



Islam

A Global Civilization

Prepared by

Islamic Affairs Department®

The Embassy of Saudi Arabia, Washington, D.C.

Consultants

Foundation for Traditional Studies, Washington, D.C.

and The Islamic Texts Society, Cambridge, U.K.

Design

Shemseddin Friedlander

Islam

And Knowledge

"He has taught you that which
[heretofore] you knew not."

(Quran, Surah II: 239)

The Grand Mosque of Herat in Afghanistan displays the use of richly colored tiles adorned with Quranic verses which characterize much of later Persian architecture.

The Attitude of the Quran and the Prophet toward Knowledge

Islam is a religion based upon knowledge for it is ultimately knowledge of the Oneness of God combined with faith and total commitment to Him that saves man. The text of the Quran is replete with verses inviting man to use his intellect, to ponder, to think and to know, for the goal of human life is to discover the Truth which is none other than worshipping God in His Oneness. The *Hadith* literature is also full of references to the importance of knowledge. Such sayings of the Prophet as "Seek knowledge even in China", "Seek knowledge from the cradle to the grave", and "Verily the men of knowledge are the inheritors of the prophets", have echoed throughout the history of Islam and incited Muslims to seek knowledge wherever it might be found. During most of its history, Islamic civilization has been witness to a veritable celebration of knowledge. That is why every traditional Islamic city possessed public and private libraries and some cities like Cordoba and Baghdad boasted of libraries with over 400,000 books. Such cities also had bookstores, some of which sold a large number of titles. That is also why the scholar has always been held in the highest esteem in Islamic society.

The Integration of the Pre-Islamic Sciences

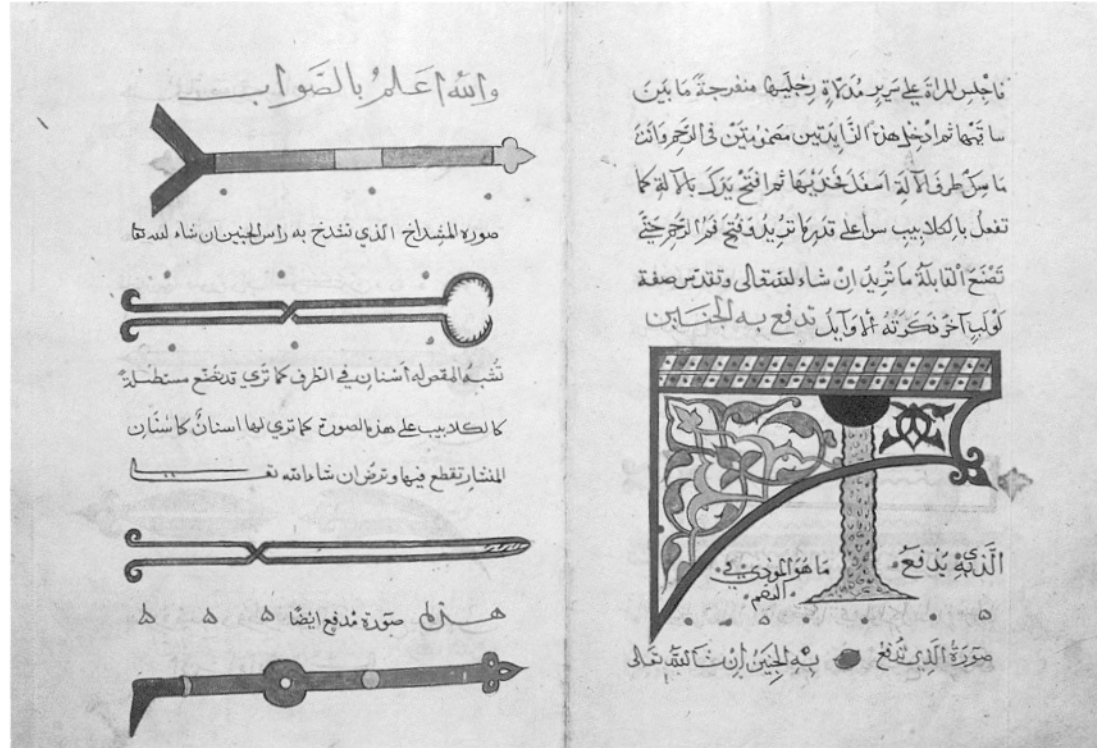
As Islam spread northward into Syria, Egypt, and the Persian empire, it came face to face with the sciences of antiquity whose heritage had been preserved in centers which now became a part of the Islamic world. Alexandria had been a major center of sciences and learning for centuries. The Greek learning cultivated in Alexandria was opposed by the Byzantines who had burned its library long before the advent of Islam. The tradition of Alexandrian learning did not die, however. It was transferred to Antioch and from there far-

ther east to such cities as Edessa by eastern Christians who stood in sharp opposition to Byzantium and wished to have their own independent centers of learning. Moreover, the Persian king, Shapur I, had established Jundishapur in Persia as a second great center of learning matching Antioch. He even invited Indian physicians and mathematicians to teach in this major seat of learning, in addition to the Christian scholars who taught in Syriac as well as the Persians whose medium of instruction was Pahlavi.

Once Muslims established the new Islamic order during the Umayyad period, they turned their attention to these centers of learning which had been preserved and sought to acquaint themselves with the knowledge taught and cultivated in them. They therefore set about with a concerted effort to translate the philosophical and scientific works which were available to them from not only Greek and Syriac (which was the language of eastern Christian scholars) but also from Pahlavi, the scholarly language of pre-Islamic Persia, and even from Sanskrit. Many of the accomplished translators were Christian Arabs such as Hunayn ibn Ishaq, who was also an outstanding physician, and others Persians such as Ibn Muqaffa', who played a major role in the creation of the new Arabic prose style conducive to the expression of philosophical and scientific writings. The great movement of translation lasted from the beginning of the 8th to the end of the 9th century, reaching its peak with the establishment of the House of Wisdom (*Bayt al-hikmah*) by the caliph al-Ma'mun at the beginning of the 9th century.

The result of this extensive effort of the Islamic community to confront the challenge of the presence of the various philosophies and sciences of antiquity and to understand and digest them in its own terms and according to its own world view was the translation of a vast corpus of writings into Arabic. Most of the important philosophical and scientific works of Aristotle and his school, much

Muslim physicians paid much attention to surgery and developed many surgical instruments as seen in this old manuscript.



of Plato and the Pythagorean school, and the major works of Greek astronomy, mathematics and medicine such as the *Almagest* of Ptolemy, the *Elements* of Euclid, and the works of Hippocrates and Galen, were all rendered into Arabic. Furthermore, important works of astronomy, mathematics and medicine were translated from Pahlavi and Sanskrit. As a result, Arabic became the most important scientific language of the world for many centuries and the depository of much of the wisdom and the sciences of antiquity.

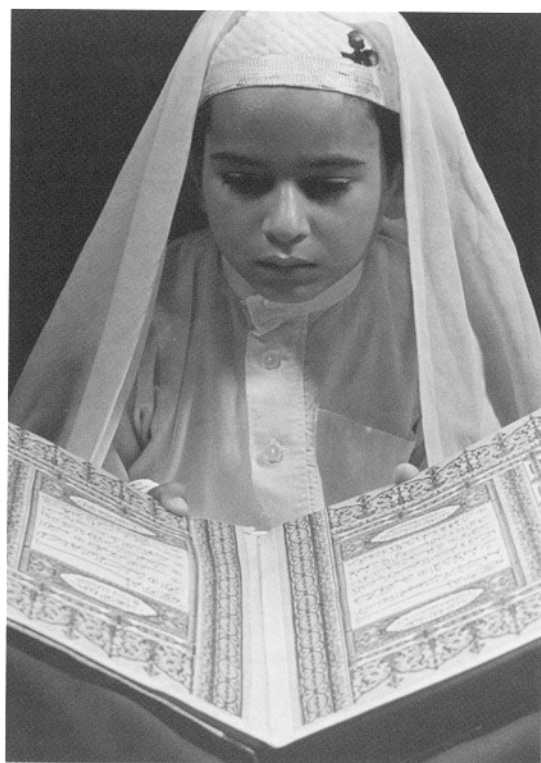
The Muslims did not translate the scientific and philosophical works of other civilizations out of fear of political or economic domination but because the structure of Islam itself is based upon the primacy of knowledge. Nor did they consider these forms of knowing as "un-Islamic" as long as they confirmed the doctrine of God's Oneness which Islam considers to have been at the heart of every authentic revelation from God. Once these sciences and philosophies confirmed the principle of Oneness, the Muslims considered them as their own. They made them part of their world view and began to cultivate the Islamic sciences based on what they had translated, analyzed, criticized, and assimilated, rejecting what was not in conformity with the Islamic perspective.

The Mathematical Sciences and Physics

The Muslim mind has always been attracted to the mathematical sciences in accordance with the

"abstract" character of the doctrine of Oneness which lies at the heart of Islam. The mathematical sciences have traditionally included astronomy, mathematics itself and much of what is called physics today. In astronomy the Muslims integrated the astronomical traditions of the Indians, Persians, the ancient Near East and especially the Greeks into a synthesis which began to chart a new chapter in the history of astronomy from the 8th century onward. The *Almagest* of Ptolemy, whose very name in English reveals the Arabic origin of its Latin translation, was thoroughly studied and its planetary theory criticized by several astronomers of both the eastern and western lands of Islam leading to the major critique of the theory by Nasir al-Din al-Tusi and his students, especially Qutb al-Din al-Shirazi, in the 13th century.

The Muslims also observed the heavens carefully and discovered many new stars. The book on stars of 'Abd al-Rahman al-Sufi was in fact translated into Spanish by Alfonso X el Sabio and had a deep influence upon stellar toponymy in European languages. Many star names in English such as Aldabaran still recall their Arabic origin. The Muslims carried out many fresh observations which were contained in astronomical tables called *zij*. One of the acutest of these observers was al-Battani whose work was followed by numerous others. The *zij* of al-Ma'mun observed in Baghdad, the Hakimite *zij* of Cairo, the *Toledan Tables* of al-Zarqali and his associates, the Il-Khanid *zij* of Nasir al-Din al-Tusi observed in Maragha, and the *zij* of Ulugh-Beg from Samarqand are among the



Muslim boys and girls are taught to read and memorize chapters of the Quran from an early age. Here a young Saudi boy is reading the sacred text.

most famous Islamic astronomical tables. They wielded a great deal of influence upon Western astronomy up to the time of Tycho Brahe. The Muslims were in fact the first to create an astronomical observatory as a scientific institution, this being the observatory of Maraghah in Persia established by al-Tusi. This was indirectly the model for the later European observatories. Many astronomical instruments were developed by Muslims to carry out observation, the most famous being the astrolabe. There existed even mechanical astrolabes perfected by Ibn Samh which must be considered as the ancestor of the mechanical clock.

Astronomical observations also had practical applications including not only finding the direction of Makkah for prayers, but also devising almanacs (the word itself being of Arabic origin). The Muslims also applied their astronomical knowledge to questions of time-keeping and the calendar. The most exact solar calendar existing to this day is the Jalali calendar devised under the direction of 'Umar Khayyam in the 12th century and still in use in Persia and Afghanistan.

As for mathematics proper, like astronomy, it received its direct impetus from the Quran not only because of the mathematical structure related to the text of the Sacred Book, but also because the laws of inheritance delineated in the Quran require rather complicated mathematical solutions. Here again Muslims began by integrating Greek and Indian mathematics. The first great Muslim mathematician, al-Khwarazmi, who lived in the 9th century, wrote a treatise on arithmetic whose Latin transla-

tion brought what is known as Arabic numerals to the West. To this day *guarismo*, derived from his name, means figure or digit in Spanish while algorithm is still used in English. Al-Khwarazmi is also the author of the first book on algebra. This science was developed by Muslims on the basis of earlier Greek and Indian works of a rudimentary nature. The very name algebra comes from the first part of the name of the book of al-Khwarazmi, entitled *Kitab al-jabr wa'l-muqabalah*. Abu Kamil al-Shuja' discussed algebraic equations with five unknowns. The science was further developed by such figures as al-Karaji until it reached its peak with Khayyam who classified by kind and class algebraic equations up to the third degree.

The Muslims also excelled in geometry as reflected in their art. The brothers Banu Musa who lived in the 9th century may be said to be the first outstanding Muslim geometers while their contemporary Thabit ibn Qurrah used the method of exhaustion, giving a glimpse of what was to become integral calculus. Many Muslim mathematicians such as Khayyam and al-Tusi also dealt with the fifth postulate of Euclid and the problems which follow if one tries to prove this postulate within the confines of Euclidian geometry.

Another branch of mathematics developed by Muslims is trigonometry which was established as a distinct branch of mathematics by al-Biruni. The Muslim mathematicians, especially al-Battani, Abu'l-Wafa', Ibn Yunus and Ibn al-Haytham, also developed spherical astronomy and applied it to the solution of astronomical problems.

The love for the study of magic squares and amicable numbers led Muslims to develop the theory of numbers. Al-Khujandi discovered a particular case of Fermat's theorem that "the sum of two cubes cannot be another cube", while al-Karaji analyzed arithmetic and geometric progressions such as:

$$1^3+2^3+3^3+\dots+n^3=(1+2+3+\dots+n)^2.$$

Al-Biruni also dealt with progressions while Ghiyath al-Din Jamshid al-Kashani brought the study of number theory among Muslims to its peak.

In the field of physics the Muslims made contributions in especially three domains. The first was the measurement of specific weights of objects and the study of the balance following upon the work of Archimedes. In this domain the writings of al-Biruni and al-Khazini stand out. Secondly they criticized the Aristotelian theory of projectile motion and tried to quantify this type of motion. The critique of Ibn Sina, Abu'l-Barakat al-Baghdadi, Ibn Bajjah and others led to the development of the idea of impetus and momentum and played an important role in the criticism of Aristotelian physics in the West up to the early

| Muslim Achievements in Science | |
|---|--|
| Muslims translated most of the scientific works of antiquity into Arabic | |
| Muslim mathematicians devised and developed algebra | |
| Al-Khwarazmi used Arabic numerals which came to the West through his work - 9th century | |
| Al-Razi described and treated smallpox - 10th c. | |
| Al-Razi used alcohol as an antiseptic - 10th c. | |
| Ibn Sina diagnosed and treated meningitis - 11th c. | |
| Ibn al-Haytham discovered the <i>camera obscura</i> - 11th c. | |
| Al-Biruni described the Ganges Valley as a sedimentary basin - 11th c. | |
| Muslims built the first observatory as a scientific institution - 13th c. | |
| Qutb al-Din al-Shirazi explained the cause of the rainbow - 13th c. | |
| Ibn al-Nafis described the minor circulation of the blood - 14th c. | |
| Al-Kashani invented a computing machine - 15th c. | |

writings of Galileo. Thirdly there is the field of optics in which the Islamic sciences produced in Ibn al-Haytham (the Latin Alhazen) who lived in the 11th century, the greatest student of optics between Ptolemy and Witelo. Ibn al-Haytham's main work on optics, the *Kitab al-manazir*, was also well known in the West as *Thesaurus opticus*. Ibn al-Haytham solved many optical problems, one of which is named after him, studied the property of lenses, discovered the *camera obscura*, explained correctly the process of vision, studied the structure of the eye, and explained for the first time why the sun and the moon appear larger on the horizon. His interest in optics was carried out two centuries later by Qutb al-Din al-Shirazi and Kamal al-Din al-Farisi. It was Qutb al-Din who gave the first correct explanation of the formation of the rainbow.

It is important to recall that in physics as in many other fields of science the Muslims observed, measured and carried out experiments. They must be credited with having developed what came to be known later as the experimental method.

The Medical Sciences

The *hadiths* of the Prophet contain many instructions concerning health including dietary habits; these sayings became the foundation of what came to be known later as "Prophetic medicine" (*al-tibb al-nabawi*). Because of the great attention paid in Islam to the need to take care of the body and to hygiene, early in Islamic history Muslims began to cultivate the field of medicine turning once again to all the knowledge that was available to them from Greek, Persian and Indian sources. At first the great physicians among Muslims were mostly Christian but by the 9th century Islamic medicine, properly speaking, was born with the appearance of the major compendium, *The Paradise of Wisdom (Firdaws al-hikmah)* by 'Ali ibn Rabban al-Tabari, who synthesized the Hippocratic and Galenic traditions of medicine with those of India and Persia. His student, Muhammad ibn Zakariyya al-Razi (the Latin Rhazes), was one of the greatest of physicians who emphasized clinical medicine and observation. He was a master of prognosis and psychosomatic medicine and also of anatomy. He was the first to identify and treat smallpox, to use alcohol as an antiseptic and make medical use of mercury as a purgative. His *Kitab al-hawi (Continens)* is the longest work ever written in Islamic medicine and he was recognized as a medical authority in the West up to the 18th century.

The greatest of all Muslim physicians, however, was Ibn Sina who was called "the prince of

physicians" in the West. He synthesized Islamic medicine in his major masterpiece, *al-Qanun fi'l-tibb (The Canon of Medicine)*, which is the most famous of all medical books in history. It was the final authority in medical matters in Europe for nearly six centuries and is still taught wherever Islamic medicine has survived to this day in such lands as Pakistan and India. Ibn Sina discovered many drugs and identified and treated several ailments such as meningitis but his greatest contribution was in the philosophy of medicine. He created a system of medicine within which medical practice could be carried out and in which physical and psychological factors, drugs and diet are combined.

After Ibn Sina, Islamic medicine divided into several branches. In the Arab world Egypt remained a major center for the study of medicine, especially ophthalmology which reached its peak at the court of al-Hakim. Cairo possessed excellent hospitals which also drew physicians from other lands including Ibn Butlan, author of the famous *Calendar of Health*, and Ibn Nafis who discovered the lesser or pulmonary circulation of the blood long before Michael Servetus, who is usually credited with the discovery.

As for the western lands of Islam including Spain, this area was likewise witness to the appearance of outstanding physicians such as Sa'd al-Katib of Cordoba who composed a treatise on gynecology, and the greatest Muslim figure in surgery, the 12th century Abu'l-Qasim al-Zahrawi (the Latin Albucasis) whose medical masterpiece *Kitab al-tasrif* was well known in the West as *Concessio*. One must also mention the Ibn Zuhr family which produced several outstanding physicians and Abu Marwan 'Abd al-Malik who was the Maghrib's most outstanding clinical physician. The well known Spanish philosophers, Ibn Tufayl and Ibn Rushd, were also outstanding physicians.

Islamic medicine continued in Persia and the other eastern lands of the Islamic world under the influence of Ibn Sina with the appearance of major Persian medical compendia such as the *Treasury* of Sharaf al-Din al-Jurjani and the commentaries upon the *Canon* by Fakhr al-Din al-Razi and Qutb al-Din al-Shirazi. Even after the Mongol invasion, medical studies continued as can be seen in the work of Rashid al-Din Fadlallah, and for the first time there appeared translations of Chinese medicine and interest in acupuncture among Muslims. The Islamic medical tradition was revived in the Safavid period when several diseases such as whooping cough were diagnosed and treated for the first time and much attention was paid to pharmacology. Many Persian doctors such as 'Ayn al-Mulk of Shiraz also travelled to India at this time



This dam in Tunisia is centuries old and still functioning. Like several other dams built throughout the Islamic world, it displays remarkable technological knowledge including the use of the correct curvature needed to offer the maximum resistance to the pressure of the water.

to usher in the golden age of Islamic medicine in the subcontinent and to plant the seed of the Islamic medical tradition which continues to flourish to this day in the soil of that land.

The Ottoman world was also an arena of great medical activity derived from the heritage of Ibn Sina. The Ottoman Turks were especially known for the creation of major hospitals and medical centers. These included not only units for the care of the physically ill, but also wards for patients with psychological ailments. The Ottomans were also the first to receive the influence of modern European medicine in both medicine and pharmacology.

In mentioning Islamic hospitals it is necessary to mention that all major Islamic cities had hospitals; some like those of Baghdad were teaching hospitals while some like the Nasiri hospital of Cairo had thousands of beds for patients with almost any type of illness. Hygiene in these hospitals was greatly emphasized and al-Razi had even written a treatise on hygiene in hospitals. Some hospitals also specialized in particular diseases including psychological ones. Cairo even had a hospital which specialized in patients having insomnia.

Islamic medical authorities were also always concerned with the significance of pharmacology and many important works such as the *Canon* have whole books devoted to the subject. The Muslims became heir not only to the pharmacological knowledge of the Greeks as contained in the works of Dioscorides, but also the vast herbal pharmacopias of the Persians and Indians. They also studied the

medical effects of many drugs, especially herbs, themselves. The greatest contributions in this field came from Maghribi scientists such as Ibn Juljul, Ibn al-Salt and the most original of Muslim pharmacologists, the 12th century scientist, al-Ghafiqi, whose *Book of Simple Drugs* provides the best descriptions of the medical properties of plants known to Muslims. Islamic medicine combined the use of drugs for medical purposes with dietary considerations and a whole lifestyle derived from the teachings of Islam to create a synthesis which has not died out to this day despite the introduction of modern medicine into most of the Islamic world.

Natural History and Geography

The vast expanse of the Islamic world enabled the Muslims to develop natural history based not only on the Mediterranean world, as was the case of the Greek natural historians, but also on most of the Eurasian and even African land masses. Knowledge of minerals, plants and animals was assembled from areas as far away as the Malay world and synthesized for the first time by Ibn Sina in his *Kitab al-Shifa' (The Book of Healing)*. Such major natural historians as al-Mas'udi intertwined natural and human history. Al-Biruni likewise in his study of India turned to the natural history and even geology of the region, describing correctly the sedimentary nature of the Ganges basin. He also wrote the most outstanding Muslim work on mineralogy.

As for botany, the most important treatises

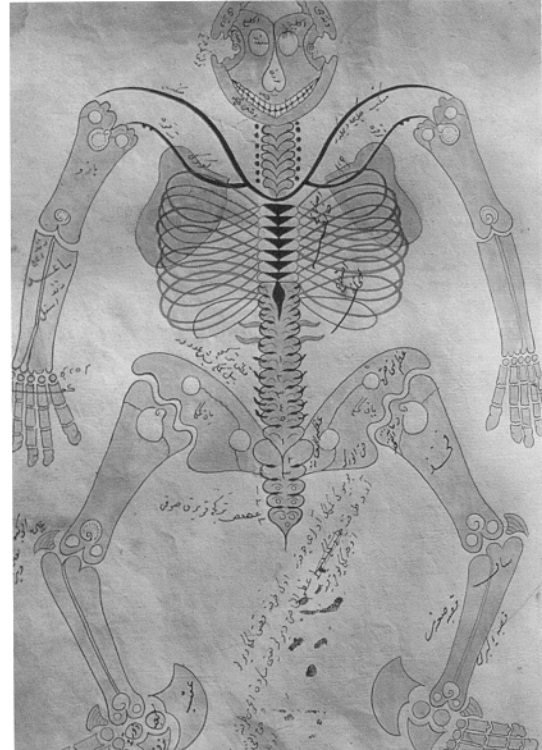
This 15th century anatomical chart from Istanbul is one of many found as illustrations in Muslim medical treatises.

were composed in the 12th century in Spain with the appearance of the work of al-Ghafiqi. This is also the period when the best known Arabic work on agriculture, the *Kitab al-falahah*, was written. The Muslims also showed much interest in zoology especially in horses as witnessed by the classical text of al-Jawaliqi, and in falcons and other hunting birds. The works of al-Jahiz and al-Damiri are especially famous in the field of zoology and deal with the literary, moral and even theological dimensions of the study of animals as well as the purely zoological aspects of the subject. This is also true of a whole class of writings on the "wonders of creation" of which the book of Abu Yahya al-Qazwini, the *'Aja'ib al-makhlukat* (*The Wonders of Creation*) is perhaps the most famous.

Likewise in geography, Muslims were able to extend their horizons far beyond the world of Ptolemy. As a result of travel over land and by sea and the facile exchange of ideas made possible by the unified structure of the Islamic world and the *hajj* which enables pilgrims from all over the Islamic world to gather and exchange ideas in addition to visiting the House of God, a vast amount of knowledge of areas from the Pacific to the Atlantic was assembled. The Muslim geographers starting with al-Khwarazmi, who laid the foundation of this science among Muslims in the 9th century, began to study the geography of practically the whole globe minus the Americas, dividing the earth into the traditional seven climes each of which they studied carefully from both a geographical and climactic point of view. They also began to draw maps some of which reveal with remarkable accuracy many features such as the origin of the Nile, not discovered in the West until much later. The foremost among Muslim geographers was Abu 'Abdallah al-Idrisi, who worked at the court of Roger II in Sicily and who dedicated his famous book, *Kitab al-rujari* (*The Book of Roger*) to him. His maps are among the great achievements of Islamic science. It was in fact with the help of Muslim geographers and navigators that Magellan crossed the Cape of Good Hope into the Indian Ocean. Even Columbus made use of their knowledge in his discovery of America.

Chemistry

The very name alchemy as well as its derivative chemistry come from the Arabic *al-kimiya'*. 'The Muslims mastered Alexandrian and even certain elements of Chinese alchemy and very early in their history, produced their greatest alchemist, Jabir ibn Hayyan (the Latin Geber) who lived in



the 8th century. Putting the cosmological and symbolic aspects of alchemy aside, one can assert that this art led to much experimentation with various materials and in the hands of Muhammad ibn Zakariyya' al-Razi was converted into the science of chemistry. To this day certain chemical instruments such as the alembic (*al-'anbiq*) still bear their original Arabic names and the mercury-sulphur theory of Islamic alchemy remains as the foundation of the acid-base theory of chemistry. Al-Razi's division of materials into animal, vegetable and mineral is still prevalent and a vast body of knowledge of materials accumulated by Islamic alchemists and chemists has survived over the centuries in both East and West. For example the use of dyes in objects of Islamic art ranging from carpets to miniatures or the making of glass have much to do with this branch of learning which the West learned completely from Islamic sources since alchemy was not studied and practiced in the West before the translation of Arabic texts into Latin in the 11th century.

Technology

Islam inherited the millennial experience in various forms of technology from the peoples who entered the fold of Islam and the nations which became part of *Dar al-islam*. A wide range of technological knowledge, from the building of water wheels by the Romans to the underground water system by the Persians, became part and parcel of the technology of the newly founded order. Muslims also imported



certain kinds of technology from the Far East such as paper which they brought from China and whose technology they later transmitted to the West. They also developed many forms of technology on the basis of earlier existing knowledge such as the metallurgical art of making the famous Damascene swords, an art which goes back to the making of steel several thousand years before on the Iranian Plateau. Likewise Muslims developed new architectural techniques of vaulting, methods of ventilation, preparations of dyes, techniques of weaving, technologies related to irrigation and numerous other forms of technology, some of which survive to this day.

In general Islamic civilization emphasized the harmony between man and nature as seen in the traditional design of Islamic cities. Maximum use was made of natural elements and forces, and men built in harmony with, not in opposition to nature. Some of the Muslim technological feats such as dams which have survived for over a millenium, domes which can withstand earthquakes, and steel which reveals incredible metallurgical know-how, attest to the exceptional attainment of Muslims in many fields of technology. In fact it was a vastly superior technology that first impressed the Crusaders in their unsuccessful attempt to capture the Holy Land and much of this technology was brought back by the Crusaders to the rest of Europe.

Architecture

One of the major achievements of Islamic civiliza-

tion is architecture which combines technology and art. The great masterpieces of Islamic architecture from the Cordoba Mosque and the Dome of the Rock in Jerusalem to the Taj Mahal in India display this perfect wedding between the artistic principles of Islam and remarkable technological know-how. Much of the outstanding medieval architecture of the West is in fact indebted to the techniques of Islamic architecture. When one views the Notre Dame in Paris or some other Gothic cathedral, one is reminded of the building techniques which travelled from Muslim Cordoba northward. Gothic arches as well as interior courtyards of so many medieval and Renaissance European structures remind the viewer of the Islamic architectural examples from which they originally drew. In fact the great medieval European architectural tradition is one of the elements of Western civilization most directly linked with the Islamic world, while the presence of Islamic architecture can also be directly experienced in the Moorish style found not only in Spain and Latin America, but in the southwestern United States as well.

The Influence of Islamic Science and Learning Upon the West

The oldest university in the world which is still functioning is the eleven hundred-year-old Islamic university of Fez, Morocco, known as the Qarawiyyin. This old tradition of Islamic learning influenced the West greatly through Spain. In this land where Muslims, Christians and Jews lived for the most part peacefully for many centuries, translations began to be made in the 11th century mostly in Toledo of Islamic works into Latin often through the intermediary of Jewish scholars most of whom knew Arabic and often wrote in Arabic. As a result of these translations, Islamic thought and through it much of Greek thought became known to the West and Western schools of learning began to flourish. Even the Islamic educational system was emulated in Europe and to this day the term chair in a university reflects the Arabic *kursi* (literally seat) upon which a teacher would sit to teach his students in the *madrasah* (school of higher learning). As European civilization grew and reached the high Middle Ages, there was hardly a field of learning or form of art, whether it was literature or architecture, where there was not some influence of Islam present. Islamic learning became in this way part and parcel of Western civilization even if with the advent of the Renaissance, the West not only turned against its own medieval past but also sought to forget the long relation it had had with the Islamic world, one which was based on intellectual respect despite religious opposition.

Treatises on natural history and especially botany by Muslim scientists were often illustrated with detailed drawings of plants to facilitate teaching of the subject.