SECONDARY SCIENCES

Secondary Sciences (adopted sciences):

These are the experimental sciences; they are acquired through experience and deduction. They aim at brining pleasures to people's lives, providing various means to lead a desired life and serving people. Among such sciences are Astronomy, Geometry, Mathematics, Algebra, Chemistry, Physics and Medicines etc.

The earlier Muslims contributed a lot to these sciences because Islam has always invited to thinking about what exists in this world and look for the manifestations of Allah's power. The inventions of Muslims in these sciences are numerous. Some of these sciences are as follow:

Astronomy:

Through this science the conditions of the stars in the sky, their movements and distances are known. Muslims carried out deep and minute researches in this field because the holy Qur'an has drawn much attention to it. In the light of the explanations of the Qur'anic verses the scholars pondered upon the expansive atmosphere, translated the books that the Greece, Persian and the Indian have written on the subject and they themselves became expert in this science. After acquiring this science thoroughly they criticized it, added various dimensions to it and invented many things beneficial for human life. The famous scholars of astronomy are:

Abu Abdullah Muhammad Bin Jabir Bin Sinan Al-Battani (died 317 AH). He invented an instrument that could measure the movements of the stars and this instrument was christened after him. He described minutely the astronomical instruments. He told the method of using the instrument called Astrolabe (an instrument used to find out the height, position and movement of the stars). He also carried out theoretical works in this science and studied the book of Greece astronaut Ptolemy and criticized it academically and added many things to it. He wrote a book about the movement of the starts and their number, which is taught until today in Europe. On the other hand, he also carried out practical experiments

that indicate to the peak of academic advancement. He defined the distance between the earth and the sun and guessed the timing of solar and lunar eclipses. For this, he adopted such a methodology that is on par with the present day methodology. This is why even today Europe accepts him to be the greatest astronomer.

Other astronomers include Abu Ishaq Ibrahim Yahya al-Zurqani, who was born in Qurtuba (Córdoba) in 4th century of the Hijri Calendar and worked from the city of Taitala (Toledo) in Al-Andalus. He invented many things for finding out the height, position and movement of the stars. For finding out the direction of the storm and its pace, and to define the duration of day and night, he invented Astrolabe. This puzzled the western scholars. The European astronomer Copernicus benefitted from his book and in all his books he has referred to Abu Ishaq's opinions.

The third great scholar of this science is al-Farghali. He wrote a book that served as a source of astronomy knowledge. Europe and Asia benefited from it for seven centuries.

Besides, there are several scholars who occupied a prominent place in astronomy.

Mathematics:

This science consists of Arithmetic, Algebra and Geometry. Allama Muhammad bin Musa al-Khwarizmi (Died 232 AH) discovered the boxes of one, ten and hundred. He separated odds and evens. He also discovered the decimal points and taught how to take out compound proportion of encircles and round. The European's were unaware of this science before that. Al-Khwarizmi was not the sole expert of this art. Besides him, many scholars have authored on Arithmetic, Algebra etc. Among them are: Abu Kamil Shuja' bin Aslam Misri, Sinan bin Fath al-Hourani, Muhammad bin Hasan al-Karkhi. He authored a book of the stature of Al-Kaafi Fi al-Hisab. In it, he mentioned some of the contemporary principles of arithmetic and added some others.

Algebra is one of the sciences that were invented by Muslims. Although some of its principles match Greece and Indian civilization, it is a fact that Muslims

developed it and added many more rules to it. The Arabic impression is quite visible over it. In different languages of the world its original Arabic name "Al-Jabr" remains.

Al-Jabr, according to al-Khwarizmi, is the best branch of arithmetic. It is he who authored an academic book on the subject and his famous book in the art is "Al-Jabr Wa al-Muqabala". It is he who first used the symbol of Jazr (√) [1] and other symbols which made the science very popular. Al-Khwarizmi surpassed the European mathematician Dekarat. The credit to invent the numeric value 0 (zero) goes to Muslims because people did not know it earlier.

Besides, the scholar who gained expertise in this art are: Abul Hasan al-Qasawi (died 891 AH), Shuja' bin Aslam Misri and Abu al-Wafa Buzjani. Buzjani added to the books of Khwarizmi. He explained the relation between Algebra and Geometry and this paved the way for Europe and Analytic Geometry was invented.

Muslims translated the book related to the Science of Triangle. They got if from the past nations. The most significant book that was translated in this art was the book of Aqlidas (Euclid). Muslims studied the science and criticized the theories of the predecessors and added many more things to it. They also invented many new concepts in Mathematics: like finding out the area of Space and volume, analyzing the arithmetic sums, dividing the angles and finding out ratio between round and circle. Due to this the Islamic architecture developed a lot. The early scholars of Arithmetic are Hasan bin Haitham, Abu Ja'far Khazin and the three sons of Moosa: Shakir, Ahmad and Hasan. They lived in the third century of Hijrah and wrote collectively the books about Arithmetic, Astronomy and Chemistry.

Geography and its relation with Astronomy and Tourism Science:

Earlier Muslims led a desert life. They belonged to this environment; felt the changing seasons. In the deserts, there were mountains, hillocks, sandy earth, valleys and water. They all inspired Muslims to know Geography and become its experts.

Muslim benefited in this field from the previous nations and added to the treasure of Geography. They described in detail and minutely the geography of many

countries, which is called "The Science of the Countries". For this, they undertook many journeys by sea and on land. They mentioned the roads, distances, cities and the countries in a very detailed way. Likewise, Muslims authored many books in this science and explained academically the geographical issues. They got expertise in mapping. The extensive and deep knowledge of Muslim geographers about maps and the locations of the countries is indicative of their vast civilization. In mapping, the most famous scholar is Al-Idrisi. He designed the map of the whole world. This, he had done on the demand of the then king of Sicily, Roger II. On a ball of pure ball and with the help of vertical and horizontal lines the map was craved over it.

Here are the famous geographers and travellers:
Muhammad bin Moosa al-Khwarizmi and his son Ahmad. The book by Muhammad Moosa "Soorat al-Ard" is base of Geography. European geographers took benefits from this book and praised it. The book was counted among the great developments of the time.

Al-Ya'qoobi (died 266 AH) is called the father of Geography. He wrote "Kitab al-Buldan" and wrote especially about natural geography and the human conditions of many countries. He described the geographical conditions of some countries with many details. This book is unique due to its complete and detailed description of the central roads of Persian cities.

Yaqut al-Hamwi (died 626 AH): He is one of the famous geographers. He wrote "Mu'jam al-Buldan" which is a very important geographical dictionary. Its order is as per the letters of the Mu'jam. It mentions about many cities and countries and the important historical events of a country in short.

Besides, there are many geographers who played important roles in developing this science. Some of them are:

Al-Istakhri: He lived in the fourth century of Hijrah. Based on his journeys and personal observations, he for the first time designed the map of the Islamic world. The scholars after him, among whom is Al-Idrisi, trusted him.

Al-Balkhi (died 322 AH): He is among the authors who wrote the descriptive geography of the Arabs and he made the maps of the Islamic states as he could.

Al-Mas'oodi (died 346 AH): He was an expert of extensive civilization, a unique geographer and a great historian. The orientalists have called him the hero of the Arab and Ptolemy (great hero) of Muslims. The world map he designed is the most subtle of all the Arabic maps. It shows that Al-Mas'oodi was one of the significant Muslim map makers.

Physics:

Muslims studied numerous changes of the ocean like tides, volcanoes, and also the environmental changes like atmospheric pressure, tempest, storm, cloud, lightning, thunder, rumbling and light etc. The theories of Ibn Haitham in Vision Science are famous. Muslims took much care of weights; they used very standard weights and excelled in finding out specific gravity (ratio of density of particular substance with that of water). Al-Bairuni laid down the principle that the specific gravity of an object corresponds to the volume of water it displaces. To determine specific gravity, he used a 'conical vessel' to find the ratio of the weight of water displaced to the weight of a substance in air. He determined the specific gravity of eighteen precious stones like gold, silver, mercury, copper, iron and diamond etc. Thus, al-Bairuni reached the conclusion which is very near to the conclusion of the present age.

Our scholars also studied the earth and declared it is round and that it has gravity towards objects in it; it evolves on its axis. It has been mentioned by Al-Bairuni. Our ulama surpassed Newton in this subject and it were they who paved the way to the theory of gravity.

Muslims were expert in manufacturing minute articles. The watch which Harun Rasheed (Died 191 AH) gifted to some European king was made of copper with great expertise.

Muslims studied sound and the light. By research on the voice wire and its trembling they told how to distinguish among the voices. They discovered various types of mirrors. This is just a glimpse of Muslims' great civilizational asset and

their services in Physics. Had there not been so much contribution of Muslims the Europe could have not developed so soon.

Biology:

This science studies the plants and animals. Muslims researched extensively on Botany and Animal Science and took much interest in them. The Qur'anic teachings, sayings and guidelines have been the basic inspiration for Muslims to research on all the sciences. One of their braches is also Biology.

Abu Hanifa al-Dainuri, who is also known as Shaikh al-Nabatat (The Botanist Shaikh) authored the book "Al-Nabaat". Al-Idrisi wrote the book "Al-Jami' Li Sifat Ashtat an-Nabaat".

Muslims cared for agriculture. They formulated rules and regulations for this. The Europeans professed the role of many Muslim scholars who transferred many plants to Egypt, Al-Andalus and Sicily. The Europeans took much benefit from the plants like cotton, watermelon, sugarcane and lemon etc. Similarly, Muslims paid attention to digging streams, canals and rivers. Ibn Hauqal has mentioned a lot of details of these rivers and canals in his book "Al-Masaalik Wa al-Mamaalik".

Muslims built big dams on some of the canals. Likewise they also dug canals for irrigation. The most important book on Agriculture is "Al-Falahatu al-Undulusiyah" which was authored by Abu Zakariya Muhammad bin Awam al-Ashbili. In it he has mentioned the types of soil and the best soil.

Muslims took much care of animals. They mentioned many details in their books in this context. The personalities who wrote on the topic are Al-Jahiz, the author of famous book "Al-Hayawan" and Al-Hafiz al-Dimyari whose book is "Al-Hayawan al-Kubra". Similarly we also find the books about treatment of the animals like "Ilaj al-Hayawanat".

Chemistry:

Muslims had known Chemistry for long. The credit goes to Khalid bin Yazid bin Mu'awiya (died 85 AH) who had renounced his right to be caliph due to his

immense love for education. He preferred education to everything else. He translated many books about astrology, medicine and chemistry.

In this field the great name is that of Jabir bin Hayyan (120-210 AH). He said that experiment is the most important phase of any academic discussion. He laid the foundation of modern experimental methodology. This is the methodology that works on experiment, observation and deduction. Ibn Hayyan recognized various chemical functions like causing evaporation, dripping of water and melting something. Similarly, he also experimented some chemical reactions and through it solution of silver nitrate. The books he authored are more than hundreds. Some of them are: "Al-Khwas al-Kabir", "Al-Mawazeen" and "Al-Eidaah" etc. The western scholars learnt the value of the books and translated them into Latin. These books were a surprise to them.

Among the Muslim chemists is Muhammad bin Zakariya al-Razi who authored the book "Al-Asrar Fi al-Keemiya". He used chemistry for medicine and for treating the inter-body human diseases.

Among these scholars is also Al-Kindi who has written many articles on Chemistry. Some of his articles are: Talweeh al-Zujaj" (Polishing of glass) and "Risalah Fi Anwa' al-Suyoof Wa al-Hadeed" (Kinds of Iron and Swords).

In the field of chemistry there are many inventions to Muslims' credit. They discovered a lot of chemical agents and composition like potassium, sodium, and used carbon dioxide in making glass. They also helped in making soaps and perfumes.

The Science of Medicines:

The Arabs had been fond of medical science since ages. In the era of the Messenger of Allah (ﷺ) Harith bin Kalada al-Thaqafi was known as the doctor of the Arab. Even the Prophet (ﷺ) certified his expertise in medicines. Besides, many women, too, were associated with this profession, especially during the war expeditions attended by the Prophet (ﷺ). Some of them are: Rafida bint Sa'd al-Aslamiyah, Shifa bint Abdullah and Umm-e-Ateeyah al-Ansariyah (may Allah be pleased with them all).

Muslims took much interest in medical science because the holy Qur'an and the Hadith have medical suggestions and the commandment to get treatment. There are numerous hadith of the Prophet (ﷺ) that are related to diseases and their treatment. Some of the hadith scholars have written on this subject. Among them we can name Imam Nawawi who wrote "Al-Tib al-Nabawi", Imam Ibn Qayyim who wrote "Zaad al-Ma'ad" and Ibn Hajar who wrote the famous explanation to Bukhari. Besides them, other scholars of hadith, too, have written on the subject.
There was abundance of doctors in Islamic countries. The books written by Hippocrates and Galen were translated into Arabic and people took much benefit from them. The most famous of the doctors is Al-Razi who distinguished between the resembling symptoms of some diseases like the appendix & big intestine pain, and the measles & the small-pox.

Ibn Seena (Avicenna) distinguished between the causes of facial paralysis and told that one of the basic causes is the central part of the brain while the other cause is external. In the seventh century of Hijri, Ibn Seena discovered that blood circulation increases and decreases. This, the Europe knew only after three hundred years. During the plague epidemic in Al-Andalus the historian from the city, Lisan al-Deen bin Khateeb warned against the infectious diseases and he also suggested ways to be safe from them.

The early Muslims got specialization in every field and they did not allow anyone to practice as a doctor unless they had passed the exam of famous specialization books. This aimed at laying emphasis over the theoretical and experimental knowledge of the students and to assess their capabilities and skills in treatment and diagnosis of diseases. The certificates they were offered mentioned the diseases in which they could prescribe medicines for people.

The fields of specialization in which Muslims were expert are:

Internal diseases:

Muslims had the knowledge of structure of human body, its system, stomach and the related diseases, appendix and piles etc.

Surgery:

The book by Al-Razi "Al-Haawi" consists of information regarding surgery of private organs, brain, the pimples in ears and stomach. The credit of Muslims' development in surgery goes to Abu Qasim Al-Zahraawi (died 403 AH) who was the master of this field. From his books the Europeans benefited for five centuries. His books were even translated into Latin. Al-Zahraawi was so expert in surgery that he did not leave a scar and easily removed the breast and thigh tumors. If there was no blood circulation into the vessels of the shin he would fix it through surgery. He would take out the kidney stones by breaking it into pieces. He invented more than 200 instruments used in surgery. While operating on a woman, he would arrange nurses for satisfaction of the women. People took much benefit from him.

Treatment of eyes:

Muslim doctors took much care of eye diseases. They experimented with the animals' eyes and became successful. They discovered that the major part of human eye is very similar to an animal eye. So, they found out various eye diseases and prescribed medicines to cure them.

The doctors who had expertise in this field are:

1. Ammar bin Ali al-Mawsili who authored "Al-Muntakhab Fil Amrad al-'Ain".
2. Ali bin Eisa al-Kahhal, who authored "Tadkirah al-Kahhaleen".

Besides them, there are various Muslim doctors in the list.

Treatment of bones:

Muslim doctors successfully treated the broken bones of nose, jaw, neck, rib, knee, arm and leg. They experimented with the corpses of the dead body to know the shape, joint and condition of the bones.

Treatment of teeth:

Muslim doctor Al-Zahraawi has written a chapter in his book "Al-Tasreef" in which he discusses dental surgery, the instruments used in it, swallowing of the jaws, pain killing and installing new teeth tied with golden and sliver wires.

Muslim doctors told the method to protect the teeth from germs by using miswak and made some powders similar to present day tooth paste.

Gynecology:

In this field Abu Bakr al-Razi, al-Zahraawi and Ibn Seena are famous. In this filed also Muslim lady doctors worked. So the sisters and daughter of Hafeed bin Zahr al-Andalusi worked as lady doctors. There are many Islamic medical books that are full of with the mention of diseases specific to women. Like midwifery, expansion of uterus mouth during birth, bleeding after child birth and its signs etc. Muslim doctors successfully treated the stopped monthly bleeding and they tried to find out the sex of the foetus through research and observation.

Pediatrics:

It has been a sensitive issue to Muslims to treat children. Muslim doctors cared much for children; they told the duration of suckling and weaning of a baby. Similarly, they treated the child diseases like cough, cold, loose motion and vomiting etc. They prescribed medicines to cure paralysis of children, their unintentional wetting of bed and other diseases. Regarding treatment of children there is a famous book "Fi Awja' al-Atfal" which has been authored by Abu Ali Bin Ahmad Bin Mandubah Asfahani (died 410 AH).

Psychology:

Al-Razi and other Muslim doctors practiced on this art and used violent pulls to bring life back to the paralyzed organs. There were special hospitals to cure psychological diseases. They were surrounded by greenery and rose flowers. The Qur'anic verses were read out to the patients.

Pharmacology:

The early Muslims got expertise in pharmacology and translated the books related to pharmacology. They developed the science and invented medicines, tablets and syrups etc. These things got mention in "Firdaus al-Hikmah" by Ali bin Sahl al-Tabri, "Al-Hawi" by Al-Razi and "Al-Qanoon" by Ibn Seena.

Muslims used herbs to make responsive medicines and these medicines were sold on the chemist shops spread across the Islamic world.

Here are important contributions of Muslims in the field of pharmacology:
1. Discovering many herbs the Arabic names of which are still safe in foreign languages: henna, hanzal (wild gourd), kafur (camphor), kurkum (turmeric) and kamun (cumin) etc.
2. Making medicines by composition of botanical, animal and mineral ingredients and modernizing the method of treatment based upon chemical medical science. Al-Razi is the first person to have used chemistry in medical science and made various compounds.
3. Mixing bitter medicines with sugarcane juice or fruit juice to make it pleasant to the patient.

The Place for treatments:
Muslims have known hospitals from the very old days. The first hospital was built during the era of caliph Waleed bin Abdul Malik (88 AH) and it was situated near Damascus. There the patients were treated for leprosy. Later the hospitals grew in number. All necessary medicines for treatment were available there. The important hospitals are: Ahmad bin Tulun Hopstial in Egypt, Noor ad-Din Mahmood Zangi Hospital in Damascus (built in 549 AH) and Salah ad-Deen Hospital in Egypt (built in 577 AH).

Mineralogy:
Muslims discovered the natural characteristics of minerals and mentioned their condition and status in details. So, they described colour, shining, transparency, solidity and specific gravity etc. with great expertise. Muslims scholars who are masters of this field are:

1. Utarid bin Muhammad al-Haseeb. He lived in the third century Hijri. He authored the first ever Islamic book about stones "Al-Jawahir Wa al-Ahjar al-Kareemah".
2. Abu Bakr Muhammad Bin Zakariya al-Razi (died 313 AH). He authored "Al-Khawaas" and "Ilal al-Ma'adin" in mineralogy. It describes the qualities of the stones and their natural components.
3. Yahya bin Masawayh authored the book "Al-Jawahir Wa Sifaatuha". This is the most important book in mineralogy. He mentioned the beginning of interest of

Muslims in mineralogy, their related books and compilations, their stand about stone business, the ways to get the stones, the places where stones were found in the old east and also the terms that related to the then science of stones.

4. Abu Raihan Muhammad bin al-Bairuni (died 440 AH), about whom the western scholars and the others believe to be the most intelligent personality of history, has left for us in inheritance the most important and the greatest book on mineralogy "Al-Jamaahir Fi Ma'rifat al-Jawaahir". It is he who invented an instrument to measure the specific gravity of the mines and stones and thus weighed 18 stones and metals. He distinguished between the mines and metals. He used the word "ma'din" (mine) for stones and the world "fulz" (metal) for the metals like gold, silver, iron and mercury etc.

5. Ibn Seena: He was the ocean of knowledge and the real founder of Geography. His caliber may be gauged through his book "Al-Shifa" in which a special chapter is about mines and the weather changes.

6. Ahmad bin Yusuf al-Taifaashi (died 651 AH). He authored a book titled "Az'har al-afkar Fi jawahir al-ahjar". If we put this book together with the book authored by Bairouni, we can guess the heights the Muslim scholar conquered in this field.

7. Muhammad bin Ibrahim bin Sa'id Al-Bukhari (died 749 AH). He authored "Nukhab al-Zakha'ir Fi Ahwal al-Jwahir".

Muslims scholars surpassed the western scholars in mineralogy seven centuries ago. The heritage they left has much contribution to the development of Europe.

Management science:

Muslims contributed to all the sciences and among them is the science of management. After establishment of Islamic state, a special management institution was much needed which would ensure execution of general policies of the country and which implemented the Shari'ah commandments and protected them.

The science of management and the Islamic administrational institute had to go through various phases.

In the era of Umar Bin al-Khattab (*Radhi Allahu Anhu*) when the Islamic state was extended it was needed that the Islamic management institution be administered to adapt itself to the contemporary conditions. Umar bin al-Khattab (*Radhi Allahu Anhu*) strengthened the management structure of Islamic state. He started Hijri calendar and established many new departments: the departments for preserving the government documents, keeping an account of salaries and the army etc.

In the age of the Umayyad, many departments and offices were established. Among them are the offices to put seals, the department of police, post, accounting and looking after the lost articles etc.

In the beginning of Abbasid era, a ministry system was founded to help the caliph run the country affairs. It was aimed at strengthening the administrative system. While the system of keeping a watch was already present, some of the rules were introduced to broaden this institution. Some of them are as under:

1. Personal vigil or self-accountability: Islam has made it compulsory for every Muslim to asses himself.
2. The Ummah is the watcher over the individuals holding any post whatsoever. The Ummah is not allowed to withdraw from its responsibility.
3. Overseeing the ruler: The ruler oversees the ministers and the office bearers subordinate to him, and if he commits shortcomings in doing his duties, he will be held responsible for that. He keeps a watch over them through his cooperative institutions.

So, Islam and its high civilization helped make important rules in the administrative field. And so Islam surpassed all the other administrative rules made by others.

Footnote:

[1] Square root; the fingered multiplied by it. The square root of 100 is 10 because when 10 is multiplied by 10 it is 100.

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