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Aspects of the Islamic Influence on Science and Learning in the Christian West (12th-13th century)

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ASPECTS OF THE ISLAMIC INFLUENCE ON SCIENCE AND LEARNING IN THE CHRISTIAN WEST (12TH-13TH CENTURY)

The history of science and civilisation according to traditional Western writing and narration, by an overwhelming majority, can be summarised as follows:

All Western, and hence our modern, civilisation is derived from the Greek heritage (roughly 6th BC to 1st – 2nd century AD). This heritage was lost during the Dark Ages (5th-15th AD), recovered during the Renaissance (16th-17th centuries), dusted off, and so was revived for our modern world.

As it was difficult to explain how such learning could be lost for nearly fifteen centuries, but recovered, Western historians gave that role to the Muslims: it was they, who, by chance, preserved it, keeping it for Western genius to arise again, before it was re-claimed and developed by that genius. One of the `illustrious' historians to defend this point, followed by hordes of modern `historians' who today crowd history departments, is the Frenchman Duhem who states:

> *"The revelations of Greek thought on the nature of the exterior world ended with the "Almagest" (of Ptolemy) which appeared about A.D. 145, and then began the decline of ancient learning. Those of its works that escaped the fires kindled by Mohammedan warriors were subjected to the barren interpretations of Mussulman commentors and, like parched seed, awaited the time when Latin Christianity would furnish a favourable soil in which they could once more flourish and bring forth fruit."* [1]

Some modern historians go further than Duhem, and even deprive the Muslims of this modest role of guardianship; one such historian, at a recent conference on the subject,[2] seemingly able to interpret the unknown, confidently asserted that had the Muslims not preserved such heritage, it would have been recovered by Western scholarship anyway.

One could write whole volumes on these and similar fallacies and abundant inanities which fill Western history. Not the place here, though. Briefly, however, one or two comments on the previous statement on the Greek role to highlight how ridiculous such an argument can be before moving on.

First and foremost, the learning recovered, or found, or available, at that so-called Renaissance of the 16th-17th (another illogically based notion of Western history) bears no resemblance to anything left by the Greeks. The mathematics, the medicine, the optics, the chemistry, the astronomy, geography, mechanics etc. of the 16th is centuries ahead of that left by the Greeks. Any person with the faintest knowledge of any such subjects can check this by looking at what was left by the Greeks and compare it with what was available in the 16th century, and even with what was available centuries up to the 14th). Anyone can thus question this notion of Greek learning recovered during the Renaissance.

Furthermore, even supposing the Greeks had made some contribution in some of the sciences cited, what is the Greek contribution to the invention of paper, printing, farming techniques, irrigation, windmills, the compass, industrial production, glass making, cotton production, the system of numerals, trade mechanisms, paper money and the cheque? Modern finance as a whole, gardens, flowers, art of living, urban design, personal hygiene, and many more manifestations that compose our modern civilisation?

As for the notion that Greek learning had disappeared, this is another preposterous point repeatedly made by Western historians. Greek learning was available throughout the so-called Dark Ages in Byzantium and even in the West.[3] Western historians never fail to insist that the Muslims sought that Greek learning from Byzantine sources, and yet say that it has disappeared, which is impossible to square. Now, if such learning was available all along, why did Western scholars have to wait until they conquered Islamic lands in Sicily (11th), Toledo (Spain) (in the 11th) and in the east during the Crusades (11th-12th) before they started acquiring such `Greek' learning? Why wait? And above all, why did Western translators of the 12th century, to whom we will return further on, chose to translate such learning from Arabic, then turn it into Latin rather than go to the Greek and even Latin sources? This is never explained by those historians who select miniscule or fragmentary pieces of evidence, often concoctions of their own, to build extensive theories (i.e the Pirenne theory, the burning of the Alexandria Library etc).

The real evidence from history shows that where the Greeks had left off, the Muslims had continued thus setting up the foundations of modern science and civilisation. Before looking, albeit briefly, at some aspects of Muslim decisive influences, this author, like other Muslim historians, first and foremost, never ceases to acknowledge that, although the Muslims had made such contributions, the Islamic mind and soul stresses that science and civilisation are God given gifts to all people of equal abilities. The reason why the Muslims excelled at the time they did, and played the part they did is not due to any special status (as others appear to recognise as their own), but simply to circumstances current then, i.e spur of Islamic values, which were very strong; driven by faith, Muslims were able to accomplish what they could never achieve under other circumstances as history has shown. Moreover, the Muslims had their own contributions but never denied their inheritance from other civilisations; particularly from the Chinese with whom they always had excellent relations. In the Muslim civilisation, opportunities were always available to others. Muslim history is crowded with instances of slaves, and their descendants of whatever ethnic mix who became great scientists, men of letters, leaders and even rulers. The multi-faith and equalitarian nature of Islamic civilisation has not be equalled by even the so-called most open multi-cultural societies of today. Even when the whole Islamic land was threatened with extinction by both crusaders and Mongols (mid 13th century), decimated populations of Muslim lands in their hundreds of thousands (800,000 deaths in Baghdad alone in 1258),[4] minorities whether Jewish or Christian (even when allies of the crusaders) still survived within Islamic jurisdictions, with all their powers, privileges, and wealth intact. These instances highlight the true character of Islamic civilisation, a characteristic completely alien to their successors. Thus, in respect to the issue debated here, it is no surprise that such successors, whilst benefiting from Islamic learning, still chose to obliterate their debt, and re-write that history in the ways indicated above.

Such observations are not conjured up by the present author to pursue his own agenda. They can be found amidst some of the best but often inaccessible and thus obscure Western historians, or men of renown. Thus, Glubb states:

> *"The indebtedness of Western Christendom to Arab civilisation was systematically played down, if not completely denied. A tradition was built up, by censorship and propaganda, that the Muslim imperialists had been mere barbarians and that the rebirth of learning in the West was derived directly from Roman and Greek sources alone, without any Arab intervention."* [5]

Draper, too, notes:

> *"the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Muhammadans (Muslims) Injustice founded on religious rancour and national conceit cannot be perpetuated forever... The Arab has left his intellectual heritage on Europe as, before long, Christendom will have to confess"* [6]

The Islamic influence is herein partly acknowledged in this extract.

A general picture of the legacy of the East before and during Islamic times is described by Wickens:

> *"In the broadest sense, the West's borrowings from the Middle East form practically the whole basic fabric of civilisation.' `Without such fundamental borrowings from the Middle East,' he adds, `we should lack the following sorts of things among others (unless, of course, we had been quick and inventive enough to devise them all for ourselves): agriculture; the domestication of animals, for food, clothing and transportation; spinning and weaving; building; drainage and irrigation; road-making and the wheel; metal-working, and standard tools and weapons of all kinds; sailing ships; astronomical observation and the calendar; writing and the keeping of records; laws and civic life; coinage; abstract thought and mathematics; most of our religious ideas and symbols'. And he concludes that, `there is virtually no evidence for any of these basic things and processes and ideas being actually invented in the West."* [7]

To go through the Islamic impact on modern science and civilisation in detail demands so vast a book that nobody has written yet, and it is much beyond the capability of this author to address this issue as extensively as he would wish. Notwithstanding just some overall observations and points are raised here. In order to highlight the true scale of the Islamic impact, it is crucial to look, however briefly, at the condition of Western Christendom during those so-called Dark Ages, when, such were the contrasts, and such was the envy of Western Christians of life in the Muslim world, that, for Europeans, as Menocal puts it, 'it must have at times appeared that wealth and comfort went hand in hand with the ability to read Arabic'.[8]

Whilst universality of learning was a fundamental element in Islamic civilisation, science was the `hobby of the masses, with paupers and kings competing to obtain knowledge...'[9] whereas in Western Christendom, as Haskins observes, '...relatively few could read and write, these being chiefly ecclesiastics and, save for the very moderate attainments of an individual parish priest, men of education were concentrated in certain definite groups separated one from another by wide stretches or rural ignorance'.[10]

As Draper puts it, when `Europe was hardly more enlightened than Caffraria is now, the Saracens were cultivating and even creating science. Their triumphs in philosophy, mathematics, astronomy, chemistry, medicine, proved to be more glorious, more durable, and therefore more important than their military actions had been.'[11]Draper goes on to say, that whilst `the Christian peasant, fever stricken or overtaken

by accident, journeyed to the nearest saint's shrine and expected a miracle; the Spanish Moor relied on the prescription or lancet of his physician, or the bandage and knife of his surgeon.'[12]

`The Spurious medicine of the time, as practised under the sanction of the Holy See,' Scott adds, `had raised up a herd of ignorant and mercenary ecclesiastical charlatans. These operated by means of chants, relics, and incense; and their enormous gains were one of the chief sources of revenue to the parish and the monastery, and a corresponding burden on the people.'[13]

Urbanity and wealth also belonged to the Muslims, at that time. In tenth century Cordova, there were 200,000 houses, 600 mosques, 900 public baths, the streets were paved with stones, and were cleaned, policed, and illuminated at night, water was brought to the public squares and to many of the houses by conduits.[14] Islamic cities, as a whole with their mosques and madrassas, their churches, synagogues, and schools, their bathhouses and other amenities, contained all that was needed for leading a religious and cultured life.[15] Such Islamic cities boasted huge expanses of gardens.[16] Basra in Iraq was described by the early geographers as a veritable Venice, with mile after mile of canals criss-crossing the gardens and orchards;[17] Damascus with its 110,000 gardens,[18] and in Turkey, Ettinghausen says flowers were a `devotion, if not mania.'[19] Whilst in Islamic towns and cities, trade flourished in all directions,[20] and the wealth of its land were the objective of the preying and attacks of Christian pirates,[21] the view from Western Christendom was hardly flattering. So big was the contrast, as Scott puts it, that the magnificent architectural works of `Arab genius were attributed to an infernal agency, as beyond the efforts of unaided human power;' an opinion still entertained by the Spanish peasantry, who firmly believe that the Moslem palaces `were constructed by evil spirits.'[22]

This account by Draper tells that:

> *"as late as 16th century England, there were highwaymen on the roads, pirates on the rivers, vermin in abundance in the clothing and beds... The population, sparse as it was, was perpetually thinned by pestilence and want....."* [23]

A similar state of wretchedness prevailed everywhere else. Scott tells how:

> *"In Paris there were no pavements until the thirteenth century; in London none until the fourteenth; the streets of both capitals were receptacles of filth, and often impassable; at night shrouded in inky darkness; at all times dominated by outlaws; the haunt of the footpad, the nursery of the pestilence, the source of every disease, the scene of every crime."* [24]

In the Spanish Asturias at the time of the Muslim arrival (early 8th century), Scott states that, `the dwellings were rude hovels constructed of stones and unhewn timber, thatched with straw floored with rushes and provided with a hole in the roof to enable the smoke to escape; their walls and ceilings were smeared with soot and grease, and every corner reeked with filth and swarmed with vermin. The owners of these habitations were, in appearance and intelligence, scarcely removed from the condition of savages. They dressed in sheepskins and the hides of wild beasts, which, unchanged, remained in one family for many generations. The salutary habit of ablution was never practised by them. Their garments were never cleansed, and were worn as long as their tattered fragments held together.'[25]

From this alone, it seems extremely odd how, instead of gratitude, Western historians, including Albornoz[26] and Spanish historians of his ilk, deny the Islamic influence. How did many aspects of Islamic civilisation pass on the West can be seen now.

Western scientific awakening and emergence out of barbarism mainly took place during the 12th century. Most serious historians now accept this. The idea of the Renaissance of the 16th-17th century now belongs either to past history, or primarily to the mass media where amateur historians working for the BBC and similar channels occasionally delve into history as one would engage into an enjoyable, but still far from mastered, hobby.

'Universities, like cathedrals and parliaments are products of the Middle Ages', says Haskins, who adds that, `The Greeks and the Romans, strange as it may seem, had no universities in the sense in which the word has been used for the past seven or eight centuries.'[27]

Also belonging to the 12th century were new architectural styles, windmills, hospitals, many sciences and scientific works etc. In the 12th century two major elements entered into play, both linked to the Muslim world:

First: The Western Christians established themselves into lands formerly Muslim, such as Sicily which had been retaken from the Muslims during the last decade of the eleventh; Spain, where the Muslims lost their main northern town of Toledo; and of course, the 12th century being (until the rise of Imad al-Din Zangi in the 1140s who inflicted the first major defeat on the Crusaders) a major period when the Crusaders followed their onslaught begun in 1097, and conquered the whole of Palestine and nearly the whole of today's Syria. From these three regions as will be seen the Westerners derived plenty, or should one say the essentials of what makes modern civilisation.

Second: In the 12th century took place the greatest translation effort of sciences ever seen, and that was primarily of Islamic science in the town of Toledo, northern Spain.

Before delving into the role of Sicily and the Crusades, it is very important to note that, without any exception, any region that first witnessed a scientific revival in Western Christendom, and began to emerge into modernity, was the area related to Islamic learning in one way or the other. Obviously, the overwhelming majority of Western historians always recognise the fact that these regions were first places of learning in the Christian West, but they never, with the exceptions of such historians as cited here see, recognise the Islamic link between these places. These Western historians have lost sight of the basic scientific principle, that similar effects have similar causes: that in the presence of similar phenomena, one should look for a similar link; However they don't, hence proving their methodology is not scientific in any way.

Briefly here on such places, the first one in Western Christendom to awaken to science, astronomy and mathematics, principally, and which in turn diffused such sciences is Lotharingia, known today as Lorraine in north eastern France. It is the first place that had links with Muslim Spain via its ambassador John of Gorze, ambassador, but also scholar.[28]

The other place that came out of darkness in the south was Catalonia. Catalonia was the adjacent to Muslim Spain, the main centre of European science The Abbey of Ripoll was the destination of most scientific manuscripts coming from Cordova, where even Latin scholars went to examine and even collect such manuscripts.[29]

The towns and cities from which learning first spread include Salerno, the location of the first medical faculty, of which more will be said. It was Salerno to which Constantine arrived from Tunisia with his library of medical lore.

Montpellier, equally was crucial to the development of learning in the Christian west, since Montpellier was the centre from which all sorts and forms of learning from the land of Islam, medical learning particularly, came whether from Muslims, or Jews, who also acted as the major disseminators of Islamic science. It was Montpellier, which gave some of the earliest renowned Western men of sciences, such as Arnau de Villanova.[30]

The School of Chartres, which was one of the principal points of departure of the intellectual movement in Europe was the work and the inspiration of people such as Fulbert (of Chartres) who was one of Gerbert of Aurillac's (d.1003) students, Gerbert, himself was the first true Arabist of all Western scholars.[31]

The Norman court in England was a thriving centre where Islamic learning, astronomy most particularly, found the largest place courtesy of the first English scholars of Muslim thought viz. Petrus Alphonsi, Walcher of Malvern, and Adelard of Bath.[32] The birth of Western mathematics began with Fibonacci's 'Liber Abacci '(1202), whose early studies were done in the city of Bejaia, in today's Algeria.[33] It is needless of course to extend this survey further, the field being open for any curious researcher who can pick on any place, or figure of learning, during the 11th to 15th centuries (and locate the Islamic link, often hidden, but nonetheless always there.

The role of Sicily has been well studied by Michelle Amari, but unfortunately the work, although extremely old has remained inaccessible because it is only available in Italian.[34] Haskins has touched a little on the role of Sicily, but other modern historians, on the whole, have worked hard to reformulate many of the conclusions arrived at by Haskins and Amari, by reducing mention of Islamic influence to its bare minimum. Hence, unless Amari's work is translated, the true place of the Muslim influence via Sicily will not be grasped, especially as the process of revisionism of history continues unabated. One must refer, albeit but briefly to some aspects of such Sicilian influence, mainly via the role of Frederick II (1194-1250).

Frederick had from his infancy grown up using Arabic, the language of his court. He was both a cultural convert and a proselytizing patron of the then current Islamic culture.[35] It was Frederick II who encouraged Plato of Tivoli and Fibonacci, `the founders of European mathematics,' to gather Muslim and Jewish scholars to undertake translation of every available Arabic book, and he himself sent Michael Scot to Cordoba to obtain works by Ibn Sina to distribute copies to existing schools.[36] Frederick himself conducted extensive correspondence with learned Muslims and Jews from both Al-Andalus and the cultural centres of the Middle East. His court was the intellectual capital of a world already in upheaval because of the translations of Islamic science which were spreading from Spain throughout the north.[37] Due to his preference of surrounding himself with Muslim rather than Christian influence, 'he was half Muslim in his own ways', states Sarton.[38] It was under his rule, Briffault explains, that Muslim culture on the island

reached its height and had `a great and far reaching civilising influence over barbaric Europe.'[39] During the reign of Frederick the University of Naples in 1224, the first university of Europe which was founded at a definite time, and by a definite charter,[40] was founded. And following the traditional Muslim model the university was fitted with a considerable collection of Arabic books.[41] Frederick also established universities in Messina and Padua, and renovated the old medical school of Salerno `in accordance with the advances of Arab medicine.'[42] Frederick himself was widely respected, admired, and even envied in certain circles. But Frederick was anathema to the Church. Like al-Andalus itself, he was viewed with astonishment, admiration, and envy combined with fear and suspicion.[43]At the Council of Lyon, Pope Innocent III made it clear that his association with heretics (to Frederick they were simply scholars and learned men) had caused Frederick's own heresy.[44]

Sicily both before and during Frederick's rule never ceased to act as a magnet for literati and intellectuals from the rest of Western Christendom. Northern scholars visited the island in large numbers, and `wished to carry back some specimen of that eastern learning whose fame was fast spreading in the lands beyond the Alps.'[45]From the island was derived the English fiscal system, similar to the name it has today: The Exchequer, introduced by Thomas Brown (Qaid Brun) when he transferred his services from Roger II in Sicily to Henry II in England.[46] The best known translator in Sicily was Michael Scot, whose translation in 1217 of Al-Bitruji (alpetragius) 'On The Sphere' literally revolutionised the study of astronomy particularly the planets.[47] Finally a few words on the island's contribution to the advances made in geography and cartography, courtesy of Al-Idrisi, who graced the courts of Roger II in Palermo, and on whose geography was built so much subsequent knowledge of the world.[48]

The best work on the influence of the Eastern Islamic thought on Western Christendom during the Crusades is by a German: Prutz's Kulturgeschichte der kreuzzuge.[49] The most unfortunate thing is, again, unlike many of the hollow books covering Islamic history and civilisation, and which have been eagerly studied and translated, this work has been left untouched, never translated into any other language. Extracts here and there offer a fairly good image of the Crusaders' impact, though. Cochrane gives some brief idea on the Crusades' impact through her study of the career and life of Adelard of Bath, the first English scientist, who travelled eastwards during the Crusades.[50] Cochrane, relying on the works by Harvey in particular,[51] shows such Muslim influence on Western construction techniques during the times of the Crusades.[52] She explains how pre Norman churches in England, so many of which had skew chancels, revealed the builders' difficulty to achieve true rectangles. In the development of the so called Gothic style, she hails the use of the pointed arch, which was made possible via the contacts with the Muslims during the Crusades. Harvey, to whom she refers, quotes Christopher Wren's `the new architecture should be called Saracenic rather than Gothic.'[53] Whilst the new geometry that was then introduced in the West could have played a part, Cochrane points out that the transition was rapid following the First Crusade. Local builders employed by the Crusaders revealed the solutions to the problems of construction orally or by demonstration. Talbot Rice points out that in the area dominated by the Seljuk Turks during the Crusades there was building work `involving fine stone masonry, pointed arches, elaborate voussoirs and defensive conceptions which were to follow in Romanesque and Gothic architecture a generation or so later.'[54] And to support the notion further, the proportioning of the arches in the Islamic world is, `basically similar to early Gothic. The system had the advantage of deriving its ratios from the perfect square, a favoured shape in Islamic buildings century after century.'[55] Cochrane also points out that it was not just via the Crusades that the influence worked but also in their former territories of Europe, where, as she explains, the first impetus towards a new style came with the defeat of the Muslims in Spain and Sicily.[56]

Higher learning, in the way it is organised today also found its way to the West via the Crusades mainly, although as shown previously Spain had provided an impact, too. Makdisi[57] outlines yet another excellent work which remains mostly inaccessible on the history of learning, that is Ribera's excellent Disertaciones Y Opusculos, in which Ribera gives his views on the Muslim source of modern university learning.[58] Ribera states that the rise of European universities followed Oriental universities, and that the channels of communication was opened by the Crusades. In justification Ribera cites three phenomena:

1) The swiftness of the universities appearance and propagation, without slow and gradual transformation of the organisation of studies.

2) The contrasts which prevailed in the customs and organisation of these universities, `betraying a fusion of opposing tendencies of two distinct civilisations.'

3) The custom of granting certificates or degrees that has no precedent in the Christian Middle Ages, or in Rome, or in Greece, but that was prevalent in the Muslim world, where masters were already doing so `for three or four centuries in that form used in the beginning by university professors, to be converted later in Europe into monopolistic patents and surviving down to the present day.' [58]

The crusades offered much else that it is too long to discuss here, and belong, hopefully to future works, including in this respect: the practice of bathing, sugar and glass production, many branches of textile manufacturing, the art of castle fortification, the spirit of chivalry, and so on and so forth.

Although translations of Islamic science were undertaken in Barcelona, Tarazon, Segovia, Leon, Pamplona, Toulouse, Beziers, Narbonne and Marseille, the chief centre of translation remained: Toledo. Re-conquered by the Christians in 1085, after being almost four centuries (702-1085) in Muslim hands, Toledo, the ancient Visigoth capital, soon became the ideal place from where Muslim science was to be transferred north. It was in Toledo that possibly the greatest translation effort in the history of science took place. Throughout the early stages of the 12th century Toledo was the focal point, which attracted every single minded scholar and translator of the Christian West.[59] D'Alverny explains how:

> *"Following the steps of the Christian armies, students from all countries rushed to Spain to lay hands on the treasures of science piling in the `armaria' of the Infidels,"* [60]

Scholars from all Christian lands rushed to that place to translate Muslim science, and thus start the scientific awakening of Europe. Many of course were Spaniards: John of Seville, Hugh of Santalla, and those working under the patronage of King Alfonso; another translator was Herman from Dalmatia; two came from Flanders, Rudolph of Bruges and Henry Bate; many from southern France: Armengaud son of Blaise, Jacob Anatoli, Moses ibn Tibbon, Jacob ben Mahir, and from Italy: Plato of Tivoli, Gerard of Cremona, Aristippus of Catania, Salio of Padua, John of Brescia.[61] From the British Isles will arrive Robert of Chester, Daniel of Morley, M. Scot, and possibly Adelard (of Bath), and others, including the intermediaries who helped transfer Islamic science from Arabic into Latin or local languages.

Amongst such translators the most prolific of all was the Italian Gerard of Cremona, who translated about 87 works amongst which included the Toledan tables of al-Zarqali Canones Arzachelis and Jabir ibn Aflah's

Islah al Majisti (correction of the Almagest of Ptolemy.) His other translations include The Banu Musa's Liber trium fratrum,[62] Al-Khwarizmi's: De jebra et elmucabala, Abu Kamil: Liber qui secundum Arabes vocatur algebra et almucabala, Abu'l Qasim Al-Zahrawi: Liber Azaragui de cirurgia (treatise on surgery)[63] Al-Farabi: De scientiis,-Al-Kindi'sworks on physics and mechanics: De aspectibus; followed by De umbris et de diversitate aspecturm,[64] Ibn al-Haytham's work on physics: De crepusculis et nubium ascensionibus,[65] Al-Kindi's: De gradibus medicinarum (on medicine).[66] Amongst the translations made by the Jew turned Christian, John of Seville, are Al-Battani's Treatise on astronomy and other works; Thabit ibn Qura: De imaginibus astronomicis; Maslama ibn Ahmed al Majriti: De astrolabio; Al-Farabi: Ihsa al-Ulum; Abu Ma'shar: Al-Madkhal ila `ilm ahkam al-nujum; Al-Ghazali: Maqasid al-falasifa; Al-Farghani: Kitab fi harakat al-Samawiya wa jawami' ilm al-nujum...

It is not necessary to list all the translations since they can be found in greater detail, together with their successive editions, and a vast bibliography relating to them in G. Sarton's Introduction.[67]

Every science was affected by the translation movement. The list and variety of seminal Muslim medical works that were translated at Toledo and used for inspiration is endless. Campbell,[68] and by far the best work on the subject by Leclerc[69] remain very good sources of reference for any curious mind on this matter. Just to mention briefly here, that it was a Tunisian born named Constantine, who introduced modern medicine into Europe through the southern Italian town of Salerno making it the first medical centre of Europe from which medical learning radiated north to Padua, Montpellier etc. Constantine had, indeed, carried with him vast amount of knowledge from Qayrawan northwards to Europe, following which arose `a generation of prominent medical teachers.'[70] Constantine's best known translation is that of Ali Abbas al-Majusti's Kitab al-Malaki, known under the Pantegni.[71]
One does not need to dwell here on the many translations and editions up to the 18th century of the works of Ibn Sina and Al-Razi, and other medical works by Ibn Zuhr, Ibn Rushd, etc.. However it must be stressed that the Muslims pioneered and had an early impact in the sphere of mental health. It was in fact the direct contribution of Al-Razi, who set up an exclusive ward for the mentally ill in Baghdad. And it was the Muslims, who, as Syed explains,[72] `brought a refreshing spirit of dispassionate clarity into psychiatry.' And as they were free from `the demonological theories' which were sweeping over the Christian world, they could make clear cut clinical observations about such diseases.[73]

Modern surgery owes about everything Al-Zahrawi (d.1013). Al-Zahrawi's chapter on surgery from Kitab al-Tasrif is `particularly outstanding' due to the frequent illustration of instruments and `its pervading sense of personal experience.'[74] Most of the instruments were devised and made by al-Zahrawi himself, and their introduction and use was a major breakthrough at the time,[75] and had a lasting influence. His surgical techniques were also revolutionary, and Smith gives very good illustrations of them.[76] For calculus in the urethra, for instance, Al-Zahrawi introduced the technique of using a fine drill inserted through the urinary passage. In the case of tonsillectomies, whilst he held the tongue by a tongue depressor, he removed the swollen tonsil holding it by a hook, and then removed it with a scissor like instrument with transverse blades which cut the gland, whilst holding it for removal from the throat. Al-Zahrawi also described how to connect sound teeth to those that were loose by gold or silver wire. In gynaecology, his work, alongside that of other pioneering Muslim surgeons, included instructions on training midwives to perform unusual deliveries, ways of extracting dead foetuses, the removal of the afterbirth, the design and introduction of vaginal dilaters, the description of forceps, and the use of caesarian methods. The surgical part of Al-tasrif was translated into Latin by Gerard of Cremona, and various editions were published at Venice in 1497, at

Basel in 1541 and Oxford in 1778, and for centuries, it remained the manual of surgery in all early medical universities such as Salerno and Montpellier, whilst the illustrations of his instruments laid the foundations for surgery in Europe.[77] Muslim surgeons also, as Smith observes, displayed a sensible and humane reluctance to undertake the riskiest and most painful operations, and were also aware of the discomfort they inflicted on patients. This could be seen as a decisive breakthrough in the relationship between the surgeon and the patient.[78]

The Muslim influence on pharmacy is similarly considerable. Levey gives a very good account of such influence.[79] According to him, many influential Latin works of the `Renaissance' and thereafter are just compilations and slightly altered works of previous Muslim treatises. Belonging to such recensions is Johannes of St Awand's Expositio Supra Nicolai Antidotarium written in 1250 and published in Venice in 1495, 1599 and 1602. Conciliator and De Venenorum remediis by Albano (professor in Padua from 1306 to 1316), while extensive extracts from Ibn Rushd and Al Maradini[80] were repeatedly printed over the years. An important work on pharmacy in the modern sense, Levey maintains, is greatly influenced by the works of Ibn Sinna, Ibn Sarabiyun (known in Latin as Serapion), Al-Zahrawi and Ibn Masawaih (al-Maradini) in form and content was written by Saladin of Ascolo, a well known physician of the 15th century, and called Compendium aromatariorum.[81] Divided into seven parts, this work follows exactly Muslim categorisation of subjects: examination of the pharmacist, the qualities desired for the pharmacist, substitute drugs, care of simple and compound drugs, etc. Another work that also greatly influenced European pharmacopoeias using material from Muslim treatises on simple 'drug' substitutes, preservation of drugs, lists of little known drugs, etc, was that by Ludovico dal Pozzo Toscanelli, a physician of Florence who was authorised to do so by the Florentine College of Physicians, and from which compendium various editions were made.[82] Pharmacopoeias in German, French, English and Spanish also showed Muslim influence,[83] whilst a later edition of the London Dispensatory, in the late 17thcentury, in its list of botanicals, minerals, simple / compound drugs for external and internal uses, oils, pills, cataplasms, etc, reflects the extent of Muslim influence.[84] Most Muslim material was in fact used until late in the nineteenth century, and Levey concludes that there is much to be learned yet from their early drug treatises.[85]

In chemistry, the works of Jabir and Al-Razi set the foundations to the modern science. Jabir, known as Geber in Latin, described the preparation of many chemical substances: sulphide of mercury, oxides, arsenics etc. He made applications that led to major industrial transformations, including the refining of metals, dyeing of clothes (crucial for the textile industry some centuries later,) the use of manganese in glass making (to become another fundamental industry in Europe,) use of pyrites, and gave an exact description of processes such as calcination, crystallisation, solution, sublimation and reduction.[86] Al-Razi's work is wary of using the mystical and even occult elements which affect so much of Jabir's and his predecessors' works. His Secret of Secrets, in Latin Liber secretorum bubacaris, describes the chemical processes and experiments conducted by him, and which can be identified as equivalent to modern processes ranging from distillation to calcination, crystallization etc.[87] Al-Razi also divided substances into animal, vegetable, and mineral.; the mineral substances include mercury, gold, silver, pyrites, glass etc: vegetable substances were mainly used by physicians; whilst animal substances divided into hair, blood, milk, eggs, bile etc.[88] Al-Razi was also a practical chemist gaving laboratory work pre-eminence over theoretical observations. Hill points out that Al-Razi's 'Book of Secrets' `foreshadows a laboratory manual' and deals with substances, equipment and processes.[89] Al-Razi's laboratory includes many items still in use today: crucible; decensory; cucurbit or retort for distillation (qar) and the head of a still with a delivery tube (ambiq, Latin alembic); various types of furnace or stove etc.[90] Some of Al-Razi's revolutionary experiments,

derived from his 'Secret of Secrets',[91] include ways of smelting metals, the sublimation of mercury, the preparation of caustic soda, the use of the mercury ammonium chloride solution as a dissolving reagent, and the preparation of glycerine from olive oil. Al-Razi's lead in careful experimentation and observations demonstrated, as Holmyard put it: `that a by-product of alchemy was a steadily increasing body of reliable chemical knowledge, a trend which Al-Razi did most to establish and for which he deserves the gratitude of succeeding generations.'[92]

Still on chemistry, Hill also notes that works by many Muslim chemists included recipes for products that had industrial or military uses.[93] He points out that the discovery of inorganic acids was of crucial importance for the history of chemistry. These acids were produced during chemical experiments but became valuable agents for industrial applications.[94]

In optics, the works of the Muslims set up the foundations for all that was to follow. Excellent extracts can be found in Lindberg's study of the Islamic impact on Latin optics in Rashed's Encyclopaedia.[95] The Islamic role is highlighted by their demolition of the previous Greek erroneous assumptions of optical theory. Hunain ibn Ishaq, first, followed by al-Kindi, criticised the Greek theory a critique outlined by Lindberg.[96] It was, however, Ibn al-Haytham who revolutionised the whole science, determining by experimentation many optical phenomena. Ibn al-Haytham's achievements, as summarised by Lindberg,[97] show that he did not just explain the principal facts of visual perception but also managed to establish the intromission theory of vision beyond all doubt and dispute for good. He `fundamentally' altered the aims and scope of the optical theory, and also managed to integrate into his theory anatomical and physiological claims of the medical theory. Thus, as Lindberg concludes, he was able `to draw together the mathematical, physical and medical traditions into a single comprehensive theory.... He created a new optical tradition and established the aims and criteria of optics which would prevail, though not without rivals, until Kepler and beyond.'[98] Further achievements of Ibn al-Haytham include developing precision instrumentalisation, expounding for the first time the use of the camera obscura, and writing treatises on the halo and rainbow.[99] Hill states, `unquestionably, the most important work on physics to reach the West in medieval times was Kitab al-Manazir.[100] The influence of this work, with its intromission theory of vision and its completely new methodology had a profound impression on others, particularly Roger Bacon and Witelo.[101]

The foregoing is just the briefest of outlines of the Islamic influence which brought about the revival of science and learning in Western Christendom, and eventually our modern civilisation based on such Western learning.

There are many excellent works that can serve future researchers interested in this subject. Sarton's 'Introduction to the History of Science' can be a beginning for anyone interested to sift through the thousands of pages of his voluminous work, looking not just under the term 'Islamic' but also `European/Latin Christendom' to understand how Christians of the Middle Ages acquired their sciences via Islamic sources. Rashed's 'Encyclopaedia' has also a volume, on the Islamic impact on European science and learning, which is very useful.[102]Other works include those cited above, most particularly those by Ribera, Leclerc, Amari, and Prutz to understand the role of the Islamic impact on the field of university learning, medicine, the Sicilian impact and that of the Crusaders. To gather how the Muslims influenced Western trade, and how the Islamic economic power was broken by both European pirates and papal policies, there is nothing better than Heyd's 'Levant Trade' cited above. To comprehend the Islamic role in mechanics and physics, the best sources are German, especially Widemann's,[103]although Hill, until his

death, in 1994, has somehow rehabilitated the subject in English. Suter has given excellent indications of the Islamic role in astronomy and mathematics.[104] Sezgin is by far one of those who have done so much these days to revive the interest in Islamic science and its impact, and again, the most unfortunate fact is that, like all excellent works, his is only available in German.[105] Amongst the English writing authors who can enlighten the reader further on the Islamic impact are Eugene Myers,[106] D. Metletzki,[107] Turner[108] and Menocal. In French Aldo Mieli's work on the role of Islamic science in the awakening of modern science, as the title suggests is a 'must'.[109] In Spanish, there are excellent works by Vernet[110] and Millas Vallicrosa,[111] and of course Castro.[112] Then, of course, there are the many works and articles, which either this author has not cited, or failed to access, or even are difficult to access with thousands of them, many gathering dust in the depths of libraries for decades- or over a century- and containing by far the best information of all on the subject. Modern works filling the shelves of libraries, and the readily available volumes on the history of science, in their overwhelming majority have very little to offer since the history of science and civilisation continues to be classically and Eurocentrically driven.

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