacher and his mastery over the subject taught, ensured to a great extent a high standard of learning.

Judging from whatever information has come down to us, the method of teaching at these Universities appear to have been of a "Seminar" type which is presently gaining popularity in Western countries. This point can be best illustrated by the following quotation from the Arab Civilization of Joseph Hell, who observes:

"And to these lectures came not inquisitive ignoramuses but Muslim savants from all parts of the empire. It was open to any member of the audience to question the lecturer, and a lecturer unable to explain the point raised or to satisfy the questioner was forthwith disgraced and discredited. Every teacher had his fixed days and hours. On the other hand, there was no time-limit to the lectures. It rested entirely with the lecturer to fix the number of lectures on any given subject . . . The lecture was usually based on a treatise composed either by the lecturer himself or by another. The lecture, delivered slowly, was taken down by the audience.

"By means of questions occasionally thrown out, the lecturer ascertained whether he was being followed or not. At times, he stepped down among the audience to discuss the subject with them."

In matters of teaching sciences what especially distinguished the Muslim scholars was the emphasis on observation, i.e., the "scientific spirit" par excellence. As testified by Sedillot, what characterised the school of Baghdad from its inception was "its scientific spirit, i.e., (i) proceeding from the known to the unknown, (ii) taking precise account of celestial phenomena, (iii) accepting nothing as true which is not confirmed by experience or established principles taught and acclaimed by the then masters of the science."

Until the eleventh century A.D. when regular academics were established by the princes, the teachers were left to earn their own living usually by appointment as judges of the courts or by carrying on trade or craft. In the academies teachers received salaries. There was, however, arrangement for copyright which often put the teachers into considerable difficulty, as no one was allowed to use the book of another at a public lecture without written permission. Even after the death of the author the copyright lay with his heirs whose permission was required for its utilization. But far from being an impediment to learning, it stimulated original thinking and ever-

fresher scholarship.

In order to have a correct estimate of the cultural attainments during the period under review, a short resume of the literary and scientific activities of some of the outstanding scholars on some important branches of humanities is necessary.

## History

Archaeology and Ethnology were included in history, and great minds applied themselves to the pursuit of this interesting branch of study. Baladhari, one of the most reputed historian, was born at Baghdad where he lived and worked. His history of the conquest is written in admirable style, and marks a distinct advance of the historical spirit. It is, however, in the monumental works of Tabari, of Masudi and Ibn al-Athir that we see the full activity of the Muslim mind during this period. Like their successors, these men were encyclopedists, philosophers, mathematicians, geographers, as well as historians.

Tabari (Abu Ja'far Muhammad ibn Jarir) who died in Baghdad in 922 A.D. brought his work down to the year 302 A.H./914 A.D. His fame rests on his remarkably elaborate and accurate history, *Tarikh al-Rusul wa al-Muluk* (Annals of the Apostles and Kings), as well as on his commentary on the Quran.\*

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Ptolemy's Geography was translated into Arabic either directly or through Syriac several times. With this as a model the celebrated Khwarizmi composed his *Sura al-Ard* (Image of the Earth), which served as a basis for later works and stimulated geographical studies and composition of original treatises. Al-Khwarizmi's work was accompanied by an image of earth, a map executed by him and sixty-nine other scholars under the patronage of al-Mamun, which is the first map of the heavens and the earth in Islam.

This first independent geographical treatises in Arabic took the form of road books in which itineraries occupied a prominent place. Ibn Khurdadhbih (912), director of the post and intelligence service

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\*The continuation of this sub-topic on history, probably consisting of several paragraphs and apparently including also parts of the next sub-topic (geography) are not found in the only available copy of this lecture.-Ed.

in al-Jibal, initiated the series with his *Masalik al-Mamalik*. This work especially valuable for its historical topography, was used by inb al-Faqih, ibn Hawqal, al-Maqdisi and later geographical writers.

The great systematic geographers of the Arabs do not make their appearance until the advent of al-Istakhri, ibn Hauqal, and al-Maqdisi. In the middle of the fourth Muslim century, Al-Istakhri flourished about 950 A.D. and produced his *Masalik al-Mamalik* with coloured maps for each country. Al-Maqqdisi visited all the Muslim lands except Spain, Sijistan and India and in 985 A.D. embodied an account of his twenty years of travel in a delightful work, *Ahsan al-Qaqzim fi Marifat-al-Awalim* (The Best Classification for Knowledge of Regions), which contains much valuable and fresh information.

Before the close of the Abbasid age lived the greatest of Eastern Muslim geographers, Yaqut ibn Abdullah al-Manawi (1179-1229), author of the often-cited geographical dictionary, *Mujam al-Buldan*. The first draft of his geographical dictionary was drawn at al-Mawsil in 1224 and the final redaction was completed in 1228 at Aleppo. This *Mujam*, in which names of places are alphabetically arranged, is a veritable encyclopaedia, containing, in addition to the whole fund of geographical knowledge of the age, valuable information on history, ethnography and natural science.

Literary geography of the Muslims is said to have left no direct impression on European medieval thought, as the work of these geographers found no translations into Latin. Certain aspects of astronomical geography, including an approximately correct theory of the causation of tides, worked out by Abu-Mashar, and of the length of the terrestrial degree, did find their way into the West, the latter through a translation of al-Farghanis work on astronomy. Likewise fragments of the geographical lore of the Greeks as exemplified by Aristotle, and Ptolemy were re-introduced to the West through the Arabs. The primary interest of Latin Occident in Arabic books had for its object the preparation of calendars, star tables, and horoscopes and the interpretation of the hidden meaning in the words of the scriptures through commentaries on Aristotle. The bulk of this scientific material, whether astronomical, astrological or geographical, penetrated the West through Spanish and Sicilian channels.

## Philosophy

To the Arabs philosophy was a knowledge of the true causes of things as they really are insofar as it is possible to ascertain them by human faculties. In essence their philosophy was Greek, modified by the thought of the conquered peoples and by other Eastern influences, adapted to the mental proclivities of Islam and expressed through the medium of Arabic.

The greatest names in the field of early Arab Philosophy are those of al-Kindi, Al-Farabi and Ibn Sina.

Abu Yousuf Yakub ibn Ishaq al-Kindi, born in Kufah about the middle of the ninth century, flourished in Baghdad. Al-Kindi was more than a philosopher. He was astrologer, alchemist, optician and music theorist. No less than two hundred and sixty five works are ascribed to him but most of them have been lost. His principal work on geometrical and physiological topics, based on the Optics of Euclid on Theon's recension, was widely used in both East and West until superseded by the greater work of Ibn al-Haytham. In its Latin translation, *De Aspectibus*, it influenced Roger Bacon.

The harmonization of Greek philosophy with Islam begun by al-Kindi, an Arab, was continued by al-Farabi, a Turk, and completed in the East by Ibn Sina, a Persian.

Muhammad ibn Muhammad ibn Yarkhan abu Nasr al-Farabi, born in Transoxiana flourished as a Sufi at Aleppo in the brilliant court of Sayf al-Dawlah al-Hamdani. He died at Damascus in 950 A.D. His system of philosophy was a syncretism of Platonism, Aristotelianism and Sufism that won him the inevitable title of the second teacher. Besides a number of commentaries on Aristotle and other Greek philosophers, al-Farabi composed various psychological, political and metaphysical works, of which the best known are the *Risalah fi Ara Ahl al-Madinah al-Fadilah* (Epistle on the Opinions of the People of the Superior City). In the latter and in his *al-Siyasah al-Madaniyah* (Political Economy), he presents his conception of the model city, which he conceives as a hierarchical organism analogous to the human body. The sovereign, who corresponds to the heart, is served by functionaries who are themselves served by others still lower. In his ideal city the object of association is the happiness of its citizens, and the sovereign is perfect, morally as well as intellectually.

Al-Farabi's other writings reveal him as a physician and mathe-

matician, an occult scientist and an excellent musician. In the presence of his patron Sayf al-Dawlah he is said to have been able to play his flute so as to cast his hearers into a fit of laughter, draw tears from their eyes or set them all asleep, including even the door-keepers.

After al-Farabi, it was Ibn Sina (1073) who contributed the most important works in Arabic on the theory of music. Ibn Sina was indebted to al-Farabi in his philosophical views. In the judgement of Ibn Khalikan, no Muslim ever reached in the philosophical sciences the same rank as al-Farabi and it was by the study of his writings and by the imitation of his style that Ibn Sina attained proficiency and his own work was rendered useful. It was Ibn Sina, however, who placed the sum total of Greek wisdom codified by his own ingenuity, at the disposal of the educated Muslim world in an intelligible form. Through him the Greek System, particularly that of Philo, was rendered capable of incorporation with Islam.

About the middle of the fourth Muslim century there flourished in al-Basrah an interesting eclectic school of popular philosophy known as Ikhwan al-Safa (The Brethren of Sincerity). The Ikhwan, which had a branch in Baghdad, formed not only a philosophical but also a religio-political association with ultra-Shiite (probably Ismailite) views and were opposed to the existing political order, which they evidently aimed to overthrow by undermining the popular intellectual system and religious beliefs. A collection of their epistles that Rasail arranged in encyclopaedic fashion survives, bearing some obscure names as collaborators. The epistles number fifty-two and treat of mathematics, astronomy, geography, music, ethics, philosophy, embodying the sum total of knowledge that cultured men of that age were supposed to acquire. The first fifty-one epistles lead up to the last, which is a summation of all sciences. The language of the epistles shows that Arabic had by that time become an adequate medium for expressing scientific thought in all its aspects.

### **Al-Ghazzali**

Abu Hamid al-Gazzali, born in 1058 in Tus, Khurasan, where he died in 1111, was unquestionably the greatest theologian-philosopher of Islam and one of its noblest and most original thinkers. It was

al-Ghazzali who fixed the ultimate form of the Ash'ariyah school of theology and established its dicta as the universal creed of Islam. This father of the church in Islam has since become the final authority for Sunnite orthodoxy. He reproduced in his religious experience all the spiritual phases developed by Islam.

Starting his religious life as an orthodox, al-Ghazzali soon turned Sufi, and when still under twenty he had broken with all the past. In 1091 he was appointed lecturer at the Nizamiyah in Baghdad where he became ascetic. Four years later he turned to Sufism after a terrific spiritual struggle that left him a physical wreck. Intellectualism had failed him. After about twelve years of retirement in various places, he returned to Baghdad to preach and teach. There he composed his masterpiece *Ihya Ulum al-Din* (Revivification of the Sciences of Religion). The mysticism of his work vitalized the law and its orthodoxy leavened the doctrines of Islam. In it and in such other works of his as *Fatihah al-Ulum*, *Tahafut-al-Falasifah*, *al-Iqtisad fi-Itiqad*, orthodox speculation reached its culminating point. These works deposed Fiqh from the high rank it had usurped, employed Greek dialect to found a pragmatic system and made philosophy palatable to the orthodox theologians. Partly translated into Latin before 1150, the works of al-Ghazzali exerted marked influence on Jewish and Christian scholasticism. Thomas Aquinas, one of the greatest theologians of Christianity, and later Pascal, were deeply influenced by the ideas of al-Ghazzali.

## Medicine

Arab interest in the curative science had been stimulated by the Prophetic tradition which had made science two-fold: theology and medicine. The physician was at the same time a metaphysician, philosopher and sage, and the title *hakim* was indifferently applied to him in all these capacities.

In the curative use of drugs some remarkable advances were made at this time by the Arabs. It was they who established the first apothecary shops, founded the earliest school of pharmacy and produced the first pharmacopoeia. Several pharmacological treatises were composed, beginning with those of the world famed Jabir ibn Hayyan, the father of Arabic alchemy, who flourished about 776 A.D.

Under the orders of al-Muqtadir's vizir Ali ibn Isa, Sinan organised a staff of physicians who would go from place to place carrying drugs and administering relief to ailing people. Other physicians made daily visits to jails. Such facts show an intelligent interest in public hygiene unknown to the rest of the world at that time. In his efforts to raise the scientific standard of the medical profession and in his efficient administration of the Baghdad hospital lay Sinan's chief title to fame. This hospital, the first in Islam, was created by Harun al-Rashid in the beginning of the ninth century. Not long afterwards other hospitals to the number of thirty-four grew up throughout the Muslim world. Travelling clinics made their appearance in the eleventh century. Muslim hospitals had special wards for women and each had its own dispensary. Some were equipped with medical libraries and offered courses in medicine.

The most notable medical authors were Persian in nationality but Arab in language: Ali al-Tabari, al-Razi, Ali ibn al-Abbas Al-Majusi, and Ibn Sina. The portraits of two of these, al-Razi and Ibn Sina, adorn the great hall of the Schools of Medicine at the University of Paris.

Abu Bakr Muhammad ibn Zakariya al-Razi (Rhazes, 865-925) was probably the greatest and most original of all the Muslim physicians, and one of the most prolific writer. He is also considered the inventor of the section in surgery. The Fihrist lists a hundred and thirteen major and twenty-eight minor works of al-Razi, of which twelve deal with alchemy. After having passed through numerous editorial hands, one of his principal works on alchemy, the *Kitab al-Asrar*, was rendered into Latin by the eminent Translator Gerard of Cremona (d.1187) and became a chief source of chemical knowledge until superseded in the fourteenth century by Jabir's (Geber's) works. Under the title *De Spiritibus Corporibus* it was quoted by Roger Bacon. While still in Persia al-Razi wrote for Mansur ibn Ishaq al-Sumani of Sijistan a monumental work in ten volumes, named after his patron *Kitab al-Mansuri*, of which a Latin translation was first published in Milan in the eighties of the fifteenth century. Parts of it have been recently done into French and German. Of his monographs one of the best known is a treatise on smallpox and measles, the earliest of its kind and rightly considered an ornament to the medical literature of the Arabs. In it we find the first clinical account of smallpox. Translated into Latin in Venice (1565) and

later into several other languages, this treatise served to establish al-Razi's reputation as one of the keenest original thinkers and greatest clinicians not only of Islam but of the Middle Ages. His most important work, however, was *al-Hawi* (The Comprehensive Book), first translated into Latin under the auspices of Charles of Anjou by the Sicilian Jewish physician Faraj bin Salim in 1279. Under the title *Continent* it was repeatedly printed from 1486 onwards, a fifth edition appearing in Venice in 1542. As the name indicates, this book was meant to be encyclopaedic in its range of medical information. It summed up the knowledge the Arabs possessed at that time of Greek, Persian and Hindu medicine and added some fresh contributions. Printed when printing was still in its infancy, these medical works of al-Razi exercised for centuries a remarkably influence over the minds of the Latin West.

The most illustrious name in Arabic medical annals after al-Razi's is that of Ibn Sina (Avicenna, 980-1037) called by the Arabs "al-Shaikh al-Rais," the sheikh and prince. In this physician, philosopher, philologist and poet, Arab science culminated and, one might say, is incarnated.

Abu Ali al-Husayn, to use his first name, was the son of an Ismaili, Abdullah. Born near Bukhara, he spent all his life in the eastern part of the Muslim world and was buried in Hamadan, where his grave is still shown. As a young man he had the good fortune to cure the Samanid sultan of Bukhara, Nuh ibn Mansur (976-97) and was therefore given the privilege of using the ruler's remarkable library. Endowed with extraordinary powers of absorbing and retaining knowledge this Persian scholar devoured the contents of his royal master's library and at the early age of twenty one was in a position to embark on his career of writing. Al-Qifti lists only twenty-one major and twenty-four minor works of Ibn Sina; other titles swell the total to ninety-nine, dealing with philosophy, medicine, geometry, astronomy, theology, philology and arts. Among his scientific works the leading two are the *Kitab al-Shifa* (The Book of Healing), a philosophical encyclopaedia based upon the Aristotelian and *al-Qanun fi al-Tibb*, which represents the final codification of Greco-Arabic Medical thought. Arabic text of the Qanun was published in Rome in 1593. Translated into Latin by Gerard of Cremona in the twelfth century, this Canon, with its encyclopaedic contents,

its systematic arrangement and philosophic plan, soon worked its way into a position of pre-eminence in the Medical literature of the age, displacing the works of Galen, al-Razi and al-Majusi and becoming the text book for medical education in the schools of Europe. In the last thirty years of the fifteenth century it passed through fifteen Latin editions and one Hebrew. In recent years a partial translation into English was made. The book distinguishes mediastinitis from pleurisy and recognizes the contagious nature of phthisis and the spread of diseases by water and soil. It gives a scientific diagnosis of ankylostomiasis and attributes it to an intestinal worm. Its *materia medica* considers some seven hundred and sixty drugs. From the twelfth to the seventeenth centuries this work served as the chief guide to medical science in the west and it is still in occasional use in the Muslim East. In the words of Dr. Osler it has remained a Medical bible for a longer period than any other work.

### Al-Biruni

At Ghaznah (Afghanistan), lived Abu al-Rayhan Muhammad ibn Ahmed al-Biruni (973-1048), considered the most original profound scholar Islam has produced in the domain of natural science. Here this Arabic author of Persian origin, who spoke Turkish and knew besides Persian, Sanskrit, Hebrew and Syriac produced in 1030 an account of the science as astronomy entitled *al-Qanun al-Masudi fi al-Gayan was al-Nujum*. In the same year he composed a short catechism of geometry, arithmetic, astronomy and astrology entitled *al-Tafhim la Awail al-Tanjim*. His first work was *al-Athar al-Baqiyah an al-Qurun al-Khaliyah*, dealing chiefly with the calendars and eras of ancient peoples. In these works al-Biruni discusses intelligently the then debatable theory of the earth's rotation on its axis and makes accurate determination of latitudes and longitudes. Among his scientific contributions are an explanation of the working of natural springs by the hydrostatic principle, the suggestion that the Indus valley must have been an ancient sea basin filled up with alluvium, and the description of several monstrosities, including what we call Siamese twins.

Of the Saljug Sultans, Jalal al-Din Malikshah patronised astronomical studies. He established in 1074 at al-Rayy or at Naysapur an observatory where there was introduced into the civil calendar

an important reform based on an accurate determination of the length of the tropical year. To this task of reforming the old Persian Calendar he called to his new observatory the celebrated Umar al-Khayyam, who was born between 1038 and 1048 at Naysapur where he died in 1123. Umar is known to the world primarily as a poet and free thinker, and very few realize that he was a first class mathematician and astronomer as well. The researches of al-Khayyam and his patron Jalaluddin Malikshah resulted to a calendar which is even more accurate than the Gregorian calendar. The latter leads to an error of one day in 3330 years, whereas al-Khayyam's apparently leads to an error of one in about 5000 years.

### **Astronomy and Mathematics**

The scientific study of astronomy in Islam was begun under the influence of an Indian work, the Siddhanta brought to Baghdad (771), translated by Muhammad ibn Ibrahim al-Fazari, and used as a model by later scholars. Pahlawi tables compiled in the Sasanid period were soon added in translated form. Greek elements, last in order of time, were first in importance. An early translation of Ptolemy's Almagest was followed by two superior ones: the one by al-Hajjaj ibn Matar completed in 212 A.H. (827-28) and the other by Hunayn ibn Ishaq, revised by Tabit ibn Qurrah (911). Early in the Ninth Century the first regular observations with fairly accurate instruments were made in Jundaysapur in southwest Persia. In connection with his Bayt al-Hikmah, al-Mamun created at Baghdad an astronomical observatory under the directorship of Sin ibn Ali and Yahya ibn abi Munsur (830). Here the Caliph's astronomers not only made systematic observation of the celestial movements, but also verified with remarkably precise results all the fundamental elements of the Almagest: the obliquity of the ecliptic, the procession of the equinoxes, the length of the solar year, etc.

Al-Mamun's astronomers performed one of the most delicate geodetic operations — measuring of the length of a terrestrial degree. The object was to determine the size of the earth and its circumference on the assumption that the earth was round.

Between 877 and 918 Abu Abdullah Muhammad ibn Jabir al-Battani (Albatenius), unquestionably the greatest astronomer of his time and one of the greatest in Islam, made his observations and

studies in al-Raqqah. Al-Battani was an original research scholar. He made several emendations to Ptolemy and rectified the calculations for the orbits of the moon and certain planets. He proved the possibility of annular eclipses of the sun and determined with greater accuracy the obliquity of the ecliptic, the length of the tropical years and the seasons and the true mean orbit of the sun.

### **Astrology**

In astrology, a handmaid of astronomy, abu Mashar (886) who flourished at Baghdad was the most distinguished figure. He is the one most frequently cited as an authority in the Christian Middle Ages and under the name Albumasar figured as a prophet in the iconography. In four of his works translated into Latin in the twelfth century by John of Seville and Abelard of Bath, Abu Mashar communicated to Europe the laws of the tides, which in a treatise he explained the basis of the relation to the moon's rise and setting.

### **The Arabic Numerals**

The same Hindu scholar who brought to the court of al-Mansur the astronomical work *Sindhind* is credited with having also introduced Hindu arithmetical lore with its numerical system and the zero. Al-Fazari's translation of the Hindu works was therefore responsible for the development of the Arabic Numerals which, when introduced in Europe through Spain and Sicily, made the progress of modern mathematical science possible.

### **Al-Khwarizmi**

Muhammad ibn Musa al-Khwarizmi (780-850) was the principal figure in the early history of Arabic mathematics. One of the greatest scientific minds, he influenced mathematical thought to a greater extent than any other medieval writer. Apart from compiling the oldest astronomical tables, al-Khwarizmi composed the oldest work on arithmetic and algebra, *Hisab al-Jabr wa al-Muqabalah* (calculation of integration and equation), presented through over eight hundred examples, which was his chief work, but was lost in Arabic. Translated in the twelfth century into Latin by Gerard of Cremona this work of

al-Khwarizmi was used until the sixteenth century as the principal mathematical text book of European universities and served to introduce into Europe the science of Algebra, and with it the name. Al-Khwarizmi's works were also responsible for the introduction into the West the Arabic numerals called Algorithm after him.

### Alchemy

After materia medica, astronomy and mathematics, the Arabs made their greatest scientific contribution in Chemistry. In the study of chemistry and other physical sciences the Arabs introduced the objective experiment, a decided improvement over the hazy speculation of the Greeks. Accurate in the observation of phenomena and diligent in the accumulation of facts, the Arabs nevertheless found it difficult to project proper hypothesis. To draw truly scientific conclusion and elaborate a final system was the weakest point in their intellectual armour.

The father of Arabic alchemy was Jabir ibn-Hayyan (Geber) who flourished in al-Kufah about 776. His name, after that of al-Razi (925), is the greatest in the field of medieval chemical. Like his Egyptian and Greek forerunners, Jabir acted on the assumption that base metals such as tin; lead, iron and copper could be transmitted into gold or silver by means of a mysterious substance. He more clearly recognized and stated the importance of experimentation than any other early alchemist and made noteworthy advance in both the theory and practice of chemistry. Jabir described scientifically the two principal operations of chemistry, calcination and reduction. He improved on the methods for evaporation, sublimation, melting and crystalization. In general Jabir modified the Aristotelian theory of the constituents of metal in a way that survived with slight alterations, until the beginning of modern chemistry in the eighteenth century.

Before we conclude, we may be reminded that it was the Holy Prophet himself who sharpened the zeal of his followers to seek knowledge. He is reported to have said:

Seek knowledge even if you have to go to China.

He who leaves his home in search of knowledge walks in

the path of God until his return home.

God makes easy the path of paradise to him who journeys for the sake of knowledge.

The cultural activities of the Muslims, which were the direct result of this encouragement, begun in Madinah, Basra, Kufa, and Damascus during the Umayyad period. The cultural and intellectual activities came to fruition in the city of Baghdad under the enlightened Abbasid Caliphs. One of the first Abbasid rulers, Mansur, had established a department of translation for rendering into Arabic books of science and learning from other languages. Under Caliph al-Mamun (813-833) translation began on a grand scale. Christians were sent to the Byzantine Empire to find new books and Muslims, on their travels, searching for rare works. Books of sciences and philosophy were translated by competent scholars from Greek, Syria, Persian and Sanskrit into Arabic. Deeper studies in various fields of sciences and philosophy which logically followed were the flowers and fruits of this fresh initiative.

The gems of learning thus collected from different sources, were carefully examined and finally integrated into a wholesome tradition, which stood out for light amidst deep and deepening darkness of the time and which was a beacon unto its own and for succeeding ages. What indeed distinguished the mentality of the Muslim scholars was the application of relentless criticism to the available data. Jabir Ibn Hayyan says, "It may be taken as an absolute rigorous principle that any proposition which is not supported by proofs is nothing more than an assertion which may be true or false. It is only when a man brings proof of his assertion that we say, 'Your proposition is true.'" If borrowing from without led these Muslim scholars to the path of glory, it was their scientific spirit and the daring and courage to accept nothing which was not supported by actuality, in other words, to enthrone reason in the place of fancy, that made them truly great and made their game endure.

Apart from their contributions to philosophy, sciences and

theology which have been noted above, it must also be said to the glory of these scholars that they succeeded for the first time in history in harmonising and reconciling the greatest Semitic contribution of monotheism with Greek rationalism the highest contribution of the speculative thought. This prepared the way for equilibrium of thought which characterises the spirit of the present age.