بسم الله الرحمن الرحيم

In the name of Allah,
the Beneficent, the Merciful

THE ROLE OF ISLAMIC SCIENTISTS IN THE ADVANCEMENT OF SCIENCE

BY

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THE ROLE OF ISLAMIC SCIENTISTS IN THE ADVANCEMENT OF SCIENCE.

BY
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The movement initiated by the Prophet of Islam which changed the history of the nations, despite the assumptions of a number of people, wasn't confined within the framework of a moral movement; it caused a fundamental scientific metamorphosis in human society as well. Even moral and social matters are based on logical, scientific reasoning.

Islam breathed new life into the dying body of society and steered it in the direction of economic, scientific, and political progress. As a result, many surprising initiatives and discoveries came into existence and, in numerous ways, the positive aspects of today's civilizations are indebted to this Islamic movement.

As we know, before Muhammad's (S.A.W.) appointment to the prophethood ignorance prevailed to such an extent that, as noted by historians, if among the Arabs a man knew how to read and write a little, he would have been called " perfect ". Today, we can still find people with this nickname.

The Christian world was not much better off. They were so imprisoned by their ignorance that when a man was once appointed Pope who accidentally had some knowledge and started to spread that knowledge, he was viewed with suspicion, because it was against their nature to be knowledgeable, and the Pope was accused of being possessed by the Devil. They declared that Satan had entered his body and had led him astray from the path of God and Jesus.

Yes, under such circumstances the holy call of

...Allah will exalt those of you who believe, and those who are given knowledge, in high degrees;...

(Holy Qur'an 58:11)

echoed throughout the darkness of that age and it did not take long for a revolution to take place and such renowned scientists as Avecenna, Farabi, Zakaria Razi, Ibn Rushd and hundreds like them shined among the Muslims.

In Islamic countries, schools and libraries were established where many people studied to become scientists while, at the same time, Europe was ruled by ignorance.

Dr. Gustave Le Bon, a Christian scientist, has stated, " When Islamic civilization was at its highest peak in Andalusia (Spain), our scientific centres were castles, our masters and rulers were living in a semi-barbaric state and they felt pride in not having any system of writing being illiterate. Among we Christians, the most knowledgeable one was the ignorant priest, who was extending his utmost effort just to take out the old Greek and Roman religious books, clean them and write some ambiguous comments on their pages."

In order to clarify the moral level of the Christians' civilization and also to prove what has been said, I refer to an interesting event from the Middle Ages.[1]

In Italy, a man called Istan Mura voiced his doubt that Jesus was alive. The Commitee for Investigation of

1. **The History book of Albert Malleh, the French historian.**

Ideas detained him and reported his infidelity to the Pope. The Pope, after due consideration declared the man to be "legally dead".

Mr. Mura was then called before the Committee for the Investigation of Ideas and his forehead was branded by a red-hot iron so that everyone would see his "dead" status. Afterwards, the miserable man was not allowed to speak to anyone. His wealth was confiscated, his wife was married to another man and his children were also taken away from him. The night that his wife was married again, after much difficulty he met them and said: "You are my wife; how can you marry someone else?" The woman did not reply, and the crowd of people nearby laughed. The condemned man ran through the streets, crying: "Just because I expressed my opinion on a matter, the followers of Jesus have taken away my wealth and have taken my wife away!"

Before we discuss further the ways that Muslims have contributed to the spread of the sciences, it is necessary to outline the factors which caused this scientific revolution.

1. CAMPAIGN AGAINST ILLITERACY

The first and foremost factor in the spread of Islam was writing and reading, because verses of the Qur'an were not written down at first, and those with the ability to recite the verses taught the Qur'an to others.

The Prophet of Islam (S.A.W.) encouraged people to seek education. After the Battle of Badr, each prisoner of war was told to teach the art of reading and writing to ten children from Medina, in order to gain freedom. This is a clear example of the line of thought of the founder of Islam.

The Prophet of Islam (S.A.W.) even compelled some of his followers to learn foreign languages. One example

is Zayd-ibn-Thabit, who was sent on a mission to learn Hebrew, as he himself stated:

" I was taken to the Prophet of Islam (S.A.W.), and when he was informed that I knew seventeen verses of the Qur'an by heart, the Prophet was surprised. I recited them all, and when the Prophet saw that I possessed this talent, he commanded me to learn Hebrew, the language of the Jews, and added that ' I fear that the Jews may change the Book (the Qur'an). I applied myself and learned Hebrew in a short time. I was put in charge of writing the Prophet's letters to the Jews and translating the letters they sent to us."

Other Muslims also were ordered by the Prophet (S.A.W.) to learn the Syriac language. When the Arab Muslims expanded their conquests to neighbouring countries, they had to learn the art of their writing and reading in order to better govern those countries. This was also another reason for the increase in the number of literate people. In addition, foreigners who accepted Islam had to learn and to understand their religious duties. This was another factor which brought the civilization of other countries to Islamic centres.

2.DEVELOPMENT OF IDEAS

Another important factor for this movement was the teachings of Islam. The Qur'an, by narrating the history of other nations and the histories of Adam, Abraham, Jonah, Moses, Joseph and other prophets , could move the icy and stony brains of the people.

The Holy Qur'an, by elaborating on the principles of belief and explaining the power of Almighty Allah and His unity, also attracted the attention of thinkers and prompted them to contemplate about the world in accordance with such verses as:

Do they not consider the kingdom of the heavens and the earth and whatever things Allah has created,... (Holy Qur'an 7:185) , So let man consider of what he is created ; ...(Holy Qur'an 86:5) , and, Most surely in the creation of the heavens and the earth and the alternation of the night and the day there are signs for men who understand. Those who remember Allah standing and sitting and lying on their sides and reflect on the creation of the heavens and the earth ; Our Lord! Thou hast not created this in vain! Glory be to Thee; save us then from the chastisement of the fire:

(Holy Qur'an 3: 189,190)

which could stimulate the people's minds and direct them towards the secrets of nature, the wisdom of the creation of the world and other matters concerning nature.

3. EMPHASIS ON SCIENTIFIC MATTERS

The most important matter is that, in the early days of Islam, all or most scientific matters were interrelated. For instance, those who were authorities in theology also knew philosophy, narration and interpretation , while those who were authorities in narration and interpretation were knowledgeable about literature, poems and phrases explaining the meaning of the Qur'an. Not many people could be found in those times, who specialised in only one subject, because speciality came from an orderly discussion in a technical or scientific manner, which did not exist at that time.

The most popular discussions were about religious matters such as Qur'anic interpretation, narration and jurisprudence. Discussions were also often held about history, philosophy, logic, chemistry and medicine.

Establishing Islamic Primary Schools— Schooling in Mecca

After the dawning of Islam , Mecca and Medina became two important scientific centres. The city of Mecca was the birth-place of Islam and Islamic legislation .

After the migration of the holy Prophet (S.A.W.), the increased power of Islam and the conquest of Mecca,

the holy Prophet (S.A.W.) appointed Mu'az to teach Islamic jurisprudence and the Qur'an. Mu'az was one of the best youths of Ansar[1] for he possessed knowledge and excellent morals and participated in most of the Muslims' battles. He was well-acquainted with Islamic precepts and had collected all of the verses of the Qur'an which had been revealed to the Prophet (S.A.W.). Mu'az was the best person to be appointed to teach and educate the inhabitants of Mecca . Unfortunately, it did not take long for the disease of the plague to claim his life, and he passed into the next world. Thus ,this great man of wisdom and knowledge bid farewell to earthly life.

Abdullah Ibn Abbas was appointed to succeed Mu'az, and he began teaching and educating people right away. The fame of this city concerning learning and science is because of his efforts.

Schooling in Medina

Medina was the centre of Islamic propagation and was the second city of the leader of Muslims. It was the home of many of the Prophet's followers and, most importantly, many historical and political events took place in this city.

The majority of the laws of Islam were explained in Medina and then spread to other regions, therefore, those interested in learning and understanding Islamic instructions had to travel to Medina in order to realize their aims.

After the passing away of the Prophet (S.A.W.), Medina became the centre of the caliphate and Muslim leaders resided there. In each war after, the victory of the Islamic troops, some of the prisoners of war,by the Caliph's order, were transferred to the capital city of

1. Ansar were a group of Companions of the Prophet of Islam who welcomed him at Medina.

Medina, and since among these prisoners of war, in particular those from Rome and Iran, many were knowledgeable and educated, as a result, Medina became familiar with the customs, traditions, sciences and other aspects of other nations' civilizations. It did not take long for Medina to become an important centre of science and knowledge and those who were educated there became specialists in subjects, such as jurisprudence, narration, and history.

For many years , from all corners of the world, students travelled to this city for education, as stated by Ibn-al-Athir:

" Abdul Aziz Ibn Marwan sent his child to be educated in the educational centres of Medina. After learning religious studies and expanding his research, he travelled to other places and continued his advancement of knowledge with amazing speed."

The way the Muslims were conquering lands was really surprising and perhaps unprecedented in other nations' histories. Their acquisition of knowledge was also surprising, as will be discussed in a later chapter.

Compilations, Collections and Codifications

Some historians believe that compilation in Islam began in the second half of the first Islamic century, but it can be said that the writing and collecting of articles started from the beginning of the first century and at the time of the Prophet, because the Prophet appointed some people to write down the Qur'anic revelations. They wrote it on paper, bones and flat stones. Several Muslims also collected the Prophet's (S.A.W.) narrations, including Abdullah Ibn Abbas, who wrote the narrations he himself heard, and Muslims' historical accounts of war and the

Prophet's participation in the Muslims' wars.An example of these Muslims is: Wahab-ibn-Monabbeh, who throughout the years 110-134 A.H. (after Hijra), wrote about the history of Islamic battles.

Urwat-ibn-Zubayr, who was one of the most famous jurisprudents of Medina in 23 to 94 A.H. wrote the biography of Prophet Muhammad (S.A.W.) and also about his battles.

Abdurrahman Ibn Mughirah , who was the student of Urwat, wrote and compiled the Prophet's (S.A.W.) way of life.

Ibn-Shahab-al-Zohari, who lived from 51 to 124 A.H., also wrote a book about the Prophet's battles.

WHERE DID THE ISLAMIC SCIENTIFIC MOVEMENT BEGIN?

In the preceding chapter we noted that in every city the Muslims entered, their first objective was to establish mosques and schools. Therefore, in all the Islamic cities, schools were established, but in Islamic history, some schools were mentioned more frequently and were centres of research in various scientific subjects. The first and most important of these schools is Baghdad Academy, which is also known as *Baitul-Hikmah* (House of Wisdom).

This scientific centre was established by Harun-al-Rashid, the Abbasid Caliph, and completed by his successor, Ma'amun, collected literature and was a centre of attraction to interpreters and researchers from many countries. The various scientific theories and practices developed in Baghdad Academy found an atmosphere conducive to scientific research.

Ma'amun greatly developed and assisted in the expansion of the House of Wisdom and spent three hundred thousand gold coins in translating Greek books. One of the conditions of the peace convention between Ma'amun and the Emperor of Rome was that the Roman

Emperor ceded the Constantinople libraries to Ma'amun. Ptolemy's book on astronomy was among these books which Ma'amun ordered for translation.

The translators of the Baghdad Academy were a group of knowledgeable and educated men from Iran, Syria, and India and most of them were Syriac, who were very learned in Greek science and philosophy. Some of the famous men were from a family called Bukhtishoou, the son of the Syriac Bukhtishoou, who was Mansoor's physician, and some were Nestorian.

There were also translators from the family of Hanin Ibn Ishagh, Karkhi, Sabet Harani Sa'ebi. The most famous translators in Persian and Hindi languages included: Ibn al-Muqaffa, the astrologist family of Nobakht and Ali-Ibn Ziad Tamimi, (who translated the books of Zeyjol -Shahriar), Hassan Ibn Sahl and Belazari Ahmad Ibn Yahya (the chief director of Baramakah Hospital).

In other parts of the Islamic world, scientific centres similar to the House of Wisdom were established, particularly after the downfall of the Caliphate and the resultant independence of small and large countries. This political separation was an important factor for scientific and non-scientific competition among different courts in various countries and each and every one of them tried to establish centres like the one in Baghdad. As a result of this competition, many centres were established in cities such as Samarghand, Marv, Harat, Tous, Nayshabur, Rey, Isfahan, Shiraz, Damascus, Quds (Jerusalem), Cairo,Ghirvan, Fez, Eshpilieh, Gharnateh, and elsewhere.

Hajj As a Scientific Congress For Islamic Schools

The religious duty of Hajj was an opportunity for great Muslim scientists from different schools to gather in Mecca and meet each other. In this way, they became enthusiastic about visiting each other's schools

and educational centres in order to discuss and exchange their ideas and inform each other of their discoveries. Very often, after performing their pilgrimage, Muslim scientists stayed in cities like Andalusia or Maghrib[1] in Egypt, held discussions with their colleagues and took notes from the scriptures and books available. Through this common scientific language, knowledge spread in all four corners of the Islamic world with tremendous speed. Due to these relations between educational centres, they progressed towards a brighter civilization.

Miracles of Muslims !

As a result of this cultural and educational relation a new scientific civilization was created for the whole world and it all came into existence in less than two centuries and spread all over the world.

Researchers and historians viewed this phenomenon with surprise and they called it the " Muslim Miracle." In other words, they confessed to the creative power of this movement and admitted it was greater than the movements which had taken place before the thirteenth Christian century. In a short time, the Muslims achieved amazing success in different subjects which we shall briefly mention:

Islamic scientists studied algebra and trigonometry on the basis that the Indians and the Greeks established and they revealed them and expanded them. In addition, they also conducted some studies in astronomy.

They have criticized Ptolemy's delegation, which paved the way for scientific movements in the sixteenth century. Muslims contributed new medical observances, founded new methods of chemistry, introduced new information regarding measurements, weights and atmospherical effects in physics.

Their research in geography included the whole world at that time, and they wrote many useful books about

1. Morocco, Algeria and Tunisia

civilized countries and also introduced a new way to analyze the philosophy of history.

NIZAMIYYAH UNIVERSITY OF BAGHDAD

The spirit of Islam spread from Mecca and changed darkness into light; ignorance into knowledge, and civilizations like that of the Romans, Greeks, Indians and Persians which were becoming extinct were revived and valuable books which had been gathering dust were put into use again. In this universal scientific movement, universities were once again established in Islamic lands and scientific works were also revived.

Palaces and Mosques Become Schools

Although in the early days of Islam there were no special places for propagating science and culture and since there were no schools or universities as was explained in the previous chapter, study groups were formed in mosques and gradually even in the Caliph's palace, the minister's house.Work areas and farms were converted into scientific, cultural or literary centres. Many people became scientists and writers and young and old, masters and slaves, were all busy learning. Some slave-owners even taught their slaves poems, narrations, history and literature and after learning these subjects, they were wonderful gifts.

Zubaidah, the wife of Harun Al-Rashid, had hundreds of female slaves and all of them knew the Qur'an by heart. In the early mornings they recited the Qur'an and filled the air with its pleasant sound.[1]

Is Nizamiyyah The First School In Islam?

In the next stage of history, Islamic schools, universities and research centres were established.

1. History of Islamic Civilization, Vol. 3 Georgi Zeydn.

Some writers, such as Ibn Khalkan, believed that Nizamiyyah University in Baghdad was the first college for Muslims, which was established by Nizam al-Mulk, Shah Malik's Prime Minister. These writers added that the " House of Wisdom" in Baghdad, which had been opened during the lifetime of Harun Al-Rashid, was merely an important library.

Nevertheless , many experts and historians believed that prior to Nizamiyyah, there were many colleges and universities in Islamic lands. A quotation from a British Encyclopedia states:

" When Ma'mun was a crown prince, he established a university in Khorasan and for lecturing he invited experienced and educated professors from different countries."

Chambers Encyclopedia writes that in Ma'mun's time, important universities were established in Baghdad, Basrah and Kufa.

In the year 400 A.H., Hakem, the Fatimi Caliph, established a large college in Egypt, dedicating many books and he also appointed a group of jurisprudents and professors for lecturing.

King Mahmud of Ghaznavi dedicated a substantial portion of his wealth to the establishment of a magnificient university and built a great library filled with valuable books. He paid for its daily expenses and endowed many acres of land and villages.

In history it can also be found that while Baghdad was waiting for the great honour of the inauguration of its university by Nizam al-Mulk in the city of Nayshabur, great colleges and universities were established, including Saiedieh College and Bay-haghieh, which Imam Ghazali graduated from.

From what has been said so far, it can be concluded that before Nizamiyyah, there were several colleges and universities in existence, yet the fame of Nizamiyyah was so great that it overshadowed all the other scientific and educational centres.

How Nizamiyyah Was Established

Nizam al-Mulk at-Tusi, the Minister of Alb Arsalan and Shah Malik, was determined to spread knowledge among the people. He did a lot towards fulfilling his aim and built several schools in villages in which he spent sixty thousand gold dinars and also endowed a tenth of his wealth for establishing libraries and colleges and most important of all, was the establishment of Nizamiyyah in Baghdad.

The foundation of Nizamiyyah was laid in 487 A.H., at a cost of two hundred thousand golden dinars, and it was completed in the year 489 A.H. It was inaugurated with a magnificient ceremony and if what has been written in history is true, all the people in Baghdad and the royal family hastened to attend the ceremony, which illustrated the Muslims' enthusiasm towards the development of knowledge.

Abu Ishaq, head lecturer, was nominated for rectorship in the university. He finally accepted after twenty days of insistence. As long as the Baghdad caliphate was in power, the Nizamiyyah was glorious and many famous scholars graduated from this university. Sa'adi, the famous poet, was one of them.

For the scholars and scientists of that time, there was no greater honour than being a lecturer at Nizamiyyah. For 200 years, no one was appointed to that position, unless he was the most knowledgeable in related subjects.

Abu Zakaria Tabrizi, a well-known writer of that era, was the director of the central library of Nizamiyyah.

In 589 A.H., Nasiruddin issued an order to establish another great library to which he dedicated many rare and valuable books, which were transferred from the caliph's library. Students were alloted a certain amount of money as a monthly allowance, which was one of the advantages of this university. Another advantage was that both poor and rich people could send their children to study at this university and six thousand students graduated from it with high qualifications.

THE SAFA BROTHERHOOD

The history of mankind has been witness to countless wars and revolutions, many of which reveal the exploitative nature of man.

The underlying aim of any revolution or movement can be understood by the behaviour of its leaders and the results of their achievements. With the passage of time, the true face of these leaders and their goals can be determined.

Expanding the almost daily establishment of schools, universities and libraries and collecting and compiling many books on Islam is clear proof of the good intentions of this Islamic scientific movement. The leaders of the Islamic lands following this aim did their best to present these God-given gifts to scholars and scientists, and the attention paid to students was in accordance with this policy. For instance, Sharafuddin Ayubi, the ruler of Damascus, once declared that anyone who memorised the book of *Almofassal* written by Zomokh-Shari would

win a prize worth a hundred dinars , and as a result, many learned that book by heart.

Public opinion was so concerned about the development of science and knowledge that rulers occasionally were obliged to do something, to show that they , too, cared.

Mourning Meeting in Baghdad

In order to have a clearer picture of the public's views at that time , this surprising event of history is sufficient:

When Iraqi scholars were informed of the students financial facilities at Nizamiyyah, they gathered together and held a mourning meeting, lamenting the fact that from that time onwards, seeking knowledge was not purely a matter of knowledge itself, because materialistic matters were also concerned.

The formation of the Safa brotherhood is one example of the deep effect of the scientific movement on the people. Those involved in forming this educational centre abandoned government support and to show their sincerity towards science they refused to print their names on their publications and hence rejected fame.

In the fourth century after hijra, a secret society was formed in Baghdad and Basra ; the members of this society were among the great Islamic scientists and scholars. They called themselves the " Safah Brotherhood", which means the brothers and followers of clarity. They had much influence in scientific and cultural centres. The scholars and scientists who belonged to the Brotherhood were learned in most of the subjects known at that time.

In their meetings, they held detailed discussions about various matters, such as the social and religious histories of nations. An agreement was reached to publish their conclusions in a series of articles.

Although the brothers and followers of clarity did not sign their names to these papers and books, they occupied an elevated position in the history of science and they performed a valuable and admirable service to the advancement of science, introducing new initiatives and ideas concerning different scientific subjects. Even after the passing of thousands of years, scientists still recognize their contributions. The level of human thinking after the tenth century was at its zenith.

Ikhwanul Safa were very popular among people and they usually nominated representative from different classes of society to guide them and tell them what they had learnt from Ikhwanul Safah.

The Goals And Constitution Of The Brotherhood of Clarity

By reading the articles written by the Brotherhood's members it can be concluded that they were not motivated by political aims, but were concerned with scientific and moral matters. A member once wrote:

" We do not have any intention of competing with the kings and our activities are not directed towards securing positions or gaining wealth, but we surely seek the positions of angels in the heavens." It was also stated:

" We harbour no hostility or enmity towards any of the subjects of religious science and every book by any scientist deserves to be valued and respected, but our reliance rests mainly on the books of prophets and matters which are revealed."

In their constitution, it was written that the religion of Islam had become mixed with the superstitions and ideas of the people and in order to purify this great religion from these corruptions, the only way to do so was by propagating Islamic culture, science and, in particular, philosophy. People would then become enlightened and Islam would be of use to them when they realised the truth of this divine religion purified from any superstition.

They must apply scientific methods and discoveries which have been discussed in Islam in order to assist and influence the advancement of Islam until it is accepted by the scientists of other nations.

Other opinions of this group which have been explained in a number of their articles include the acknowledgement that since philosophical matters had been translated from one language into another, some of the translated facts were rendered ambiguous and complicated. Perversions and deviations have also affected philosophical matters, and therefore the original meanings of philosophy must be understood directly from the original texts.

Members Of The Society And Their Contributions

Since the members of this society never printed their names , different opinions emerged in understanding the mentality of different authors most of whom were usually determined by guessing. Sometimes an article was believed to be related to one of the Imams descended from Imam Ali Ibn Abi Talib (A.S.) and some believed differently. Others said that the writer of the article was from the Mutakallim of Mu'utazilite. But from what Abu Hayyan Tawhidi told the Minister of Samsam-ud-Dolah, some of the writers of these articles and members of this society are known.

When Samsam-ud-Dolah asked Abu Hayyan who was one of the professors and brothers of this society he explained about Zaid Ibn Rafa'ah and said that the people whom Zaid was close to were Abu Sulayman Muhammad Ibn Ma'ashar al-Basti, who was nicknamed Al-Qudsi, Abul-Hassan Ali Ibn Harunul Zanjani, Abu-Ahmad Mehrejani, and Abul-Hassan Ali Ibn Raminas al-Ufi.

The Four Levels of The Safa Brotherhood

1. Ikhwanul Abrar and Ar-ruhama (after fifteen years),
2. Ikhwanul Akhyar and Al-Fuzala (after thirty years),
3. Ikhwanul Fuzala'ul Kiram (after forty years),

4. The highest level consisted of members who, with the support of the unseen power, increased their writing ability and this level could be reached after fifty years. Over fifty articles were written by the Ikhwanul Safa. The articles dealt with such subjects as natural matters, divine matters, matters of logic and social matters.

ISLAMIC SCIENTISTS' METHODS OF RESEARCH

The real importance and value of methods of research were only discovered in Europe after the Middle Ages in the 18th and 19th centuries when the fundamentals of scientific evolution were being introduced. Thence forward the Europeans made use of philosophy and science and paid much attention to Islamic thoughts. They then replaced the old methods of comparison and intellectual deductions by a new method of practice and experience. Later on, they achieved wonderful results and discoveries that we witness today. Generally speaking, a method is defined as a collection of means

and ways of the feasibility of an aim and scientific method is the one which makes an exploration achievable.

Descartes has written much about the value and importance of applying the correct method in his books. For instance, in one of his books called *Articles About The Correct Use of Our Intellect*, he wrote that, " In order to solve scientific problems, not only a clear and intellectual mind is necessary, but, more important, is the application of correct methods in using the mind."

Descartes also believed that without comprehensive awareness of the method which we must use, the results of our thoughts are meaningless and the mind just makes itself tired. Without adopting a procedure, no one can research into the truth, because it is a fact that unorganized study and research only cripple our ideas and minds and all efforts will be in vain.

Descartes places much importance on methods and, like Bacon, believes that the great differences which can be seen between intellects is the result of the various methods that they adopt.

Methods of Thinking

Before the new period of science, the methods which were used by scientists were mostly the methods of comparison and of intellect. They attempted to solve all matters and problems, whether philosophical, mathematical, physical or concerning astronomy, within the framework of reasoning and logic and they believed all these matters could only be determined in this way.

Method of Experience

By using this method scientific theories can be

proved or disaproved, because it includes close observations and repeatitive experiments, therefore a definite result can be achieved.

In this way usually an experiment is repeated several times, under different conditions.

For example, to know whether heat is the main factor in the expansion of a piece of metal, a scientist can repeat the experiment on different metals, such as iron or copper, and can prove that the main cause of expansion in metals is heat.

How The Method of Experiment Was Founded In The 17th Century

In the Middle Ages, the Church had tremendous power in Europe. Scientific research and discussions and in fact reading any reports of scientists of that era was totally forbidden by Church leaders throughout Europe. It was also forbidden to reason and discuss, and they wanted human beings to forget that they possessed brains and intellects, and wanted them to convince themselves only by what they could find in the divine book and what they could comprehend with their external senses. But even through this restricted way, science made itself known.

The searchers of the truth thought it was better just to observe nature and its effects. This occupation was not forbidden by the church leaders and therefore was not dangerous, because in their opinion, it was better than attacking Ptolemy's theories. They observed how the matters in nature worked and there was no harm to the church in counting the stars.

Bacon: The Famous English Philosopher's Methods

A young researcher named Francis Bacon used to think that the methods which were taught at that time in the universities belonged to the olden days and that those methods could not convince students. They never spent any time on experiments or observation. Throughout his lifetime Bacon, although busy with various jobs, considered the introduction of new methods of science to be an important duty. In two of his famous books, one which concerned the progress and value of science and another, called *New Organ*, Bacon attempted to attract the attention of people to scientific research by experiment. Bacon's method was to collect as many facts as possible about a given thing, and then evaluate and classify them.

In every case, he conducted different experiments and reached the result in accordance with their qualities and divided them into different groups in a table called " attendants" and another one of "absents", and he called them the graded table. By this grading, classification and levelling he formed several rules.

ISLAMIC SCIENTISTS' ATTENTION TO THE EXPERIMENTAL METHODS

Europe was proud to have introduced the experimental method and presented itself as the founder of this method. However, the history of science has shown that Europe is indebted to Muslim scientists for this honour. Muslims were the first scientists to develop and apply this method.

After translating and publishing books on different subjects, the Muslims realised that experimentation and observation was a much better method of discovering the

facts.

Humble, in his book *The World*, which was translated into several languages, after explaining that the lightest scientific progress in the history of man has been due to his personal experience, explained that experimental methods were first pioneered by Muslims.

Moshiyo Sayid Helu wrote that an important aspect of the teachings of Baghdad University was the way of reasoning which was generally based on scientific principles, and correct observations of events and happenings with reasons confirming the results of experiments. He said this was a procedure which has led present-day scientists to great discoveries and inventions. For the Muslims in the Middle Ages, the application of this method was dear.

The proof of what we say is the initiative of the Muslims in chemistry, physics and so on. For example in chemistry aqua-regia,* alcohol and sulphur were, discovered. These very Muslims' discoveries which paved the way for research by scientists like La Voisier , Jabir, the great Muslim chemist who lived in the latter part of the 8th century, wrote several articles about chemical mixtures that were not clear before him, such as aqua-regia*, which was a very important factor in chemistry. From what he has written, it can be concluded that Jabir knew the properties of gases and he explaineo that when gases combine with other substances they loose their shape and properties and, in fact, change from one form to another. He discovered the two forms of chemical reactions. He realized in a reaction the substances may undergo either a physical change, which is reversible to the original substances or a chemical change, which is irreversible to the original substances on separation.

*** a mixture of nitric and hydrochloric acid that dissolves gold or platinum.**

Muslims And Other Sciences

It was mentioned earlier that Islam brought about a revolution in different aspects of people's lives by laying the foundation of a great scientific revolution. This was followed by the establishment of numerous schools, colleges and universities which attracted many scientists and researchers, who wrote valuable books and papers. But as one must work hard in order to reach the top, civilized nations too, before rising to greatness, passed through different stages. In the history of civilization, a nation has never been able, or perhaps it is impossible for a nation, to jump from a primitive way of life to a progressive one. Each nation which has become powerful in the world was once the puppet of another nation. For instance, if Greece, with its magnificence and greatness is known as the centre of science and philosophy, it should be remembered that Greece had been the student of Egypt, and that the foundation of its philosophy was, to some extent, taken from the Egyptians.

Romans, too, with all their fame were once scientifically dominated by the Greeks and they only contributed a little to what they had learned from them. Therefore it would not be surprising if in the history of Islamic civilization we saw that at the time of gaining other sciences and industries the Caliphs of Ummayyad and Abbasid invited Iranian, Greek or Indian scientists to come to Islamic countries to teach. They also made efforts to translate books from Pahlavi , Syriac and Greek into Arabic (the official language of Muslims) in order to improve and have better insights into other nations' cultures and sciences.

The Advantage of Muslims To Greeks and Romans

Sociological surveys in the history of nations have

shown that Muslims held a superior position in terms of talents and administration. Although the Greeks took the initiative in philosophy and some sciences, yet they were very weak in establishing order and legislation. Most of the time they were living in Feudal systems and spent their forces in civil wars and internal conflicts. On the contrary, Romans were very strong in legislation and establishing government, but they didn't take any initiative in researching sciences and philosophy and they didn't add anything to what they had already taken from the Greeks. The strong points of these two nations can be clearly seen in the Muslims because Muslims, like the Greeks, were very powerful in science and philosophy. They not only made use of these two valuable assets of the Greeks but enriched these with logic and the narrations of Iranians and Indians and established new legislation laws together with much progress in the study of grammar, syntax, theology, narration and research in natural sciences. All this gave the Muslims greater superiority in establishing an even stronger government than the Romans.

When the Muslims established governments and ruled the countries under their domination, they legislated laws derived from Islamic revelations which were spread throughout much of the world.

The Muslims' motivation in studying and learning foreign sciences originally came from the very emphasis and encouragement that the Holy Qur'an and the Prophet of Islam had prescribed about sciences. They knew the Prophet had repeatedly stated that wisdom and knowledge are the properties that a believer is always in search of ; wherever he hears a knowledgeable word he learns and he would not pay attention to where or whom it is from.

Until the end of the first Islamic century and into

the beginning of the second century, that is, throughout the reigns of the First Caliphs and the Umayyad Caliphs in different regions of the country, the Muslims were busy with their conquests and, as a result, they didn't have many opportunities to pay attention to their jobs, important religious issues and government. Yet from the time that the Iranians and Iraqi people and some Asians and other nearby nations established relations and began mixing with the Muslims, they gradually entered the fields of administration and social work.

General needs, such as the need to learn about medicine and mathematics, also prompted the Muslims to pay attention to other nations' sciences.

The First Translated Book

The first translation of foreign science to Arabic was completed by Khalid Ibn Yazid Ibn Mu'awiyya, who was known as the wise man of Al-e-Marwan, or "Hakim Al-e-Marwan."

After the death of his brother, Khalid was thinking wasknown as the wise man of Al-e-Marwan, the son of Hakim, defeated him and the Caliphate of the family of Abu Sofyan was transferred to the family of Marwan Ibn Hakam.

Disappointed at not becoming caliph, Khalid pursued his education and it was a pity to realise that the other members of this old family, to be rulers did not use their talents in other areas, such as sciences, from the beginning. In any case, at that time, chemistry was a very popular course in secondary schools. Khalid brought a group of graduates from a school to Damascus in order to learn about chemistry from them one of the students was known to be a Syriac or a Roman named either

Marianus or Maryanus, who taught chemistry to Khalid and also wrote a book for him.

When Khalid gained some knowledge of chemistry, he decided to translate chemistry books. Together with another man called Stephen, they translated the first translated book in chemistry and called it *Kimiya* (chemistry or alchemy).

Ibn Nadeem, in a book called *Al-Fehrest* wrote that the first person whose books on chemistry, astronomy and medicine were translated by him, was Khalid Ibn Yazid. Some of the books credited to him include *Al-Al-Sahifatul Kabira, Al-Sahifatul-Saghira, and Wasitatu-Ila-Abnibi-f-San'a.*

Ibn Khalkan has also narrated that, Khalid was a master in chemistry and had translated books related to chemistry and medicine.

The author of a book called *Kashful Dhanoon* says that Khalid Ibn Yazid was the first person among the Muslims to teach chemistry and had written a book on this subject. However, some researchers, including Ibn Khaldun and western researchers, have doubts about this matter and refute these assertions. They even claim that the first chemistry book translated from Latin to Arabic in the year 1182, was actually done by someone called Robert Castansis years before the time of Khalid (who died in the year 85 after Hijra), and not Maryanus. I f we disregard the first book which has been attributed to the time of Khalid Ibn Yazid in chemistry, the first book which was translated from Greek to Arabic was a book called *Arze Miftahun Nujun*, which concerns the principles of astronomy, and has been attributed to a man named Hermes. A review of this book was published in November 1909, and in this book it was clearly indicated that the translation was done (in the Arabic month of Zil-Qadah) in

the year 125 A.H.

MUSLIMS' LEARNING AND RESEARCH IN MEDICAL FIELD

The second and third century A.H. was the period of the Muslims' familiarization with study of foreign sciences. Scientific books in Greek, Pahlawi and Hindu were translated into Arabic with great speed by Muslims who felt great enthusiasm for their work.

Muslims were more interested in medicine than other sciences and, after a short period of time, they started their own research and writings and left behind valuable books about medicine. The reason for this interest, in addition to their need, was the emphasis of their religious leaders placed on learning medicine. The Prophet of Islam (S.A.W.) had always encouraged people to learn the principles of belief, Islamic literature, knowledge of religion and medicine, and particularly stressed the importance of medical knowledge.

The Prophet of Islam had always told his Companions that religious and scientific studies were at the same level of importance and learning about both were necessary. Medicine was first established among Muslims by doctors at Jondi Shapur Hospital. Then, with the transferral and education of a group of doctors from Greece, they gained more knowledge from the books which were narrated from Greek and Syriac and then translated into Arabic, they increased their knowledge of this science by all the available means.

Regarding the methods of the Iranian doctors of Jondi Shapur in the propagation and distribution of medical books , it was said that Mansur, the second Abbaside Caliph, once became ill with stomach pains. He had no appetite and asked all of his doctors to do whatever they could to cure him. However, they could not find a cure and all their efforts were in vain. One day Mansur asked if anyone

knew of any skillful doctor who could help him. He was told that the head of Jondi Shapur hospital, a person called George Ibn-Bakhtishooa' was a very knowledgeable doctor and no one knew of anyone more reliable than him. George, a Christian was one of the most skillful doctors of his time. He had written many books about medicine and due to his skillfullness and because of his meritoriousness in medicine, he became the head of Jondi Shapur Hospital, which was one of the biggest medical schools in the region at that time. Mansur dispatched someone to bring Dr. Bukhtishoou to him.After describing his illness, George agreed to begin treating him and after some time Mansur was cured. The Caliph became so interested in him that he did not want the doctor to return to Jondi Shapur and asked him to stay in Baghdad. George remained there and as he was fluent in Arabic, Syriac and Persian, he wrote several books on medicine while in Baghdad, some of which he translated from Greek into Arabic.

The Research Period

After spending some time translating new books and taking selected information from the non-Islamic sciences, the Muslims entered a new era of research. They displayed such initiative in the history of science that they were regarded with amazement. In medicine , in particular, they produced great physicians. Ibn -Abi -Usaybiah in one of the volumes of his book *Tabaghatul Atba'* (the classification of physicians) catagorized and listed the names of all of the Islamic scientists.

A Distinguished Scientist And Doctor In Islam

One of the most famous examples of a Muslim

scientist was Muhammad Ibn Zakariyya Razi, who was also nicknamed *Tabib-al-Muslimin,* (The Doctor of the Muslims)or Jalinusul Arab, (The Galenus of Arab). Razi was a respected physician , a famous philosopher and a very skilled mathematician, but he was best known in the field of medicine. It is said that he was first a jeweller, but he had a great interest in chemistry and for that reason, he spent most of his time experimenting with various chemicals. Due to his hard working and daily contacts with various gases and chemicals his eyes began to be seriously inflamed. Razi consulted a doctor for treatment and was charged 500 Ashrafi, which was the unit of currency at that time. The doctor told him that " It was the money which was the real alchemy" and not what he was doing. The doctor's words affected Razi so much that he began thinking of studying medicine at the age of 40.

Razi's thought was materialised and at the age of forty he displayed such dedication to medicine and became such a good physician that anyone suffering from a physical ailment and had heard of Razi came to him.

In the years 289-295 A.H., Razi was head of the physicians in Baghdad and for showing his greatness and the services he had rendered in medicine, experts in the history of science have said that'" The science of medicine which was in danger of dying, was revived by Jalinus, and it was Muhammad Ibn Zakariyya Razi who organized it. This science was imperfect, but Ibn Sina perfected it. Razi busy in medicine at Baghdad for 50 years and as well as applying what he read in other medical books, he carried out numerous experiments and displayed great initiative in treating patients. He has outlined and described all the methods he had adopted in his books.

Some of his ideas, suggestions and initiatives are still of points of value and are being applied at the present time.

The Role Of Religion In Muslim Physicians

Here we have to notice that, after the transferral of foreign sciences to Islamic countries and the familiarization of the Muslims with those sciences, the spirit of science in all civilizations was manifested and two great forces, spirituality and materialism, were combined. Nevertheless, for a Muslim physician the doctrine of " Every thing Belongs to God" had always been the main pivoting criteria and was always outstanding in their activities. The Muslim scientists who believed in this principle were humble servants of their society. Secularists, who based their practice on laws and were primarily concerned with acquiring the means of their enjoyment, were categorically different.

Great Islamic scientists have referred to Razi with much respect and they have confirmed that he acted compassionately towards his patients and used to treat poor people free of charge. He spent some of his wealth in order to purchase medicine or food for his patients. and if they didn't have a place in which to be treated, he used to bring them to his own house. There are many stories about the life of Razi and all of them illustrate that he possessed high morals and great spirit. One example we would like to mention here is the story that one day Razi was walking alone in the street, where he saw someone lying unconcious on the floor. The passerby, had thought the man was dead. But Razi, after a close examination, asked people to find pieces of sticks. He told them to beat the unconscious man's consciousness and opened his eyes. In the view of everybody who witnessed this, Razi has restored life to a dead body . When the Caliph asked Razi what this miracleous treatment had been, he answered that he had never

used that treatment previously, but it had been applied successfully by primitive people, and it was not such an important matter. " The only thing which I did was to remember what the Beduins did to a sufferer of this kind; hence the credit should go to them and not me", said Razi.

THE VALUABLE WORKS OF RAZI

Mankind is indebted to Razi for his valuable contribution and research. Europe especially has greatly benefitted from his works. Razi has a special, universal fame. One cannot find many scientists who have written as many useful books as Razi. Over 250 books have been authored by Razi, most of which are about medicine. The most important one is the book called *Al-Hawi* which we will discuss later. Another book is *Al-Mansuri*, or Mansuri Medicine, which has been compiled for Amir Ibn Mansur Ibn Ishaq Samani the ruler of Rey. This book is divided into two sections and is briefer than *Al- Hawi*.

In the Middle Ages, *Al-Mansuri* was translated into Latin and it has been reprinted numerous times since then. Other books by Razi are *Borhan, Tibbun Nufus and* a book called *Quality of Sight*, an other book which is concerned with the diseases of the joints of the body and there is a book about avoiding extremes. The Arab Jalinus Razi, has made a lot of objections and criticisms in the ideas of the famous physician Galenus in a book *Al-Shakuk*. The book called *Man la Yahdharul Tayb* is one of the famous works of Razi and Ibn Abi Usaybiah has called it the medicine of poor people, because in this book he has outlined simple and inexpensive instructions for treating patients which is very helpful for the deprived segment of society. In many of his instructions a doctor's advice is not needed.[1]

1. Uyan ul Anbaa, Vol. 1, page 314-315.

The book *Bur'a Sa'a* is another of Razi's works describing the treatment of emergency cases before reaching a doctor.

In a book called *Al Tibbul Muluki* Razi proposed the treatment of all diseases with food, not medicine. This method of curing was a new method and since that time, has gained a lot of supporters.

Other books by Razi are too numerous to mention individually. In addition to books, there are many articles said to be written by Razi in the Middle Ages which were translated into Latin and, after the invention of the printing machine, were printed often.[1]

Al-Hawi— A Medical Encyclopedia

The most important and the biggest work of Razi is a world famous book called *Al-Hawi*, which has been called the ' general book on the science of medicine'. This encyclopedia identified and discussed all or most of the problems facing medical science at that time. The ideas and methods of treatment of the ancient Greeks, Iranians and other scientists have also been collected in this book. European physicians , in particular the medical society of Italy and the doctors in this land, have gotten much benefit from the book, and the ancient scientists had a very strong belief in this book. Many historians have mentioned Razi's book with respect. Aruzue Samarghandi, in a book called *Four Articles* in the section of "medical signs " wrote that every doctor should read Jalinus's book, *Al-Hawi*, which has been written by Razi, and *Qanun*, written by Ibn Sina, and derive benefit from these books.

Regarding *Al-Hawi*, it has been noted that during his lifetime, Razi did not succeed in collecting and putting the chapters in order; he just wrote them like notes and after his death, Ibn al-Amid nicknamed Sahib Ibn Eebad

1. History of Literature, by Dr. Safa

paid a lot of money to Razi's sister to collect all of her brother's notes. With the assistance of his students, he put them in order and it was published. Some researchers believe that this book is thirty volumes. Ibn Nadeem , in a book called *Al-Fihris*, and Ibn Usaybiah in a book called *Ayunul Anbaa*, said that this book has twelve sections. The importance the Europeans place on this book, in Razi's treatments and results of his patients' treatment have all been reflected in this book, and Razi noted all his observations in the book.

For the first time, the book *Al-Hawi*, was translated to Latin in Italy and two volumes were published in the 1486 and later this book was re-published in Venice,Italy, in the year 1509 and 1542.

The manuscript of this book is available in the British Museum, Munich Library, Oxford and Cambridge Libraries, Excoria Library of Spain, the Library of Salimaqa in Istanbul, Suliemaniyya Library, Shahid Ali Pasha Library in Istanbul, Musal Library, Astane Quds Library in Mashad, Modarres Library in India and Malik Library in Tehran.

Abu Raihan Muhammad Ibn Ahmad al-Biruni—Another Muslim Scientist

Abu Raihan Biruni, one of the great scientists of the fourth hijrah century, approximately a thousand years ago, was born in the north of Khorasan province in Iran. He made discoveries in mathematics, astronomy, history, social sciences, and philosophy and wrote many books in Persian and Arabic. His scientific contributions include the accurate determination of the density of eighteen different metals and mineral stones. He calculated the sine and cosine of angles from zero to 90 degrees and recorded them in a table.

One of his discoveries was the measurement of the

radius of the earth using a new and difficult method. He measured the radius of the earth twice, once from a mountain peak in the Hindukush mountains in Afghanistan and the other time from the peak of a high mountain next to a flat plain when he was travelling to India.

According to the figure in order to measure the radius of the earth through this method one should climb to the peak of a high mountain which overlooks a flat plain.

(Mountain is indicated with the height of AH in figure (1) but as we know the irregularities on the surface of the earth are insignificant in respect to the largeness of the earth but in order to make the mountain recognizable in the figure we drew it bigger than its real size.)

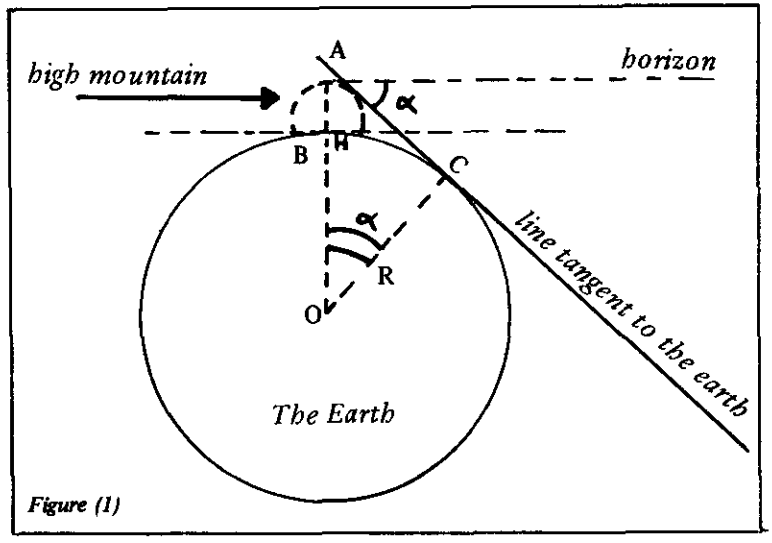

Figure (1)

The horizon should be drawn on top of the mountain (But how?) Abu Raihan then by using an instrument similar to today's telescope overlooked the surface of the earth and measured the angle (α) between the horizon

(AH) and the tangent line to the earth's surface (AC) which was a small angle about 30 minuted (half a degree). By measuring the height of the mountain's peak (AH) and using the following equations, he measured the radius of the earth.

In the right triangle of (OAC), the equation could be written as:

$$\text{Cos}\alpha = \frac{OC}{OA} = \frac{R}{R+h}$$

$$R\text{Cos}\alpha + h\text{Cos}\alpha = R$$

$$\text{Therefore: } R = h\,\frac{\text{Cos}\alpha}{1-\text{Cos}\alpha}$$

Therefore, by measuring the angle (α) and the height of the mountain (h) the radius of the earth could be measured , through Abu Raihan's method.

Have you ever considered how the height of a mountain could be measured? Abu Raihan Biruni in his book entitled *Ghanoon Masoudi* which is an astronomical book, described the measuring method of a mountain's height. Figure (2) shows this method which is still used today.

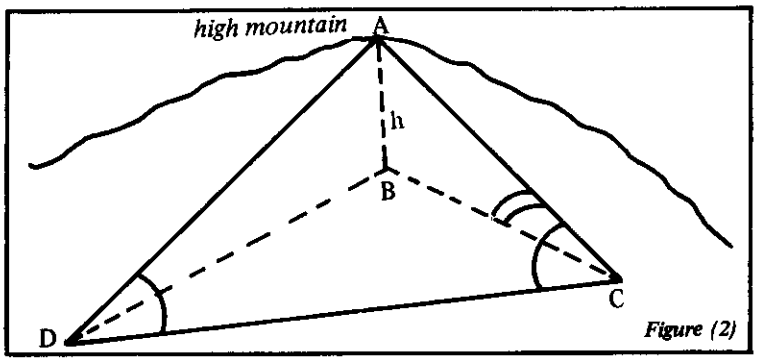

Figure (2)

LIST OF:

PERSONALITIES

PLACES

AND

BOOKS

PERSONALITIES

PLACES

BOOKS

نقش دانشمندان اسلام
در پیشرفت علوم

از
استاد شهید ـ حجت الاسلام دکتر محمد مفتح

ترجمه به زبان انگلیسی
توسط
بنیاد اندیشه اسلامی