Encyclopedia of Muslim World

Garrison Aragon

Revised Edition: 2016

ISBN 978-1-280-22798-1

Published by:
Learning Press
48 West 48 Street, Suite 1116,
New York, NY 10036, United States
Email: info@wtbooks.com

Table of Contents

Chapter- 1

Muslim History

Muslim history involves the history of the Islamic faith as a religion and as a social institution. The evolution of Islam has impacted the political, economic, and military history of an enormous geography. The concept of the *Islamic world* is useful in observing the different periods of Islamic history; similarly useful is an understanding of the identification with a quasi-political community of believers, or *ummah*, on the part of Islam's practitioners down the centuries. Islamic culture encourages identification with the ummah, and this principle has influenced the behavior of a number of players in history. The history of Islam is closely tied to the political, economic, and military.

A century after the death of the Islamic prophet Muhammad, an Islamic empire extended from the Atlantic Ocean in the west to Central Asia in the east. The subsequent empires of the Umayyads, Abbasids, the Fatimids, the Mughals, the Safavids, and Ottomans were among the largest and most powerful in the world. The Islamic civilization gave rise to many centers of culture and science and produced notable scientists, astronomers, mathematicians, doctors, nurses and philosophers during the Golden Age of Islam. Technology flourished; there was much investment in economic infrastructure, such as irrigation systems and canals; and especially, the importance of reading the Qur'an produced a comparatively high level of literacy in the general populace.

Later, in the 18th century and 19th century, many Islamic regions fell under the tutelage of European imperial powers. After the First World War, the remnants of the Ottoman empire were parceled out as European protectorates. Since 1924, there has been no major widely accepted claim to the caliphate (which had been last claimed by the Ottomans).

Although affected by various ideologies such as communism, during much of the 20th century, the Islamic identity and the dominance of Islam on political issues have arguably increased during the early 21st century. The fast-growing Western interests in Islamic regions, international conflicts and globalization have changed the influence of Islam on the world of the 21st century.

Origins

According to the traditionalist view, the Qur'an began with revelations on Muhammad's divine revelations in AD 610. The verses of the Quran were written down and memorized during his life. Makkah was conquered by the Muslims in the year AD 630. In 628 the Makkan tribe of Quraish and the Muslim community in Madina had signed a truce called the Treaty of Hudaybiyya beginning a ten-year period of peace, which was broken when the Quraish and their allies, the tribe of 'Bakr', attacked the tribe of 'Khuza'ah', who were allies of the Muslims. Prophet Muhammad died in June 632. The Battle of Yamama was fought in December of the same year, between the forces of the Rashidun Caliph Abu Bakr and Musailima.

Andrey Korotayev and his colleagues suggest to view the origins of Islam against the background of the 6th century AD Arabian socioecological crisis whose model is specified by Korotayev and his colleagues through the study of climatological, seismo-logical, volcanological and epidemiological history of the period. They find that most sociopolitical systems of the Arabs reacted to the socioecological crisis by getting rid of the rigid supratribal political structures (kingdoms and chiefdoms) which started posing a real threat to their very survival. The decades of fighting which led to the destruction of the most of the Arabian kingdoms and chiefdoms (reflected in *Ayyam al-`Arab* tradition) led to the elaboration of some definite "antiroyal" freedom-loving tribal ethos. At the beginning of the 7th century a tribe which would recognize themselves as subjects of some terrestrial supratribal political authority, a "king", risked to lose its honour. However, this seems not to be applicable to the authority of another type, the "celestial" one. At the meantime the early 7th century evidences the merging of the Arabian tradition of prophecy and the Arabian Monotheist "Rahmanist" tradition which produced "the Arabian prophetic movement". The Monotheist "Rahmanist" prophets appear to have represented a supratribal authority just of the type many Arab tribes were looking for at this very time, which seems to explain to a certain extent those prophets' political success (including the extreme political success of Muhammad). (Andrey Korotayev, Vladimir Klimenko, and Dmitry Proussakov. Origins of Islam: Political-Anthropological and Environmental Context. *Acta Orientalia Academiae Scientiarum Hungaricae*. 53/3–4 (1999): 243–276). v

Early Caliphate

After Muhammad died, a series of Caliphs governed the Islamic State: Abu Bakr Siddique, Umar, Uthman and Ali. These first Caliphs are popularly known as the "Rashidun" or "rightly guided" Caliphs in Sunni Islam. After the Rashidun, a series of

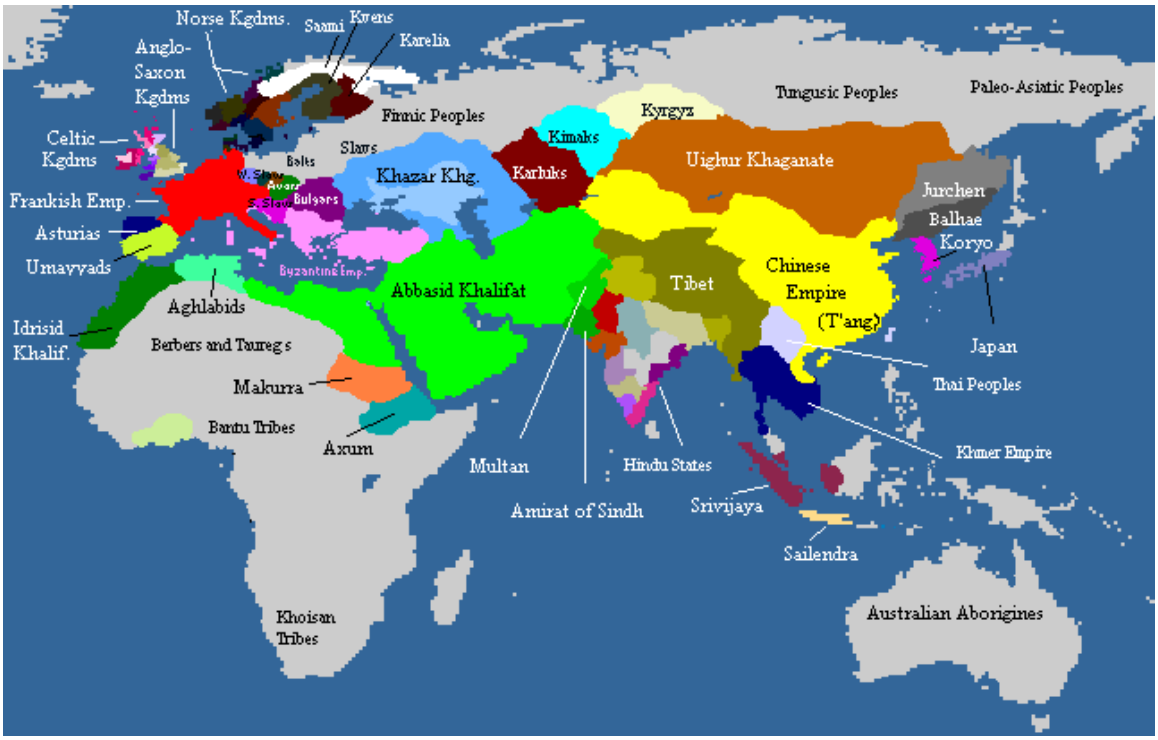
Caliphates were established. Each caliphate developed its own unique laws based on the sharia. There were at times competing claims to the Sunni caliphate, and the Imams of Ismaili Shi'a Islam, descended from Ali and Muhammad through his daughter Hazrat Fatimah, set up their own caliphate which ruled the Fatimid Empire.

Al-Rashidun - "The Rightly Guided Caliphs"

Following Muhammad's death, a series of four Caliphs lead the Islamic Empire during this period. Starting with Abu Bakr, Omar, Uthman, and ending with Ali. Before his death, Muhammad acknowledged Ali as the leader after him. (as per Shiaa belief). Ali was born in the Kaaba. He made this announcement at Masjid-al-Haram when Ali was born. (As per Shiaa belief)

Abbasids - "Islamic Golden Age"

The gains of the Ummayad empire were consolidated upon when the Abbasid dynasty rose to power in 750, with the conquest of the Mediterranean islands including the Balearics and Sicily. The new ruling party had been instated on the wave of dis-satisfaction propagated against the Ummayads, cultured mainly by the Abbasid revolutionary, Abu Muslim. Under the Abbasids, Islamic civilization flourished. Most notable was the development of Arabic prose and poetry, termed by *The Cambridge History of Islam* as its "golden age". This was also the case for commerce and industry (considered a Muslim Agricultural Revolution), and the arts and sciences (considered a Muslim Scientific Revolution), which prospered, especially under the rule of Abbasid caliphs al-Mansur (ruled 754 — 775), Harun al-Rashid (ruled 786 — 809), al-Ma'mun (ruled 809 — 813), and their immediate successors.



Abbasid Caliphate and contemporary states and empires in 820

Baghdad was made the new capital of the caliphate (moved from the previous capital, Damascus) due to the importance placed by the Abbasids upon eastern affairs in Persia and Transoxania. It was at this time however, that the caliphate showed signs of fracture and we witness the uprising of regional dynasties. Although the Ummayad family had been killed by the revolting Abbasids, one family member, Abd ar-Rahman I, was able to flee to Spain and establish an independent caliphate there in 756. In the Maghreb region, Harun al-Rashid appointed the Arab Aghlabids as virtually autonomous rulers, although they continued to recognise the authority of the central caliphate. Aghlabid rule was short lived, as they were deposed by the Shiite Fatimid dynasty in 909. By around 960, the Fatimids had conquered Abbasid Egypt, building a new capital there in 973 called "*al-Qahirah*" (meaning "the planet of victory", known today as Cairo). Similar was the case in Persia, where the Turkic Ghaznavids managed to snatch power from the Abbasids. Whatever temporal power of the Abbasids remained had eventually been consumed by the Seljuq Turks (a Muslim Turkish clan which had migrated into mainland Persia), in 1055.

During this time, expansion continued, sometimes by military warfare, sometimes by peaceful proselytism. The first stage in the conquest of India began just before the year 1000. By some 200 (from 1193 — 1209) years later, the area up to the Ganges river had been conquered. In sub-Saharan West Africa, it was just after the year 1000 that Islam was established. Muslim rulers are known to have been in Kanem starting from sometime between 1081 to 1097, with reports of a Muslim prince at the head of Gao as early as 1009. The Islamic kingdoms associated with Mali reached prominence later, in the 13th century.

During the Abbasid reign, Baghdad became one of the greatest cultural centers of the world. Abbasid caliphs Harun al-Rashid and Al-Mamun were great patrons of arts and sciences, and enabled these domains to flourish. Islamic philosophy also developed as the Shariah was codified, and the four Madhabs were established and built. This era also saw the rise of classical Sufism. The greatest achievement, however, was completion of the canonical collections of Hadith of Sahih Bukhari and others.

Regional powers

The Abbasids soon became caught within a three-way rivalry of Arabs, Persians and the immigrant Turks. In addition, the cost of running a large empire became too great. The political unity of Islam began to disintegrate. The Emirates, still recognizing the theoretical leadership of the caliphs, drifted into independence, and a brief revival of control was ended with the establishment of rival caliphates. Eventually the Abbasids ruled as puppets for the Buwayhid emirs. During this time, great advancements were made in the areas of astronomy, poetry, philosophy, science, and mathematics.

The Fatimid Empire

Al-Hakim Mosque, Cairo, Egypt

The Fatimids had their origins in Ifriqiya (modern-day Tunisia and eastern Algeria). The dynasty was founded in 909 by **'Abdullāh al** -Mahdī Billah, who legitimised his claim through descent from Muhammad by way of his daughter Fātima as-Zahra and her

husband ʿAlī ibn -Abī-Tālib, the first Shī ʿa Imām, hence the name *al-Fātimiyyūn* "Fatimid".

Abdullāh al-Mahdi's control soon extended over all of central Maghreb, an area consisting of the modern countries of Morocco, Algeria, Tunisia and Libya, which he ruled from Mahdia, his newly built capital in Tunisia.

The Fatimids entered Egypt in the late 10th century, conquering the Ikhshidid dynasty and founding a new capital at *al-Qāhira*(Cairo) in 969. The name was a reference to the planet Mars, "The Subduer", which was prominent in the sky at the moment that city construction started. Cairo was intended as a royal enclosure for the Fatimid caliph and his army, though the actual administrative and economic capital of Egypt was in cities such as Fustat until 1169. After Egypt, the Fatimids continued to conquer the surrounding areas until they ruled from Tunisia to Syria and even crossed over into Sicily and southern Italy.

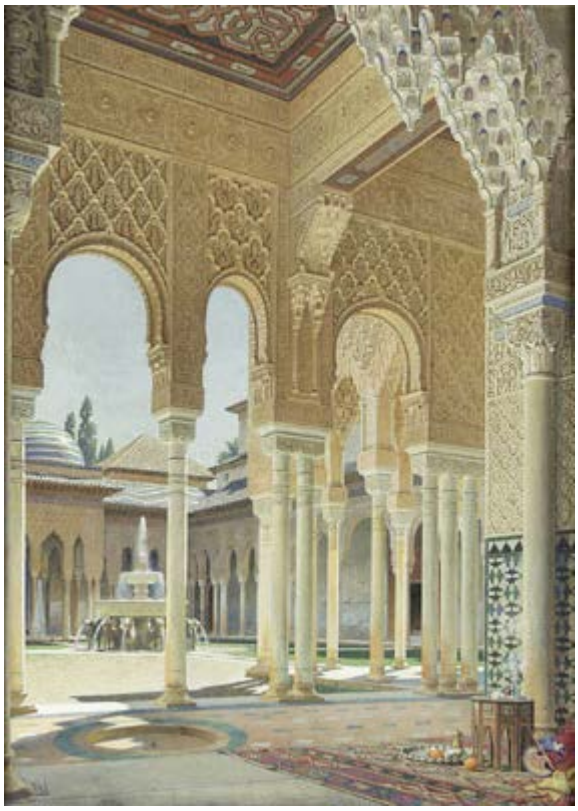
Under the Fatimids, Egypt became the center of an empire that included at its peak North Africa, Sicily, Palestine, Lebanon, Syria, the Red Sea coast of Africa, Yemen and the Hejaz. Egypt flourished, and the Fatimids developed an extensive trade network in both the Mediterranean and the Indian Ocean. Their trade and diplomatic ties extended all the way to China and its Song Dynasty, which eventually determined the economic course of Egypt during the High Middle Ages.

Unlike other governments in the area, Fatimid advancement in state offices was based more on merit than on heredity. Members of other branches of Islam, like the Sunnis, were just as likely to be appointed to government posts as Shiites. Tolerance was extended even to non-Muslims such as Christians and Jews, who occupied high levels in government based on ability. There were, however, exceptions to this general attitude of tolerance, most notably Al-Hakim bi-Amr Allah.

The Fatimid palace was two parts. it used to be in the Khan el-Khalili area at Bin El-Quasryn street.

yahi hai tumhara allah jo tum sab ka palne wala hai usi kee saltant aur badshaht h aur jinhe tum uske siva pukaarte ho woh toh khjuur [date] ke guthli ke chhilka ke barabar bhi nahi hai.

The Iberian peninsula under the Umayyads and the Berber dynasties



The interiors of the Alhambra in Granada, Spain decorated with arabesque designs.

The Arabs, under the command of the Berber General Tarik ibn Ziyad, first began their conquest of southern Spain or al-Andalus in 711. A raiding party led by Tarik was sent to intervene in a civil war in the Visigothic kingdom in Hispania. Crossing the Strait of Gibraltar (named after the General), it won a decisive victory in the summer of 711 when the Visigothic king Roderic was defeated and killed on July 19 at the Battle of Guadalete. Tariq's commander, Musa bin Nusair quickly crossed with substantial reinforcements, and by 718 the Muslims dominated most of the peninsula. There are some later Arabic and Christian sources that present an earlier raid by a certain Ṭārif in 710 and also, the *Ad Sebastianum* recension of the *Chronicle of Alfonso III*, refers to an Arab attack incited by Erwig during the reign of Wamba (672–80). The two reasonably large armies may have been in the south for a year before the decisive battle was fought.

The rulers of Al-Andalus were granted the rank of Emir by the Umayyad Caliph Al-Walid I in Damascus. After the Abbasids came to power in the Middle East, some Umayyads fled to Muslim Spain to establish themselves there. By the end of the 10th century, the ruler Abd al-Rahman III took over the title of *Emir of Córdoba*(912-961). Soon after, the Umayyads went on developing a strengthened state with its capital as Córdoba. Al-Hakam II succeeded to the Caliphate after the death of his father Abd ar-Rahman III in 961. He secured peace with the Christian kingdoms of northern Iberia, and

made use of the stability to develop agriculture through the construction of irrigation works. Economical development was also encouraged through the widening of streets and the building of markets. The rule of the Caliphate is known as the heyday of Muslim presence in the peninsula.

The rule of the Umayyad Caliphate collapsed in 1031 due to political divisions and civil unrest during the rule of Hicham II who was ousted because of his indolence. Al-Andalus then broke up into a number of mostly independent states called *taifa kingdoms* (Arabic, *Muluk al-ṭawā'if*; English, Party kingdoms). The decomposition of the Caliphate into those petty kingdoms would then weaken the power of the Muslims in the Iberian Peninsula *vis-à-vis* the Christian kingdoms of the north. Some of the *taifas* such as that of Seville would consequently be forced to enter into alliances with the Christian princes and pay tributes in money to Castille.

The Crusades

Beginning in the 8th century C.E. the Christian kingdoms of Spain had begun the Reconquista aimed at retaking Al-Andalus from the Moors. In 1095, Pope Urban II, inspired by the holy wars in Spain and implored by the eastern Roman emperor to help defend Christianity in the East, called for the First Crusade from Western Europe which captured Edessa, Antioch, Tripoli and Jerusalem. The Christian Kingdom of Jerusalem emerged and for a time controlled many holy sites of Islam. Saladin, however, restored unity within the Umma by defeating the Fatimids, and was then able to put an end to the Kingdom of Jerusalem in 1187 C.E. Other crusades were launched with at least the nominal intent to recapture the holy city and other holy lands, but hardly more was ever accomplished than the errant looting and occupation of Christian Constantinople, leaving the Eastern Roman, or Byzantine Empire severely weakened and ripe for later conquest. However, the crusaders did manage to weaken Muslim territories preventing them from further expansion into Christendom.

The Mamluks

In 1250 C.E., the short-lived Ayyubid dynasty (established by Saladin) was overthrown by slave regiments, and a new dynasty—the Mamluks—was born. The Mamluks, who were Turkic, soon expanded into Palestine, expelled the remaining Crusader states and repelled the Mongol attempt to invade Syria. Thus they united Syria and Egypt for the longest period of time between the Abbasid and Ottoman empires (1250–1517).

Islam in Africa

The first continent outside of Arabia to have an Islamic history was Africa, particularly Abyssinia (modern day Ethiopia via modern day Eritrea).

Islam in Maghreb

The Great Mosque of Kairouan also known as the Mosque of Uqba was founded in 670, it is the oldest mosque in the Maghreb, situated in the city of Kairouan, Tunisia.

Kairouan in Tunisia was the first city founded by Muslims in this region. Arab general Uqba ibn Nafi erected the city (in 670) and, in the same time, the Great Mosque of Kairouan considered as the oldest and most prestigious sanctuary in the western Islamic world.

This part of Islamic territory has had independent governments during most of Islamic history, with a number being of historical importance.

The Idrisid dynasty were the first Arab rulers in the western Maghreb (Morocco), ruling from 788 to 985. The dynasty is named after its first sultan Idris I.

The Almoravid dynasty was a Berber dynasty from the Sahara that flourished over a wide area of North-Western Africa and the Iberian peninsula during the 11th century. Under this dynasty the Moorish empire was extended over present-day Morocco, Western Sahara, Mauritania, Gibraltar, Tlemcen (in Algeria) and a great part of what is now Senegal and Mali in the south, and Spain and Portugal in the north.

The Almohad Dynasty or "the Unitarians," were a Berber Muslim religious power which founded the fifth Moorish dynasty in the 12th century, and conquered all Northern Africa as far as Egypt, together with Al-Andalus.

Islam in East Africa

Islam in the East Africa can be dated back to the founding of the religion and the beginning with the hijra; in 615, when a group of Muslims were counseled by Muhammad to escape persecution in Mecca and travel to Abyssinia (an act known as the First migration to Abyssinia), which was ruled by, in Muhammad's estimation, a pious Christian king named *al-Najashi* (Negus, King of Abyssinia). Moreover, Islamic tradition states that the first muezzin Bilal al-Habeshi, one of the foremost companions of Muhammad, was from Abyssinia (*Habasha*).

There were Islamic governments in Tanzania. The people of *Zayd* were allegedly the first Muslims to immigrate to East Africa. Islam came to East Africa mainly through trade routes. The African peoples that lived along these routes became converts due to the close contact they had with Arab traders in areas like Tabora. They learned from them the manners of the Muslims and this lead eventually to their conversion neither with encouragement nor discouragement by the Muslim Arabs. In pre-colonial East Africa, the structure of Islamic authority was held up through the *Ulema* (*wanawyuonis,* in Swahili language). Their base was mainly in Zanzibar. These leaders had some degree of authority over most of the Muslims in East Africa at this time; especially before territorial boundaries were established. This is because the majority of Muslims lived within the sphere of influence of the Sultanate in Zanzibar. The chief Qadi there was recognized for having the final religious authority.

Islam in West Africa

Usman dan Fodio after the Fulani War, found himself in command of the largest state in Africa, the Fulani Empire. Dan Fodio worked to establish an efficient government, one grounded in Islamic laws. Already aged at the beginning of the war, dan Fodio retired in 1815 passing the title of Sultan of Sokoto to his son Muhammed Bello.

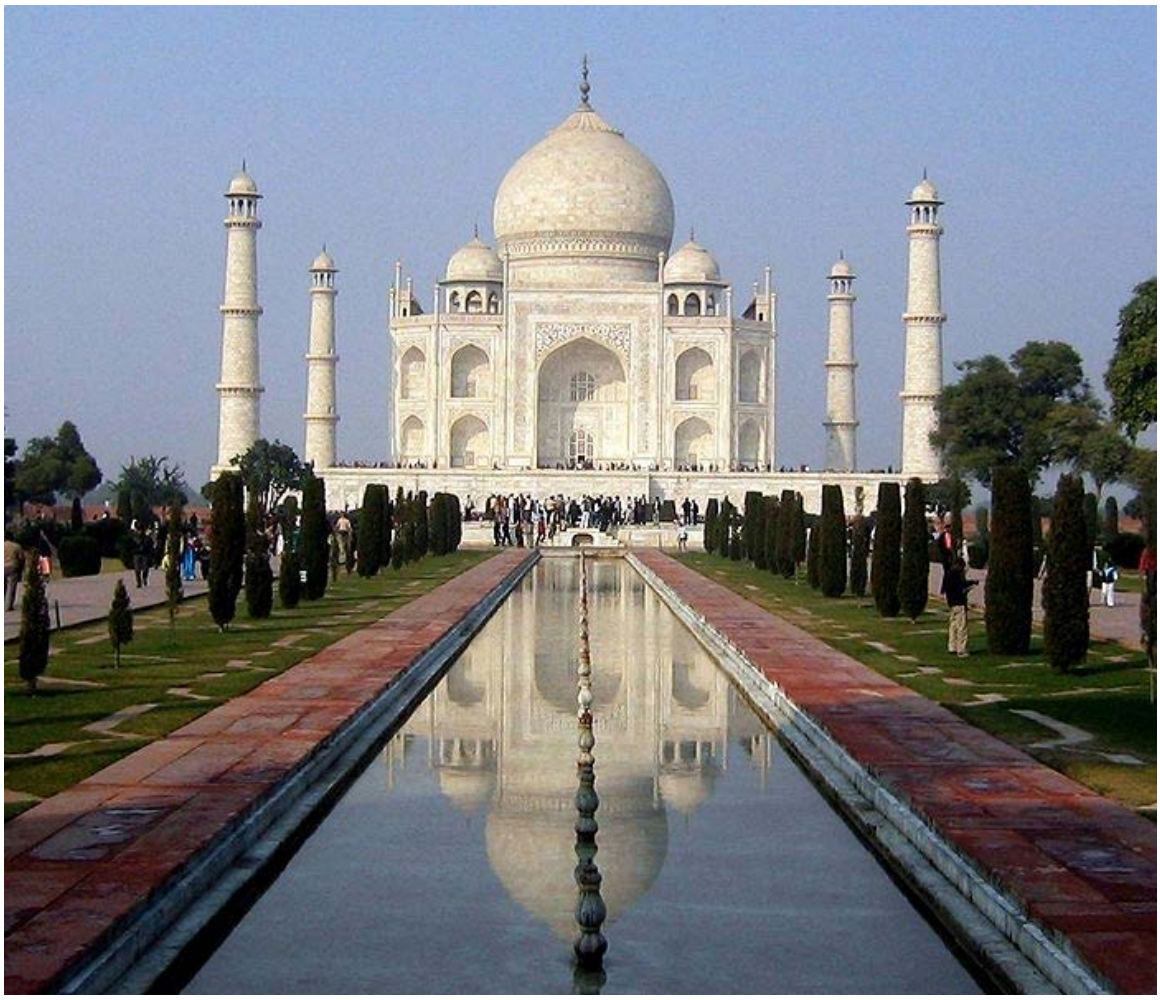
Islam in Asia

Indian Subcontinent

On the Indian subcontinent, Islam first appeared in the south western tip of the peninsula, in today's Kerala state. Arabs had trade relations with Malabar even before the birth of the Prophet Muhammed. The native legends say that, a group of Sahaba, under Malik Ibn Deenar, arrived on the Malabar Coast and preached Islam. According to that legend, the first mosque of India was built by Second Chera King Cheraman Perumal, who eventually accepted Islam and received the name *Tajudheen*. He traveled to Arabia to meet

the Prophet and died on the trip back, somewhere in today's Oman. There are historical records which suggests that the Cheraman Perumal Mosque was built in Hijra 5(629 CE).

In North India, Islamic rule came to the region in the 8th century, when Muhammad bin Qasim conquered Sindh, (Now Pakistan). Muslim conquests were expanded under Mahmud and the Ghaznavids until the late 12th century, when the Ghurids overran the Ghaznavids and extended the conquests in Northern India. Qutb-ud-din Aybak conquered Delhi in 1206 and began the reign of the Delhi Sultanates.



The Taj Mahal

In the 14th century, Alauddin Khilji extended Muslim rule south to Gujarat, Rajasthan and Deccan. Various other Muslim dynasties also formed and ruled across India from the 13th to the 18th century such as the Qutb Shahi and the Bahmani, but none rivalled the power and extensive reach of the Mughal Empire at its peak.

[azar]=this artical relatid by muslim power and mind india is best cuntri muslim power in india 1000 year total india in hindu-40% and muslim-60% muslim in-shaa sunni ahla-hadis hanfi adher india in panipath war in 1626-22 jnu. sakind panipath in 1656 and third

1745 they time mugall power is ultimad first time intre einland laisans in india akber child baber maharastra in thane-did you mean

China

China has never been a Muslim country, but it has a substantial Muslim community.

Southeast Asia

Islam reached the islands of Southeast Asia through Indian Muslim traders from Gujarat near the end of the 13th century. The traders offered increased economic opportunities to locals who adopted Islam. Soon, many Sufi missionaries translated classical Sufi literature from Arabic and Persian into Malay. Coupled with the composing of original Islamic literature in Malay, this led the way to the transformation of Malay into an Islamic language. By 1292, when Marco Polo visited Sumatra, most of the inhabitants had converted to Islam. The Sultanate of Malacca was founded by Parameswara, a Srivijayan Prince in the Malay peninsula. Through trade and commerce, Islam spread to Borneo and Java, Indonesia. By the late 15th century, Islam had been introduced to the Philippines.

As Islam spread, three main Muslim political powers emerged. Aceh, the most important Muslim power, was based firmly in Northern Sumatra. It controlled much of the area between Southeast Asia and India. The Sultunate also attracted Sufi poets. The second Muslim power was the Sultanate of Malacca on the Malay peninsula. The Sultanate of Demak was the third power, appearing in Java, where the emerging Muslim forces defeated the local Majapahit kingdom in the early 16th century. Although the sultanate managed to expand its territory somewhat, its rule remained brief.

Portuguese forces captured Malacca in 1511 under the naval general Afonso de Albuquerque. With Malacca subdued, the Aceh Sultanate and Brunei established themselves as centers of Islam in Southeast Asia. Brunei's sultanate remains intact even to this day.

Mongol invasions

The wave of Mongol invasions, which had initially commenced in the early 13th century under the leadership of Genghis Khan, marked a violent end to the Abbasid era. The Mongol Empire had spread rapidly throughout Central Asia and Persia: the Persian city of Isfahan had fallen to them by 1237. With the election of Khan Mongke in 1251, Mongol sights were set upon the Abbasid capital, Baghdad. Mongke's brother, Hulegu, was made leader of the Mongol Army assigned to the task of subduing Baghdad. This was achieved at the Battle of Baghdad (1258), in which the Abbasid army was defeated by the superior Mongol army. The last Abbasid caliph, al-Musta'sim, was captured and killed; and Baghdad was ransacked and subsequently destroyed. The cities of Damascus and Aleppo fell shortly afterwards, in 1260. Plans for the conquest of Egypt were temporarily delayed due to the death of Mongke at around the same time.

With Mongol conquest in the east, the Ayyubid dynasty ruling over Egypt had been replaced by a man who was born prince struggled as a slave named Mamluks also known as Lion of Ain Jaloot in 1250. This had been done through the marriage between Shajar al-Durr, the widow of Ayyubid caliph al-Salih Ayyub, with the Mamluk general Aybak. Military prestige was at the center of Mamluk society, and it played a key role in the confrontations with the Mongol forces. After the assassination of Aybak, and the succession of Qutuz in 1259, the Mamluks challenged and decisively routed the Mongols at the Battle of Ain Jalut in late 1260. This signalled an adverse shift in fortunes for the Mongols, who were again defeated by the Mamluks at the Battle of Hims a few months later, and then driven out of Syria altogether. With this, the Mamluks were also able to conquer the last of the crusader territories.

Three Muslim empires of the Early Modern Era

In the 15th and 16th centuries three major Muslim empires were created: the aforementioned Ottoman Empire in much of the Middle East, the Balkans and Northern Africa; the Safavid Empire in Greater Iran; and the Mughul Empire in South Asia. These new imperial powers were made possible by the discovery and exploitation of gun-powder, and a more efficient administration. By the end of the 19th century, all three had declined significantly, and by the early 20th century, with the Ottomans' defeat in World War I, the last Muslim empire collapsed.

Mughal Empire

Humayun's Tomb inDelhi, India

The Mughal Empire was a product of various Central Asian invasions into the Indian subcontinent. It was founded by the Timurid prince Babur in 1526 with the destruction of the Delhi sultanate, with its capital in Agra. Babur's death some years later, and the indecisive rule of his son, Humayun, brought a degree of instability to Mughal rule. The resistance of the Afghani Sher Shah, through which a string of defeats had been dealt to Humayun, significantly weakened the Mughals. Just a year before his death, however, Humayun managed to recover much of the lost territories, leaving a substantial legacy for his son, the 13 year old Akbar (later known as *Akbar the Great*), in 1556. Under Akbar, consolidation of the Mughal Empire occurred through both expansion and administrative reforms. After Akbar, Jahangir and Shah Jahan came to power. Subsequently, Aurangazeb ruled vast areas including Afghanisthan, Pakistan, India and Bangladesh.

The empire ruled most of present-day India, Pakistan, Bangladesh and Afghanistan for several centuries, before it declined in the early 18th century, which led to India being divided into smaller kingdoms and princely states. The Mughal dynasty was eventually dissolved by the British Empire after the Indian rebellion of 1857. It left a lasting legacy on Indian culture and architecture. Famous buildings built by the Mughals, include: the Taj Mahal, the Red Fort, the Badshahi Mosque, the Lahore Fort, the Shalimar Gardens and the Agra Fort. During the empire's reign, Muslim communities flourished all over India, particularly in Gujarat, Bengal and Hyderabad. Various Sufi orders from Afghanistan and Iran were very active throughout the region. Consequently, more than a quarter of the population converted to Islam.

Safavid Empire

Shah Suleiman I and his courtiers, Isfahan, 1670. Painter is Ali Qoli Jabbador, and is kept at The St. Petersburg Institute of Oriental Studies in Russia, ever since it was acquired by Tsar Nicholas II. Note the two Georgian figures with their names at the top left.

The **Safavids** (Persian: نایوفص) were an Iranian dynasty from Iranian Azarbaijan that ruled from 1501 to 1736, and which established Twelver Shi'a Islam as Iran's official religion and united its provinces under a single Iranian sovereignty, thereby reigniting the Persian identity.

Although claiming to be the descendants of Ali ibn Abu Talib, the Safavids were originally Sunni (the name "Safavid" comes from a Sufi order called *Safavi*). Their origins go back to Firuz Shah Zarrinkolah, an Iranian local dignitary from Iran's north. During their rule, the Safavids recognized Twelver Shi'a Islam as the State religion, thus giving Iran a separate identity from its Sunni neighbours.

In 1524, Tahmasp acceded to the throne, initiating a revival of the arts in the region. Carpet making became a major industry, gaining new importance in Iran's cities. But the finest of all artistic revivals was the commissioning of the *Shahnama*. The *Shahnama* was meant to glorify the reign of the *Shah* through artistic means. The two-volume copy contained 258 large paintings to illustrate the works of Firdawsi, a Persian poet. The Shah also prohibited the drinking of wine, forbade the use of hashish and ordered the removal of gambling casinos, taverns and brothels.

Tahmasp's grandson, Shah Abbas I, also managed to increase the glory of the empire. Abbas restored the shrine of the eighth Twelver Shi'a Imam, Ali al-Ridha at Mashhad, and restored the dynastic shrine at Ardabil. Both shrines received jewelry, fine manuscripts and Chinese porcelains. Abbas also moved the empire's capital to Isfahan, revived old ports, and established thriving trade with the Europeans. Amongst Abbas's most visible cultural achievements was the construction of *Naqsh-e Jahan Square* ("Design of the World"). The plaza, located near a Friday mosque, covered 20 acres (81,000 m^2), thus dwarfing Piazza San Marco and St. Peter's Square.

Ottoman Empire

The Seljuk Turks fell apart rapidly in the second half of the 13th century, especially after the Mongol invasion of Anatolia. This resulted in the establishment of multiple Turkish principalities, known as beyliks. Osman I, the founder of the Ottoman dynasty, assumed leadership of one of these principalities (Söğüt) in 1281, succeeding his father Ertuğrul. Declaring an independent Ottoman emirate in 1299, Osman I led it to a series of consecutive victories over the Byzantine Empire. By 1331, the Ottomans had captured Nicaea, the former Byzantine capital, under the leadership of Osman's son and successor, Orhan I. Victory at the Battle of Kosovo against the Serbs in 1389 then facilitated their expansion into Europe. The Ottomans were firmly established in the Balkans and Anatolia by the time Bayezid I ascended to power in the same year, now at the helm of a swiftly growing empire.

Further growth was brought to a sudden halt, as Bayezid I had been captured by Mongol warlord Timur (also known as "*Tamerlane*") in the Battle of Ankara in 1402, upon which a turbulent period known as the Ottoman Interregnum ensued. This episode was

characterized by the division of the Ottoman territory amongst Bayezid I's sons, who submitted to Timurid authority. When a number of the territories recently conquered by the Ottomans regained independent status, potential ruin for the Ottoman Empire became imminent. However, the empire quickly recovered, as the youngest son of Bayezid I, Mehmed I, waged offensive campaigns against his ruling brothers, thereby reuniting Asia Minor and declaring himself the new Ottoman sultan in 1413.

Around this time the naval fleet of the Ottomans developed considerably, such that they were able to challenge Venice, traditionally a naval power. Focus was also directed towards reconquering the Balkans. By the time of Mehmed I's grandson, Mehmed II (ruled 1444 — 1446; 1451 — 1481), the Ottomans felt strong enough to lay siege to Constantinople, the capital of Byzantium. A decisive factor in this siege was the use of firearms and large cannons introduced by the Ottomans, against which the Byzantines were unable to compete. The Byzantine fortress finally succumbed to the Ottoman invasion in 1453, after 54 days of siege. Mehmed II, entering the city victorious, renamed it *Istanbul*. With its capital fallen to the Ottomans, the rest of the Byzantine Empire quickly disintegrated. The future successes of the Ottomans and later empires would depend heavily upon the exploitation of gunpowder.

The Suleiman Mosque (Süleymaniye Camii) in Istanbul was built on the order of sultan Suleiman the Magnificent by the great Ottoman architect Mimar Sinan in 1557

In the early 16th century, the Shi'ite Safavid dynasty assumed control in Persia under the leadership of Shah Ismail I, upon the defeat of the ruling Turcoman federation Aq

Qoyunlu (also called the "White Sheep Turkomans") in 1501. The Ottoman sultan Selim I quickly sought to repel Safavid expansion, challenging and defeating them at the Battle of Chaldiran in 1514. Selim I also deposed the ruling Mamluks in Egypt, absorbing their territories into the Ottoman Empire in 1517. Suleiman I (also known as *Suleiman the Magnificent*), Selim I's successor, took advantage of the diversion of Safavid focus to the Uzbeks on the eastern frontier and recaptured Baghdad, which had previously fallen under Safavid control. Despite this, Safavid power remained substantial, with their empire rivalling the Ottomans'. Suleiman I also advanced deep into Hungary following the Battle of Mohács in 1526 — reaching as far as the gates of Vienna thereafter, and signed a Franco-Ottoman alliance with Francis I of France against Charles V of the Roman Empire 10 years later. Suleiman I's rule (1520 — 1566) signified the height of the Ottoman Empire, after which it fell into a relative decline with the rapid industrialization of the European empires.

Wahhabism

During the 18th century, Muhammad ibn Abd al Wahhab (1703 – 1792) led a religious movement (Wahhabism) in Najd (central Arabia) that sought to purify Islam. Wahhab wanted to return Islam to what he thought were its original principles as taught by the *as-salaf as-saliheen* (the earliest converts to Islam) and rejected what he regarded as corruptions introduced by bid‘ah (religious innovation) and Shirk (polytheism). He allied himself with the House of Saud, which eventually triumphed over the Rashidis to control Central Arabia, and led several revolts against the Ottoman empire. Initial success (the conquest of Mecca and Medina) was followed by ignominious defeat, then a resurgence which culminated in the creation of Saudi Arabia.

The 20th century

The modern age brought radical technological and organizational changes to Europe and the Islamic countries found themselves less modern when compared to many western nations. Europe's state-based government and rampant colonization allowed the West to dominate the globe economically and forced Islamic countries to change.

Demise of the Ottoman Empire

By the end of the 19th century, the Ottoman empire had declined due to internal conflict. The decision to back Germany in World War I meant they shared the Central Powers' defeat in that war, which led directly to the overthrow of the Ottomans by Turkish nationalists led by the victorious general of the Battle of Gallipoli: Mustapha Kemal, who became known to his people as Atatürk, "Father of the Turks." It was Atatürk who was primarily creditted with successfully renegotiating the treaty of Sèvres (1920) which ended their involvement in the war and establishing the modern Republic of Turkey, which was officially recognized by the Allies in the Treaty of Lausanne (1923). Atatürk went on to implement an ambitious program of modernization that emphasized economic development and secularization. He effectively transformed Turkish culture to reflect

European style laws and clothing, adopted Hindu-Arabic numerals, the Roman alphabet, separated the religious establishment from the state, and emancipated woman- even giving them the right to vote roughly contemporary with the same transformation in western law for the first time. Following World War I, the vast majority of former Ottoman territory located outside of Asia Minor was handed over to the victorious European powers as European protectorates. The Allies had promised the subjected people of the former Ottoman Empire during the war future independence in exchange for their assistance fighting the central Turkish powers in Asia Minor. To their dismay, old-fashioned European imperialism was put into practice through this system of "protectorates" which was a mere smoke-screen for their continued subjugation by the new powers in the region: the British and the French. The struggles for independence from their Turkish overlords and the cooperation of partisan forces with the British were romanticized in the stories of British secret intelligence agent T.E. Lawrence- later known as "Lawrence of Arabia." Ottoman successor states include today's Albania, Bosnia and Herzegovina, Bulgaria, Egypt, Greece, Iraq, Lebanon, Montenegro, Romania, Saudi Arabia, Serbia, Syria, Jordan, Turkey, other Balkan states, North Africa and the north shore of the Black sea.

Many Muslim countries sought to adopt European political organization and nationalism began to emerge in the Muslim world. Countries like Egypt, Syria, and Turkey organized their governments with definable policies and sought to develop national pride amongst their citizens. Other places, like Iraq, were not as successful due to a lack of unity and an inability to resolve age-old prejudices between Muslim sects and against non-Muslims.

Some Muslim countries, such as Turkey and Egypt, sought to separate Islam from the secular government. In other cases, such as Saudi Arabia, the new government brought out new religious expression in the re-emergence of the puritanical form of Sunni Islam known to its detractors as Wahabism which found its way into the Saudi royal family.

Partition of India

The *partition of India* refers to the creation in August 1947 of the two sovereign states of India and Pakistan. The two nations were formed out of the former British Raj, including treaty states, when Britain granted independence to the area. In particular, the term refers to the partition of Bengal and Punjab, the two main provinces of what would be Pakistan.

In 1947, after the partition of India, Pakistan became the largest Islamic Country in the world (by population) and the tenth largest post-WWII state in the modern world. In 1971, after a bloody war of independence, the Bengal part of Pakistan became an independent state called Bangladesh.

Today, Pakistan is the second largest Islamic country in the world following Indonesia. Pakistan is presently the only nuclear power of the Muslim world.

Arab-Israeli conflict

The Arab-Israeli conflict spans about a century of political tensions and open hostilities. It involves the establishment of the modern State of Israel as a Jewish nation state, the consequent displacement of the Palestinian people, as well as the adverse relationship between the Arab nations and the state of Israel. Despite initially involving only the Arab states bordering Israel, animosity has also developed between other Muslim nations and Israel. Many countries, individuals and non-governmental organizations elsewhere in the world feel involved in this conflict for reasons such as cultural and religious ties with Islam, Arab culture, Christianity, Judaism, Jewish culture or for ideological, human rights, or strategic reasons. While some consider the Arab-Israeli conflict a part of (or a precursor to) a wider clash of civilizations between the Western World and the Arab or Muslim world, others oppose this view. Animosity emanating from this conflict has caused numerous attacks on supporters (or perceived supporters) of each side by supporters of the other side in many countries around the world.

Oil wealth

Between 1953 and 1964, King Saud reorganized the government of the monarchy his father, Ibn Saud, had created. Saudi Arabia's new ministries included Communication (1953), Agriculture and Water (1953), Petroleum (1960), Pilgrimage and Islamic Endowments (1960), Labour and Social Affairs (1962) and Information (1963). He also put Talal, one of his many younger brothers (by 29 years his junior) in charge of the Ministry of Transport.

In 1958-59, Talal proposed the formation of a National Council. As he proposed it, it would have been a consultative body, not a legislature. Still, he thought of it as a first step toward broader popular participation in the government. Talal presented this proposal to the king when the Crown Prince was out of the country. Saud simply forwarded the proposal to the ulama asking them whether a National Council was a legitimate institution in Islam. The idea seems to have died in committee, so to speak. It would be revived more than three decades later. A Consultative Council came into existence in 1992.

Meantime, the Organization of Petroleum Exporting Countries came into existence in 1960. For the first decade or more of its existence, it was ineffectual in terms of increasing revenue for the member nations. But that would change. Tension between Faisal and Saud continued to mount until a final showdown in 1964. Saud threatened to mobilize the Royal Guard against Faisal and Faisal threatened to mobilize the National Guard against Saud. It was Saud who blinked, abdicating and leaving for Cairo, then Greece, where he would die in 1969. Faisal then became King.

The Six-Day War of June 5–10, 1967, a war between Israel and the neighbouring states of Egypt, Jordan, and Syria. had other effects. It effectively closed the Suez canal, it may have contributed to the revolution in Libya that put Muammar al-Gaddafi in power, and it led in May 1970 to the closure of the "tapline" from Saudi Arabia through Syria to

Lebanon. These developments had the effect of increasing the importance of petroleum in Libya, which is a conveniently short (and canal-free) shipping distance from Europe.

In 1970, it was Occidental Petroleum which constituted the first crack in the wall of oil company solidarity in dealing with the oil producing nations; specifically, in this case, with the demands for price increases from the new Qaddafi government.

In October 1973, another war between Israel and its Muslim neighbors, known as the Yom Kippur War, broke out just as oil company executives were heading to Vienna, site of a planned meeting with OPEC leaders. OPEC had been emboldened by the success of Libya's demands anyway, and the war strengthened the unity of their new demands.

The Arab defeats in the Six Day and the victory in 1973 Arab-Israeli wars triggered the 1973 oil crisis. In response to the emergency resupply effort by the West that enabled Israel to defeat Egyptian and Syrian forces, the Arab world imposed the 1973 oil embargo against the United States and Western Europe. Faisal agreed that Saudi Arabia would use some of its oil wealth to finance the "front-line states," those that bordered Israel, in their struggle.

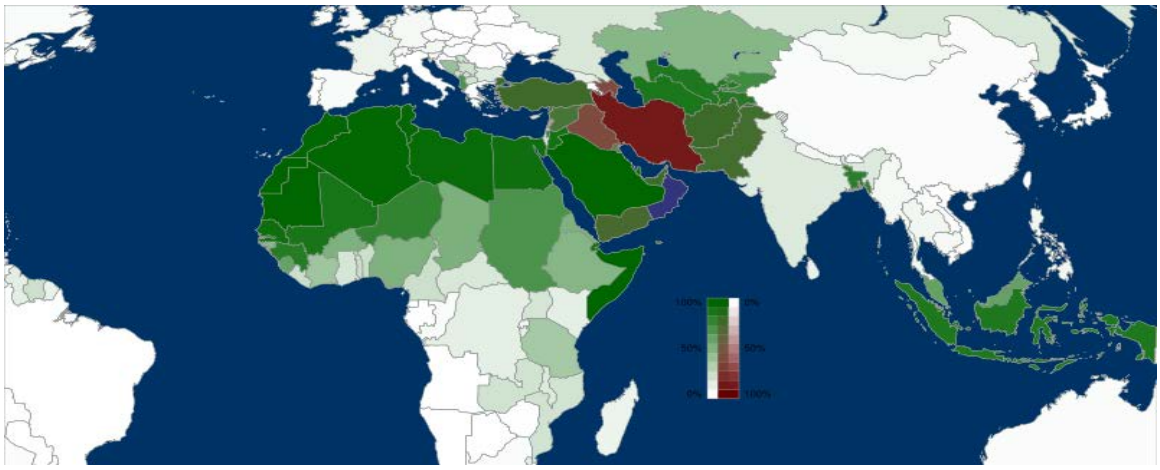
The centrality of petroleum, the Arab-Israeli Conflict and political and economic instability and uncertainty remain constant features of the politics of the region.

Two Iranian revolutions

The Iranian Constitutional Revolution took place between 1905 and 1911. The revolution marked the beginning of the end of Iran's feudalistic society and led to the establishment of a parliament in Persia and the restriction of the power of Shah (king). The first constitution of Iran was approved. But after the final victory of the revolutionaries over the Shah, the modernist and conservative blocks began to fight with each other. Then World War I took place and all of the combatants invaded Iran and this weakened the government and threatened the independence of Iran. The system of constitutional monarchy created by the decree of Mozzafar al-Din Shah that was established in Persia as a result of the Revolution, was weakened in 1925 with the dissolution of the Qajar dynasty and the ascension of Reza Shah Pahlavi to the throne.

In 1979 the Iranian Revolution (also called "The Islamic Revolution") transformed Iran from a constitutional monarchy, under Shah Mohammad Reza Pahlavi, to a populist theocratic Islamic republic under the rule of Ayatollah Ruhollah Khomeini, a Shi`i Muslim cleric and *marja*. Following the Revolution, an Iranian referendum established the Islamic republic as a new government, and a new constitution was approved, electing Ruhollah Khomeini as Supreme Leader of Iran. During the following two years, liberals, leftists, and Islamic groups fought with each other, and ultimately the Islamics captured power. At the same time, the U.S., the USSR, and most of the Arab governments of the Middle East feared that their dominance in the region was challenged by the new Islamic ideology, so they encouraged and supported Saddam Hussein to invade Iran, which resulted in the Iran-Iraq war.

The 21st century



Islam in the world. Green: Sunni, Red: Shia

Islam in Turkey

Since the establishment of the Republic of Turkey in 1923, there has been a strong tradition of secularism in Turkey established and institutionalized by Atatürk's Reforms. Although the First Grand National Assembly of Turkey had rallied support from the population for the Independence War against the occupying forces on behalf of Islamic principles, Islam was gradually omitted from the public sphere after the Independence War. The principle of secularism was thus inserted in the Turkish Constitution as late as 1937. This legal action was assisted by stringent state policies against domestic Islamist groups and establishments to neutralize the strong appeal of Islam in Turkish society. Even though an overwhelming majority of the population, at least nominally, adheres to Islam in Turkey, the state, which was established with the Kemalist ideology has no official religion nor promotes any and it actively monitors the area between the religions using the Presidency of Religious Affairs. The Republic Protests were a series of mass rallies by Turkish secular citizens that took place in Turkey in 2007. The target of the first protest was the possible presidential candidacy of the Prime Minister Recep Tayyip Erdoğan, afraid that if elected President of Turkey Erdoğan would alter the Turkish secularist stateThe struggle between the secularist and democratic citizens and the Islamic fanatics who has just emigrated from rural areas are still a great argument over both religion and democracy.

Dynasties of Muslim Rulers

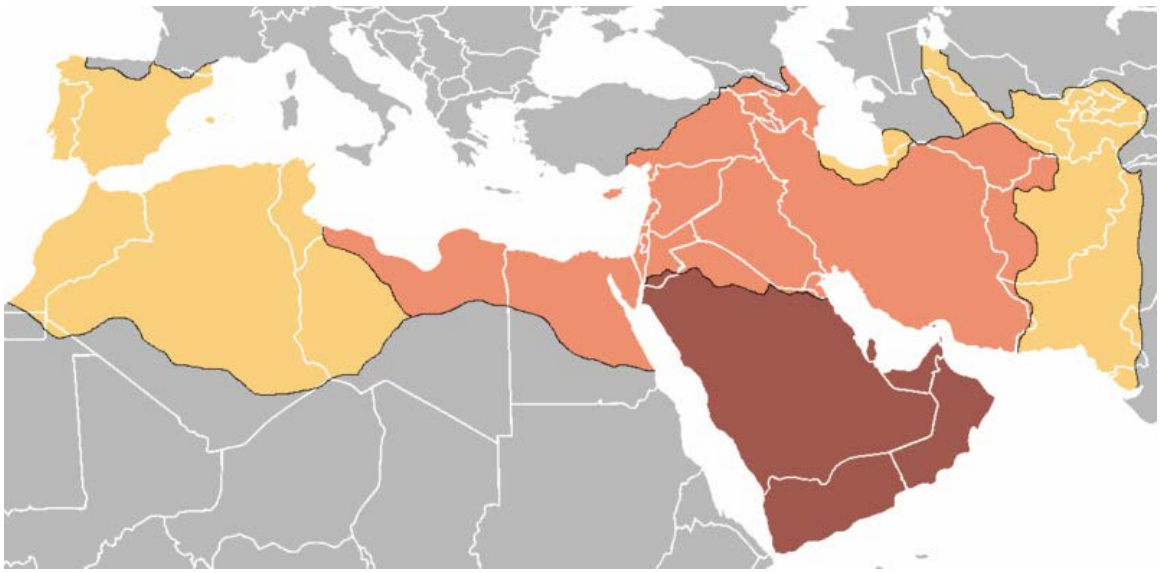
There are Muslim Dynasties which can be found in list of dynasties of Muslim Rulers

Chapter- 2

Islamic Golden Age

The **Islamic Golden Age** is traditionally dated from the mid-8th to the mid-13th century A.D. (sack of Baghdad by Hulagu, the grand-son of Gengis-Khan). During this period, artists, engineers, scholars, poets, philosophers, geographers and traders in the Islamic world contributed to agriculture, the arts, economics, industry, law, literature, navigation, philosophy, sciences, sociology, and technology, both by preserving earlier traditions and by adding inventions and innovations of their own. Howard R. Turner writes: "Muslim artists and scientists, princes and laborers together made a unique culture that has directly and indirectly influenced societies on every continent."

Foundations



Age of the Caliphs Expansion under the Islamic Prophet Muhammad, 622–632 Expansion during the Rashidun Caliphate, 632–661 Expansion during the Umayyad Caliphate, 661–750

During the Muslim conquests of the early 7th and 9th centuries, Rashidun armies established the Caliphate, or Islamic Empire, one of the largest empires in history. The 8th century ascension of the Abbasid Caliphate and the transfer of the capital from Damascus to the newly founded city Baghdad marks the beginning of this period. The

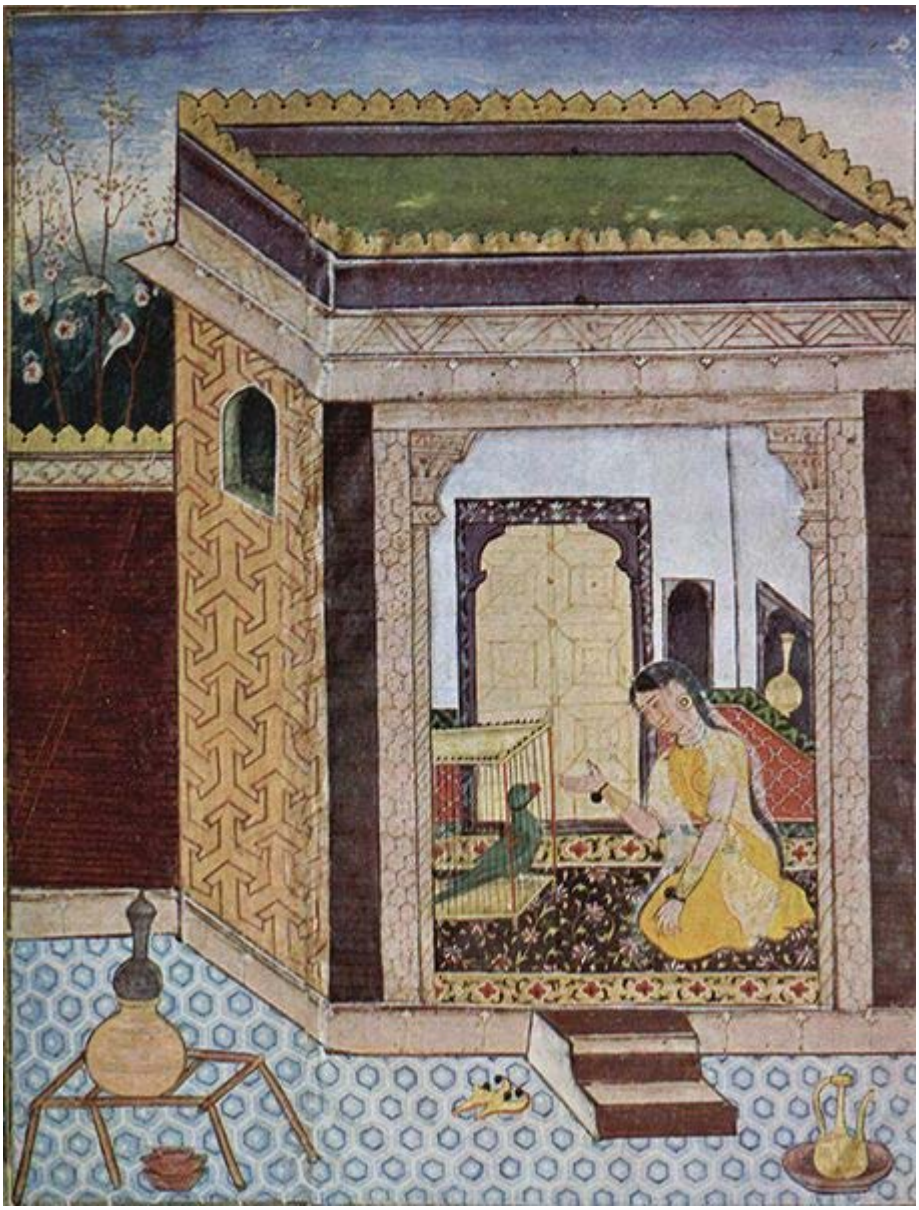
Abbassids were influenced by the Qur'anic injunctions and hadith such as "The ink of the scholar is more holy than the blood of martyrs" stressing the value of knowledge. During this period the Muslim world became a major intellectual centre for science, philosophy, medicine and education. They established the "House of Wisdom" (Arabic:بيت الحكمة) in Baghdad, where scholars, both Muslim and non-Muslim, sought to gather and translate all the world's knowledge into Arabic in the Translation Movement. Many classic works of antiquity that would otherwise have been forgotten were translated into Arabic and later in turn translated into Turkish, Sindhi, Persian, Hebrew and Latin. Knowledge was synthesized from works originating in ancient Mesopotamia, Ancient Rome, China, India, Persia, Ancient Egypt, North Africa, Ancient Greece and Byzantine civilizations. Rival Muslim dynasties such as the Fatimids of Egypt and the Umayyads of al-Andalus were also major intellectual centres with cities such as Cairo and Córdoba rivaling Baghdad. According to Bernard Lewis, the Caliphate was the first "truly universal civilization," which brought together for the first time "peoples as diverse as the Chinese, the Indians, the people of the Middle East and North Africa, black Africans, and white Europeans."

A major innovation of this period was paper – originally a secret tightly guarded by the Chinese. The art of papermaking was obtained from prisoners taken at the Battle of Talas (751), spreading to the islamic cities of Samarkand and Baghdad. The Arabs improved upon the Chinese techniques of using mulberry bark by using starch to account for the Muslim preference for pens vs. the Chinese for brushes. By AD 900 there were hundreds of shops employing scribes and binders for books in Baghdad and public libraries began to become established. From here paper-making spread west to Fez and then to al-Andalus and from there to Europe in the 13th century.

Much of this learning and development can be linked to topography. Even prior to Islam's presence, the city of Mecca served as a center of trade in Arabia. The tradition of the pilgrimage to Mecca became a center for exchanging ideas and goods. The influence held by Muslim merchants over African-Arabian and Arabian-Asian trade routes was tremendous. As a result, Islamic civilization grew and expanded on the basis of its merchant economy, in contrast to their Christian, Indian and Chinese peers who built societies from an agricultural landholding nobility. Merchants brought goods and their faith to China, India, South-east Asia, and the kingdoms of Western Africa and returned with new inventions. Merchants used their wealth to invest in textiles and plantations.

Aside from traders, Sufi missionaries also played a large role in the spread of Islam, by bringing their message to various regions around the world. The principal locations included: Persia, Ancient Mesopotamia, Central Asia and North Africa. Although, the mystics also had a significant influence in parts of Eastern Africa, Ancient Anatolia (Turkey), South Asia, East Asia and South-east Asia.

Ethics



a Mughal girl with Parrot, scene from the *Tuti-Nâma-Manuscript*

Many medieval Muslim thinkers pursued humanistic, rational and scientific discourses in their search for knowledge, meaning and values. A wide range of Islamic writings on love, poetry, history and philosophical theology show that medieval Islamic thought was open to the humanistic ideas of individualism, occasional secularism, skepticism and liberalism.

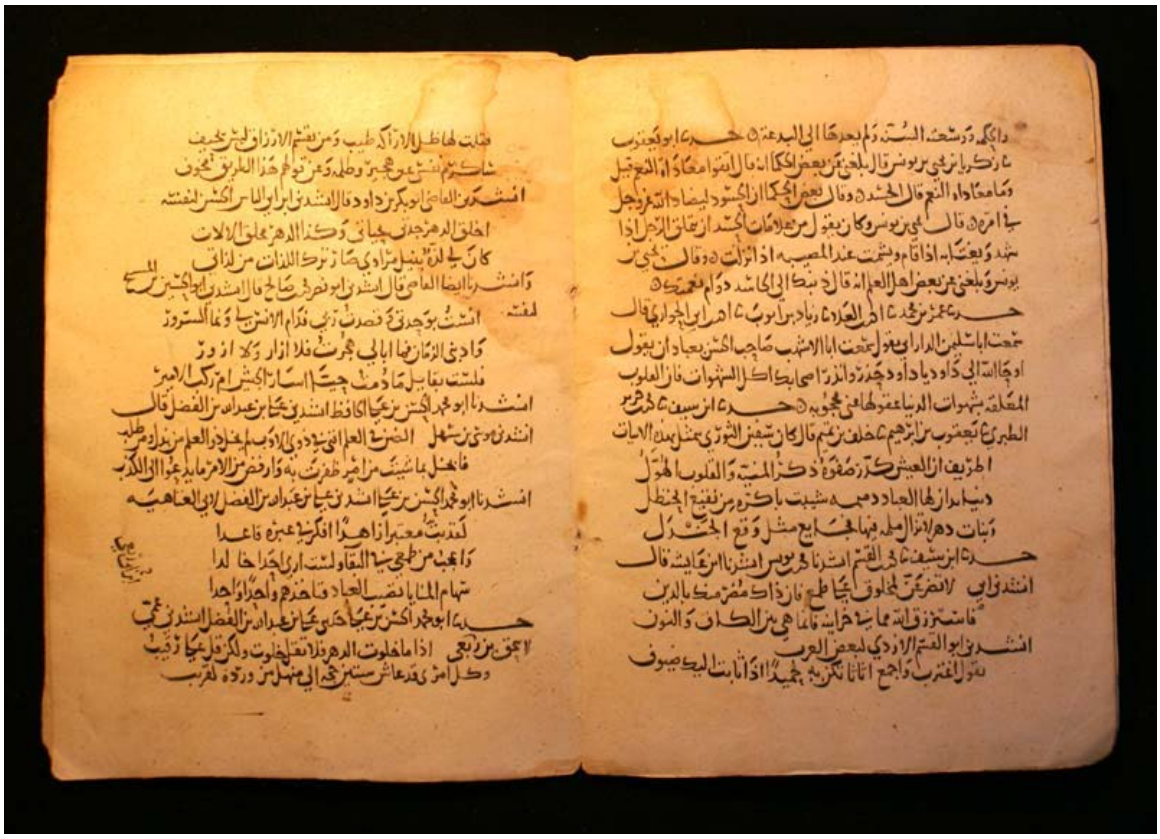
Religious freedom, though society was still controlled under Islamic values, helped create cross-cultural networks by attracting Muslim, Christian and Jewish intellectuals and thereby helped spawn the greatest period of philosophical creativity in the Middle Ages

from the 8th to 13th centuries. Another reason the Islamic world flourished during this period was an early emphasis on freedom of speech, as summarized by al-Hashimi (a cousin of Caliph al-Ma'mun) in the following letter to one of the religious opponents he was attempting to convert through reason:

"Bring forward all the arguments you wish and say whatever you please and speak your mind freely. Now that you are safe and free to say whatever you please appoint some arbitrator who will impartially judge between us and lean only towards the truth and be free from the empary of passion, and that arbitrator shall be Reason, whereby God makes us responsible for our own rewards and punishments. Herein I have dealt justly with you and have given you full security and am ready to accept whatever decision Reason may give for me or against me. For "There is no compulsion in religion" (Qur'an 2:256) and I have only invited you to accept our faith willingly and of your own accord and have pointed out the hideousness of your present belief. Peace be upon you and the blessings of God!"

The earliest known treatises dealing with environmentalism and environmental science, especially pollution, were Arabic treatises written by al-Kindi, al-Razi, Ibn Al-Jazzar, al-Tamimi, al-Masihi, Avicenna, Ali ibn Ridwan, Abd-el-latif, and Ibn al-Nafis. Their works covered a number of subjects related to pollution such as air pollution, water pollution, soil contamination, municipal solid waste mishandling, and environmental impact assessments of certain localities. Cordoba, al-Andalus also had the first waste containers and waste disposal facilities for litter collection.

Institutions



A manuscript written during the Abbasid Era

A number of important educational and scientific institutions previously unknown in the ancient world have their origins in the early Islamic world, with the most notable examples being: the public hospital (which replaced healing temples and sleep temples) and psychiatric hospital, the public library and lending library, the academic degree-granting university, and the astronomical observatory as a research institute (as opposed to a private observation post as was the case in ancient times).

The first universities which issued diplomas were the Bimaristan medical university-hospitals of the medieval Islamic world, where medical diplomas were issued to students of Islamic medicine who were qualified to be practicing doctors of medicine from the 9th century. The Guinness Book of World Records recognizes the University of Al Karaouine in Fez, Morocco as the oldest degree-granting university in the world with its founding in 859 CE. Al-Azhar University, founded in Cairo, Egypt in the 975 CE, offered a variety of academic degrees, including postgraduate degrees, and is often considered the first full-fledged university. The origins of the doctorate also dates back to the *ijazat attadris wa 'l-ifttd* ("license to teach and issue legal opinions") in the medieval Madrasahs which taught Islamic law.

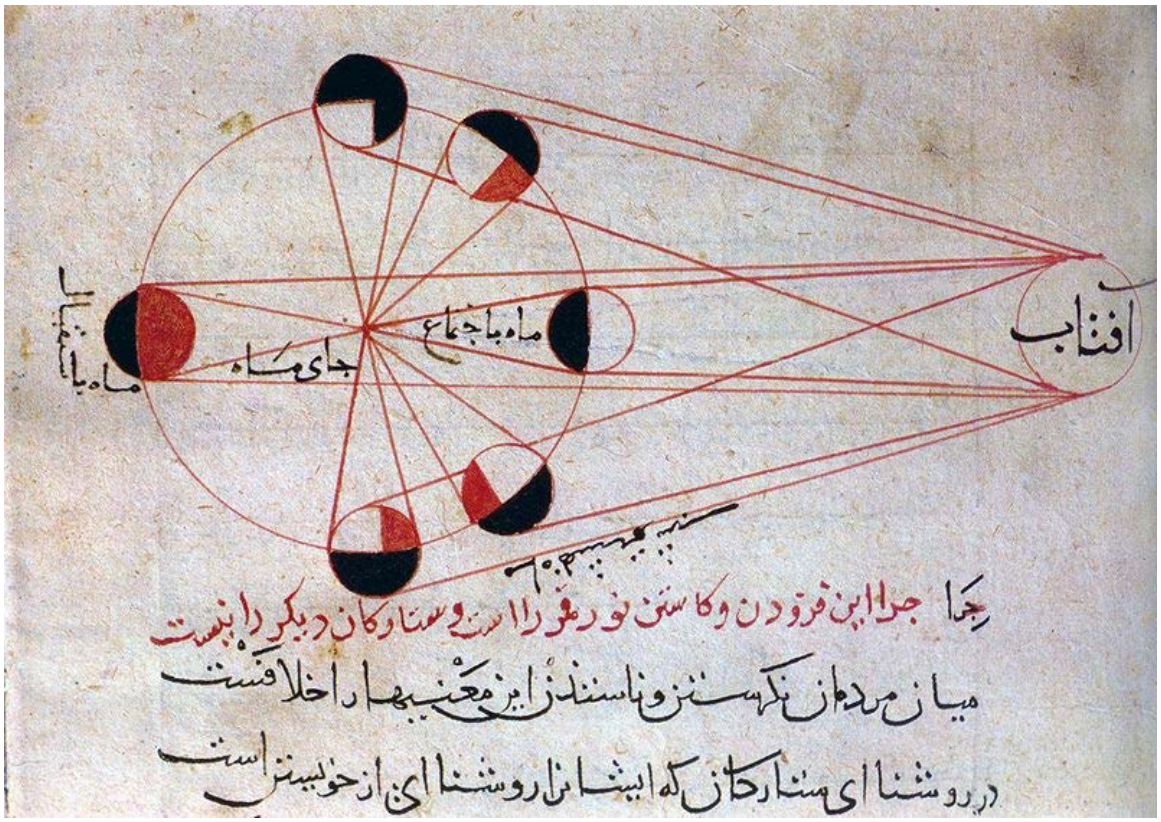
By the 10th century, Cordoba had 700 mosques, 60,000 palaces, and 70 libraries, the largest of which had 600,000 books. In the whole al-Andalus, 60,000 treatises, poems, polemics and compilations were published each year. The library of Cairo had two million books, while the library of Tripoli is said to have had as many as three million books before it was destroyed by Crusaders. The number of important and original medieval Arabic works on the mathematical sciences far exceeds the combined total of medieval Latin and Greek works of comparable significance, although only a small fraction of the surviving Arabic scientific works have been studied in modern times. For instance, Jamil Ragep, an historian of science from McGill University, says that 'less than 5% of the available material has been studied.'Salim Al-Hassani states that 50,000 of the surviving manuscripts have been reviewed and that there are 5 million more manuscripts still awaiting review. A Russian historian O. B. Frolova gives an idea of the numerical quantity of these manuscripts and works always findable:

"The results of the Arab scholars' literary activities are reflected in the enormous amount of works (about some hundred thousand) and manuscripts (not less than 5 million) which were current... These figures are so imposing that only the printed epoch presents comparable materials"

A number of distinct features of the modern library were introduced in the Islamic world, where libraries not only served as a collection of manuscripts as was the case in ancient libraries, but also as a public library and lending library, a centre for the instruction and spread of sciences and ideas, a place for meetings and discussions, and sometimes as a lodging for scholars or boarding school for pupils. The concept of the library catalogue was also introduced in medieval Islamic libraries, where books were organized into specific genres and categories.

Legal institutions introduced in Islamic law include the trust and charitable trust (Waqf), the agency and aval (Hawala), and the lawsuit and medical peer review.

Polymaths



An illustration from al-Biruni's Persian book. It shows different phases of the moon.

Another common feature during the Islamic Golden Age was the large number of Muslim polymath scholars, who were known as "Hakeems", each of whom contributed to a variety of different fields of both religious and secular learning, comparable to the later "Renaissance Men" (such as Leonardo da Vinci) of the European Renaissance period. During the Islamic Golden Age, polymath scholars with a wide breadth of knowledge in different fields were more common than scholars who specialized in any single field of learning.

Notable medieval Muslim polymaths included al-Biruni, al-Jahiz, al-Kindi, Ibn Sina (Latinized: Avicenna), al-Idrisi, Ibn Bajjah, Ibn Zuhr, Ibn Tufail, Ibn Rushd (Latinized: Averroes), al-Suyuti, Jābir ibn Hayyān, Abbas Ibn Firnas, Ibn al-Haytham (Latinized: Alhazen or Alhacen), Ibn al-Nafis, Ibn Khaldun, al-Khwarizmi, al-Masudi, al-Muqaddasi, and Nasīr al-Dīn al-Tūsī.

Economy

Age of discovery

Part of the Piri Reis map (1513) showing Europe and the Mediterranean Basin

The Islamic Empire significantly contributed to globalization during the Islamic Golden Age, when the knowledge, trade and economies from many previously isolated regions and civilizations began integrating through contacts with Muslim (and Jewish Radhanite) explorers and traders. Their trade networks extended from the Atlantic Ocean and Mediterranean Sea in the west to the Indian Ocean and China Sea in the east. These trade networks helped establish the Islamic Empire (including the Rashidun, Umayyad, Abbasid and Fatimid caliphates) as the world's leading extensive economic power throughout the 7th–13th centuries.

Agricultural Revolution

Barley, oats, and some products made from them

The Islamic Golden Age witnessed a fundamental transformation in agriculture known as the "Arab Agricultural Revolution". Muslim traders enabled the diffusion of many crops and farming techniques between different parts of the Islamic world, as well as the adaptation of plants and techniques from beyond the Islamic world. Crops from Africa such as sorghum, crops from China such as citrus fruits, and numerous crops from India such as rice, cotton, and sugar cane, were distributed throughout Islamic lands which normally would not be able to grow these crops. Newly adopted crops combined with an increased mechanization of agriculture which led to major changes in economy, population distribution, vegetation cover, agricultural production and income, population levels, urban growth, the distribution of the labour force, cooking and diet, clothing, and numerous other aspects of life in the Islamic world.

During the Muslim Agricultural Revolution, sugar production was refined and transformed into a large-scale industry, as Arabs and Berbers built the first sugar refineries and established sugar plantations. Sugar production diffused throughout the Islamic Empire from the 8th century.

Muslims introduced cash cropping and a crop rotation system in which land was cropped four or more times in a two-year period. Winter crops were followed by summer ones. In areas where plants of shorter growing season were used, such as spinach and eggplants,

the land could be cropped three or more times a year. In parts of Yemen, wheat yielded two harvests a year on the same land, as did rice in Iraq. Muslims developed a scientific approach to agriculture based on three major elements; sophisticated systems of crop rotation, highly developed irrigation techniques, and the introduction of a large variety of crops which were studied and catalogued according to the season, type of land and amount of water they require. Numerous detailed encyclopaedias on farming and botany were produced.

Market economy

Silver dirham of the Umayyad Caliphate, minted at Balkh in AH 111 (730 AD)

Early forms of proto-capitalism and free markets were present in the Caliphate, where an early market economy and early form of merchant capitalism was developed between the 8th–12th centuries, which some refer to as "Islamic capitalism". A vigorous monetary economy was created on the basis of a widely circulated common currency (the dinar) and the integration of monetary areas that were previously independent. Business techniques and forms of business organisation employed during this time included early contracts, bills of exchange, long-distance international trade, early forms of partnership (*mufawada*) such as limited partnerships (*mudaraba*), and early forms of credit, debt, profit, loss, capital (*al-mal*), capital accumulation (*nama al-mal*), circulating capital, capital expenditure, revenue, cheques, promissory notes, trusts (*waqf*), savings accounts, transactional accounts, pawning, loaning, exchange rates, bankers, money changers, ledgers, deposits, assignments, the double-entry bookkeeping system, and lawsuits. Organizational enterprises independent from the state also existed in the medieval Islamic world. Many of these early proto-capitalist concepts were further advanced in medieval Europe from the 13th century onwards.

Industrial growth

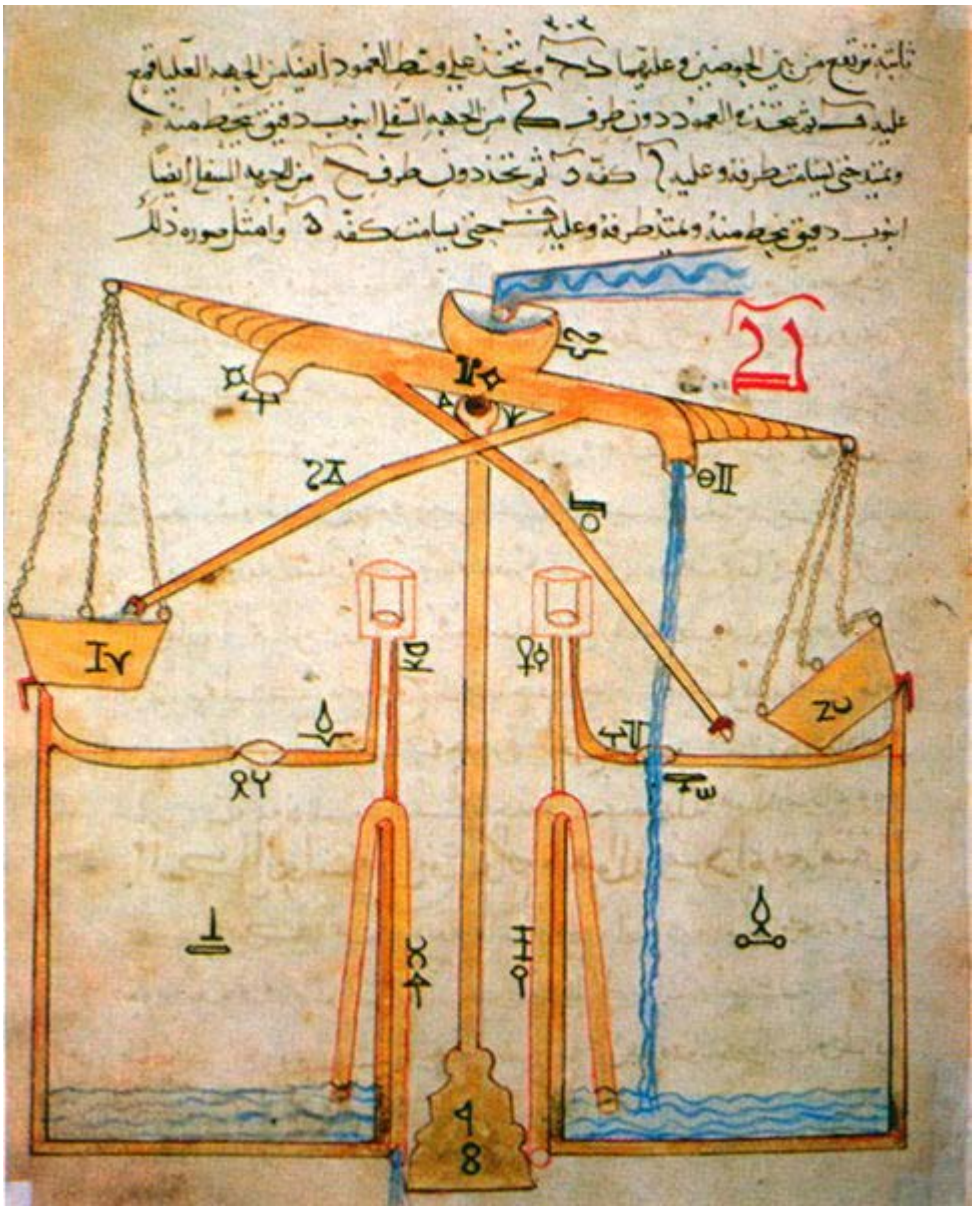


Diagram of a hydropowered water-raising machine from *The Book of Knowledge of Ingenious Mechanical Devices* by Al-Jazari in 1206.

Hydropower, tidal power, and wind power were used to power mills and factories. Limited use was also made of fossil fuels such as petroleum. The industrial use of watermills in the Islamic world dates back to the 7th century, while horizontal-wheeled and vertical-wheeled water mills were both in widespread use since at least the 9th century. A variety of industrial mills were being employed in the Islamic world, including early fulling mills, gristmills, hullers, sawmills, shipmills, stamp mills, steel mills, sugar mills, tide mills and windmills.

By the 11th century, mills operated throughout the Islamic world, from al-Andalus and North Africa to the Middle East and Central Asia. Muslim engineers also invented crankshafts and water turbines, employed gears in mills and water-raising machines, and pioneered the use of dams as sources of water power, used to provide additional power to watermills and water-raising machines. Such advances made it possible for many industrial tasks that were previously driven by manual labour in ancient times to be mechanized and driven by machinery instead in the medieval Islamic world. The transfer of these technologies to medieval Europe had an influence on the Industrial Revolution.

Established industries active during this period included astronomical instruments, ceramics, chemicals, distillation technologies, clocks, glass, mechanical hydropowered and wind powered machinery, matting, mosaics, pulp and paper, perfumery, petroleum, pharmaceuticals, rope-making, shipping, shipbuilding, silk, sugar, textiles, water, weapons, and the mining of minerals such as sulphur, ammonia, lead and iron. Knowledge of these industries were later transmitted to medieval Europe, especially during the Latin translations of the 12th century. For example, the first glass factories in Europe were founded in the 11th century by Egyptian craftsmen in Greece. The agricultural and handicraft industries also grew during this period.

Labor

Abbasid coins during Al-Mu'tamid's reign

The labour force in the Caliphate were employed from diverse ethnic and religious backgrounds, while both men and women were involved in diverse occupations and

economic activities. Women were employed in a wide range of commercial activities and diverse occupations in the primary sector (as farmers for example), secondary sector (as construction workers, dyers, spinners, etc.) and tertiary sector (as investors, doctors, nurses, presidents of guilds, brokers, peddlers, lenders, scholars, etc.). Muslim women also had a monopoly over certain branches of the textile industry.

Slaves occupied an important place in the economic life of Islamic world. Large numbers of slaves were exported from eastern Africa to work in salt mines and labour-intensive plantations; the best evidence for this is the magnitude of the Zanj revolt in Iraq in the 9th century. Slaves were also used for domestic work, military service, and civil administration. Central and Eastern European slaves were generally known as *Saqaliba* (i.e. Slavs), while slaves from Central Asia and the Caucasus were often known as *Mamluk*.

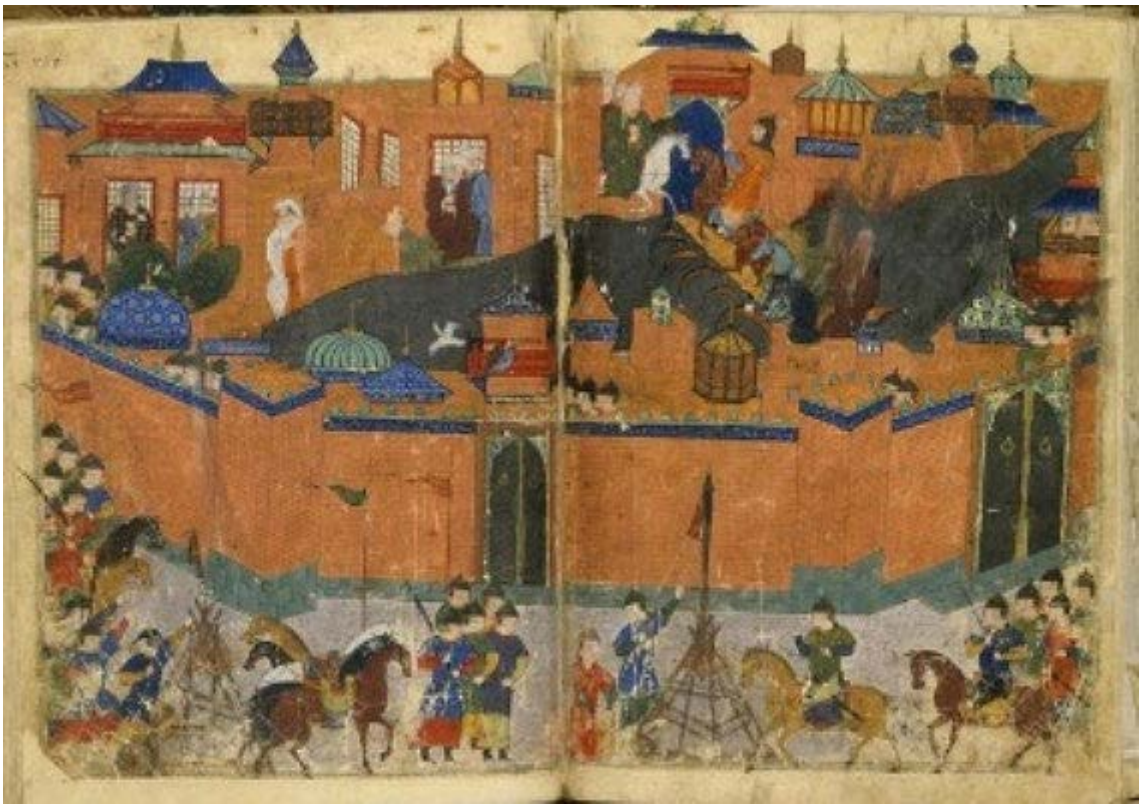
Technology

The programmable automata of al-Jazari

A significant number of inventions were produced by medieval Muslim engineers and inventors, such as Abbas Ibn Firnas, the Banū Mūsā, Taqi al-Din, and most notably al-Jazari.

Some of the inventions journalist Paul Vallely has stated to have come from the Islamic Golden Age include the camera obscura, coffee, soap bar, tooth paste, shampoo, distilled alcohol, uric acid, nitric acid, alembic, valve, reciprocating suction piston pump, mechanized waterclocks, quilting, surgical catgut, vertical-axle windmill, inoculation, cryptanalysis, frequency analysis, three-course meal, stained glass and quartz glass, Persian carpet, and celestial globe.

Urbanization



The battle of Baghdad, 1258

As urbanization increased, Muslim cities grew unregulated, resulting in narrow winding city streets and neighbourhoods separated by different ethnic backgrounds and religious affiliations. Suburbs lay just outside the walled city, from wealthy residential communities, to working class semi-slums. City garbage dumps were located far from the city, as were clearly defined cemeteries which were often homes for criminals. A place of prayer was found just near one of the main gates, for religious festivals and public executions. Similarly, military training grounds were found near a main gate.

Muslim cities also had advanced domestic water systems with sewers, public baths, drinking fountains, piped drinking water supplies, and widespread private and public toilet and bathing facilities. By the 10th century, Cordoba had 700 mosques, 60,000 palaces, and 70 libraries.

The demographics of medieval Islamic society varied in some significant aspects from other agricultural societies, including a decline in birth rates as well as a change in life expectancy. Other traditional agrarian societies are estimated to have had an average life expectancy of 20 to 25 years, while ancient Rome and medieval Europe are estimated at 20 to 30 years. Conrad I. Lawrence estimates the average lifespan in the early Islamic Caliphate to be above 35 years for the general population, and several studies on the lifespans of Islamic scholars concluded that members of this occupational group had a

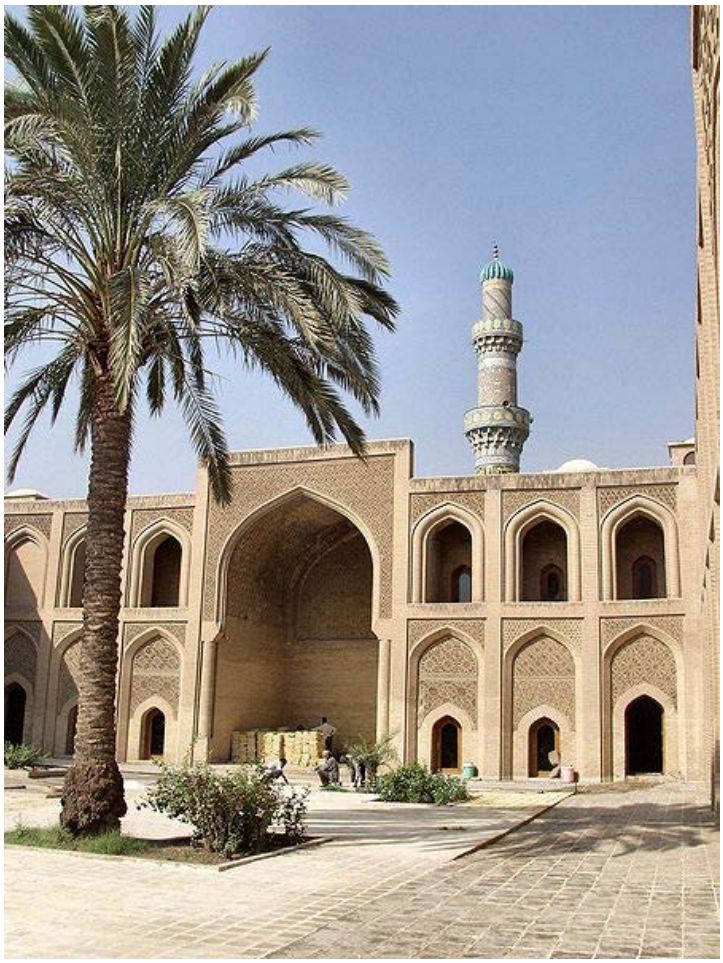
life expectancy between 69 and 75 years, though this longevity was not representative of the general population.

The early Islamic Empire also had the highest literacy rates among pre-modern societies, alongside the city of classical Athens in the 4th century BC, and later, China after the introduction of printing from the 10th century. One factor for the relatively high literacy rates in the early Islamic Empire was its parent-driven educational marketplace, as the state did not systematically subsidize educational services until the introduction of state funding under Nizam al-Mulk in the 11th century. Another factor was the diffusion of paper from China, which led to an efflorescence of books and written culture in Islamic society, thus papermaking technology transformed Islamic society (and later, the rest of Afro-Eurasia) from an oral to scribal culture, comparable to the later shifts from scribal to typographic culture, and from typographic culture to the Internet. Other factors include the widespread use of paper books in Islamic society (more so than any other previously existing society), the study and memorization of the Qur'an, flourishing commercial activity, and the emergence of the Maktab and Madrasah educational institutions.

Sciences

The traditional view of Islamic science was that it was chiefly a preserver and transmitter of ancient knowledge. For example, Donald Lach argues that modern science originated in Europe as an amalgam of medieval technology and Greek learning. These views have been disputed in recent times, with some scholars suggesting that Muslim scientists laid the foundations for modern science, for their development of early scientific methods and an empirical, experimental and quantitative approach to scientific inquiry. Some scholars have referred to this period as a "Muslim scientific revolution", a term which expresses the view that Islam was the driving force behind the Muslim scientific achievements, and should not to be confused with the early modern European Scientific Revolution leading to the rise of modern science. Edward Grant argues that modern science was due to the cumulative efforts of the Hellenic, Islamic and Latin civilizations.

Scientific method



Mustansiriya University in Baghdad

Early scientific methods were developed in the Islamic world, where significant progress in methodology was made, especially in the works of Ibn al-Haytham (Alhazen) in the 11th century, who is considered the pioneer of experimental physics. The most important development of the scientific method was the use of experimentation and quantification to distinguish between competing scientific theories set within a generally empirical orientation. Ibn al-Haytham (Alhazen) wrote the *Book of Optics*, in which he significantly reformed the field of optics, empirically proved that vision occurred because of light rays entering the eye, and invented the camera obscura to demonstrate the physical nature of light rays.

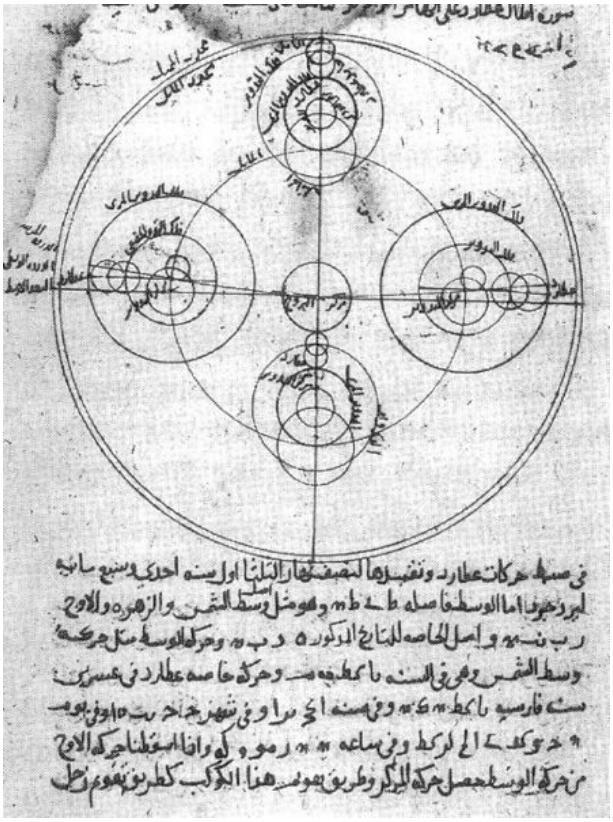
Ibn al-Haytham has also been described as the "first scientist" for his introduction of the scientific method, and his pioneering work on the psychology of visual perception is considered a precursor to psychophysics and experimental psychology although this is still the matter of debate.

Peer review

The earliest medical peer review, a process by which a committee of physicians investigate the medical care rendered in order to determine whether accepted standards of care have been met, is found in the *Ethics of the Physician* written by Ishaq bin Ali al-Rahwi (854–931) of al-Raha in Syria. His work, as well as later Arabic medical manuals, state that a visiting physician must always make duplicate notes of a patient's condition on every visit. When the patient was cured or had died, the notes of the physician were examined by a local medical council of other physicians, who would review the practising physician's notes to decide whether his/her performance have met the required standards of medical care. If their reviews were negative, the practicing physician could face a lawsuit from a maltreated patient.

The first scientific peer review, the evaluation of research findings for competence, significance and originality by qualified experts, was described later in the *Medical Essays and Observations* published by the Royal Society of Edinburgh in 1731. The present-day scientific peer review system evolved from this 18th century process.

Astronomy



Ibn al-Shatir's model for the appearances of Mercury, showing the multiplication of epicycles using the Tusi-couple, thus eliminating the Ptolemaic eccentrics and equant.

Some have referred to the achievements of the Maragha school and their predecessors and successors in astronomy as a "Maragha Revolution", "Maragha School Revolution" or "Scientific Revolution before the Renaissance". Advances in astronomy by the Maragha school and their predecessors and successors include the construction of the first observatory in Baghdad during the reign of Caliph al-Ma'mun, the collection and correction of previous astronomical data, resolving significant problems in the Ptolemaic model, the development of universal astrolabes, the invention of numerous other astronomical instruments, the beginning of astrophysics and celestial mechanics after Ja'far Muhammad ibn Mūsā ibn Shākir discovered that the heavenly bodies and celestial spheres were subject to the same physical laws as Earth, the first elaborate experiments related to astronomical phenomena, the use of exacting empirical observations and experimental techniques, the discovery that the celestial spheres are not solid and that the heavens are less dense than the air by Ibn al-Haytham, the separation of natural philosophy from astronomy by Ibn al-Haytham and Ibn al-Shatir, the first non-Ptolemaic models by Ibn al-Haytham and Mo'ayyeduddin Urdi, the rejection of the Ptolemaic model on empirical rather than philosophical grounds by Ibn al-Shatir, the first empirical observational evidence of the Earth's rotation by Nasīr al-Dīn al-Tūsī and Ali Qushji, and al-Birjandi's early hypothesis on "circular inertia."

Several Muslim astronomers also considered the possibility of the Earth's rotation on its axis and perhaps a heliocentric solar system. It is known that the Copernican heliocentric model in Nicolaus Copernicus' *De revolutionibus* was adapted from the geocentric model of Ibn al-Shatir and the Maragha school (including the Tusi-couple) in a heliocentric context, and that his arguments for the Earth's rotation were similar to those of Nasīr al-Dīn Tūsī and Ali Qushji.

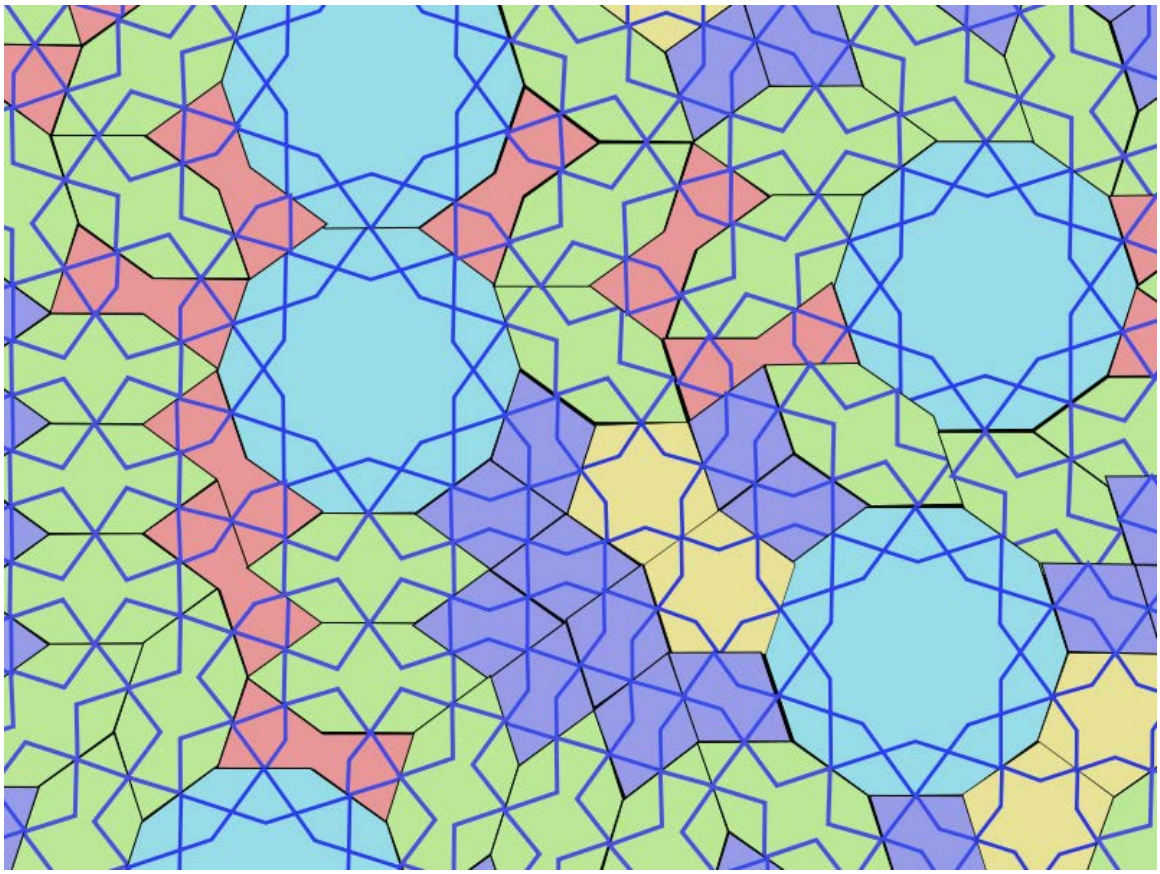
Chemistry

Tin-glazed Hispano-Moresque ware with lusterware decoration, from Spain *circa* 1475

Jābir ibn Hayyān (Geber) is considered a pioneer of chemistry, as he was responsible for introducing an early experimental scientific method within the field, as well as the alembic, still, retort, and the chemical processes of pure distillation, filtration, sublimation, liquefaction, crystallisation, purification, oxidisation and evaporation.

The alchemists' claims about the transmutation of metals were rejected by al-Kindi, followed by Abū Rayhān al-Bīrūnī, Avicenna, and Ibn Khaldun. Nasīr al-Dīn al-Tūsī stated a version of the law of conservation of mass, noting that a body of matter is able to change, but is not able to disappear. Alexander von Humboldt and Will Durant consider medieval Muslim chemists to be founders of chemistry.

Mathematics



An illustration of patterned Girih tiles, found in Islamic architecture dating back over five centuries ago. These featured the first quasicrystal patterns and self-similar fractal quasicrystalline tilings.

Among the achievements of Muslim mathematicians during this period include the development of algebra and algorithms by the Persian and Islamic mathematician Muhammad ibn Mūsā al-Khwārizmī, the invention of spherical trigonometry, the addition of the decimal point notation to the Arabic numerals, the invention of all the trigonometric functions besides sine, al-Kindi's introduction of cryptanalysis and frequency analysis, al-Karaji's introduction of algebraic calculus and proof by mathematical induction, the development of analytic geometry and the earliest general formula for infinitesimal and integral calculus by Ibn al-Haytham, the beginning of algebraic geometry by Omar Khayyam, the first refutations of Euclidean geometry and the parallel postulate by Nasīr al-Dīn al-Tūsī, the first attempt at a non-Euclidean geometry by Sadr al-Din, the development of symbolic algebra by Abū al-Hasan ibn Alī al-Qalasādī, and numerous other advances in algebra, arithmetic, calculus, cryptography, geometry, number theory and trigonometry.

An Arabic manuscript describing the eye, dating back to the 12th century

Medicine

Islamic medicine was a genre of medical writing that was influenced by several different medical systems. The works of ancient Greek and Roman physicians Hippocrates, Dioscorides, Soranus, Celsus and Galen had a lasting impact on Islamic medicine.

Muslim physicians made many significant contributions to medicine in the fields of anatomy, experimental medicine, ophthalmology, pathology, the pharmaceutical sciences, physiology, surgery, etc. They also set up some of the earliest dedicated hospitals, including the first medical schools and psychiatric hospitals. Al-Kindi wrote the *De Gradibus*, in which he first demonstrated the application of quantification and

mathematics to medicine and pharmacology, such as a mathematical scale to quantify the strength of drugs and the determination in advance of the most critical days of a patient's illness. Al-Razi (Rhazes) discovered measles and smallpox, and in his *Doubts about Galen*, proved Galen's humorism false.

Abu al-Qasim (Abulcasis) helped lay the foudations for modern surgery, with his *Kitab al-Tasrif*, in which he invented numerous surgical instruments, including the surgical uses of catgut, the ligature, surgical needle, retractor, and surgical rod.

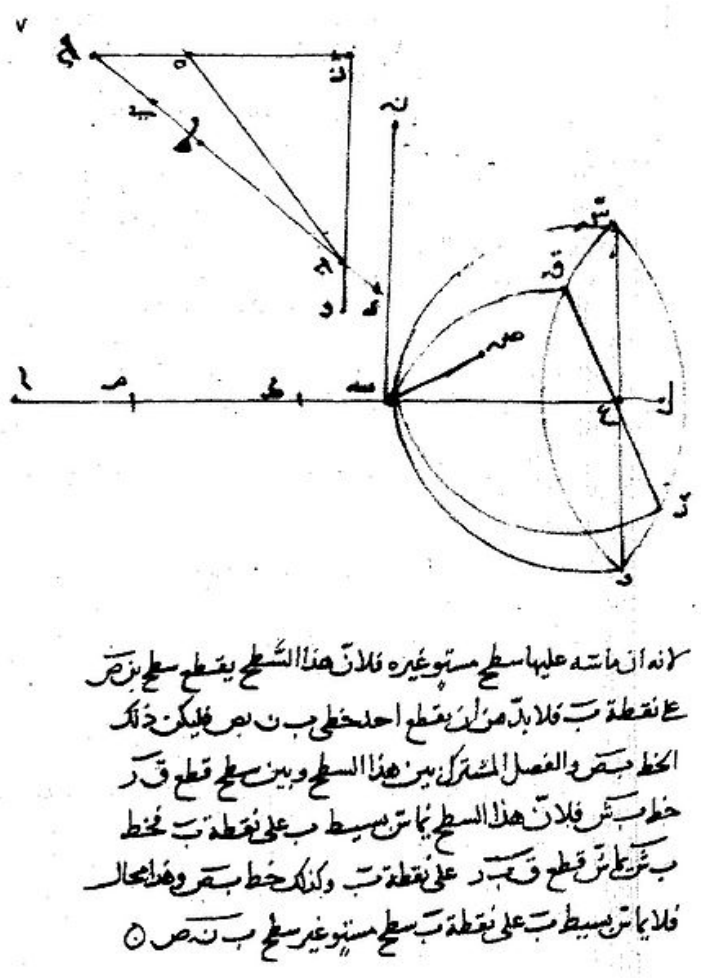
Ibn Sina (Avicenna) helped lay the foundations for modern medicine, with *The Canon of Medicine*, which was responsible for the discovery of contagious disease, introduction of quarantine to limit their spread, introduction of experimental medicine, evidence-based medicine, clinical trials, randomized controlled trials, efficacy tests, and clinical pharmacology, the first descriptions on bacteria and viral organisms, distinction of mediastinitis from pleurisy, contagious nature of tuberculosis, distribution of diseases by water and soil, skin troubles, sexually transmitted diseases, perversions, nervous ailments, use of ice to treat fevers, and separation of medicine from pharmacology.

Ibn Zuhr (Avenzoar) was the earliest known experimental surgeon. In the 12th century, he was responsible for introducing the experimental method into surgery, as he was the first to employ animal testing in order to experiment with surgical procedures before applying them to human patients. He also performed the first dissections and postmortem autopsies on humans as well as animals.

Ibn al-Nafis laid the foundations for circulatory physiology, as he was the first to describe the pulmonary circulation and coronary circulation, which form the basis of the circulatory system, for which he is considered "the greatest physiologist of the Middle Ages." He also described the earliest concept of metabolism, and developed new systems of physiology and psychology to replace the Avicennian and Galenic systems, while discrediting many of their erroneous theories on humorism, pulsation, bones, muscles, intestines, sensory organs, bilious canals, esophagus, stomach, etc.

Ibn al-Lubudi rejected the theory of humorism, and discovered that the body and its preservation depend exclusively upon blood, women cannot produce sperm, the movement of arteries are not dependent upon the movement of the heart, the heart is the first organ to form in a fetus' body, and the bones forming the skull can grow into tumors. Ibn Khatima and Ibn al-Khatib discovered that infectious diseases are caused by microorganisms which enter the human body. Mansur ibn Ilyas drew comprehensive diagrams of the body's structural, nervous and circulatory systems.

Physics



A page of Ibn Sahl's manuscript showing his discovery of the law of refraction (Snell's law).

The study of experimental physics began with Ibn al-Haytham, a pioneer of modern optics, who introduced the experimental scientific method and used it to drastically transform the understanding of light and vision in his *Book of Optics*, which has been ranked alongside Isaac Newton's *Philosophiae Naturalis Principia Mathematica* as one of the most influential books in the history of physics, for initiating a scientific revolution in optics and visual perception.

The experimental scientific method was soon introduced into mechanics by Biruni, and early precursors to Newton's laws of motion were discovered by several Muslim scientists. The law of inertia, known as Newton's first law of motion, and the concept of momentum were discovered by Ibn al-Haytham (Alhacen) and Avicenna. The proportionality between force and acceleration, considered "the fundamental law of classical mechanics" and foreshadowing Newton's second law of motion, was discovered by Hibat Allah Abu'l-Barakat al-Baghdaadi, while the concept of reaction, foreshadowing

Newton's third law of motion, was discovered by Ibn Bajjah (Avempace). Theories foreshadowing Newton's law of universal gravitation were developed by Ja'far Muhammad ibn Mūsā ibn Shākir, Ibn al-Haytham, and al-Khazini. Galileo Galilei's mathematical treatment of acceleration and his concept of impetus was enriched by the commentaries of Avicenna and Ibn Bajjah to Aristotle's *Physics* as well as the Neoplatonic tradition of Alexandria, represented by John Philoponus.

Other sciences

Many other advances were made by Muslim scientists in biology (anatomy, botany, evolution, physiology and zoology), the earth sciences (anthropology, cartography, geodesy, geography and geology), psychology (experimental psychology, psychiatry, psychophysics and psychotherapy), and the social sciences (demography, economics, sociology, history and historiography).

Other famous Muslim scientists during the Islamic Golden Age include al-Farabi (a polymath), Biruni (a polymath who was one of the earliest anthropologists and a pioneer of geodesy), Nasīr al-Dīn al-Tūsī (a polymath), and Ibn Khaldun (considered to be a pioneer of several social sciences such as demography, economics, cultural history, historiography and sociology), among others.

Other achievements

Architecture

Selimiye Mosque, built by Mimar Sinan in 1575. Edirne, Turkey.

The Great Mosque of Xi'an in China was completed *circa* 740, and the Great Mosque of Samarra in Iraq was completed in 847. The Great Mosque of Samarra combined the hypostyle architecture of rows of columns supporting a flat base above which a huge spiraling minaret was constructed.

The Spanish Muslims began construction of the Great Mosque at Cordoba in 785 marking the beginning of Islamic architecture in Spain and Northern Africa. The mosque is noted for its striking interior arches. Moorish architecture reached its peak with the construction of the Alhambra, the magnificent palace/fortress of Granada, with its open and breezy interior spaces adorned in red, blue, and gold. The walls are decorated with stylized foliage motifs, Arabic inscriptions, and arabesque design work, with walls covered in glazed tiles.

In the Sunni Muslim Ottoman Empire massive mosques with ornate tiles and calligraphy were constructed by a series of sultans including the Süleymaniye Mosque, Sultanahmet Mosque, Selimiye Mosque, and Bayezid II Mosque.

Arts

An Arabic manuscript from the 13th century depicting Socrates (*Soqrāt*) in discussion with his pupils.

The golden age of Islamic (and/or Muslim) art lasted from 750 to the 16th century, when ceramics, glass, metalwork, textiles, illuminated manuscripts, and woodwork flourished. Lustrous glazing was an Islamic contribution to ceramics. Islamic luster-painted ceramics were imitated by Italian potters during the Renaissance. Manuscript illumination developed into an important and greatly respected art, and portrait miniature painting flourished in Persia. Calligraphy, an essential aspect of written Arabic, developed in manuscripts and architectural decoration.

Literature

The most well known work of fiction from the Islamic world was *The Book of One Thousand and One Nights* (*Arabian Nights*), which was a compilation of many earlier folk tales told by the Persian Queen Scheherazade. The epic took form in the 10th century and reached its final form by the 14th century; the number and type of tales have varied from one manuscript to another. All Arabian fantasy tales were often called "Arabian Nights" when translated into English, regardless of whether they appeared in *The Book of One Thousand and One Nights*, in any version, and a number of tales are known in Europe as "Arabian Nights" despite existing in no Arabic manuscript.

"Ali Baba" by Maxfield Parrish

This epic has been influential in the West since it was translated in the 18th century, first by Antoine Galland. Many imitations were written, especially in France. Various characters from this epic have themselves become cultural icons in Western culture, such as Aladdin, Sinbad and Ali Baba. However, no medieval Arabic source has been traced for Aladdin, which was incorporated into *The Book of One Thousand and One Nights* by its French translator, Antoine Galland, who heard it from an Arab Syrian Christian storyteller from Aleppo. Part of its popularity may have sprung from the increasing historical and geographical knowledge, so that places of which little was known and so marvels were plausible had to be set further "long ago" or farther "far away"; this is a process that continues, and finally culminate in the fantasy world having little connection, if any, to actual times and places. A number of elements from Arabian mythology and Persian mythology are now common in modern fantasy, such as genies, bahamuts, magic carpets, magic lamps, etc. When L. Frank Baum proposed writing a modern fairy tale that banished stereotypical elements, he included the genie as well as the dwarf and the fairy as stereotypes to go.

Ferdowsi's *Shahnameh*, the national epic of Iran, is a mythical and heroic retelling of Persian history. *Amir Arsalan* was also a popular mythical Persian story, which has influenced some modern works of fantasy fiction, such as *The Heroic Legend of Arslan*.

A famous example of Arabic poetry and Persian poetry on romance (love) is *Layla and Majnun*, dating back to the Umayyad era in the 7th century. It is a tragic story of undying love much like the later *Romeo and Juliet*, which was itself said to have been inspired by a Latin version of *Layli and Majnun* to an extent.

Ibn Tufail (Abubacer) and Ibn al-Nafis were pioneers of the philosophical novel. Ibn Tufail wrote the first fictional Arabic novel *Hayy ibn Yaqdhan* (*Philosophus Autodidactus*) as a response to al-Ghazali's *The Incoherence of the Philosophers*, and then Ibn al-Nafis also wrote a novel *Theologus Autodidactus* as a response to Ibn Tufail's *Philosophus Autodidactus*. Both of these narratives had protagonists (Hayy in *Philosophus Autodidactus* and Kamil in *Theologus Autodidactus*) who were autodidactic feral children living in seclusion on a desert island, both being the earliest examples of a desert island story. However, while Hayy lives alone with animals on the desert island for the rest of the story in *Philosophus Autodidactus*, the story of Kamil extends beyond the desert island setting in *Theologus Autodidactus*, developing into the earliest known coming of age plot and eventually becoming an early example of proto-science fiction.

Theologus Autodidactus, written by the Arabian polymath Ibn al-Nafis (1213–1288), is an early example of proto-science fiction. It deals with various science fiction elements such as spontaneous generation, futurology, and the end of the world and doomsday. Rather than giving supernatural or mythological explanations for these events, Ibn al-Nafis attempted to explain these plot elements using the scientific knowledge of biology, astronomy, cosmology and geology known in his time. His main purpose behind this science fiction work was to explain Islamic religious teachings in terms of science and philosophy through the use of fiction.

A Latin translation of Ibn Tufail's work, *Philosophus Autodidactus*, first appeared in 1671, prepared by Edward Pococke the Younger, followed by an English translation by Simon Ockley in 1708, as well as German and Dutch translations. These translations later inspired Daniel Defoe to write *Robinson Crusoe*, regarded as the first novel in English. *Philosophus Autodidactus* also inspired Robert Boyle to write his own philosophical novel set on an island, *The Aspiring Naturalist*. The story also anticipated Rousseau's *Emile: or, On Education* in some ways, and is also similar to Mowgli's story in Rudyard Kipling's *The Jungle Book* as well as Tarzan's story, in that a baby is abandoned but taken care of and fed by a mother wolf.

Dante Alighieri's *Divine Comedy*, considered the greatest epic of Italian literature, derived many features of and episodes about the hereafter directly or indirectly from Arabic works on Islamic eschatology: the *Hadith* and the *Kitab al-Miraj* (translated into Latin in 1264 or shortly before as *Liber Scale Machometi*, "The Book of Muhammad's Ladder") concerning Muhammad's ascension to Heaven, and the spiritual writings of Ibn Arabi. The Moors also had a noticeable influence on the works of George Peele and William Shakespeare. Some of their works featured Moorish characters, such as Peele's *The Battle of Alcazar* and Shakespeare's *The Merchant of Venice*, *Titus Andronicus* and *Othello*, which featured a Moorish Othello as its title character. These works are said to have been inspired by several Moorish delegations from Morocco to Elizabethan England at the beginning of the 17th century.

Music

The Arabic four-stringed oud was the ancestor of the lute and guitar

A number of musical instruments used in classical music are believed to have been derived from Arabic musical instruments: the lute was derived from the *al'ud*, the rebec (ancestor of violin) from the *rebab*, the guitar from *qitara*, naker from *naqareh*, adufe from *al-duff*, alboka from *al-buq*, anafil from *al-nafir*, exabeba from *al-shabbaba* (flute), atabal (bass drum) from *al-tabl*, atambal from *al-tinbal*, the balaban, the castanet from *kasatan*, sonajas de azófar from *sunuj al-sufr*, the conical bore wind instruments, the xelami from the *sulami* or *fistula* (flute or musical pipe), the shawm and dulzaina from the reed instruments *zamr* and *al-zurna*, the gaita from the *ghaita*, rackett from *iraqya* or *iraqiyya*, the harp and zither from the *qanun*, geige (violin) from *ghichak*, and the theorbo from the *tarab*.

A theory on the origins of the Western Solfège musical notation suggests that it may have also had Arabic origins. It has been argued that the Solfège syllables (*do, re, mi, fa, sol, la, ti*) may have been derived from the syllables of the Arabic solmization system *Durr-i-Mufassal* ("Separated Pearls") (*dal, ra, mim, fa, sad, lam*). This origin theory was first proposed by Meninski in his *Thesaurus Linguarum Orientalum* (1680) and then by Laborde in his *Essai sur la Musique Ancienne et Moderne* (1780).

Ottoman military bands are thought to be the oldest variety of military marching band in the world. Though they are often known by the Persian-derived word *Mehter*. The standard instruments employed by a Mehter are: Bass drum (timpani), the kettledrum (nakare), Frame drum (davul), the Cymbals (zil), Oboes and Flutes, Zurna, the "Boru" (a kind of trumpet), Triangle (instrument), and the *Cevgen* (a kind of stick bearing small concealed bells). These military bands inspired many Western nations and especially the Orchestra inspiring the works of Wolfgang Amadeus Mozart and Ludwig van Beethoven.

Philosophy

Ibn Rushd, founder of the Averroism school of philosophy, whose works and commentaries had an impact on the rise of secular thought in Western Europe.

Arab philosophers like al-Kindi (Alkindus) and Ibn Rushd (Averroes) and Persian philosophers like Ibn Sina (Avicenna) played a major role in preserving the works of Aristotle, whose ideas came to dominate the non-religious thought of the Christian and Muslim worlds. They would also absorb ideas from China, and India, adding to them tremendous knowledge from their own studies. Three speculative thinkers, al-Kindi, al-Farabi, and Avicenna (Ibn Sina), fused Aristotelianism and Neoplatonism with other ideas introduced through Islam, such as Kalam and Qiyas. This led to Avicenna founding his own Avicennism school of philosophy, which was influential in both Islamic and Christian lands. Avicenna was also a critic of Aristotelian logic and founder of Avicennian logic, and he developed the concepts of empiricism and tabula rasa, and distinguished between essence and existence.

From Spain the Arabic philosophic literature was translated into Hebrew, Latin, and Ladino, contributing to the development of modern European philosophy. The Jewish philosopher Moses Maimonides, Muslim sociologist-historian Ibn Khaldun, Carthage citizen Constantine the African who translated ancient Greek medical texts, and the

PersianAl-Khwarzimi's collation of mathematical techniques were important figures of the Golden Age.

One of the most influential Muslim philosophers in the West was Averroes (Ibn Rushd), founder of the Averroism school of philosophy, whose works and commentaries had an impact on the rise of secular thought in Western Europe. He also developed the concept of "existence precedes essence".

Another influential philosopher who had a significant influence on modern philosophy was Ibn Tufail. His philosophical novel, *Hayy ibn Yaqdhan*, translated into Latin as *Philosophus Autodidactus* in 1671, developed the themes of empiricism, tabula rasa, nature versus nurture, condition of possibility, materialism, and Molyneux's Problem. European scholars and writers influenced by this novel include John Locke, Gottfried Leibniz, Melchisédech Thévenot, John Wallis, Christiaan Huygens, George Keith, Robert Barclay, the Quakers, and Samuel Hartlib.

Al-Ghazali also had an important influence on Jewish thinkers like Maimonides and Christian medieval philosophers such as Thomas Aquinas. However, al-Ghazali also wrote a devastating critique in his *The Incoherence of the Philosophers* on the speculative theological works of Kindi, Farabi and Ibn Sina. The study of metaphysics declined in the Muslim world due to this critique, though Ibn Rushd (Averroes) responded strongly in his *The Incoherence of the Incoherence* to many of the points Ghazali raised. Nevertheless, Avicennism continued to flourish long after and Islamic philosophers continued making advances in philosophy through to the 17th century, when Mulla Sadra founded his school of Transcendent Theosophy and developed the concept of existentialism.

Other influential Muslim philosophers include al-Jahiz, a pioneer of evolutionary thought and natural selection; Ibn al-Haytham (Alhacen), a pioneer of phenomenology and the philosophy of science and a critic of Aristotelian natural philosophy and Aristotle's concept of place (topos); Biruni, a critic of Aristotelian natural philosophy; Ibn Tufail and Ibn al-Nafis, pioneers of the philosophical novel; Shahab al-Din Suhrawardi, founder of Illuminationist philosophy; Fakhr al-Din al-Razi, a critic of Aristotelian logic and a pioneer of inductive logic; and Ibn Khaldun, a pioneer in the philosophy of history and social philosophy.

End of the Golden Age

Mongol invasion and Turkic settlement

After the Crusades from the West that resulted in the instability of the Islamic world during the 11th century, a new threat came from the East during the 13th century: the Mongol invasions. In 1206, Genghis Khan from Central Asia established a powerful Mongol Empire. A Mongolian ambassador to the Abbasid Caliph in Baghdad is said to have been murdered, which may have been one of the reasons behind Hulagu Khan's sack of Baghdad in 1258.

Mongol imperial war banners

The Mongols and Turks from Central Asia conquered most of the Eurasian land mass, including both China in the east and parts of the old Islamic Caliphate and Persian Islamic Khwarezm, as well as Russia and Eastern Europe in the west, and subsequent invasions of the Levant. Later Turkic leaders, such as Timur, though he himself became a Muslim, destroyed many cities, slaughtered thousands of people and did irreparable damage to the ancient irrigation systems of Mesopotamia. On the other hand, due to the lack of a powerful leader after the Mongolian invasion and Turkish settlement, some local Turkish kingdoms appeared in the Islamic world and they were in war and fighting against each other for centuries. The most powerful kingdoms among them were the empire of Ottoman Turks, who became Sunni Muslims and the empire of Safavi Turks, who became Shia Muslims. Eventually, they invaded very wide parts of the Islamic world and entered in a competition and a series of bloody wars until the middle of seventeenth century.

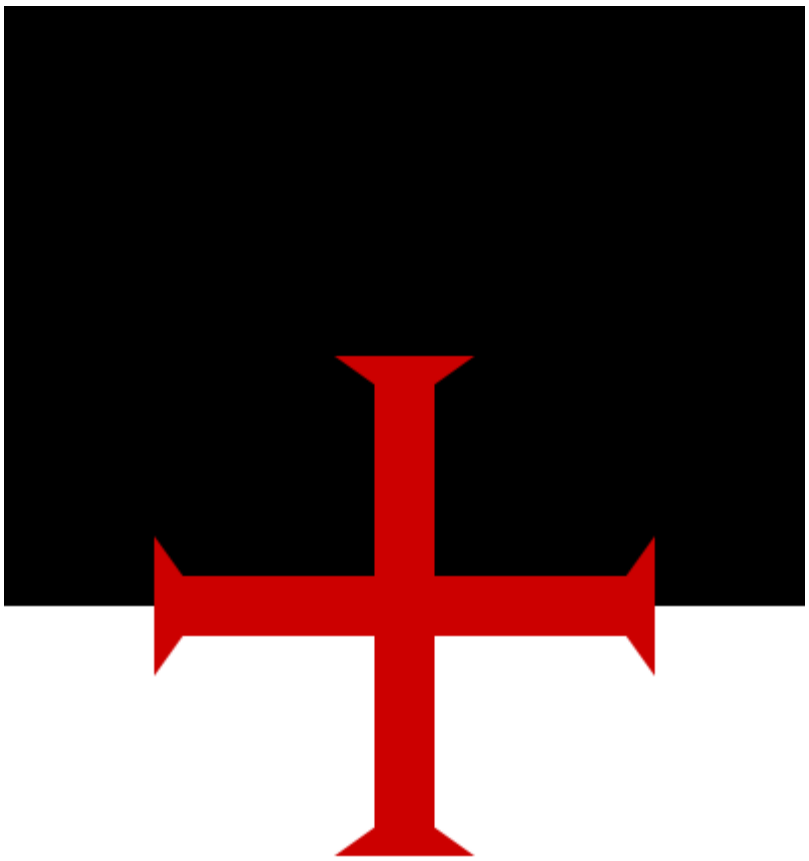
Traditionalist Muslims at the time, including the polymath Ibn al-Nafis, believed that the Crusades and Mongol invasions were a divine punishment from God against Muslims deviating from the Sunnah. As a result, the falsafa, some of whom held ideas incompatible with the Sunnah, became targets of criticism from many traditionalist Muslims, though other traditionalists such as Ibn al-Nafis made attempts at reconciling reason with revelation and blur the line between the two. However Saladin rejected the widespread belief of *divine punishment* and instead blamed Muslim's for committing a series of errors in their policies (regarding social stability) and on the battlefield.

Eventually, the Mongols and Turks that settled in parts of Persia, Central Asia, Russia and Anatolia converted to Islam, and as a result, the Ilkhanate, Golden Horde and Chagatai Khanates became Islamic states. In many instances, Mongols assimilated into various Muslim Iranian or Turkic peoples (for instance, one of the greatest Muslim astronomers of the 15th century, Ulugh Beg, was a grandson of Timur). By the time the Ottoman Empire rose from the ashes, the Golden Age is considered to have come to an end.

Causes of decline

"The achievements of the Arabic speaking peoples between the ninth and twelfth centuries are so great as to baffle our understanding. The decadence of Islam and of Arabic is almost as puzzling in its speed and completeness as their phenomenal rise. Scholars will forever try to explain it as they try to explain the decadence and fall of Rome. Such questions are exceedingly complex and it is impossible to answer them in a simple way."
— George Sarton, *The Incubation of Western Culture in the Middle East'*

According to the traditional view of Islamic civilization, which had at the outset been creative and dynamic in dealing with issues, it began to struggle to respond to the challenges and rapid changes it faced from the 12th century onwards, towards the end of the Abbassid rule; despite a brief respite with the new Ottoman rule, the decline apparently continued until its eventual collapse and subsequent stagnation in the 20th century. Some scholars such as M. I. Sanduk believe that the declination began from around the 11th century and still continued after this. Some other scholars have come to question the traditional picture of decline, pointing to a continuing and creative scientific tradition through to the 15th and 16th centuries, with the works of Ibn al-Shatir, Ulugh Beg, Ali Kuşçu, al-Birjandi and Taqi al-Din considered noteworthy examples. This was also the case for other fields, such as medicine, notably the works of Ibn al-Nafis, Mansur ibn Ilyas and Şerafeddin Sabuncuoğlu; mathematics, notably the works of al-Kashi and al-Qalasadi; philosophy, notably Mulla Sadra's transcendent theosophy; and the social sciences, notably Ibn Khaldun's *Muqaddimah* (1370), which itself points out that though science was declining in Iraq, Al-Andalus and Maghreb, it continued to flourish in Persia, Syria and Egypt during his time. Nevertheless, many agree that there was still a decline in scientific activity after the 16th century.



One of the many reported flags of the Knights Templar used during the Crusades

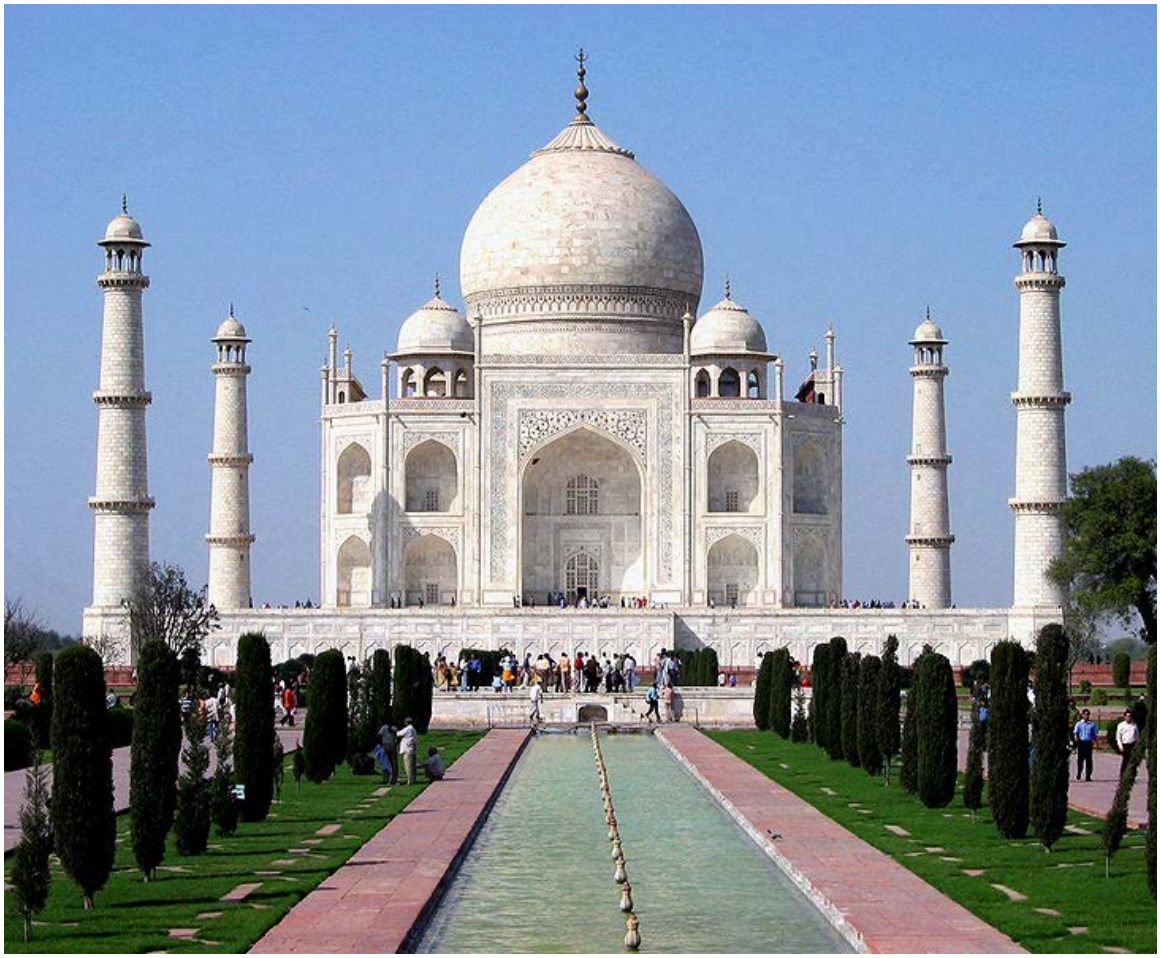
Despite a number of attempts by many writers, historical and modern, none seem to agree on the causes of decline. The main views on the causes of decline comprise the following: political mismanagement after the early Caliphs (10th century onwards), foreign involvement by invading forces and colonial powers (11th century Crusades, 13th century Mongol Empire, 15th century Reconquista, 19th century European colonial empires), and the disruption to the cycle of equity based on Ibn Khaldun's famous model of Asabiyyah (the rise and fall of civilizations) which points to the decline being mainly due to political and economic factors.

North Africa's Islamic civilization collapsed after exhausting its resources in internal fighting and suffering devastation from the invasion of the Arab Bedouin tribes of Banu

Sulaym and Banu Hilal. The Black Death ravaged much of the Islamic world in the mid-14th century. Plague epidemics kept returning to the Islamic world up to the 19th century. There was apparently an increasing lack of tolerance of intellectual debate and freedom of thought, with some seminaries systematically forbidding speculative metaphysics, while polemic debates in this field appear to have been abandoned after the 14th century. A significant intellectual shift in Islamic philosophy is perhaps demonstrated by al-Ghazali's late 11th century polemic work *The Incoherence of the Philosophers*, which lambasted metaphysical philosophy in favor of the primacy of Revelation, and was later criticized in *The Incoherence of the Incoherence* by Averroes. Institutions of science comprising Islamic universities, libraries (including the House of Wisdom), observatories, and hospitals, were later destroyed by foreign invaders like the Crusaders and particularly the Mongols, and were rarely promoted again in the devastated regions. Not only wasn't new publishing equipment accepted but also wide illiteracy overwhelmed the devastated lands, especially in Mesopotamia. Meanwhile in Persia, due to the Mongol invasions and the plague, the average life expectancy of the scholarly class in Persia had declined from 72 years in 1209 to 57 years by 1242. American economist Timur Kuran has argued that economic development in the Middle East lagged behind that of the West in modern times due to the limitations of Islamic partnership law and inheritance law. These laws restricted the growth of Middle Eastern enterprises, and prevented the development of corporate forms.

Chapter- 3

Islamic Art



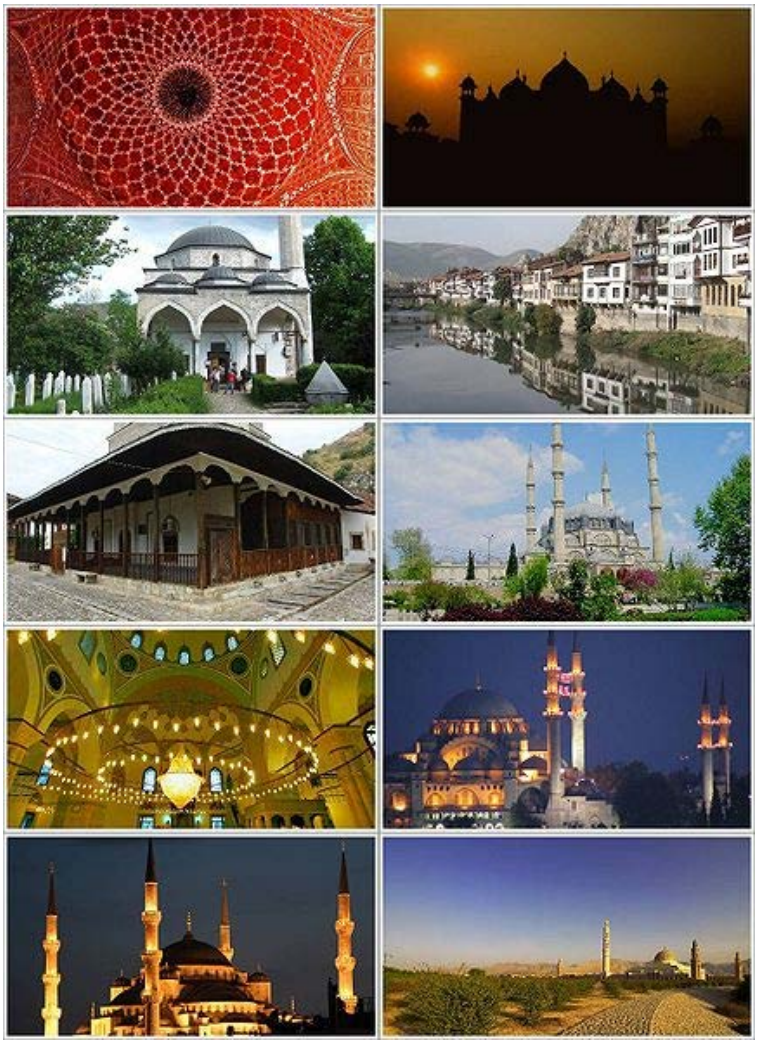
The Taj Mahal, Agra. Shah Jahan's 1648 memorial to wife Mumtaz Mahal, would, in 1983, be cited as "the jewel of Muslim art in India and one of the universally admired masterpieces of the world's heritage."

Embroidered panel, 18th to 19th century, from the Caucasus, possibly Karabagh. These colorful textiles of the Caucasus region were a domestic art made for home use and local commerce, and may have inspired the better-known Caucasian rugs made for export. Textile Museum collections.

Islamic art encompasses the visual arts produced from the 7th century onwards by people (not necessarily Muslim) who lived within the territory that was inhabited by culturally Islamic populations. It includes fields as varied as architecture, calligraphy, painting, and ceramics, among others.

Typically, though not entirely, Islamic art has focused on the depiction of patterns and Arabic calligraphy, rather than on figures, because it is feared by many Muslims that the depiction of the human form is idolatry and thereby a sin against Allah, forbidden in the Qur'an.

Overview



Islamic art is not an art pertaining to religion only. The term "Islamic" refers not only to the religion, but to the rich and varied Islamic culture as well. Islamic art frequently adopts secular elements and elements that are frowned upon, if not forbidden, by some Islamic theologians.

Islamic art developed from many sources: Roman, Early Christian art, and Byzantine styles were taken over in early Islamic art and architecture; the influence of the Sassanian art of pre-Islamic Persia was of paramount significance; Central Asian styles were brought in with various nomadic incursions; and Chinese influences had an important effect on Islamic painting, pottery, and textiles."

There are repeating elements in Islamic art, such as the use of geometrical floral or vegetal designs in a repetition known as the arabesque. The arabesque in Islamic art is often used to symbolize the transcendent, indivisible and infinite nature of Allah.

Mistakes in repetitions may be intentionally introduced as a show of humility by artists who believes only Allah can produce perfection, although this theory is disputed.

Human portrayals can be found in all eras of Islamic art. Human representation for the purpose of worship is considered idolatry and is duly forbidden in Islamic law, known as *Sharia* law. There are also many depictions of Muhammad, Islam's chief prophet, in historical Islamic art.

Architecture

Perhaps the most important expression of Islamic art is architecture, particularly that of the mosque (four-iwan and hypostyle). Through the edifices, the effect of varying cultures within Islamic civilization can be illustrated. The North African and Spanish Islamic architecture, for example, has Roman-Byzantine elements, as seen in the Alhambra palace at Granada, or in the Great Mosque of Cordoba.

The role of domes in Islamic architecture has been considerable. Domes have been used in Islamic architecture for centuries. The earliest surviving dome is part of the Dome of the Rock monument, built in 691 CE. Another prominent dome is that of the 17th century Taj Mahal. And as late as the 19th century, Islamic domes were incorporated into Western architecture.

Calligraphy

Calligraphic design is omnipresent in Islamic art, and is usually expressed in a mix of Qur'anic verses and historical proclamations. Two of the main scripts involved are the symbolic *kufic* and *naskh* scripts, which can be found adorning and enhancing the visual appeal of the walls and domes of buildings, the sides of minbars, and so on. Illuminated scripts, coinage, and other "minor art" pieces such as ewers and incense holders are also often decorated with calligraphy.

Pile carpet

From the yarn fiber to the colors, every part of the Persian rug is traditionally hand made from natural ingredients over the course of many months.

No Islamic artistic concept has become better known outside its original home than the pile carpet, more commonly referred to as the *Oriental carpet* (oriental rug). Their versatility is utilized in everyday Islamic and Muslim life, from floor coverings to

architectural enrichment, from cushions to bolsters to bags and sacks of all shapes and sizes, and to religious objects (such as a prayer rug, which would provide a clean place to pray). Carpet weaving is a rich and deeply embedded tradition in Islamic societies, and the practice is seen in cities as well as in rural communities and nomadic encampments. In older times, special establishments and workshops were in existence that functioned directly under court patronage in Islamic lands.

Pottery

Tin-glazed Hispano-Moresque ware with lusterware decoration, from Spain *circa* 1475

From the eighth to eighteenth centuries, the use of glazed ceramics was prevalent in Islamic art, usually assuming the form of elaborate pottery. Tin-opacified glazing was one of the earliest new technologies developed by the Islamic potters. The first Islamic opaque glazes can be found as blue-painted ware in Basra, dating to around the 8th century. Another significant contribution was the development of stonepaste ceramics, originating from 9th century Iraq. The first industrial complex for glass and pottery production was built in Ar-Raqqah, Syria, in the 8th century. Other centers for innovative

ceramic pottery in the Islamic world included Fustat (from 975 to 1075), Damascus (from 1100 to around 1600) and Tabriz (from 1470 to 1550).

Another innovation was the albarello, a type of maiolica earthenware jar originally designed to hold apothecaries' ointments and dry drugs. The development of this type of pharmacy jar had its roots in the Islamic Middle East. Brought to Italy by Hispano-Moresque traders, the earliest Italian examples were produced in Florence in the 15th century.

The Hispano-Moresque style emerged in Andalusia in the 8th century, under the Fatimids. This was a style of Islamic pottery created in Islamic Spain, after the Moors had introduced two ceramic techniques to Europe: glazing with an opaque white tin-glaze, and painting in metallic lusters. Islamic Hispano-Moresque ware was distinguished from the pottery of Christendom by the Islamic character of its decoration; the term also includes wares produced by Christians.

The medieval Islamic world also had pottery with animal imagery. Examples are found throughout the medieval Islamic world, particularly in Persia and Egypt.

Others

Although the art of figurative monumental sculpture was hardly practiced at all, work in metal and ivory was often developed to a high degree of technical accomplishment. It is also necessary to mention the importance of painting, and particularly of the illumination of both sacred and secular texts.

History of Islamic art

The beginnings of Islamic art

Before the Dynasties

The period of a rapid expansion of the Islamic era forms a reasonably accurate beginning for the label of Islamic art. Early geographical boundaries of the Islamic culture were in present-day Syria. It is quite difficult to distinguish the earliest Islamic objects from their predecessors in Persian or Sassanid art and Byzantine art. There was, notably, a significant production of unglazed ceramics, witnessed by a famous small bowl preserved in the Louvre, whose inscription assures its attribution to the Islamic period. Vegetal motifs were the most important these early productions.

Influences from the Sassanian artistic tradition include the image of the king as a warrior and the lion as a symbol of nobility and virility. The Bedouin tribal tradition represented the geographically "native" artistic hegemony.

Coinage and metalwork were imported and used for trade with the Byzantines.

Umayyad art

Mosaics from the *riwaq* (portico) of the Great Mosque of Damascus

Religious and civic architecture were developed under the Umayyads, when new concepts and new plans were put into practice. Thus, the "Arab plan," with court and hypostyle prayer hall, truly became a functional type with the construction of the Umayyad Mosque, or the Great Mosque of Damascus (completed in 715 by caliph Al-Walid I) on top of the ancient temple of Jupiter and in place of the basilica of St. John the Baptist, the most sacred site in the city. This building served as a point of reference for builders (and for art historians) for the birth of the Arab plan, as Byzantine Christian.

The Dome of the Rock in Jerusalem is one of the most important buildings in all of Islamic architecture, marked by a strong Byzantine influence (mosaic against a gold background, and a central plan that recalls that of the Church of the Holy Sepulchre), but already bearing purely Islamic elements, such as the great epigraphic frieze. The desert palaces in Jordan and Syria (for example, Mshatta, Qasr Amra, and Khirbat al-Mafjar) served the caliphs as living quarters, reception halls, and baths, and were decorated to promote an image of royal luxury.

Work in ceramics was still somewhat primitive (unglazed) during this period. Some metal objects have survived from this time, but it remains rather difficult to distinguish these objects from those of the pre-Islamic period.

'Abd al-Malik introduced standard coinage that featured Arabic inscriptions, instead of images of the monarch. The quick development of a localized coinage around the time of

the Dome of the Rock's construction demonstrates the reorientation of Umayyad acculturation. This period saw the genesis of a particularly Islamic art.

In this period, Umayyad artists and artisans did not invent a new vocabulary, but began to prefer those received from Mediterranean and Iranian late antiquity, which they adapted to their own artistic conceptions. For example, the mosaics in the Great Mosque of Damascus are based on Byzantine models, but replace the figurative elements with images of trees and cities. The desert palaces also bear witness to these influences. By combining the various traditions that they had inherited, and by readapting motifs and architectural elements, artists created little by little a typically Muslim art, particularly discernible in the aesthetic of the arabesque, which appears both on monuments and in illuminated Qur'ān.

Abbasid art

Luster-ware bowl from Susa, 9th century, today in the Louvre

The Abbasid dynasty (750 A.D.- 1258) witnessed the movement of the capital from Damascus to Baghdad, and then from Baghdad to Samarra. The shift to Baghdad influenced politics, culture, and art. Art historian Robert Hillenbrand (1999) likens the movement to the foundation of an "Islamic Rome", because the meeting of Eastern

influences from Iranian, Eurasian steppe, Chinese, and Indian sources created a new paradigm for Islamic art. Classical forms inherited from Byzantine Europe and Greco-Roman sources were discarded in favor of those drawn from the new Islamic hub. Even the design of the city of Baghdad placed it in the "navel of the world," as 9th-century historian al-Ya'qubi wrote.

The Mosque of Uqba also known as the Great Mosque of Kairouan was founded in 670, its actual aspect dates back to the 9th century.

The ancient city of Baghdad cannot be excavated well, as it lies beneath the modern city. However, Samarra has been well studied, and is known for its extensive cultivation of the art of stucco. Motifs known from the stucco at Samarra permit the dating of structures built elsewhere, and are furthermore found on portable objects, particular in wood, from Egypt through to Iran.

Abbasid architecture in Iraq as exemplified in the Fortress of Al-Ukhaidir (c.775-6) demonstrated the "despotic and the pleasure-loving character of the dynasty" in its grand size but cramped living quarters.

Samarra witnessed the "coming of age" of Islamic art. Polychrome painted stucco allowed for experimentation in new styles of moulding and carving. The Great Mosque of Samarra, once the largest in the world, was built for the new capital.

Other major mosques built in the Abbasid Dynasty include the Mosque of Ibn Tulun in Cairo, Abu Dalaf in Iraq, the great mosque in Tunis, and the great mosque in Kairouan.

The Abbasid period also coincided with two major innovations in the ceramic arts: the invention of faience, and of metallic lusterware. Hadithic prohibition of the use of golden or silver pottery led to the development of metallic lusterware, which was made by mixing sulphur and metallic oxides to ochre and vinegar, painted onto an already glazed vessel and then fired a second time. It was expensive, and difficult to manage the second round through the kiln, but the need to replace fine Chinese pottery led to the development of this technique.

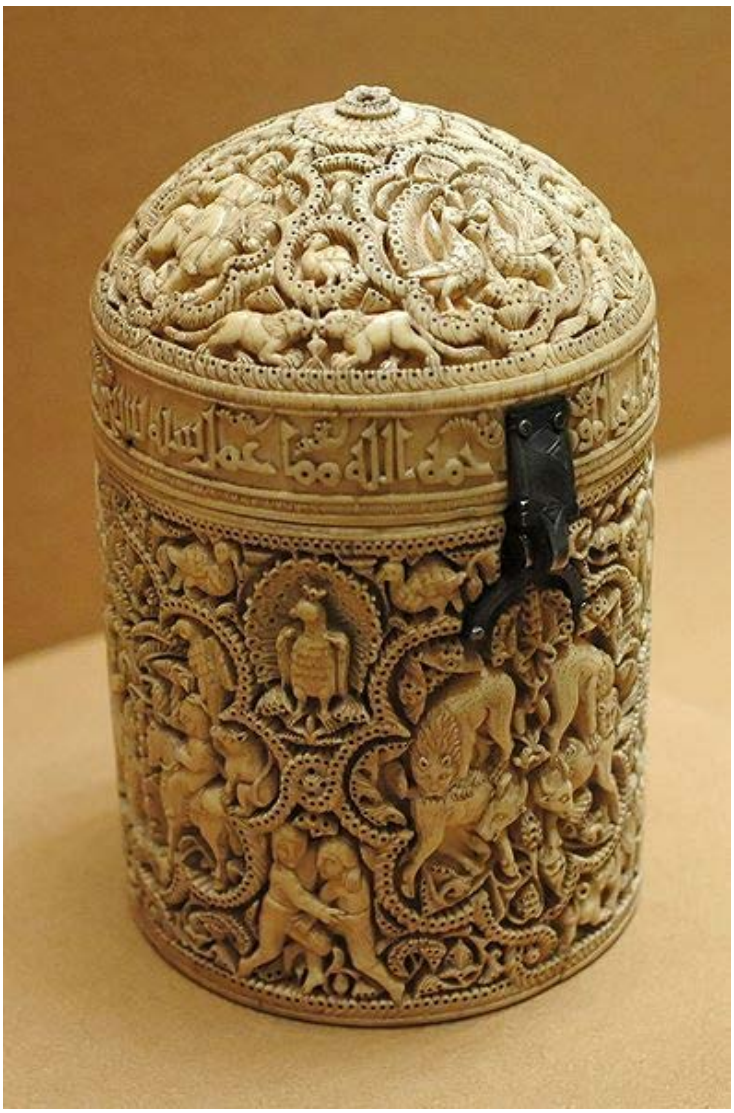
Though the common perception of Abbasid artistic production focuses largely on pottery, the greatest development of the Abbasid period was in textiles. Government-run workshops known as *tiraz* produced silks bearing the name of the monarch, allowing for aristocrats to demonstrate their loyalty to the ruler. Other silks were pictorial. The utility of silk-ware in wall decor, entrance adornment, and room separation were not as important as their cash value along the "silk route".

Calligraphy began to be used in surface decoration on pottery during this period. Illuminated Qur'ans gained attention, letter-forms now more complex and stylized to the point of slowing down the recognition of the words themselves.

The medieval period (9th–15th centuries)

Beginning in the 9th century, Abbasid sovereignty was contested in the provinces furthest removed from the Iraqi center. The creation of a Shi'a dynasty, that of the north African Fatimids, followed by the Umayyads in Spain, gave force to this opposition, as well as small dynasties and autonomous governors in Iran.

Spain and the Arab Maghreb



Pyxis of al-Mughira, Madinat al-Zahra, 968, today in the Louvre

The first Islamic dynasty to establish itself in Spain (or al-Andalus) was that of the Spanish Umayyads. As their name indicates, they were descended from the great Umayyads of Syria. After their fall, the Spanish Umayyads were replaced by various autonomous kingdoms, the taifas (1031–91), but the artistic production from this period does not differ significantly from that of the Umayyads. At the end of the 11th centuy, two Berber tribes, the Almoravids and the Almohads, captured the head of the Maghreb and Spain, successively, bringing Maghrebi influences into art. A series of military victories by Christian monarchs had reduced Islamic Spain by the end of the 14th century to the city of Granada, ruled by the Nasirid dynasty, who managed to maintain their hold until 1492.

Al-Andalus was a great cultural center of the Middle Ages. Besides the great universities, which taught philosophies and sciences yet unknown in Christendom (such as those of Averroes), the territory was an equally vital center for art. One thinks immediately, in architecture, of the Great Mosque of Cordoba, but other, smaller, monuments should not be forgotten, such as the Bab Mardum in Toledo, or the caliphal city of Medina Azahara. In the later period one finds notably the palace of the Alhambra, in Granada.

Many techniques were employed in the manufacture of objects. Ivory was used extensively for the manufacture of boxes and caskets. The pyxis of al-Mughira is a masterwork of the genre. In metalwork, large sculptures in the round, normally rather scarce in the Islamic world, served as elaborate receptacles for water or as fountain spouts. A great number of textiles, most notably silks, were exported: many are found in the church treasuries of Christendom, where they served as covering for saints' reliquaries. From the periods of Maghrebi rule one may also note a taste for painted and sculpted woodwork.

The art of north Africa is not as well studied. The Almoravid and Almohad dynasties are characterized by a tendency toward austerity, for example in mosques with bare walls. Nevertheless, luxury arts continued to be produced in great quantity. The Marinid and Hafsid dynasties developed an important, but poorly understood, architecture, and a significant amount of painted and sculpted woodwork.

Arab Mashriq

Detail of the "Baptistère de Saint-Louis," 13th-14th century, Mamluk, today in the Louvre.

The Fatamid dynasty, which reigned in Egypt from 909 and 1171 introduced crafts and knowledge from politically troubled Baghdad to Cairo.

By the year 1070 the Seljuks emerged as the dominant political force in the Muslim world after they liberated Baghdad and defeated the Byzanties at Manzikert, during the rule of Malik Shah the Seljuks excelled in arcetecture at the same time in Syria, the atabegs (governors of Seljuk princes) assumed power. Quite independent, they capitalized on conflicts with the Frankish crusaders. In 1171, Saladin seized Fatimid Egypt, and installed the transitory Ayyubid dynasty on the throne. This period is notable for innovations in metallurgy and the widespread manufacture of the Damascus steel swords and daggers and the production ceramics, glass and metalwork of a high quality were produced without interruption, and enameled glass became another important craft.

In 1250 the Mamluks seized control of Egypt from the Ayyubids, and by 1261 had managed to assert themselves in Syria as well their most famous ruler was Baibars. The Mamluks were not, strictly speaking, a dynasty, as they did not maintain a patrilineal mode of succession; in fact, Mamluks were freed Turkish and Caucasian slaves, who (in theory) passed the power to others of like station. This mode of government persevered for three centuries, until 1517, and gave rise to abundant architectural projects (many thousands of buildings were constructed during this period), while patronage of luxury arts favored primarily enameled glass and metalwork, and is remembered as the golden age of mideval Egypt.

The Baptistery of Saint Louis, one of the most famous Islamic objects, dates to this period.

Iran and Central Asia

The Mausoleum of the Samanids, Bukhara, Uzbekistan, ca. 914-43

In Iran and the north of India, the Tahirids, Samanids, Ghaznavids, and Ghurids struggled for power in the 10th century, and art was a vital element of this competition. Great cities were built, such as Nishapur and Ghazni, and the construction of the Great Mosque of Isfahan (which would continue, in fits and starts, over several centuries) was initiated. Funerary architecture was also cultivated, while potters developed quite individual styles: kaleidoscopic ornament on a yellow ground; or marbled decorations created by allowing colored glazes to run; or painting with multiple layers of slip under the glaze.

The Seljuqs, nomads of Turkic origin from present-day Mongolia, appeared on the stage of Islamic history toward the end of the 10th century. They seized Baghdad in 1048, before dying out in 1194 in Iran, although the production of "Seljuq" works continued through the end of the 12th and beginning of the 13th century under the auspices of smaller, independent sovereigns and patrons. During their time, the center of culture, politics and art production shifted from Damascus and Baghdad to Merv, Nishapur, Rayy, and Isfahan, all in Iran.

Popular patronage expanded because of a growing economy and new urban wealth. Inscriptions in architecture tended to focus more on the patrons of the piece. For example, sultans, viziers or lower ranking officials would receive often mention in inscriptions on mosques. Meanwhile, growth in mass market production and sale of art made it more commonplace and accessible to merchants and professionals. Because of increased production, many relics have survived from the Seljuk era and can be easily dated. In contrast, the dating of earlier works is more ambiguous. It is, therefore, easy to mistake Seljuk art as new developments rather than inheritance from classical Iranian and Turkic sources.

Under the Seljuqs the "Iranian plan" of mosque construction appears for the first time. Lodging places called *khans*, or caravanserai, for travellers and their animals, or caravansarais, generally displayed utilitarian rather than ornamental architecture, with rubble masonry, strong fortifications, and minimal comfort. Another important architectural trend to arise in the Seljuk era is the development of mausolea including the tomb tower such as the Gunbad-i-qabus (circa 1006-7) (showcasing a Zoroastrian motif) and the domed square, an example of which is the tomb of the Samanids in the city of Bukhara (circa 943).

Innovations in the ceramic arts that date to this period include the production of minai ware and the manufacture of vessels, not out of clay, but out of a silicon paste ("frit-ware"), while metalworkers began to encrust bronze with precious metals. Across the Seljuk era, from Iran to Iraq, a unification of book painting can be seen. These paintings have animalistic figures that convey strong symbolic meaning of fidelity, treachery, and courage.

In the 13th century the Mongols, under the leadership of Genghis Khan, swept through the Islamic world. Upon the death of Genghis Khan, his empire was divided among his sons and many dynasties were thus formed: the Yuan in China, the Ilkhanids in Iran, and the Golden Horde in northern Iran and southern Russia.

Iskandar at the talking tree, from an Ilkhanid Shahnameh, ca. 1330-1340, Smithsonian

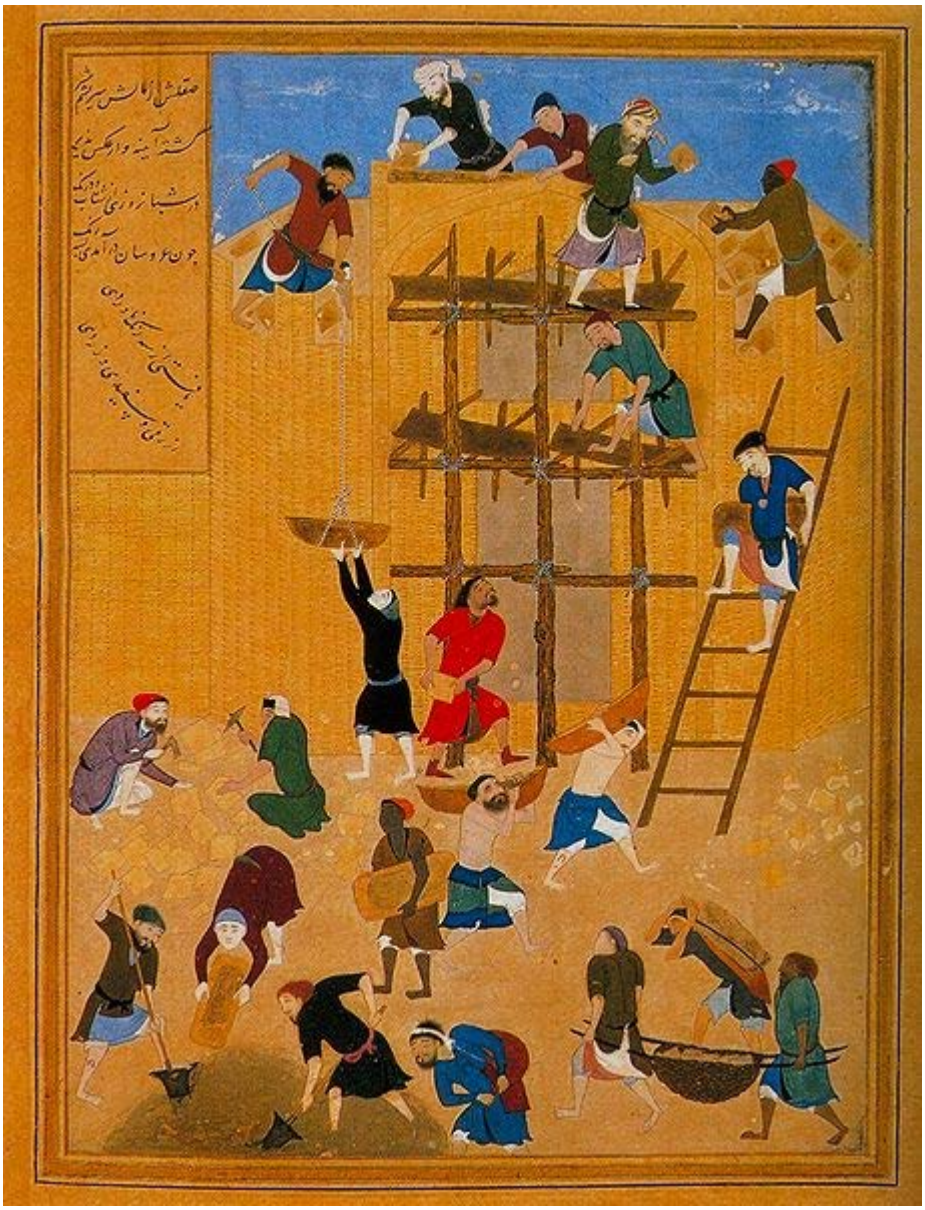
The Ilkhanids

A rich civilization developed under these "little khans," who were originally subservient to the Yuan emperor, but rapidly became independent. Architectural activity intensified as the Mongols became sedentary, and retained traces of their nomadic origins, such as the north-south orientation of the buildings. At the same time a process of "iranisation" took place, and construction according to previously established types, such as the "Iranian plan" mosques, was resumed. The tomb of Öljeitü in Soltaniyeh is one of the greatest and most impressive monuments in Iran, despite many later depredations. The art of the Persian book was also born under this dynasty, and was encouraged by aristocratic patronage of large manuscripts such as the *Jami' al-tawarikh* by Rashid-al-Din Hama-

dani. New techniques in ceramics appeared, such as the lajvardina (a variation on luster-ware), and Chinese influence is perceptible in all arts.

The Golden Horde and the Timurids

The early arts of the nomads of the Golden Horde are poorly understood. Research is only beginning, and evidence for town planning and architecture has been discovered. There was also a significant production of works in gold, which often show a strong Chinese influence. Much of this work is preserved today in the Hermitage.



Construction of the fort at Kharnaq, Al-Hira, painting by Behzād, 1494-45, British Museum

The beginning of the third great period of medieval Iranian art, that of the Timurids, was marked by the invasion of a third group of nomads, under the direction of Timur. During the 15th century this dynasty gave rise to a golden age in Persian manuscript painting, including renowned painters such as Kamāl ud-Dīn Behzād, but also a multitude of workshops and patrons. Iranian architecture and city planning also reached an apogee, in particular with the monuments of Samarkand, and are marked by extensive use of exterior ceramic tiles and muqarnas vaulting within.

Syria, Iraq, and Anatolia

The Seljuq Turks pushed beyond Iran into Anatolia, winning a victory over the Byzantine Empire in the Battle of Manzikert (1071), and setting up a sultanate independent of the Iranian branch of the dynasty. Their power seems largely to have waned following the Mongol invasions in 1243, but coins were struck under their name until 1304. Architecture and objects synthesized various styles, both Iranian and Syrian, sometimes rendering precise attributions difficult. The art of woodworking was cultivated, and at least one illustrated manuscript dates to this period. Caravanserais dotted the major trade routes across the region, placed at intervals of a day's travel. The construction of these caravanserai inns improved in scale, fortification, and replicability. Also, they began to contain central mosques.

The Turkmen, nomads who settled in the area of Lake Van, were responsible for a number of mosques, such as the Blue Mosque in Tabriz, and they had a decisive influence after the fall of the Anatolian Seljuqs. Starting in the 13th century, Anatolia was dominated by small Turkmen dynasties, which progressively chipped away at Byzantine territory. Little by little a major dynasty emerged, that of the Ottomans, who, after 1450, are referred to as the “first Ottomans.” Patronage was exercised primarilyso be seen as the forerunners of Ottoman art, in particular the “Milet” ceramics and the first blue-and-white Anatolian works.

Islamic book painting witnessed its first golden age in the thirteenth century, mostly from Syria and Iraq. Influence from Byzantine visual vocabulary (blue and gold coloring, angelic and victorious motifs, symbology of drapery) combined with Mongoloid facial types in 12th-century book frontispieces.

Earlier coinage necessarily featured Arabic epigraphs, but as Ayyubid society became more cosmopolitan and multi-ethnic, coinage began to feature astrological, figural (featuring a variety of Greek, Seleucid, Byzantine, Sasanian, and contemporary Turkish rulers' busts), and animal images.

Hillenbrand suggests that the medieval Islamic texts called *Maqamat*, copied and illustrated by Yahya ibn Mahmud al-Wasiti were some of the earliest "coffee table books." They were among the first texts to hold up a mirror to daily life in Islamic art, portraying humorous stories and showing little to no inheritance of pictorial tradition.

South Asia

Archway from the Qutb complex, Delhi, India, constructed by successive rulers under the Delhi Sultanate.

The Indian subcontinent, conquered by the Ghaznavids and Ghurids in the 9th century, did not become autonomous until 1206, when the Muizzi, or slave-kings, seized power, marking the birth of the Delhi Sultanate. Later other competing sultanates were founded in Bengal, Kashmir, Gujarat, Jaunpur, Malwa, and in the north Deccan (the Bahmanids). They separated themselves little by little from Persian traditions, giving birth to an original approach to architecture and urbanism, marked in particular by interaction with Hindu art. Study of the production of objects has hardly begun, but a lively art of manuscript illumination is known. The period of the sultanates ended with the arrival of the Mughals, who progressively seized their territories. The Taj Mahal was ordered to be built by Shah Jahan, a Muslim king.

The Three Empires

Ottomans

Ceramic tile produced in Iznik, Turkey, second half of 16th century, kept in the Louvre

The Ottoman Empire, whose origins lie in the 14th century, continued in existence until shortly after World War I. This impressive longevity, combined with an immense territory (stretching from Anatolia to Tunisia), led naturally to a vital and distinctive art, including plentiful architecture, mass production of ceramics (most notably Iznik ware), an important jeweler's art, Turkish paper marbling Ebru, Turkish carpets as well as tapestries and an exceptional art of manuscript illumination, with multiple influences

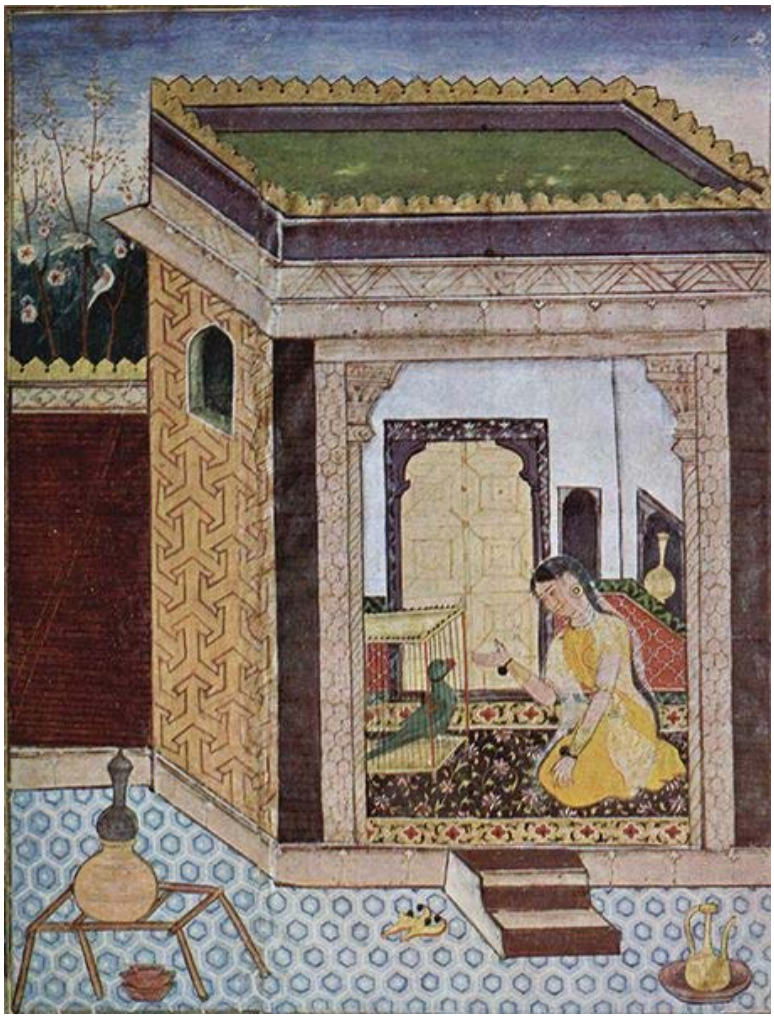
The standard plan of Ottoman architecture was inspired in part by the example of Hagia Sophia in Constantinople/Istanbul, Ilkhanid works like Oljeitu Tomb and earlier Seljuks of Rum and Anatolian Beylik monumental buildings and their own original innovations.

The most famous of Ottoman architects was (and remains) Mimar Sinan, who lived for approximately one hundred years and designed several hundreds of buildings, of which two of the more important are Süleymaniye Mosque in Istanbul and Selimiye Mosque in Edirne. Apprentaces of Sinan later built the famous Blue Mosque in Istanbul and the Taj Mahal in India.

Masterpieces of Ottoman manuscript illumination include the two "books of festivals," one dating from the end of the 16th century, and the other from the era of Sultan Murad III. These books contain numerous illustrations and exhibit a strong Safavid influence; thus they may have been inspired by books captured in the course of the Ottoman-Safavid wars of the 16th century.

The Ottomans are also known for their development of a bright red pigment, "Iznik red," in ceramics.

Mughals



Girl with parrot, scene from the *Tuti-Nâma-Manuscript*, 1585, Chester Beatty Library

The Mughal Empire in India lasted from 1526 until 1858, when the English seized the country and created and exiled the last Mughal Emperor.

Various arts particularly architecture was accorded a place of honor within Mughal art, with the development of a distinctive plan and style in Islamic Architecture, which were used in the creation of various monuments the first one was the pivotal Tomb of Humayun, Mughal architects later modified the style and built Fatehpur Sikri during the reign of Akbar, "Minar" (Minarets) were refined during the rule of Jahangir and can be seen in his tomb in Lahore, his son the Mughal Emperor Shah Jahan built famous monuments such as the Red Fort and the Taj Mahal, which was designed by Ustad Ahmad Lauhori and his team of Mughal, Ottoman and Safavid architects.

The arts of jewelry and hardstone carving of gemstones, such as jasper, jade, rubies, diamonds and emerelds are mentiond by the Mughal chronicler Abu'l Fazl; the series of hard stone daggers in the form of horses' heads is particularly impressive.

The Mughals were also fine metallurgists they introduced Damascus steel and refined the locally produced Wootz steel, the Mughals also introduced the "bidri" technique of metalwork in which silver motifs are pressed against a black background. Famous Mughal metallurgists like Ali Kashmiri and Muhammed Salih Thatawi created the seamless celestial globes.

The Mughals also gave rise to a magnificent art of manuscript illumination, in which a strong European influence may be perceived, both through the utilization of perspective and the late period the use of European engravings as models. Nevertheless a strong Persian influence remains, as Persian painters founded the Mughal art of the book under the reign of Humayun. This latter had taken refuge among the Safavids after being temporarily dethroned, and upon his return brought with him certain Persian painters. The influence of Hindu artists may also be perceived, particularly in provincial productions by Mughal Nawabs (governors).

Safavids and Qajars

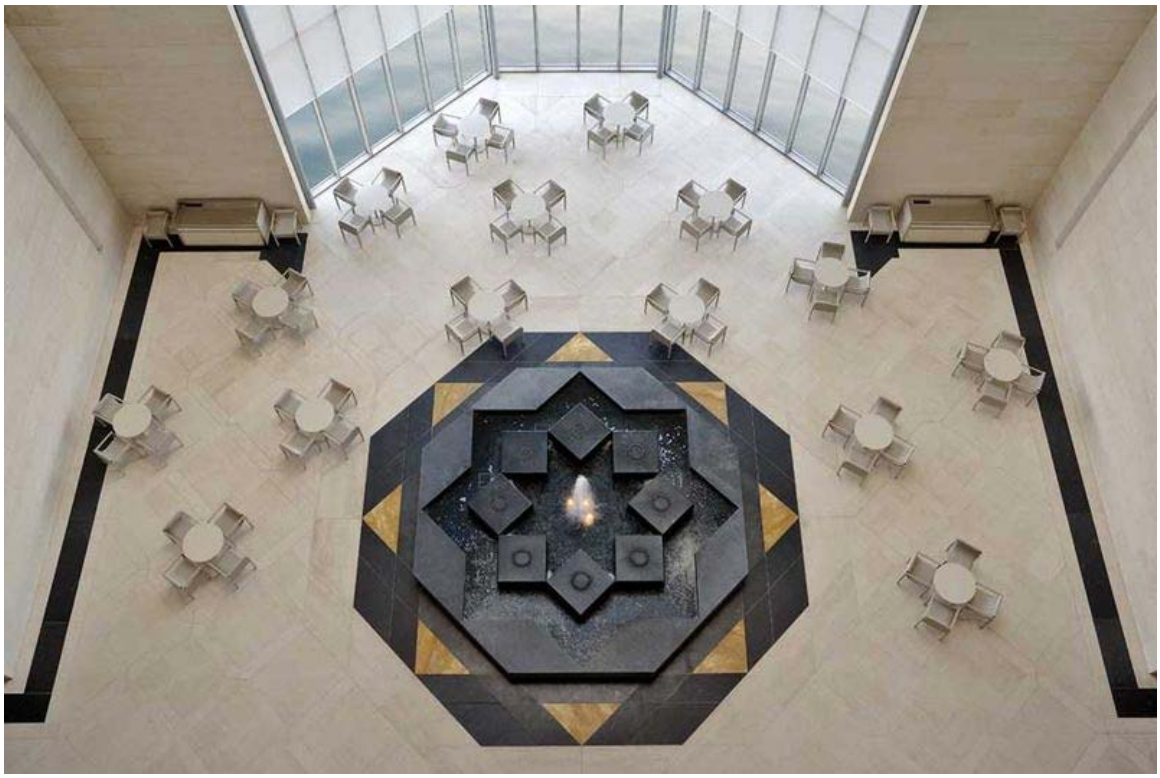
Iwan, Shah Mosque, Isfahan

The Iranian Safavids, a dynasty stretching from 1501 to 1786, is distinguished from the Mughal and Ottoman Empires in part through the Shi'a faith of its shahs. Ceramic arts are marked by the strong influence of Chinese porcelain, executed in blue and white. Architecture flourished, attaining a high point with the building program of Shah Abbas in Isfahan, which included numerous gardens, palaces (such as Ali Qapu), an immense bazaar, and a large imperial mosque.

The art of manuscript illumination also achieved new heights, in particular in the Shah Tahmasp Shahnameh, an immense copy of Ferdowsi's poem containing more than 250 paintings. In the 17th century a new type of painting develops, based around the album (muhaqqa). The albums were the creations of conoisseurs who bound together single sheets containing paintings, drawings, or calligraphy by various artists, sometimes excised from earlier books, and other times created as independent works. The paintings of Reza Abbasi figure largely in this new art of the book.

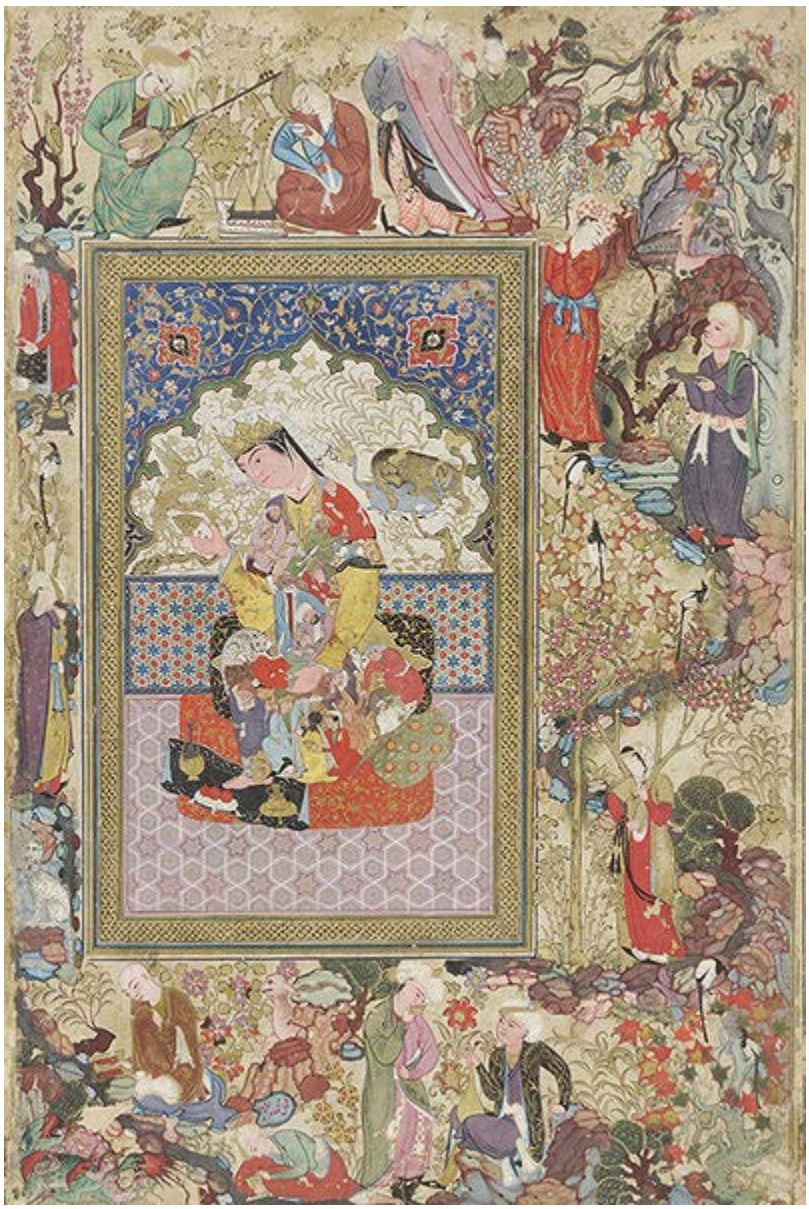
After the fall of the Safavids, the Qajars, a Turkmen tribe established from centuries on the banks of the Caspian Sea, assumed power. Qajar art displays an increasing European influence, as in the large oil paintings portraying the Qajar shahs. Steelwork also assumed a new importance. Like the Ottomans, the Qajar dynasty survived until the First World War.

Present time



Painting gallery

Woman with a Spray of Flowers, Safavid Dynasty, c. 1575



Muhammad-Sharif Musawwir, *Seated Princess,* c. 1600

Chapter- 4

Aniconism & Arabesque in Islam

Aniconism in Islam

Aniconism in Islam is a proscription against the creation of images of God in Islam. Other forms of aniconism in Islam prohibit the depiction of Muhammad, which is the consensual view among Sunni Muslims, or even, in a more extreme case, other living creatures in artwork.

Theological views

The Qur'an, the Islamic holy book, does not explicitly prohibit the depiction of human figures; it merely condemns idolatry (5:87–92, 21:51–52). Interdictions of figurative representation are present in the Hadith, among a dozen of the hadith recorded during the latter part of the period when they were being written down. Because these hadith are tied to particular events in the life of the Islamic prophet, Muhammad, they need to be interpreted in order to be applied in any general manner.

Sunni exegetes, from the 9th century onward, increasingly saw in them categorical prohibitions against producing and using any representation of living beings. There are variations between religious *Madh'hab* (schools) and marked differences between different branches of Islam. Aniconism is common among fundamentalist Sunni sects such as Salafis and Wahhabis (which are also often iconoclastic), and less prevalent among liberal movements within Islam. Shi'a and mystical orders also have less stringent views on aniconism. On the individual level, whether or not specific Muslims believe in aniconism may depend on how much credence is given to hadith (e.g. Submitters do not believe in any hadith), and how liberal or strict they are in personal practice.

Aniconism in Islam not only deals with the material image, but touches upon mental representations as well. It is a thorny question, discussed by early theologians, as to how to describe God, Muhammad and other prophets, and, indeed, if it is permissible at all to do so. God is usually represented by immaterial attributes, such as "holy" or "merciful", commonly known from His "Ninety-nine beautiful names". Muhammad's physical appearance, however, is amply described, particularly in the traditions on his life and deeds recorded in the biographies known as *Sirah Rasul Allah*. Of no less interest is the validity of sightings of holy personages made during dreams.

While talking about Islam, Titus Burckhardt sums up the role of aniconism in a way that might hold true for cases throughout a variety of cultures:

> "Islam is centred on Unity, and Unity is not expressible in terms of any image. Thus, Islamic art as a whole aims to create an ambiance which helps man to realise his primordial dignity; it therefore avoids everything that could be an 'idol' even in a relative and provisional manner - nothing must stand between man and the invisible presence of God - thus eliminating all the turmoil and passionate suggestions of the world and in their stead creating an order that expresses equilibrium, serenity and peace."

Hadith and exegesis examples

During its early days, aniconism in Islam was intended as a measure against idolatry, particularly against the statues worshipped by pagans. The following hadith presents Muhammad condemning pictures:

> Narrated Aisha (a wife of Muhammad):
> I bought a cushion having on it pictures (of animals). When Allah's Apostle saw it, he stood at the door and did not enter. I noticed the sign of disapproval on his face and said, "O Allah's Apostle! I repent to Allah and His Apostle. What sin have I committed?' Allah's Apostle said. "What is this cushion?" I said, "I have bought it for you so that you may sit on it and recline on it." Allah's Apostle said, "The makers of these pictures will be punished on the Day of Resurrection, and it will be said to them, 'Give life to what you have created (i.e., these pictures).' "The Prophet added, "The Angels of (Mercy) do not enter a house in which there are pictures (of animals)."
> —Sahih al-Bukhari, 3:34:318, 7:62:110
>
> Narrated Aisha, *umm-al-mu'minīn*:
> When the Apostle of Allah arrived after the expedition to Tabuk or Khaybar (the narrator is doubtful), the draught raised an end of a curtain which was hung in front of her store-room, revealing some dolls which belonged to her. He asked: What is this? She replied: My dolls. Among them he saw a horse with wings made of rags, and asked: What is this I see among them? She replied: A horse. He asked: What is this that it has on it? She replied: Two wings. He asked: A horse with two wings? She replied: Have you not heard that Solomon had horses with wings? She said: Thereupon the Apostle of Allah laughed so heartily that I could see his molar teeth.
> —41:4914, Sunnan Abu Dawud, 41:4913
>
> Narrated Ali (Ali ibn AbuTalib):
> Safinah AbuAbdurRahman said that a man prepared food for Ali ibn AbuTalib who was his guest, and Fatimah said: I wish we had invited the Apostle of Allah and he had eaten with us. They invited him, and when he came he put his hands on the side-ports of the door, but when he saw the figured curtain which had been put at the end of the house, he went away. So Fatimah said to Ali: Follow him and see what turned him back. I (Ali) followed him and asked: What turned you back, Apostle of Allah? He replied: It is not fitting for me or for any Prophet to enter a house which is decorated.
> —27:3746

Narrated Aisha:

The Prophet entered upon me while there was a curtain having pictures (of animals) in the house. His face got red with anger, and then he got hold of the curtain and tore it into pieces. The Prophet said, "Such people as paint these pictures will receive the severest punishment on the Day of Resurrection."

—Sahih al-Bukhari, 7:73:133

Narrated Aisha:

Allah's Apostle returned from a journey when I had placed a curtain of mine having pictures over (the door of) a chamber of mine. When Allah's Apostle saw it, he tore it and said, "The people who will receive the severest punishment on the Day of Resurrection will be those who try to make the like of Allah's creations." So we turned it (i.e., the curtain) into one or two cushions.

—Sahih al-Bukhari, 7:72:838

To show the superiority of the monotheist faith, Muhammad smashed the idols at the Kaaba. He also removed paintings that were blasphemous to Islam, while protecting others (the images of Mary and Jesus) inside the building. The hadith below emphasizes that aniconism depends not only on *what*, but also on *how* things are depicted.

Narrated `Abd Allah ibn `Abbas:

When the Prophet saw pictures in the Ka'ba, he did not enter it till he ordered them to be erased. When he saw (the pictures of Abraham and Ishmael carrying the arrows of divination, he said, '"May Allah curse them (i.e. the Quraysh)! By Allah, neither Abraham nor Ishmael practiced divination by arrows.'

—Sahih al-Bukhari, 4:55:571

Muslim b. Subaih reported:

I was with Masriuq in the house which had the portrayals of Mary (hadrat Maryam). Thereupon Masriuq said: These are portraits of Kisra. I said: No, these are of Mary. Masruq said: I heard Abdullah b. Mas'ud as saying Allah's Messenger had said: The most grievously tormented people on the Day of Resurrection would be the painters of pictures. (Muslim said): I read this before Nasr b. 'Ali at-Jahdami and he read it before other narrators, the last one being Ibn Sa'id b Abl at Hasan that a person came to Ibn 'Abbas and said: I am the person who paints pictures; give me a religious verdict about them. He (Ibn 'Abbas) said to him: Come near me (still further). He came near him so much so that he placed his hand upon his head and said: I am going to narrate to yor what I heard from Allah's Messenger. I heard him say: All the painters who make pictures would be in the fire of Hell. The soul will be breathed in every picture prepared by him and it shall punish him in the Hell, and he (Ibn 'Abbas) said: If you have to do it at all, then paint the pictures of trees and lifeless things; and Nasr b. 'Ali confirmed it.

—Sahih Muslim, 24:5272

It is interesting to note that pagans in Muhammad's times were also worshipping trees and stones. Muhammad, however, opposed only images of animated beings — humans and animals —, as reported by the Hadith. Subsequently, geometrical ornamentation became a sophisticated art form in Islam.

Narrated Said bin Abu Al-Hasan:
While I was with Ibn 'Abbas a man came and said, "O father of 'Abbas! My sustenance is from my manual profession and I make these pictures." Ibn 'Abbas said, "I will tell you only what I heard from Allah's Apostle. I heard him saying, 'Whoever makes a picture will be punished by Allah till he puts life in it, and he will never be able to put life in it.' " Hearing this, that man heaved a sigh and his face turned pale. Ibn 'Abbas said to him, "What a pity! If you insist on making pictures I advise you to make pictures of trees and any other inanimate objects."
—Sahih al-Bukhari, 3:34:428

Aisha reported:
We had a curtain with us which had portraits of birds upon it. Whenever a visitor came, he found them in front of him. Thereupon Allah's Messenger said to me: Change them, for whenever I enter the room) I see them and it brings to my mind (the pleasures) of worldly life. She said: We had with us a sheet which had silk badges upon it and we used to wear it. This hadith has been transmitted on the authority of Ibn Muthanna but with this addition: 'Allah's Messenger did not command us to tear that."
—Sahih Muslim, 24:5255

Aisha reported:
Allah's Messenger visited me. and I had a shelf with a thin cloth curtain hanging over it and on which there were portraits. No sooner did he see it than he tore it and the colour of his face underwent a change and he said: A'isha, the most grievous torment from the Hand of Allah on the Day of Resurrection would be for those who imitate (Allah) in the act of His creation. A'isha said: We tore it into pieces and made a cushion or two cushions out of that.
—Sahih Muslim, 24:5261

Mohammad also warned his followers of dying amongst people that built places of worship at graves and placed pictures in it (i.e. Christians).

Narrated Aisha:
Um Habiba and Um Salama mentioned about a church they had seen in Ethiopia in which there were pictures. They told the Prophet about it, on which he said, "If any religious man dies amongst those people they would build a place of worship at his grave and make these pictures in it. They will be the worst creature in the sight of Allah on the Day of Resurrection."
—Sahih al-Bukhari, 1:8:419

Narrated Aisha:
When the Prophet became ill, some of his wives talked about a church which they had seen in Ethiopia and it was called Mariya. Um Salma and Um Habiba had been to Ethiopia, and both of them narrated its (the Church's) beauty and the pictures it contained. The Prophet raised his head and said, "Those are the people who, whenever a pious man dies amongst them, make a place of worship at his grave and then they make those pictures in it. Those are the worst creatures in the Sight of Allah."
—Sahih al-Bukhari, 2:23:425

Mohammad made it very clear that angels do not like picture.

Narrated Abu Talha:
Allah's Apostle said, "Angels (of mercy) do not enter a house where there are pictures.'" The sub-narrator Busr added: "Then Zaid fell ill and we paid him a visit. Behold! There was, hanging at his door, a curtain decorated with a pictures. I said to 'Ubaidullah Al-Khaulani, the step son of Maimuna, the wife of the Prophet, "Didn't Zaid tell us about the picture the day before yesterday?" 'Ubaidullah said, "Didn't you hear him saying: 'except a design in a garment'?"
—Sahih al-Bukhari, 7:72:841

Narrated Salim's father:
Once Gabriel promised to visit the Prophet but he delayed and the Prophet got worried about that. At last he came out and found Gabriel and complained to him of his grief (for his delay). Gabriel said to him, "We do not enter a place in which there is a pictures or a dog."
—Sahih al-Bukhari, 7:72:843

Narrated Ali ibn Abu Talib:
The Prophet said: Angels do not enter the house where there is a picture, or a dog, or a person who is sexually defiled.
—1:227, Sunnan Abu Dawud, 32:4140

Aniconism in practice

Religious core

In practice, the core of normative religion in Islam is consistently aniconic. Its embodiment are spaces such as the mosque and objects like the Qur'an or the white dress of pilgrims entering Mecca, deprived of figurative images. Other spheres of religion — schisms, mysticism, popular piety, private level — exhibit in this regard significant variability. Profane aniconism is even more fluctuating. Generally speaking aniconism in Islamic societies is restricted in modern times to specific religious contexts, while its prevalence in the past wasn't enforced in numerous areas and during extended periods.

Present

Depending on which segment of Islamic societies are referred to, the application of aniconism is characterized with noteworthy differences. Factors are the epoch considered, the country, the religious orientation, the political intent, the popular beliefs, the private benefit or the dichotomy between reality and discourse.

Today, the concept of an aniconic Islam coexists with a daily life for Muslims awash with images. TV stations and newspapers (which do present still and moving representations of living beings) have an exceptional impact on public opinion, sometimes, as in the case of Al Jazeera, with a global reach, beyond the Arabic speaking and Muslim audience. Portraits of secular and religious leaders are omnipresent on banknotes and coins, in streets and offices (e.g. presidents like Nasser and Mubarak, Arafat, al-Assad or Hezbollah's Nasrallah and Ayatollah Khomeini). Anthropomorphic statues in public places are to be found in most Muslim countries (Saddam Hussein's are infamous), as

well as art schools training sculptors and painters. In the Egyptian countryside, it is fashionable to celebrate and advertise the returning of pilgrims from Mecca on the walls of their houses.

Taliban movement in Afghanistan banned photography and destructed non-Muslim artifacts, especially carvings and statues such as Buddhas of Bamyan, generally tolerated by other Muslims, on the grounds that the artifacts are idolatrous or Shirk (polytheism). However, sometimes those who profess aniconism will practice figurative representation (cf. portraits of Talibans from the Kandahar photographic studios during their imposed ban on photography).

For Shi'a communities, portraits of the major figures of Shi'ite history are important elements of religious devotion. Portraits of Ali — with veiled and unveiled face alike — can be bought in Iran around shrines and in the streets, to be hung in homes or carried with oneself, while in Pakistan, India and Bangladesh they notoriously ornate trucks, buses and rickshaws. Contrary to the Sunni tradition, a photographic picture of the deceased can be placed on the Shi'ite tombs. A curiosity in Iran is a Orientalist photography supposed to represent Muhammad as a young boy. The Grand Ayatollah Sistani of Najaf in Iraq has given a fatwā declaring the depiction of Muhammad, the prophets and other holy characters, permissible if it is made with the utmost respect.

Persian miniature painting from the 16th century CE, depicting Muhammad, his face veiled, ascending on the Buraq into the Heavens, a journey known as the Miraj.

Past

Neither is the representation of living beings in Islamic countries a modern phenomenon or due to current technology, westernization or the cult of the personality. Statues of humans and animals adorned palaces of the Ummayad era, while frescoes were common under the Ummayads, and later in many countries of Dar al-Islam, notably under the Safavids and various Central Asian dynasties. Figurative miniatures from Medieval Arabic countries, India, Persia and Turkey are one of the fleuron of Islamic arts and a good deal of its attraction power for non-Muslim societies. Potent rulers like Shah Tahmasp in Persia and Akbar in India, patrons of some of the most beautiful figurative

miniatures in arts from Islamic countries, migrated during their life between an extravagant 'figurative' and an extremist 'aniconic' period. During the 15th and 17th century representations of Muhammad (veiled, unveiled) and other prophets or Biblical characters, like Adam, Abraham or Jesus and Solomon and Alexander the Great, became common in painted manuscripts from Persia, India and Turkey. Extreme rarities are an illustrated Qur'an depicting Muhammad and, in a Spanish-Muslim manuscript datable from the 16th century, five Ummayad and Abbasid caliphs. Iblis too is present in various illustrated manuscripts. There aren't, however, known figurative depictions of God.

Circumvention methods

Medieval Muslim artists found various ways not to infringe any prohibition of the image, while still representing living beings. It can be argued that since God is absolute, the act of depiction is his own and not that of a human; and miniatures are obviously very crude representations of the reality, so the two can't be mistaken. At the material level, prophets in manuscripts can have their face covered by a veil or all humans have a stroke drawn over their neck, a symbolical cut defending them to be alive. Calligraphy, the most Islamic of arts in the Muslim world, has also its figurative side due to anthropo- and zoomorphic calligrams.

Causes

It is equally important to stress that, wherever it surfaced, Islamic aniconism is partially due to the special historical relationship between images and Muslim identity. In the early days of Islam, for example, it was critical to distinguish the customs of the nascent Ummah from those of Christians, Jews, Zoroastrians and pagans. Therefore, emphasizing calligraphy and abstract decoration over figurative painting and sculpture set the Qur'an apart from the Bible, the mosque from the church and — after a certain period of using Byzantine and Sassanid coins — the Muslim dinar from the Christian solidus. After the Mongol invasions of the 13th century, there were lively debates in Persia about the merits of (Islamic) calligraphy and (Chinese influenced) painting. In modern times, the image-producing technologies of print, photography, movie, television and, more recently, the Internet, were all imports from a world outside the Muslim community, and thus easily perceived as threats to its integrity. These changes also came through difficult contexts for the Islamic world: colonization, modernization, authoritarian regimes, economic difficulties, and wars. Quite naturally, a paradoxical mix ensued, of an aniconist Islamic discourse propagated through representational mass media.

Arabesque

Arabesque pattern at the Alhambra

The **arabesque** is an artistic motif that is characterized by the application of repeating geometric forms and fancifully combined patterns; these forms often echo those of plants and animals. Arabesques are, as their name indicates, elements of Islamic art often found decorating the walls of mosques. The choice of which geometric forms are to be used and how they are to be formatted is based upon the Islamic view of the world. To Muslims, these forms, taken together, constitute an infinite pattern that extends beyond the visible material world. To many in the Islamic world, they concretely symbolize the infinite, and therefore uncentralized, nature of the creation of the one God (Allah). Furthermore, the Islamic Arabesque artist conveys a spirituality without the iconography of Christian art.

Mistakes in repetitions may be intentionally introduced as a show of humility by artists who believe only Allah can produce perfection, although this theory is disputed.

History

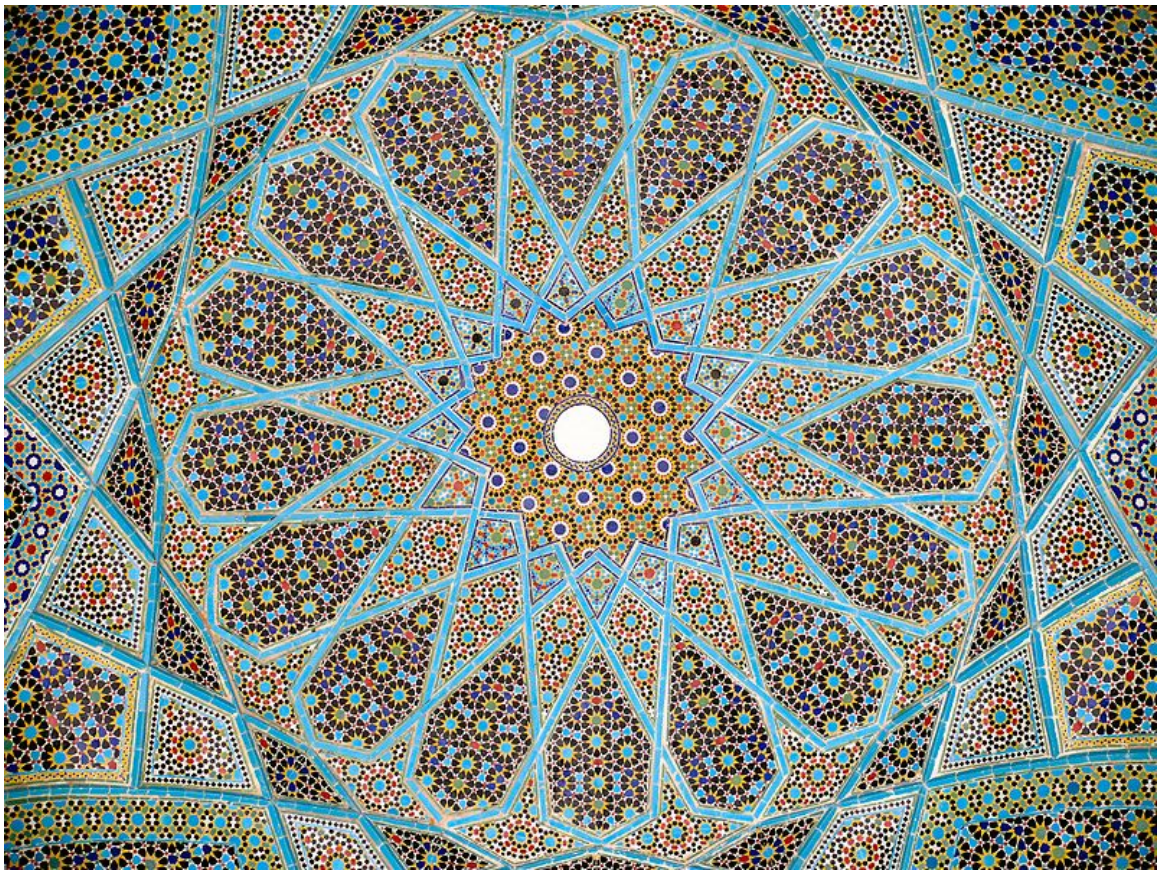
Geometric artwork in the form of the Arabesques was not widely used in the Middle East or Mediterranean Basin until the golden age of Islam came into full bloom. During this time, ancient texts on Greek and Hellenistic mathematics as well as Indian mathematics were translated into Arabic at the House of Wisdom, an academic research institution in

Baghdad. Like the later European Renaissance that followed, mathematics, science, literature and history were infused into the Muslim Islamic world with great, mostly positive repercussions.

The works of ancient scholars such as Plato, Euclid, Aryabhata and Brahmagupta were widely read among the literate and further advanced in order to solve mathematical problems which arose due to the Islamic requirements of determining the Qibla and times of Salah and Ramadan. Plato's ideas about the existence of a separate reality that was perfect in form and function and crystalline in character, Euclidean geometry as expounded on by Al-Abbās ibn Said al-Jawharī (ca. 800-860) in his *Commentary on Euclid's Elements*, the trigonometry of Aryabhata and Brahmagupta as elaborated on by the Persian mathematician Khwārizmī (ca. 780-850), and the development of spherical geometry by Abū al-Wafā' al-Būzjānī (940–998) and spherical trigonometry by Al-Jayyani (989-1079) for determining the Qibla and times of Salah and Ramadan, all served as an impetus for the art form that was to become the Arabesque.

Description and symbolism

Arabesque art consists of a series of repeating geometric forms which are occasionally accompanied by calligraphy. Ettinghausen et al. describe the arabesque as a "vegetal design consisting of full...and half palmettes [as] an unending continuous pattern...in which each leaf grows out of the tip of another." To the adherents of Islam, the Arabesque are symbolic of their united faith and the way in which traditional Islamic cultures view the world.



Geometric arabesque tiling on the underside of the dome of the Tomb of Hafez in Shiraz

Two modes

There are two modes to arabesque art. The first recalls the principles that govern the order of the world. These principles include the bare basics of what makes objects structurally sound and, by extension, beautiful (i.e. the angle and the fixed/static shapes that it creates—esp. the truss). In the first mode, each repeating geometric form has a built-in symbolism ascribed to it. For example, the square, with its four equilateral sides, is symbolic of the equally important elements of nature: earth, air, fire and water. Without any one of the four, the physical world, represented by a circle that inscribes the square, would collapse upon itself and cease to exist. The second mode is based upon the flowing nature of plant forms. This mode recalls the feminine nature of life giving. In addition, upon inspection of the many examples of Arabesque art, some would argue that there is in fact a third mode, the mode of Arabic calligraphy.

Calligraphy

An example of Arabic calligraphy

Instead of recalling something related to the 'True Reality' (the reality of the spiritual world), for the Muslim calligraphy is a visible expression of the highest art of all; the art of the spoken word (the transmittal of thoughts and of history). In Islam, the most important document to be transmitted orally is, of course, the Qur'an. Proverbs and complete passages from the Qur'an can be seen today in Arabesque art. The coming together of these three forms creates the Arabesque, and this is a reflection of unity arising from diversity (a basic tenet of Islam).

Role

The arabesque can also be equally thought of as both art and science, some say. The artwork is at the same time mathematically precise, aesthetically pleasing, and symbolic. So due to this duality of creation, they say, the artistic part of this equation can be further subdivided into both secular and religious artwork. However, for many Muslims there is no distinction; all forms of art, the natural world, mathematics and science are all creations of God and therefore are reflections of the same thing - that is, God's will expressed through His Creation. In other words, man can discover the geometric forms that constitute the Arabesque, but these forms always existed before as part of God's creation, as shown in this

Order and unity

There is great similarity between arabesque artwork from very different geographic regions. In fact, the similarities are so pronounced, that it is sometimes difficult for experts to tell where a given style of arabesque comes from. The reason for this is that the science and mathematics that are used to construct Arabesque artwork are universal.

Therefore, for most Muslims, the best artwork that can be created by man for use in the Mosque is artwork that displays the underlying order and unity of nature. The order and unity of the material world, they believe, is a mere ghostly approximation of the spiritual world, which for many Muslims is the place where the only true reality exists. Discovered geometric forms, therefore, exemplify this perfect reality because God's creation has been obscured by the sins of man.

Chapter- 5

Alchemy and Chemistry in Medieval Islam

Alchemy and chemistry in Islam refers to the study of both traditional alchemy and early practical chemistry (the early chemical investigation of nature in general) by scientists in the medieval Islamic world. The word *alchemy* itself was derived from the Arabic word الكيمياء *al-kimia*, in turn derived from the Persian word كيمیا *kimia*.

After the fall of the Roman Empire, the focus of alchemical development moved to the Arab Empire and the Islamic civilization. Much more is known about Islamic alchemy as it was better documented; indeed, most of the earlier writings that have come down through the years were preserved as Arabic translations.

The study of alchemy and chemistry often overlapped in the early Islamic world, but later there were disputes between the traditional alchemists and the practical chemists who discredited alchemy. Muslim chemists and alchemists were the first to employ the experimental scientific method (as practised in modern chemistry), while Muslim alchemists also developed theories on the transmutation of metals, the philosopher's stone and the *Takwin* (artificial creation of life in the laboratory), like in later medieval European alchemy, though these alchemical theories were rejected by practical Muslim chemists from the 9th century onwards.

Contributions to alchemy

The Islamic world was a melting pot for alchemy. Islamic philosophers made great contributions to alchemical hermeticism. The most influential author in this regard was arguably Jābir ibn Hayyān (جابر بن حيان, Latin Geberus; usually rendered in English as Geber). He analyzed each Aristotelian element in terms of four basic qualities of *hotness*, *coldness*, *dryness*, and *moistness*. According to Jābir, in each metal two of these qualities were interior and two were exterior. For example, lead was externally cold and dry, while gold was hot and moist. Thus, Jabir theorized, by rearranging the qualities of one metal, a different metal would result. By this reasoning, the search for the philosopher's stone was introduced to Western alchemy. Jabir developed an elaborate numerology whereby the root letters of a substance's name in Arabic, when treated with various transformations, held correspondences to the element's physical properties.

The elemental system used in medieval alchemy was developed by Jābir ibn Hayyān (Geber). His original system consisted of seven elements, which included the five

classical elements (aether, air, earth, fire and water), in addition to two chemical elements representing the metals: sulphur, ‘the stone which burns’, which characterized the principle of combustibility, and mercury, which contained the idealized principle of metallic properties. Shortly thereafter, this evolved into eight elements, with the Arabic concept of the three metallic principles: sulphur giving flammability or combustion, mercury giving volatility and stability, and salt giving solidity.

Muslim alchemists also developed theories on the transmutation of metals, the philosopher's stone and the *Takwin* (artificial creation of life in the laboratory), like in later medieval European alchemy, though these alchemical theories were rejected by practical Muslim chemists from the 9th century onwards.

Beginnings of chemistry

Jābir ibn Hayyān (Geber), considered the "father of chemistry", introduced experimentation, invented the alembic still and retort, many chemical processes such as filtration, and many chemical substances such as distilled alcohol. He also established the perfumery industry.

Muhammad ibn Zakariya ar-Razi (Rhazes) isolated many chemical substances, produced many medications, and described many laboratory apparatus.

Early Islamic chemists such as Jabir ibn Hayyan, Al-Kindi (Latinized as Alkindus) and Al-Razi (Latinized as Rasis or Rhazes) contributed key chemical discoveries, including:

- Distillation apparatus (such as the alembic, still, and retort) which were able to fully purify chemical substances.
- The words *elixir*, *alembic* and *alcohol* are of Arabic origin.
- The muriatic (hydrochloric), sulfuric, nitric and acetic acids.
- Soda and potash.
- Purified distilled alcohol.
- Perfumery

- Many more chemical substances and apparatus.
- From the Arabic names of *al-natrun* and *al-qalīy*, Latinized into *Natrium* and *Kalium*, come the modern symbols for sodium and potassium.
- The discovery that aqua regia, a mixture of nitric and hydrochloric acids, could dissolve the noblest metal, gold, was to fuel the imagination of alchemists for the next millennium.

An early experimental scientific method for chemistry began emerging among early Muslim chemists. The first and most influential was the 9th century chemist, Jābir ibn Hayyān, who is "considered by many to be the father of chemistry", for introducing:

- The experimental method; apparatus such as the alembic, still, and retort; and chemical processes such as liquefaction, purification, oxidisation and evaporation.
- Purification by crystallisation.
- Filtration.
- Pure distillation (Impure distillation methods were known to the Babylonians, Greeks and Egyptians since ancient times, but Jābir was the first to introduce distillation apparatus and techniques which were able to fully purify chemical substances.)
- The distillation and production of numerous chemical substances.

Jabir clearly recognized and proclaimed the importance of experimentation:

The first essential in chemistry is that thou shouldest perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery."

The historian of chemistry E. J. Holmyard gives credit to Jabir for his part in the development of alchemy into an experimental science and he writes that Jabir's importance to the history of chemistry is equal to that of Robert Boyle and Antoine Lavoisier. The historian Paul Kraus, who had studied most of Jabir's extant works in Arabic and Latin, summarized the importance of Jabir ibn Hayyan to the history of chemistry by comparing his experimental and systematic works in chemistry with that of the allegorical and unintelligble works of the ancient Greek alchemists:

"To form an idea of the historical place of Jabir's alchemy and to tackle the problem of its sources, it is advisable to compare it with what remains to us of the alchemical literature in the Greek language. One knows in which miserable state this literature reached us. Collected by Byzantine scientists from the tenth century, the corpus of the Greek alchemists is a cluster of incoherent fragments, going back to all the times since the third century until the end of the Middle Ages."
"The efforts of Berthelot and Ruelle to put a little order in this mass of literature led only to poor results, and the later researchers, among them in particular Mrs. Hammer-Jensen, Tannery, Lagercrantz, von Lippmann, Reitzenstein, Ruska, Bidez, Festugiere and others, could make clear only few points of detail…"

The study of the Greek alchemists is not very encouraging. An even surface examination of the Greek texts shows that a very small part only was organized according to true experiments of laboratory: even the supposedly technical writings, in the state where we find them today, are unintelligible nonsense which refuses any interpretation.
It is different with Jabir's alchemy. The relatively clear description of the processes and the alchemical apparatuses, the methodical classification of the substances, mark an experimental spirit which is extremely far away from the weird and odd esotericism of the Greek texts. The theory on which Jabir supports his operations is one of clearness and of an impressive unity. More than with the other Arab authors, one notes with him a balance between theoretical teaching and practical teaching, between the *`ilm* and the *`amal*. In vain one would seek in the Greek texts a work as systematic as that which is presented for example in the *Book of Seventy*."

Jabir's teacher, Ja'far al-Sadiq, refuted Aristotle's theory of the four classical elements and discovered that each one is made up of different chemical elements:

"I wonder how a man like Aristotle could say that in the world there are only four elements - Earth, Water, Fire, and Air. The Earth is not an element. It contains many elements. Each metal, which is in the earth, is an element."

Al-Sadiq also developed a particle theory, which he described as follows:

"The universe was born out of a tiny particle, which had two opposite poles. That particle produced an atom. In this way matter came into being. Then the matter diversified. This diversification was caused by the density or rarity of the atoms."

Al-Sadiq also wrote a theory on the opacity and transparency of materials. He stated that materials which are solid and absorbent are opaque, and materials which are solid and repellent are more or less transparent. He also stated that opaque materials absorb heat.

Al-Kindi, who was a chemist and an opponent of alchemy, was the first to refute the study of traditional alchemy and the theory of the transmutation of metals into more precious metals such as gold or silver. Abū Rayhān al-Bīrūnī, Avicenna and Ibn Khaldun were also opponents of alchemy who refuted the theory of the transmutation of metals.

Another influential Muslim chemist was al-Razi (Rhazes), who in his *Doubts about Galen*, was the first to prove both Aristotle's theory of classical elements and Galen's theory of humorism wrong using an experimental method. He carried out an experiment which would upset these theories by inserting a liquid with a different temperature into a body resulting in an increase or decrease of bodily heat, which resembled the temperature of that particular fluid. Al-Razi noted particularly that a warm drink would heat up the body to a degree much higher than its own natural temperature, thus the drink would trigger a response from the body, rather than transferring only its own warmth or coldness to it. Al-Razi's chemical experiments further suggested other qualities of matter, such as "oiliness" and "sulfurousness", or inflammability and salinity, which were not

readily explained by the traditional fire, water, earth and air division of elements. Al-Razi was also the first to:

- Distill petroleum.
- Invent kerosene and kerosene lamps.
- Invent soap bars and modern recipes for soap.
- Produce antiseptics.
- Develop numerous chemical processes such as sublimation.

In the 13th century Nasīr al-Dīn al-Tūsī stated a version of the law of conservation of mass, noting that a body of matter is able to change, but is not able to disappear.

From the 12th century, the writings of Jābir ibn Hayyān, al-Kindi, al-Razi and Avicenna became widely known in Europe during the Arabic-Latin translation movement and later through the Latin writings of a pseudo-Geber, an anonymous alchemist born in 14th century Spain, who translated more of Jabir's books into Latin and wrote some of his own books under the pen name of "Geber".

The Alchemists

There are more Islamic figures within chemistry than is generally acknowledged in the literature on the subject.

More recent research into the matter has provided a string outline. Regarding Muslim chemists beginning with the Umayyad Prince Khalid Ibn Yazid (Calid)(d.704), Ja'far al-Sadiq, Jabir Ibn Hayyan and Ibn Wahshiyya (.870) who wrote chemical works which were subsequently used by Al-Dimashqi in his Mineralogy. al-Razi and Muhammed ibn Umail al-Tamimi (wrote *Miftah al-hikma al-'uzma*). Al-Farabi (d. 950) and Ibn Badis on *Silver filling* also wrote on chemistry, and were succeeded chronologically by a chemist from Spain, Al-Majriti (d. 1007), Ziryab, Abu al-Salt, Ibn al-Wafid of Toledo (Abenguefit) and Ibn ar-Tafiz (Artephius) of Córdoba in Islamic Spain.

In Baghdad and nearby, Al-Khwarizmi al-Khati (.1034) (not the mathematician), who wrote *Ain al-San'a wa awn al-Sunâ* (The essential of the Art and the Help for the Artisans), Ibn Sina, Abū Rayhān al-Bīrūnī and Abu Mansur Muwaffaq of Herat. In the 12th century came to prominence the famous Seljuk vizier-scholar Al-Tughrai (d.1122) who wrote numerous works such as *Kitab al-anwar wa'l mafatih*. Later in the same century flourished Ahmad Ibn Imad ul-din, Abul Hasan ibn Musa ibn Arfa Ra'a (d. 1197) who is the author of *Shudhur al-dahab* (The Gold Spangle), Al-Nabarawi and al-Khazini. In the early 14th century Al-Simawi, Ibn Rassam, then the famed al-Jaldaki (c. 1342), Abul Ashba ibn Tammam (d.1361) and Hassan al-Rammah.

Legacy

Alexander von Humboldt regarded the Muslim chemists as the true founders of chemistry. Will Durant wrote in *The Story of Civilization IV: The Age of Faith*:

"Chemistry as a science was almost created by the Moslems; for in this field, where the Greeks (so far as we know) were confined to industrial experience and vague hypothesis, the Saracens introduced precise observation, controlled experiment, and careful records. They invented and named the alembic (al-anbiq), chemically analyzed innumerable substances, composed lapidaries, distinguished alkalis and acids, investigated their affinities, studied and manufactured hundreds of drugs. Alchemy, which the Moslems inherited from Egypt, contributed to chemistry by a thousand incidental discoveries, and by its method, which was the most scientific of all medieval operations."

Fielding H. Garrison wrote in the *History of Medicine*:

"The Saracens themselves were the originators not only of algebra, chemistry, and geology, but of many of the so-called improvements or refinements of civilization, such as street lamps, window-panes, firework, stringed instruments, cultivated fruits, perfumes, spices, etc..."

Robert Briffault wrote in *The Making of Humanity*:

"Chemistry, the rudiments of which arose in the processes employed by Egyptian metallurgists and jewellers—combining metals into various alloys and 'tinting' them to resemble gold—processes long preserved as a secret monopoly of the priestly colleges, and clad in the usual mystic formulas, developed in the hands of the Arabs into a widespread, organized passion for research which led them to the invention of distillation, sublimation, filtration, to the discovery of alcohol, of nitric and sulfuric acids (the only acid known to the ancients was vinegar), of the alkalis, of the salts of mercury, of antimony and bismuth, and laid the basis of all subsequent chemistry and physical research."

George Sarton, the father of the history of science, wrote in the *Introduction to the History of Science*:

"We find in his (Jabir, Geber) writings remarkably sound views on methods of chemical research, a theory on the geologic formation of metals (the six metals differ essentially because of different proportions of sulfur and mercury in them); preparation of various substances (e.g., basic lead carbonatic, arsenic and antimony from their sulfides)."

Chemical processes

Geber and Ahmad Ibn Imad ul-din invented the following chemical processes in the 8th century:

- Pure distillation (*al-taqtir*) which could fully purify chemical substances with the alembic.
- Filtration (*al-tarshih*).
- Purification by crystallization (*al-tabalwur*).
- Liquefaction, purification, oxidisation, and evaporation (*tabkhir*).

Al-Razi invented the following chemical processes in the 9th century:

- Dry distillation
- Calcination (*al-tashwiya*).

Other chemical processes introduced by Muslim chemists include:

- Assation (or roasting), cocotion (or digestion), ceration, lavage, solution, mixture, and fixation.
- Destructive distillation was invented by Muslim chemists in the 8th century to produce tar from petroleum.
- Steam distillation was invented by Avicenna in the early 11th century for the purpose of producing essential oils.
- Water purification

Laboratory apparatus

Distillation by alembic

Distillation apparatus

The alembic was invented and named by the Muslim chemist Geber. The still was also invented by Geber as part of the alembic.

The chemical retort used for distillation was invented by Geber as part of the alembic, and was widely used by later Muslim scientists. The retort was later introduced to the West by 1570.

In the 11th century, Avicenna invented the refrigerated coil, which condenses aromatic vapours. This was a breakthrough in distillation technology and he made use of it in his steam distillation process, which requires refrigerated tubing, to produce essential oils.

Other chemistry equipment

Muslim chemists and engineers invented the cucurbit and aludel, and the equipment needed for melting metals such as furnaces and crucibles.

In his *Secretum secretorum* (Latinized title), Al-Razi (Rhazes) described the following tools that were invented by him and his Muslim predecessors (Calid, Geber and al-Kindi) for melting substances (*li-tadhwib*): hearth (*kur*), bellows (*minfakh aw ziqq*), crucible (*bawtaqa*), the *but bar but* (in Arabic) or *botus barbatus* (in Latin), tongs (*masik aq kalbatan*), scissors (*miqta*), hammer (*mukassir*), file (*mibrad*).

Al-Razi also described the following tools that were invented by him and his Muslim predecessors for the preparation of drugs (*li-tadbir al-aqaqir*): cucurbit and still with evacuation tube (*qar aq anbiq dhu-khatm*), receiving matras (*qabila*), blind still (without evacuation tube) (*al-anbiq al-ama*), Alembic *al-inbiq*, aludel (*al-uthal*), goblets (*qadah*), flasks (*qarura* or *quwarir*), rosewater flasks (*ma wariyya*), cauldron (*marjal aw tanjir*), earthenware pots varnished on the inside with their lids (*qudur aq tanjir*), water bath or sand bath (*qadr*), oven (*al-tannur* in Arabic, *athanor* in Latin), small cylindirical oven for heating aludel (*mustawqid*), funnels, sieves, filters, etc.

From the list, more than twenty of these chemical apparatus were developed by Geber.

Physics apparatus

Abū Rayhān al-Bīrūnī invented the conical measure, in order to find the ratio between the weight of a substance in air and the weight of water displaced, and to accurately measure the specific weights of the gemstones and their corresponding metals, which are very close to modern measurements.

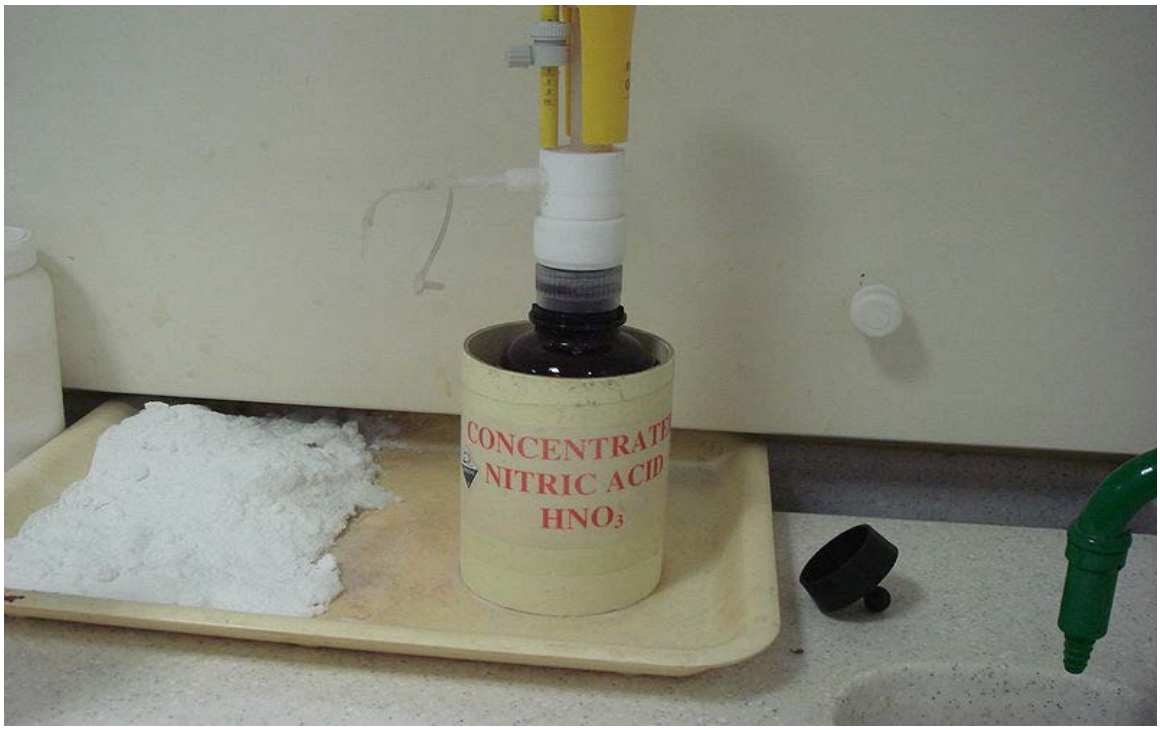
Abū Rayhān al-Bīrūnī also invented the laboratory flask and pycnometer in the early 11th century, and the hydrostatic balance and steelyard were invented by al-Khazini in the early 12th century. The earliest descriptions for these instruments are found in al-Khazini's *The Book of the Balance of Wisdom* (1121).

Biruni's contemporary Ibn al-Haytham gave the first clear description and correct analysis of the camera obscura and pinhole camera.

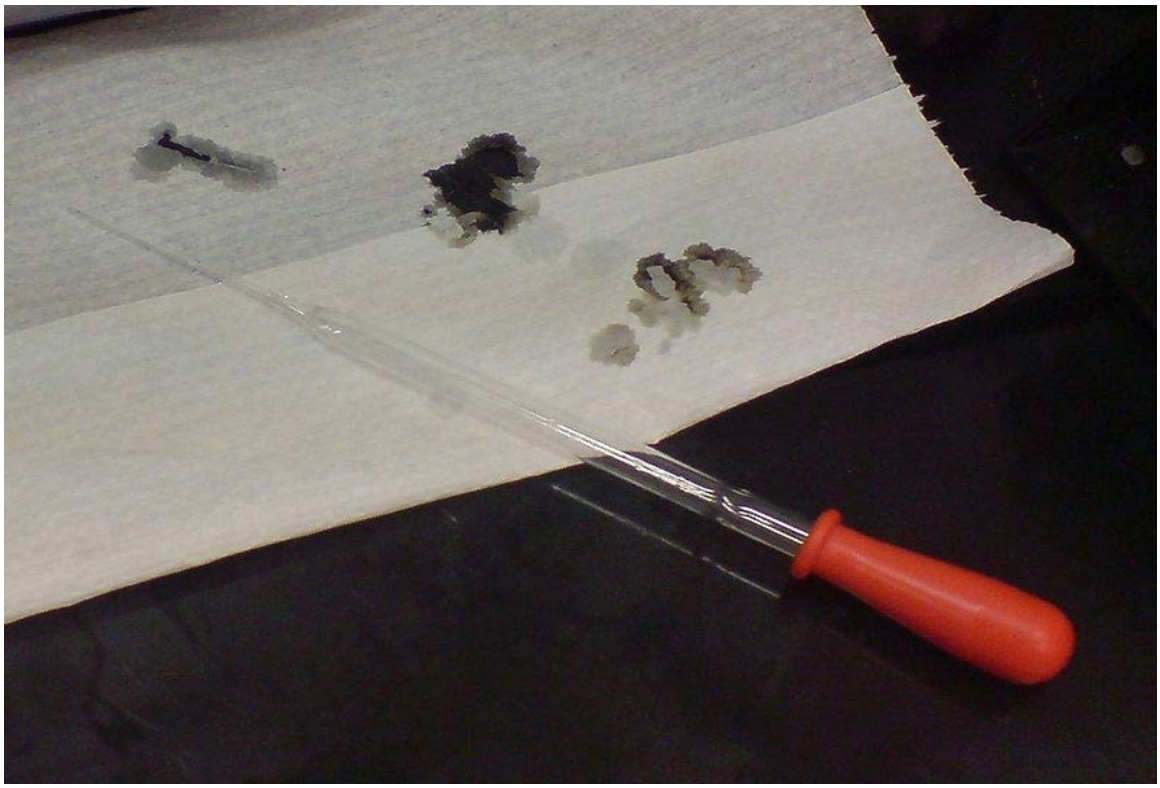
Chemical substances

Aqua regia was first prepared by Geber

Hydrochloric acid, a mineral acid, was first isolated by Geber



Nitric acid, a mineral acid, was first isolated by Geber



Sulfuric acid, a mineral acid, was first isolated by Geber

Arsenic, a chemical element, was first isolated by Geber in the 8th century

Acids

The only acid known to the ancients was vinegar. Using new equipment such as the alembic and processes such as pure distillation, Muslim chemists were the first to discover and isolate a variety of new acids, such as nitric acid and sulfuric acid.

The important mineral acids—nitric, sulfuric and hydrochloric acids—were all first produced by Geber. These have remained some of the most common products in the chemical industry for over a thousand years.

Acetic acid was also first concentrated from vinegar through distillation by Geber in the 8th century. He is also credited with the discovery of citric acid (the sour component of lemons and other unripe fruits) and tartaric acid (from wine-making residues).

Chemical elements

Several chemical elements were first discovered by Geber: arsenic, antimony and bismuth. Geber was also the first to classify sulfur (‘the stone which burns’ that characterized the principle of combustibility) and mercury (which contained the idealized principle of metallic properties) as 'elements'.

Lead and tin were also first purified and clearly differentiated from one another by Arabic alchemists.

Derivative and artificial substances

In the 10th century Muhammad ibn Zakarīya Rāzi wrote that he and his Muslim predecessors (Calid, Geber and al-Kindi) invented the following derivative and artificial chemical substances: lead(II) oxide (PbO), red lead (Pb3O4), tin(II) oxide (*Isfidaj*), copper acetate (*Zaniar*), copper(II) oxide (CuO), lead sulfide, zinc oxide, bismuth oxide, antimony oxide, iron rust, iron acetate, *Daws* (a contituent of steel), cinnabar (HgS), arsenic trioxide (As2O3), alkali (*al-Qili*), sodium hydroxide (caustic soda), and *Qalimiya* (anything that separates from metals during their purification).

Distilled alcohol

The isolation of ethanol (alcohol) as a pure compound was first achieved by Muslim chemists who developed the art of distillation during the Abbasid caliphate, the most notable of whom were Jābir ibn Hayyān (Geber), Al-Kindi (Alkindus) and al-Razi (Rhazes). The writings attributed to Jabir ibn Hayyan (721-815) mention the flammable vapors of boiled wine. Al-Kindi (801-873) unambiguously described the distillation of wine. This may have been for the purpose of separating alcoholic content from drinks due to the Islamic prohibition of alcohol consumption.

Muslim chemists were the first to produce fully purified distilled alcohol from the 8th century and manufactured them on a large scale from at least the 10th century, for use in medicine and the chemical and pharmaceutical industries, though it was rarely used for drinking due to the Islamic prohibition of alcohol consumption. Alcohol was still consumed by non-Muslims in the Islamic world however.

Ahmad Y Hassan wrote:

"The distillation of wine and the properties of alcohol were known to Islamic chemists from the eighth century. The prohibition of wine in Islam did not mean that wine was not produced or consumed or that Arab alchemists did not subject it to their distillation processes. Jabir ibn Hayyan described a cooling technique which can be applied to the distillation of alcohol."

Medicinal substances

Muslim chemists and physicians discovered and produced at least 2,000 medicinal substances for use in medicine and the pharmaceutical sciences.

Ibn al-Wafid of Toledo (Abenguefit), was among the most famous pharmacists and chemists during the Renaissance. His main work is *Kitab al-adwiya al-mufrada* (translated into Latin as *De medicamentis simplicibus*) was printed in Latin more than fifty times.

Natural substances

In the 10th century Muhammad ibn Zakarīya Rāzi classified the natural chemical substances that were discovered by him and his Muslim predecessors (mainly Calid, Geber, al-Kindi and al-Tamimi) as follows:

- Four spirits: mercury, sal ammoniac, arsenic, sulfur.
- Seven fusible metals: gold, silver, copper, iron, tin, lead, mercury.
- Thirteen stones: *marqashisha, maghnisiya, daws* (a constituent of iron and steel), *tutiya*, lapis lazuli, malachite green, turquoise, hematite, arsenic oxide, lead sulfide, *talq* (mica and asbestos), gypsum, glass.
- Six vitriols: black vitriol, alum, *qalqand, qalqadis, qalqatar, suri*.
- Seven borates: borax, bread borax, natron, nitrate, sodium nitrate, potassium nitrate, sodium borate.
- Thirteen salts: lead(II) acetate (sweet), magnesium sulfate (bitter), *andarani* salt, *tabarzad*, potassium nitrate, naphthenate, black salt (Indian), salt of egg, alkali (*al-qali*), salt of urine, calcium hydroxide (slaked lime), salt of oak ashes, natron.

Vegetable and animal substances

Muhammad ibn Zakarīya Rāzi writes that the only vegetable substance used by Muslim alchemists are the ashes of the *Ushnan* plant, from which they produced alkali metals and alkali salts. Razi also lists ten animal substances that were used by him and his contemporary alchemists: hair, skulls, brains, bile, blood, milk, urine, eggs, nacre (mother of pearl) and horn. He writes that hair, brains, bile, eggs, skulls and blood were used to prepare sal ammoniac.

Other substances

Through their experiments with various chemical compounds, Arabic chemists first produced many other chemical substances, including:

- Arsenic, alkali, alkali salt, rice vinegar, boraxes, potassium nitrate, sulfur and purified sal ammoniac by Geber.
- Aqua regia, alum, sal ammoniac, stones, sulfur, salts, and spirits of mercury, by Geber.
- Sal nitrum and vitriol by al-Razi.
- Ethanol, sulfuric acid, ammonia, mercury, camphor, pomades, and syrups.
- Lead carbonatic, arsenic, and antimony.
- Nitric and sulfuric acids, alkali, the salts of mercury, antimony, and bismuth.

Geber was also the first to classify all seven classical metals: gold, silver, tin, lead, mercury, iron and copper.

Chemical industries

A number of chemical substances and products were developed by Muslim chemists for use in the chemical industries.

Ceramics and pottery

Tin-glazed Hispano-Moresque ware with lusterware decoration, from Spain *circa* 1475

From the eighth to eighteenth centuries, the use of glazed ceramics was prevalent in Islamic art, usually assuming the form of elaborate pottery. Tin-opacified glazing was one of the earliest new technologies developed by the Islamic potters. The first Islamic opaque glazes can be found as blue-painted ware in Basra, dating to around the 8th century. Another significant contribution was the development of stonepaste ceramics, originating from 9th century Iraq. The first industrial complex for glass and pottery production was built in Ar-Raqqah, Syria, in the 8th century. Other centers for innovative ceramic pottery in the Islamic world included Fustat (from 975 to 1075), Damascus (from 1100 to around 1600) and Tabriz (from 1470 to 1550).

Another innovation was the albarello, a type of maiolica earthenware jar originally designed to hold apothecaries' ointments and dry drugs. The development of this type of pharmacy jar had its roots in the Islamic Middle East. Brought to Italy by Hispano-Moresque traders, the earliest Italian examples were produced in Florence in the 15th century.

The Hispano-Moresque style emerged in Andalusia in the 8th century, under the Fatimids. This was a style of Islamic pottery created in Islamic Spain, after the Moors had introduced two ceramic techniques to Europe: glazing with an opaque white tin-glaze, and painting in metallic lusters. Hispano-Moresque ware was distinguished from the pottery of Christendom by the Islamic character of it decoration.

Cheese glue

In *The Book of the Hidden Pearl*, Geber described the first recipes for the manufacture of glue from cheese.

Oil and petrolium products

From the 8th century the streets of Baghdad were the first to be paved with tar, derived from petroleum through destructive distillation. In the 9th century oil fields were exploited in the area around modern Baku, Azerbaijan, to produce the earliest naphtha. These fields were described by Masudi in the 10th century, and by Marco Polo in the 13th century, who described the output of those oil wells as hundreds of shiploads.

Muslim chemists were the first to produce petrol from crude oil, using the process of distillation.

Kerosene was produced from the distillation of petroleum and was first described by al-Razi (Rhazes) in 9th century Baghdad. In his *Kitab al-Asrar* (*Book of Secrets*), he described two methods for the production of kerosene. One method involved using clay as an absorbent, while the other method involved using ammonium chloride (*sal ammoniac*). Al-Razi also described the first kerosene lamps (*naffatah*) used for heating and lighting in his *Kitab al-Asrar* (*Book of Secrets*). These were used in the oil lamp industry.

Essential oils were first produced by Avicenna in the early 11th century, using steam distillation, for use in aromatherapy and the drinking and perfumery industries.

Plated mail

Plated mail was invented by Geber in *The Book of the Hidden Pearl* for use in armours (*jawasin*), helmets (*bid*) and shields (*daraq*).

Rosewater

Rosewater was first produced by Muslim chemists through the distillation of roses, for use in the drinking and perfumery industries.

Drinking industry

Coffee

An Arab named Khalid was tending his goats in the Kaffa region of Ethiopia, when he noticed his animals became livelier after eating a certain berry. He boiled the berries to make the first coffee. Certainly the first record of the drink is of beans exported from Yemen to Ethiopia where Sufis drank it to stay awake all night to pray on special occasions. By the late 15th century, it had arrived in Makkah and Turkey from where it made its way to Venice in 1645. It was brought to England in 1650 by a Greek named Pasqua Rosee who opened the first coffee house in Lombard Street in the City of London. The Arabic *qahwa* became the Turkish *kahve*, then the Italian *caffè*, and then English *coffee*.

Distilled and purified water

Arab chemists were the first to produce distilled water and purified water, used for water supply systems and for long journeys across deserts where the supplies were uncertain. In the 10th century, Abu Mansur Muwaffaq of Herat wrote *The foundations of the true properties of Remedies*, where he described 585 drugs. He also described the distillation of sea-water for drinking.

Another Alchemist to mention distilled and purified water was **Ibn ar-Tafiz** (Artephius) of Córdoba in Islamic Spain.

Al-Tughrai the Seljuk Vizier also patronized new methods, techniques and processes used to distill water easily.

Soft drink

Sherbet, the first juiced and carbonated soft drink, made of crushed fruit, herbs, or flowers, has long existed as one of the most popular beverages from and of the Muslim world, winning over Western figures such as Lord Byron. Muslims developed a variety of juices to make their *sharab*, an Arabic word from which the Italian sorbetto, French sorbet and English sherbet were derived. Today, this juice is known by a multitude of names, is associated with numerous cultural traditions, and is produced by countries ranging from India to the United States of America.

Syrups

The medieval Muslim sources contain many recipes for drink syrups that can be kept outside the refrigerator for weeks or months.

Glass industry

Glass factories

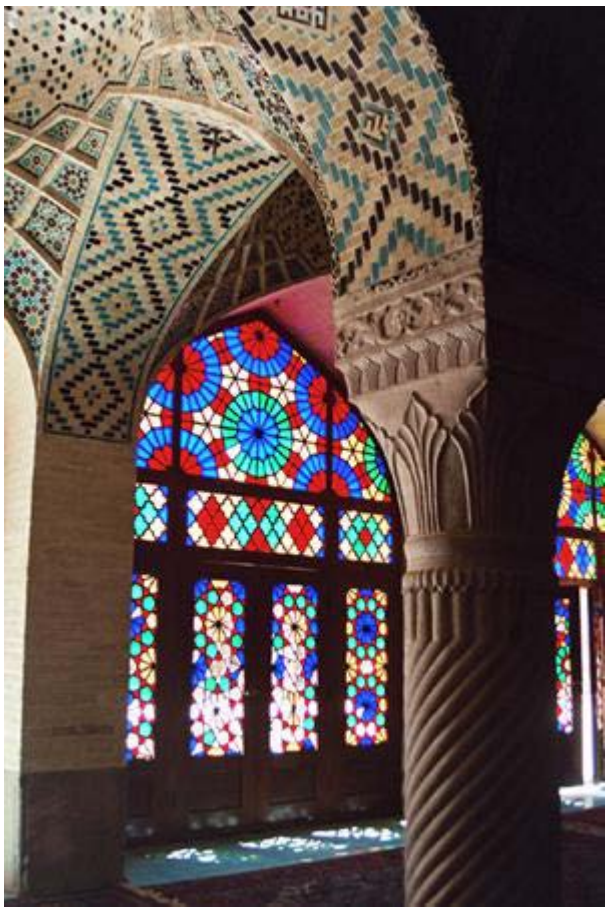
The first industrial complex for glass and pottery production was built in Ar-Raqqah, Syria, in the 8th century. Extensive experimentation was carried out at the complex, which was two kilometres in length, and a variety of innovative high-purity glass were developed there. Two other similar complexes have also been discovered, and nearly three hundred new chemical recipes for glass are known to have been produced at all three sites.

The first glass factories were thus built by Muslim craftsmen in the Islamic world. The first glass factories in Europe were later built in the 11th century by Egyptian craftsmen in Corinth, Greece.

Clear, colourless and high-purity glass

The earliest examples of clear, colourless and high-purity glass were produced by Muslims in the 9th century, such as the quartz glass invented by Abbas Ibn Firnas. The Arab poet al-Buhturi (820-897) describes the clarity of such glass as follows:

"Its colour hides the glass as if it is standing in it without a container."



Coloured stained glass windows in the Nasir al-Mulk mosque in Shiraz, Iran

Coloured and stained glass

Stained glass was first produced by Muslim architects in Southwest Asia using coloured glass rather than stone. In the 8th century, the Arab chemist Jabir ibn Hayyan (Geber) scientifically described 46 original recipes for producing coloured glass in *Kitab al-Durra al-Maknuna* (*The Book of the Hidden Pearl*), in addition to 12 recipes inserted by al-Marrakishi in a later edition of the book.

Gemstones and pearls

In his *Kitab al-Durra al-Maknuna* (*The Book of the Hidden Pearl*), Jabir described the first recipes for the manufacture of artificial pearls and for the purification of pearls that were discoloured from the sea or from grease.

In *The Book of the Hidden Pearl*, Jabir described the first recipes for the dyeing and artificial colouring of gemstones and pearls. Jabir also first described the production of high quality coloured glass cut into artificial gemstones.

Mirrors

The parabolic mirror, earlier studied by Diocles and others, was described by Ibn Sahl in his *On the Burning Instruments* in the 10th century. It was later described again in Ibn al-Haytham's *On Burning Mirrors* and *Book of Optics* (1021).

Ibn al-Haytham also discussed concave and convex mirrors in both cylindrical and spherical geometries, described spherical and parabolic mirrors, carried out a number of experiments with mirrors, and solved the problem of finding the point on a convex mirror at which a ray coming from one point is reflected to another point.

By the 11th century, clear glass mirrors were being produced in Moorish Spain.

Silica and quartz glass

Silica glass and Quartz glass, a clear, colourless, high-purity glass, was invented by Abbas Ibn Firnas (810-887), who was the first to produce glass from sand and stones such as quartz.

Hygiene industries

Cosmetics

Early forms of cosmetics had been used since ancient times, but these were usually created primarily for the purpose of beautification and often used harmful substances. This changed with Muslim cosmetologists who emphasized hygiene, due to religious requirements, and invented various healthy and hygienic cosmetics that are still used today.

In the 9th century, Ziryab is known to have invented an early toothpaste, which he popularized throughout Islamic Spain. The exact ingredients of this toothpaste are not currently known, but it was reported to have been both "functional and pleasant to taste." For women, he opened a beauty parlour or “cosmetology school” near Alcázar, where he taught "the use of depilatories for removing body hair", and he introduced new perfumes and cosmetics. He also introduced under-arm deodorants.

Soap

True soaps made from vegetable oils (such as olive oil), aromatic oils (such as thyme oil) and Sodium Lye (*al-Soda al-Kawia*) were first produced by Muslim chemists in the medieval Islamic world. Due to washing and bathing being religious requirements for Muslims, they invented the recipe for true soap, which is still in use today, and they invented the soap bar. The formula for soap used since then hasn't changed and are identical to the current soap sold in modern times.

From the beginning of the 7th century soap was produced in Nablus (Palestine), Kufa (Iraq) and Basra (Iraq). Soaps, as we know them today, are descendants of historical Arabian Soaps. Arabian Soap was perfumed and colored, while some of the soaps were liquid and others were solid. They also had special shaving soap for shaving. It was commercially sold for 3 Dirhams (0.3 Dinars) a piece in 981 AD. A manuscript of Al-Razi (Rhazes) contains various modern recipes for soap. A recently discovered manuscript from the 13th century details more recipes for soap making, e.g. take some sesame oil, a sprinkle of potash, alkali and some lime, mix them all together, and boil. When cooked, they are poured into molds and left to set, leaving hard soap (soap bar).

Perfumery

Islamic cultures contributed significantly to the development of perfumery in both perfecting the extraction of fragrances through steam distillation and by introducing new raw ingredients. Both the raw ingredients and distillation technology significantly influenced western perfumery and scientific developments, particularly chemistry.

As traders, Islamic cultures such as the Arabs and Persians had wider access to different spices, herbals, and other fragrance materials. In addition to trading them, many of these exotic materials were cultivated by the Muslims such that they could be successfully grown outside of their native climates. Two examples of this include jasmine, which is native to South and Southeast Asia, and various citrus fruits, which are native to East Asia. Both of these ingredients are still highly important in modern perfumery.

In Islamic culture, perfume usage has been documented as far back as the 7th century and its usage is considered a religious duty. Muhammad said:

"The taking of a bath on Friday is compulsory for every male Muslim who has attained the age of puberty and (also) the cleaning of his teeth with Siwak, and the using of perfume if it is available."
—Sahih Bukhari Sahih al-Bukhari, 2:13:5.

Such rituals gave incentives to scholars to search and develop a cheaper way to produce incenses and in mass production. Two talented chemists, Jabir ibn Hayyan (born 722, Iraq), and al-Kindi (born 801, Iraq) established the perfume industry. Jabir developed many techniques, including distillation, evaporation and filtration, which enabled the collection of the odour of plants into a vapour that could be collected in the form of water or oil. Al-Kindi, however, was the real founder of the perfume industry, as he carried out extensive research and experiments in combining various plants and other sources to produce a variety of scent products. He elaborated a vast number of ‘recipes’ for a wide range of perfumes, cosmetics and pharmaceuticals. His work in the laboratory is reported by a witness who said:

"I received the following description, or recipe, from Abu Yusuf Ya'qub b. Ishaq al-Kindi, and I saw him making it and giving it an addition in my presence.

The writer goes on in the same section to speak of the preparation of a perfume called *ghaliya*, which contained musk, amber and other ingredients, and reveals a long list of technical names of drugs and apparatus.

Musk and floral perfumes were brought to Europe in the 11th and 12th centuries from Arabia, through trade with the Islamic world and with the returning Crusaders. Those who traded for these were most often also involved in trade for spices and dyestuffs. There are records of the Pepperers Guild of London, going back to 1179, which show them trading with Muslims in spices, perfume ingredients and dyes.

Shampoo

Shampoo was first developed by the Bengali Muslim Sake Dean Mahomet. He introduced it to England when he opened "Mahomed's Indian Vapour Baths" in Brighton seafront in 1759. He was later appointed as a "Shampooing Surgeon" to Kings George IV and William IV.

Chapter- 6

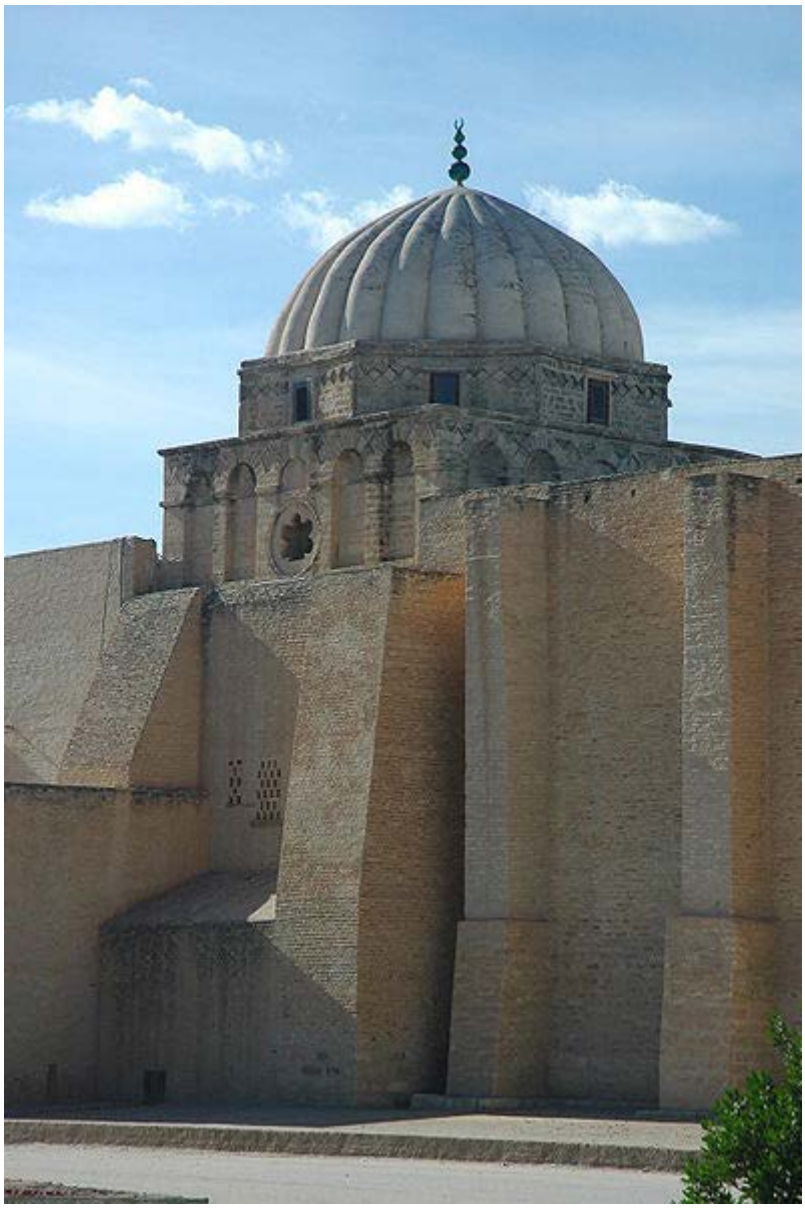
Islamic Architecture

The interior side view of the main dome of Selimiye Mosque in Edirne, Turkey

Sultan Abdul Samad Building, Kuala Lampur, Malaysia

Islamic architecture encompasses a wide range of both secular and religious styles from the foundation of Islam to the present day, influencing the design and construction of buildings and structures in Islamic culture. The principal Islamic architectural types are: the Mosque, the Tomb, the Palace and the Fort. From these four types, the vocabulary of Islamic architecture is derived and used for buildings of lesser importance such as public baths, fountains and domestic architecture.

Influences and styles



Dome of the mihrab in the Great Mosque of Kairouan also known as the Mosque of Uqba, in Kairouan, Tunisia

Arabic Calligraphy on large pishtaq of the Taj Mahal

A specifically recognisable Islamic architectural style emerged soon after Muhammad's time, developing from localized adaptations of Egyptian, Persian/Sassanid and Greek Byzantine models, the Germanic Visigoths in Spain also made a big contribution to Islamic architecture They invented the Horseshoe arch in Spain and used them as one of their main architectural features, After the moorish invasion of spain in 711 AD the form was taken by the Ummayyads who accentuated the curvature of the horseshoe. An early example of Islamic architecture may be identified as early as 691 AD with the completion of the Dome of the Rock (*Qubbat al-Sakhrah*) in Jerusalem. It featured interior vaulted spaces, a circular dome, and the use of stylized repeating decorative patterns (arabesque).

The Great Mosque of Kairouan (in Tunisia), considered as the ancestor of all the mosques in the western Islamic world, is one of the best preserved and most significant examples of early great mosques. Founded in 670 AD, it dates in its present form largely from the Aghlabid period (9th century). The Great Mosque of Kairouan is constituted of a massive square minaret, a large courtyard surrounded by porticos and a huge hypostyle prayer hall covered on its axis by two cupolas.

The Great Mosque of Samarra in Iraq, completed in 847 AD, combined the hypostyle architecture of rows of columns supporting a flat base above which a huge spiraling minaret was constructed.

The Hagia Sophia in Istanbul also influenced Islamic architecture. When the Ottomans captured the city from the Byzantines, they converted the basilica to a mosque (now a museum) and incorporated Byzantine architectural elements into their own work (e.g. domes). The Hagia Sophia also served as a model for many Ottoman mosques such as the Shehzade Mosque, the Suleiman Mosque, and the Rüstem Pasha Mosque.

Distinguishing motifs of Islamic architecture have always been ordered repetition, radiating structures, and rhythmic, metric patterns. In this respect, fractal geometry has been a key utility, especially for mosques and palaces. Other significant features employed as motifs include columns, piers and arches, organized and interwoven with alternating sequences of niches and colonnettes. The role of domes in Islamic architecture has been considerable. Its usage spans centuries, first appearing in 691 with the construction of the Dome of the Rock, and recurring even up until the 17th century with the Taj Mahal. As late as the 19th century, Islamic domes had been incorporated into Western architecture.

Persian architecture

The Shah Mosque in Isfahan, Iran

The Islamic conquest of Persia in the 7th century led early Islamic architects to borrow and adopt some traditions and ways of the fallen Persian empire. Islamic architecture thus

borrows heavily from Persian architecture and in many ways can be called an extension and further evolution of Persian architecture.

Many cities, including Baghdad, were based on precedents such as Firouzabad in Persia. In fact, it is now known that the two designers hired by al-Mansur to plan the city's design were Naubakht (نوبخت), a former Persian Zoroastrian, and Mashallah (ماشاءالله), a former Jew from Khorasan, Iran.

Persian-style mosques are characterized by their tapered brick pillars, large arcades and arches each supported by several pillars. In South Asia, elements of Hindu architecture were employed, but were later superseded by Persian designs.

Azerbaijani architecture

The Bibi-Heybat Mosque in Baku, Azerbaijan

The Islamic conquest of Persia in the 7th century also helped Islamic architecture to flourish in Azerbaijan. The country became home of Nakchivan and Shirvan-Absheron architecture schools. An example of the first direction in the Azerbaijani Islamic architecture is the mausoleum of Yusuf, built in 1162.

The Shirvan-Absheron school unlike Nakchivan style used stones instead of the bricks in the construction. At the same characteristics of this trend were the asymmetry and stone carving, which includes famous landmarks like Palace of the Shirvanshahs.

Moorish architecture

Interior of the Mezquita

Construction of the Great Mosque at Cordoba (now a cathedral known as the Mezquita) beginning in 785 CE marks the beginning of Islamic architecture in the Iberian peninsula and North Africa. The mosque is noted for its striking interior arches. Moorish architecture reached its peak with the construction of the Alhambra, the magnificent palace/fortress of Granada, with its open and breezy interior spaces adorned in red, blue, and gold. The walls are decorated with stylized foliage motifs, Arabic inscriptions, and arabesque design work, with walls covered in glazed tile. Moorish architecture has its roots deeply established in the Arab tradition of architecture and design established during the era of the first Caliphate of the Umayyads in the Levant circa 660AD with its capital Damascus having very well preserved examples of fine Arab Islamic design and geometrics, including the carmen, which is the typical Damascene house, opening on the inside with a fountain as the house's centre piece.

Even after the completion of the Reconquista, Islamic influence had a lasting impact on the architecture of Spain. In particular, medieval Spaniards used the Mudéjar style, highly

influenc Islamic design. One of the best examples of the Moors' lasting impact on Spanish architecture is the Alcázar of Seville.

Turkistan (Timurid) architecture

Registan is the ensemble of three madrasahs, in Samarkand, modern day Uzbekistan

Timurid architecture is the pinnacle of Islamic art in Central Asia. Spectacular and stately edifices erected by Timur and his successors in Samarkand and Herat helped to disseminate the influence of the Ilkhanid school of art in India, thus giving rise to the celebrated Mughal school of architecture. Timurid architecture started with the sanctuary of Ahmed Yasawi in present-day Kazakhstan and culminated in Timur's mausoleum Gur-e Amir in Samarkand. The style is largely derived from Persian architecture. Axial symmetry is a characteristic of all major Timurid structures, notably the Shah-e Zendah in Samarkand and the mosque of Gowhar Shad in Mashhad. Double domes of various shapes abound, and the outsides are perfused with brilliant colors.

Ottoman Turkish architecture

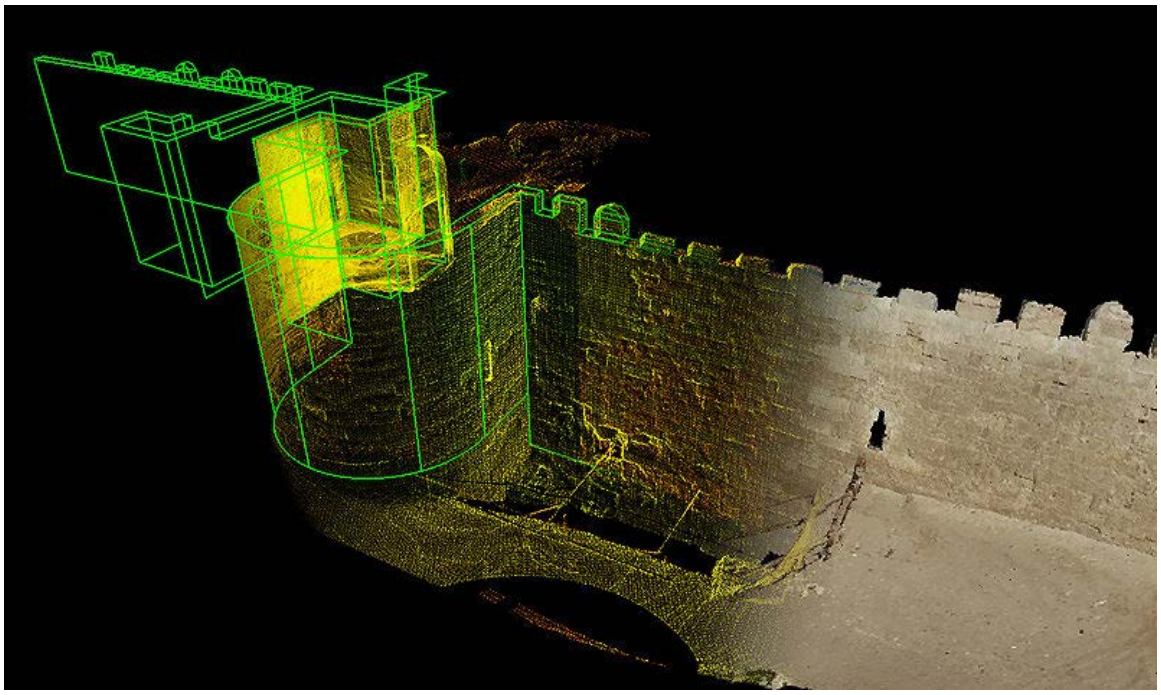
The Sultan Ahmed Mosque in Istanbul

The most numerous and largest of mosques exist in [Turkey], which obtained influence from Byzantine, Persian and Syrian-Arab designs. Turkish architects implemented their own style of cupola domes. The architecture of the Turkish Ottoman Empire forms a distinctive whole, especially the great mosques by and in the style of Mimar Sinan, like the mid-16th century Suleiman Mosque. For almost 500 years Byzantine architecture such as the church of Hagia Sophia served as models for many of the Ottoman mosques such as the Shehzade Mosque, the Suleiman Mosque, and the Rüstem Pasha Mosque.

Selimiye Mosque, built by Sinan in 1575. Edirne, Turkey.

The Ottomans mastered the technique of building vast inner spaces confined by seemingly weightless yet massive domes, and achieving perfect harmony between inner and outer spaces, as well as light and shadow. Islamic religious architecture which until then consisted of simple buildings with extensive decorxations, was transformed by the Ottomans through a dynamic architectural vocabulary of vaults, domes, semidomes and columns. The mosque was transformed from being a cradmped and dark chamber with arabesque-covered walls into a sanctuary of esthetic and technical balance, refined elegance and a hint of heavenly transcendence.

Fatimid architecture



Isometric laser scan data image of a portion of the 12th century Ayyubid Wall that borders Cairo's Al-Azhar Park

In architecture, the Fatimids followed Tulunid techniques and used similar materials, but also developed those of their own. In Cairo, their first congregational mosque was al-Azhar mosque ("the splendid") founded along with the city (969–973), which, together with its adjacent institution of higher learning (al-Azhar University), became the spiritual center for Ismaili Shia. The Mosque of al-Hakim (r. 996–1013), an important example of Fatimid architecture and architectural decoration, played a critical role in Fatimid ceremonial and procession, which emphasized the religious and political role of the Fatimid caliph. Besides elaborate funerary monuments, other surviving Fatimid structures include the Aqmar Mosque (1125) as well as the monumental gates for Cairo's city walls commissioned by the powerful Fatimid emir and vizier Badr al-Jamali (r. 1073–1094).

Aqmar Mosque, Cairo renovation of damaged right wing done by Dawoodi Bohra

Al Hakim Mosque (990-1012) and Aqmar Mosque built in 1125 in Cairo, Egypt features with its Fatimi philosophy and symbolism and bring its architecture vividly to life: "The Fatemi rulers in North Africa and Egypt made the masjid the focal point of the uninterrupted flow of both the water of life and water of learning. They fostered noble traditions of thought and philosophy. They Produced and preserved an immense wealth of literature. They founded Cairo and Al-Azher university. They built Jame-Anwer(Al Hakim Mosque), the second largest masjid in Egypt which was restored and renovated in 1982 by the 52nd Fatimid Dawoodi Bohra Dai His Holiness Dr. Syedna Mohammed Burhanuddin(TUS). They initiated an efflorescence and resurgence of art, culture and thought which posterity remembers as the resplendent Fatemi civilization and which to this day nourishes human intellect and imparts strength and richness to life and living. Al

Jamea tus Saifiyah today is the continuing link in that long chain of centuries which inspired scholarship, valiant leadership and lofty thought." By: Dr. Y. Najmuddin, Rector, Al Jamea tus Saifiyah.

Emir Qurqumas complex

Sultan Hassan Mosque

Mamluk architecture

The reign of the Mamluks (1250-1517 AD) marked a breathtaking flowering of Islamic art which is most visible in old Cairo. Religious zeal made them generous patrons of architecture and art. Trade and agriculture flourished under Mamluk rule, and Cairo, their capital, became one of the wealthiest cities in the Near East and the center of artistic and intellectual activity. This made Cairo, in the words of Ibn Khaldun, "the center of the universe and the garden of the world", with majestic domes, courtyards, and soaring minarets spread across the city.

The architectural identity of Mamluk religious monuments stems from the major purpose that individuals erected their own memorials, therefore adding a high degree of individuality. Each building reflected the patron's individual tastes, choices, and name. Mamluk architecture is oftentimes categorized more by the reigns of the major sultan, than a specific design. Interestingly, the mamluk elite were often more knowledgeable in the art of buildings than many historians. Since the Mamluks had both wealth and power, the overall moderate proportions of Mamluk architecture—compared to Timurid or classical Ottoman styles—is due to the individual decisions of patrons who preferred to sponsor multiple projects. The sponsors of the mosques of Al-Zahir Baybars, al-Nasir Muhammad, Faraj, al-Mu'ayyad, Barsbay, Qaytbay and al-Ghawri all preferred to build several mosques in the capital rather than focusing on one colossal monument. Patrons used architecture to strengthen their religious and social roles within the community.

While the organization of Mamluk monuments varied, the funerary dome and minaret were constant leitmotifs. These attributes are prominent features in a Mamluk mosque's profile and were significant in the beautification of the city skyline. In Cairo, the funerary dome and minaret were respected as symbols of commemoration and worship. Patrons used these visual attributes to express their individuality by decorating each dome and minaret with distinct patterns. Patterns carved on domes ranged from ribs and zigzags to floral and geometric star designs. The funerary dome of Aytimish al-Bajasi and the mausoleum dome of Qaytbay's sons reflect the diversity and detail of Mamluk architecture. Therefore the creativity of Mamluk builders was effectively emphasized with these leitmotifs.

Expanding on the Fatimids concept of street-adjusted mosque facades, the Mamluks developed their architecture to enhance street vistas. In addition, new aesthetic concepts and architectural solutions were created to reflect their assumed role in history. By 1285 the essential features of Mamluk architecture were already established in the complex of Sultan Qalawan. However, it took three decades for the Mamluks to create a new and distinct architecture. By 1517, the Ottoman conquest brought Mamluk architecture to an end without a term of decadence.

The Mamluk utilized chiaroscuro and dappled light effects in their buildings. Mamluk history is divided into two periods based on different dynastic lines: the Bahri Mamluks (1250–1382) of Qipchaq Turkic origin from southern Russia, named after the location of their barracks on the Nile and the Burji Mamluks (1382–1517) of Caucasian Circassian origin, who were quartered in the citadel. The Bahri reign defined the art and architecture of the entire Mamluk period. Mamluk decorative arts—especially enameled and gilded glass, inlaid metalwork, woodwork, and textiles—were prized around the Mediterranean as well as in Europe, where they had a profound impact on local production. The influence of Mamluk glassware on the Venetian glass industry is only one such example.

The reign of Baybars's ally and successor, Qala'un (r. 1280–90), initiated the patronage of public and pious foundations that included madrasas, mausolea, minarets, and hospitals. Such endowed complexes not only ensured the survival of the patron's wealth but also perpetuated his name, both of which were endangered by legal problems relating

to inheritance and confiscation of family fortunes. Besides Qala'un's complex, other important commissions by Bahri Mamluk sultans include those of al-Nasir Muhammad (1295–1304) as well as the immense and splendid complex of Hasan (begun 1356).

The Burji Mamluk sultans followed the artistic traditions established by their Bahri predecessors. Mamluk textiles and carpets were prized in international trade. In architecture, endowed public and pious foundations continued to be favored. Major commissions in the early Burji period in Egypt included the complexes built by Barquq (r. 1382–99), Faraj (r. 1399–1412), Mu'ayyad Shaykh (r. 1412–21), and Barsbay (r. 1422–38).

In the eastern Mediterranean provinces, the lucrative trade in textiles between Iran and Europe helped revive the economy. Also significant was the commercial activity of pilgrims en route to Mecca and Medina. Large warehouses, such as the Khan al-Qadi (1441), were erected to satisfy the surge in trade. Other public foundations in the region included the mosques of Aqbugha al-Utrush (Aleppo, 1399–1410) and Sabun (Damascus, 1464) as well as the Madrasa Jaqmaqiyya (Damascus, 1421).

In the second half of the 15th century, the arts thrived under the patronage of Qa'itbay (r. 1468–96), the greatest of the later Mamluk sultans. During his reign, the shrines of Mecca and Medina were extensively restored. Major cities were endowed with commercial buildings, religious foundations, and bridges. In Cairo, the complex of Qa'itbay in the Northern Cemetery (1472–74) is the best known and admired structure of this period. Building continued under the last Mamluk sultan, Qansuh al-Ghawri (r. 1501–17), who commissioned his own complex (1503–5); however, construction methods reflected the finances of the state. Though the Mamluk realm was soon incorporated into the Ottoman empire (1517), Mamluk visual culture continued to inspire Ottoman and other Islamic artistic traditions.

Islamic (Mughal) architecture

The Badshahi Masjid, literally the 'Royal Mosque', was built in 1674 by Aurangzeb. It is one of Lahore's best known landmarks, and epitomizes the beauty and grandeur of the Mughal era.

Another distinctive sub-style is the architecture of the Mughal Empire in South Asia in the 16th century and a fusion of Arabic, and Persian elements. The Mughal emperor Akbar the Great constructed the royal city of Fatehpur Sikri, located 26 miles west of Agra, in the late 16th century. The most famous example of Mughal architecture is the Taj Mahal, the "teardrop on eternity," completed in 1648 by emperor Shah Jahan in memory of his wife Mumtaz Mahal who died while giving birth to their 14th child. The extensive use of precious and semiprecious stones as inlay and the vast quantity of white marble required nearly bankrupted the empire. The Taj Mahal is completely symmetric except for Shah Jahan's sarcophagus, which is placed off center in the crypt room below the main floor. This symmetry extended to the building of an entire mirror mosque in red sandstone to complement the Mecca-facing mosque place to the west of the main structure. Another structure that showed great depth of Mughal influence was the Shalimar Gardens.

Sino-Islamic architecture

Hui people who have also migrated to the south such as this Darunaman Mosque, locating in Chiang Rai province, Thailand shows a great mixture between Chinese and Islamic architecture.

The Great Mosque of Xi'an, China

The first Chinese mosque was established in the 7th century during the Tang Dynasty in Xi'an. The Great Mosque of Xi'an, whose current buildings date from the Ming Dynasty, does not replicate many of the features often associated with traditional mosques. Instead, it follows traditional Chinese architecture. Some Chinese mosques in parts of western China were more likely to incorporate minarets and domes while eastern Chinese mosques were more likely to look like pagodas.

An important feature in Chinese architecture is its emphasis on symmetry, which connotes a sense of grandeur; this applies to everything from palaces to mosques. One notable exception is in the design of gardens, which tends to be as asymmetrical as possible. Like Chinese scroll paintings, the principle underlying the garden's composition

is to create enduring flow; to let the patron wander and enjoy the garden without prescription, as in nature herself.

Chinese buildings may be built with either red or grey bricks, but wooden structures are the most common; these are more capable of withstanding earthquakes, but are vulnerable to fire. The roof of a typical Chinese building is curved; there are strict classifications of gable types, comparable with the classical orders of European columns.

Most mosques have certain aspects in common with each other however as with other regions Chinese Islamic architecture reflects the local architecture in its style. China is renowned for its beautiful mosques, which resemble temples. However in western China the mosques resemble those of the Arab World, with tall, slender minarets, curvy arches and dome shaped roofs. In northwest China where the Chinese Hui have built their mosques, there is a combination of eastern and western styles. The mosques have flared Buddhist style roofs set in walled courtyards entered through archways with miniature domes and minarets.

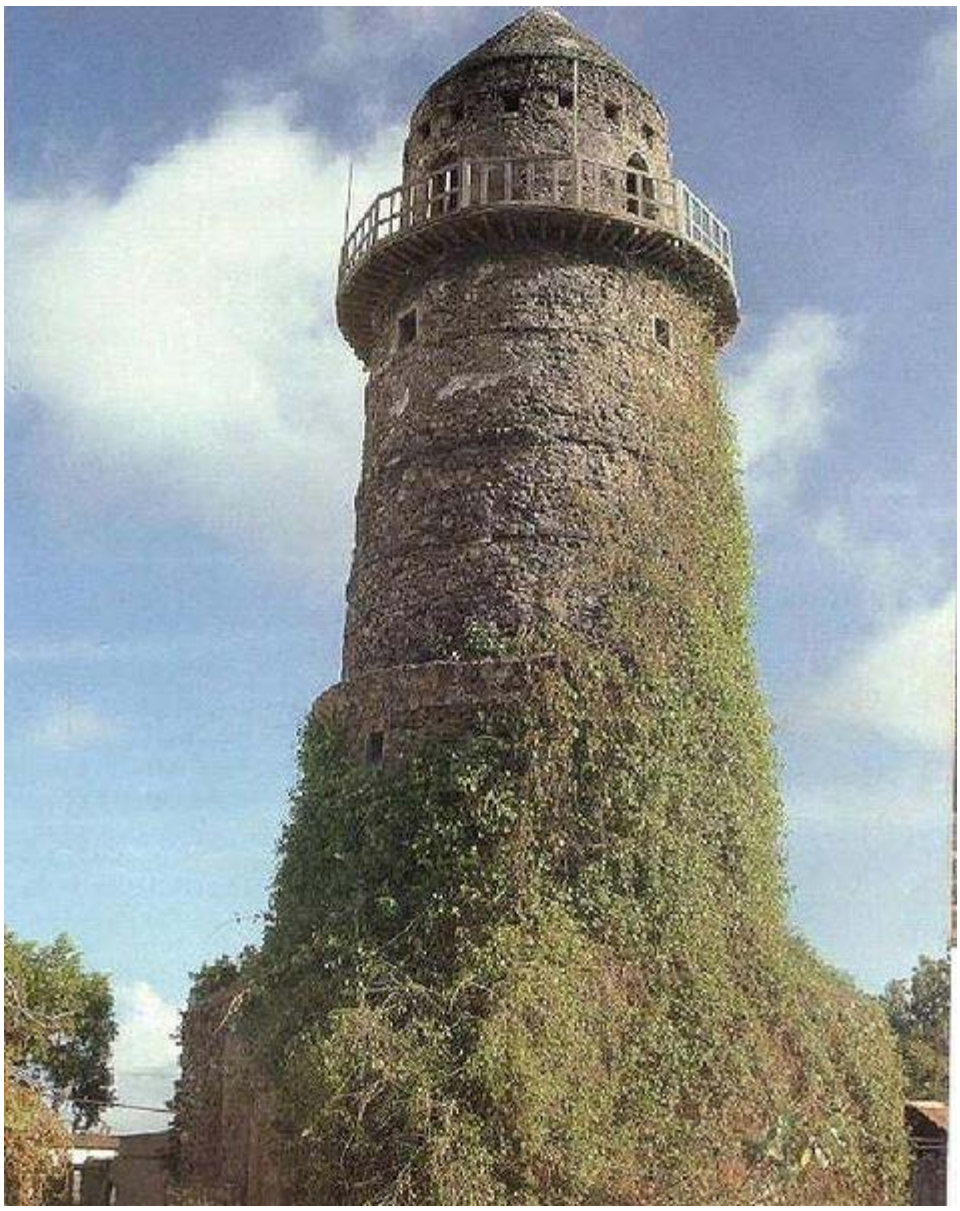
Sahelian-Islamic architecture

The Great Mosque of Djenné in Mali is a great example of Sudano-Sahelian architectural style.

In West Africa, Islamic merchants played a vital role in the Western Sahel region since the Kingdom of Ghana. At Kumbi Saleh, locals lived in domed-shaped dwellings in the king's section of the city, surrounded by a great enclosure. Traders lived in stone houses in a section which possessed 12 beautiful mosques (as described by al-bakri), one centered on Friday prayer. The king is said to have owned several mansions, one of which was sixty-six feet long, forty-two feet wide, contained seven rooms, was two stories high, and had a staircase; with the walls and chambers filled with sculpture and painting. Sahelian architecture initially grew from the two cities of Djenné and Timbuktu. The Sankore Mosque in Timbuktu, constructed from mud on timber, was similar in style to the Great Mosque of Djenné.

Somali-Islamic architecture

Ruins of a mosque in Zeila, Somalia. (circa 1500)



Almnara Tower Somalia

The peaceful introduction of Islam in the early medieval era of Somalia's history brought Islamic architectural influences from Arabia and Persia, which stimulated a shift from drystone and other related materials in construction to coral stone, sundried bricks, and the widespread use of limestone in Somali architecture. Many of the new architectural designs such as mosques were built on the ruins of older structures, a practice that would continue over and over again throughout the following centuries. Concordant with the ancient presence of Islam in the Horn of Africa region, mosques in Somalia are some of the oldest on the entire continent. One architectural feature that made Somali mosques distinct from other mosques in Africa were minarets.

For centuries, Arba Rukun (1269), the Friday mosque of Merca (1609) and Fakr ad-Din (1269) were, in fact, the only mosques in East Africa to have minarets. Fakr ad-Din, which dates back to the Mogadishan Golden Age, was built with marble and coral stone and included a compact rectangular plan with a domed mihrab axis. Glazed tiles were also used in the decoration of the mihrab, one of which bears a dated inscription. The 13th century *Al Gami University* consisted of a rectangular base with a large cylindrical tower architecturally unique in the Islamic world.

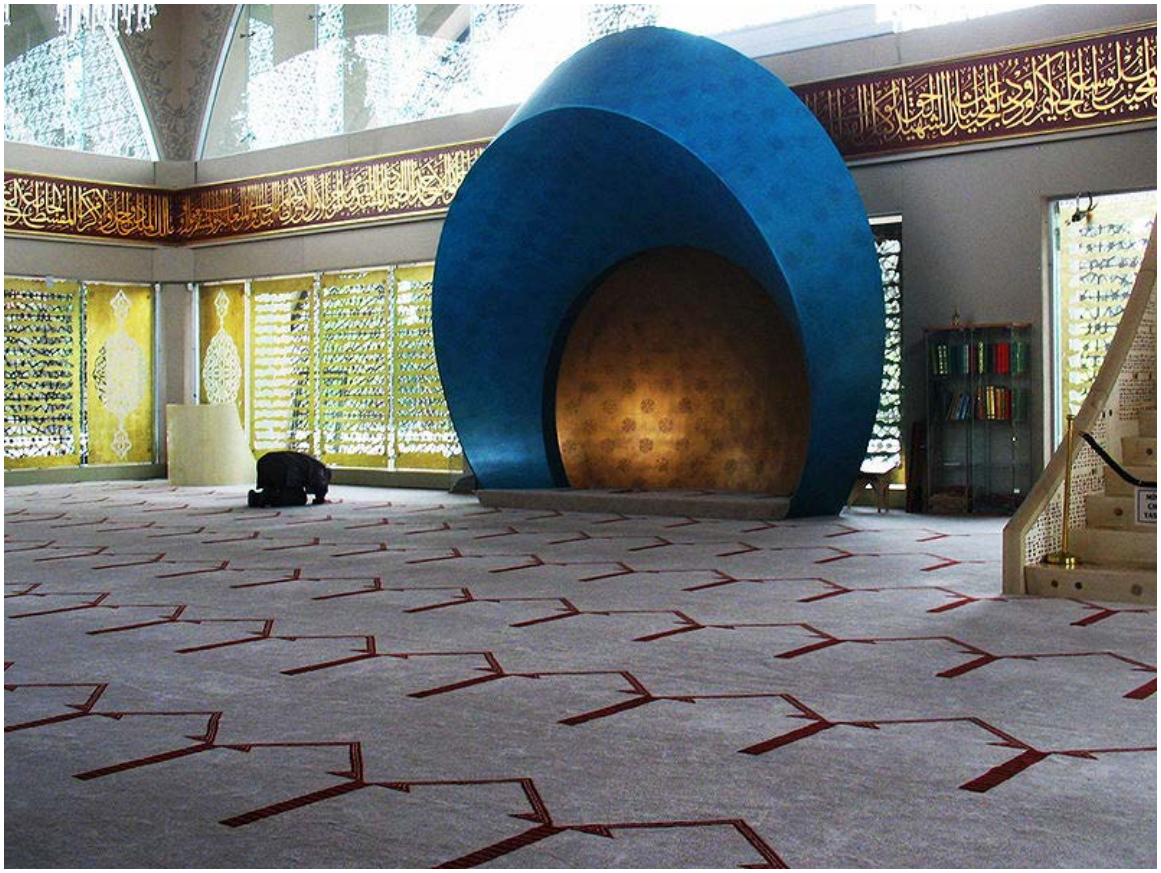
Shrines to honor Somali patriarchs and matriarchs evolved from ancient Somali burial customs. In Southern Somalia the preferred medieval shrine architecture was the Pillar tomb style while the North predominantly built structures consisting of domes and square plans.

Contemporary architecture

Modern Islamic architecture has recently been taken to a new level with such buildings being erected such as the Burj Khalifa, currently the world's tallest building. The Burj Khalifa's design is derived from the patterning systems embodied in Islamic architecture, with the triple-lobed footprint of the building based on an abstracted version of the desert flower hymenocallis which is native to the Dubai region. Nature and flowers have often been the focal point in most traditional Islamic designs. Many modern interpretations of Islamic architecture can be found in Dubai due to the architectural boom of the Arab world. Yet to be built is Madinat al-Hareer in Kuwait which also has modern versions of Islamic architecture in its epically tall tower.

Another example of modern Islamic architecture is the King Abdulaziz International Airport's Hajj Terminal, designed for pilgims on the Hajj in Saudi Arabia. The terminal's Bangladeshi architect Fazlur Khan received the Aga Khan Award for Architecture for "An Outstanding Contribution to Architecture for Muslims". Khan was also the inventor of the tube structure design used in all supertall skyscrapers since the 1960s.

The Faisal Mosque, Islamabad, Pakistan, named after King Faisal of Saudi Arabia



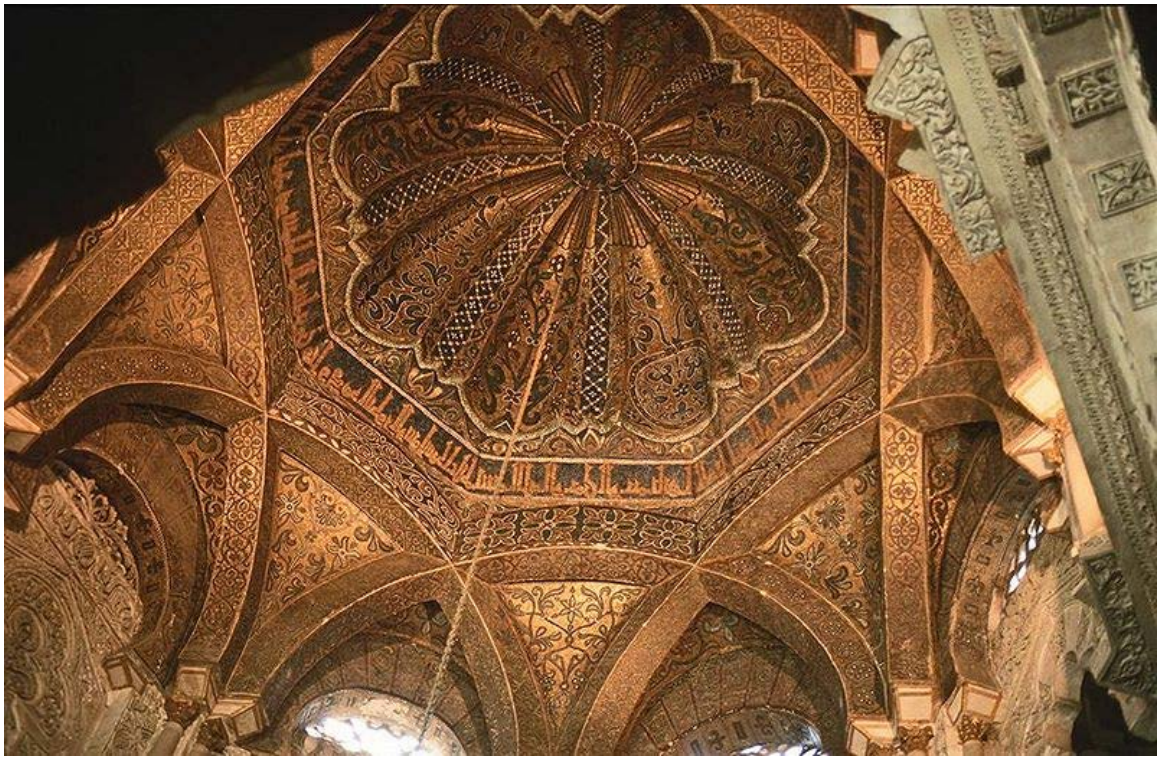
Mihrab of the Şakirin Mosque in Turkey

Interpretation

Common interpretations of Islamic architecture include the following: The concept of Allah's infinite power is evoked by designs with repeating themes which suggest infinity. Human and animal forms are rarely depicted in decorative art as Allah's work is considered to be matchless. Foliage is a frequent motif but typically stylized or simplified for the same reason. Arabic Calligraphy is used to enhance the interior of a building by providing quotations from the Qur'an. Islamic architecture has been called the "architecture of the veil" because the beauty lies in the inner spaces (courtyards and rooms) which are not visible from the outside (street view). Furthermore, the use of grandiose forms such as large domes, towering minarets, and large courtyards are intended to convey power.

Architecture Forms and Styles of mosques and buildings in Muslim countries

Forms



the interior of the Mezquita in Córdoba, Spain

Hassan II Mosque in Casablanca, Morocco. 210m high. A floor with room for 25,000 worshippers.

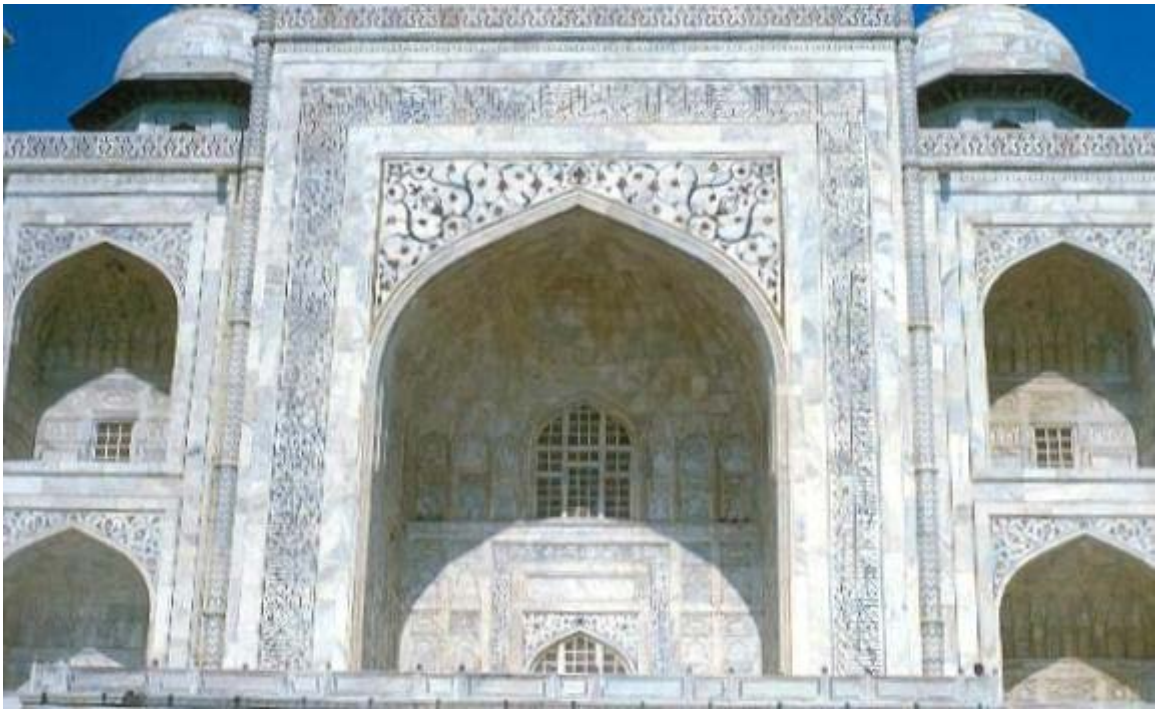
Many forms of Islamic architecture have evolved in different regions of the Islamic world. Notable Islamic architectural types include the early Abbasid buildings, T-Type mosques, and the central-dome mosques of Anatolia. The oil-wealth of the 20th century drove a great deal of mosque construction using designs from leading modern architects.

Arab-plan or *hypostyle* mosques are the earliest type of mosques, pioneered under the Umayyad Dynasty. These mosques are square or rectangular in plan with an enclosed courtyard and a covered prayer hall. Historically, because of the warm Mediterranean and Middle Eastern climates, the courtyard served to accommodate the large number of worshipers during Friday prayers. Most early hypostyle mosques have flat roofs on top of prayer halls, necessitating the use of numerous columns and supports. One of the most notable hypostyle mosques is the Mezquita in Córdoba, Spain, as the building is supported by over 850 columns. Frequently, hypostyle mosques have outer arcades so that visitors can enjoy some shade. Arab-plan mosques were constructed mostly under the Umayyad and Abbasid dynasties; subsequently, however, the simplicity of the Arab plan limited the opportunities for further development, and as a result, these mosques gradually fell out of popularity.

The Ottomans introduced *central dome mosques* in the 15th century and have a large dome centered over the prayer hall. In addition to having one large dome at the center, there are often smaller domes that exist off-center over the prayer hall or throughout the

rest of the mosque, where prayer is not performed. This style was heavily influenced by the Byzantine religious architecture with its use of large central domes.

Iwan



the iwan entrance to the Taj Mahal in Agra

An iwan (Persian ایوان derived from Pahlavi word Bān meaning house) is defined as a vaulted hall or space, walled on three sides, with one end entirely open.

Iwans were a trademark of the Sassanid architecture of Persia, later finding their way into Islamic architecture. This transition reached its peak during the Seljuki era when iwans became established as a fundamental design unit in Islamic architecture. Typically, iwans open on to a central courtyard, and have been used in both public and residential architecture.

Iwan mosques are most notable for their domed chambers and *iwans*, which are vaulted spaces open out on one end. In *iwan* mosques, one or more iwans face a central courtyard that serves as the prayer hall. The style represents a borrowing from pre-Islamic Iranian architecture and has been used almost exclusively for mosques in Iran. Many *iwan* mosques are converted Zoroastrian fire temples where the courtyard was used to house the sacred fire. Today, iwan mosques are seldom built. A notable example of a more recent four iwan design is the King Saud Mosque in Jeddah, Saudi Arabia, finished in 1987.

Sehan

Overview of the Great Mosque of Kairouan which has a spacious courtyard (or sehan) surrounded by arcades, in Kairouan, Tunisia.

Almost every mosque and traditionally all houses and buildings in areas of the Arab World contain a courtyard known as a sehan (Arabic صحن), which are surrounded on all sides by rooms and sometimes an arcade. Sehans usually feature a centrally positioned pool known as a howz.

The Sehan, acts like an indoor garden, where the Women in the house can feel free to not wear the traditional Islamic outfit that is worn in public, and in the Streets.

If a sehan is in a mosque, it is used for performing ablutions. If a sehan is in a traditional house or private courtyard, it is used for aesthetics and to cool the summer heat.

Gardens

The Qur'an uses the garden as an analogy for paradise and Islam came to have a significant influence on garden design.

Qolsharif mosque in Kazan

Arabesque

An element of Islamic art usually found decorating the walls of mosques and Muslim homes and buildings, the arabesque is an elaborate application of repeating geometric forms that often echo the forms of plants, shapes and sometimes animals (specifically birds). The choice of which geometric forms are to be used and how they are to be formatted is based upon the Islamic view of the world. To Muslims, these forms, taken together, constitute an infinite pattern that extends beyond the visible material world. To many in the Islamic world, they in fact symbolize the infinite, and therefore un-centralized, nature of the creation of the one God ("Allah" in Arabic). Furthermore, the Islamic Arabesque artist conveys a definite spirituality without the iconography of

Christian art. Arabesque is used in mosques and building around the Muslim world, and it is a way of decorating using beautiful, embellishing and repetitive Islamic art instead of using pictures of humans and animals (which is forbidden *Haram* in Islam).

Calligraphy

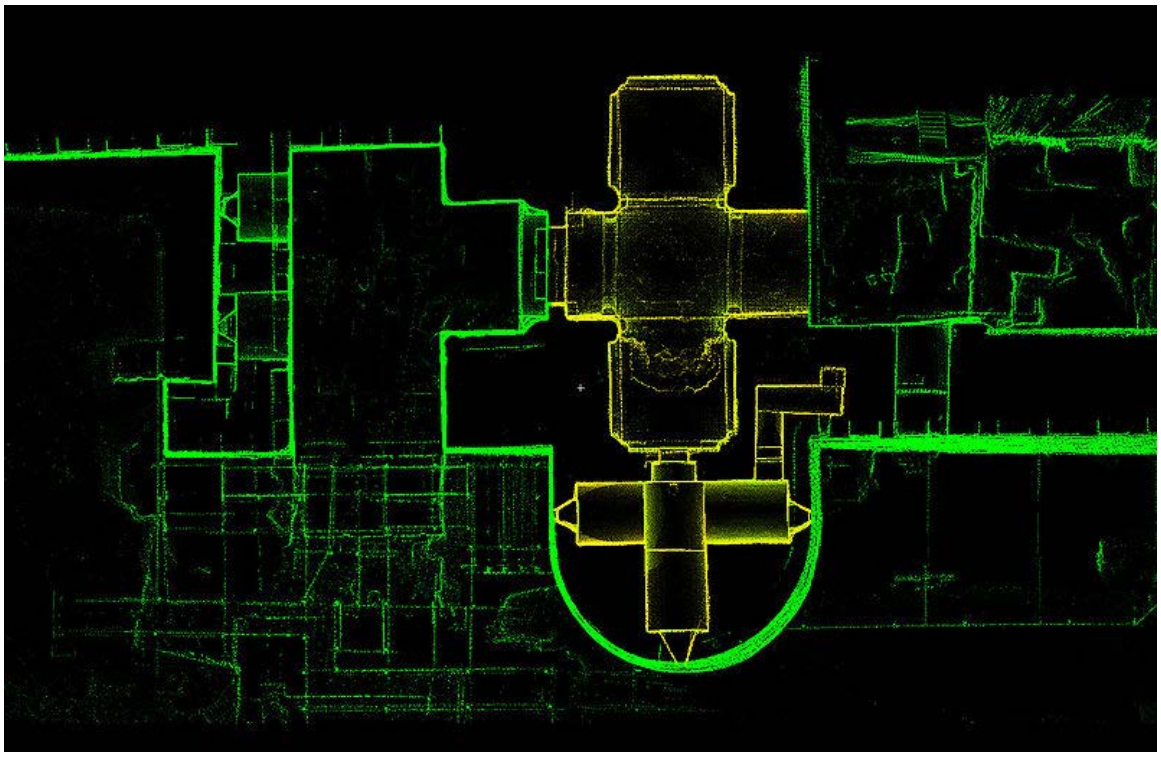
Arabic calligraphy is associated with geometric Islamic art (the Arabesque) on the walls and ceilings of mosques as well as on the page. Contemporary artists in the Islamic world draw on the heritage of calligraphy to use calligraphic inscriptions or abstractions in their work.

Instead of recalling something related to the reality of the spoken word, calligraphy for the Muslim is a visible expression of spiritual concepts. Calligraphy has arguably become the most venerated form of Islamic art because it provides a link between the languages of the Muslims with the religion of Islam. The holy book of Islam, al-Qur'ān, has played a vital role in the development of the Arabic language, and by extension, calligraphy in the Arabic alphabet. Proverbs and complete passages from the Qur'an are still active sources for Islamic calligraphy.

Elements of Islamic style

Islamic architecture may be identified with the following design elements, which were inherited from the first mosque built byr hall (originally a feature of the Masjid al-Nabawi).

Minaret of the Great Mosque of Kairouan regarded as the oldest surviving minaret in the world, situated in Kairouan, Tunisia.



Plan view of Bab al-Barqiyya along Ayyubid Wall. Located close to one of Cairo's main modern traffic arteries, al-Azhar Street, the Fatimid-era Bab al-Barqiyya fortified gate was constructed with interlocking volumes that surrounded the entrant in such a way as to provide greater security and control than typical city wall gates.

- Minarets or towers (these were originally used as torch-lit watchtowers, as seen in the Great Mosque of Damascus; hence the derivation of the word from the Arabic *nur*, meaning "light"). The minaret of the Great Mosque of Kairouan in Tunisia is considered as the oldest surviving minaret in the world. It has the shape of a square massive tower of three superimposed sections.

- A four-iwan plan, with three subordinate halls and one principal one that faces toward Mecca

- Mihrab or prayer niche on an inside wall indicating the direction to Mecca. This may have been derived from previous uses of niches for the setting of the Torah scrolls in Jewish synagogues or the haikal of Coptic churches.

- Domes and Cupolas.

- Iwans to intermediate between different pavilions.

- The use of geometric shapes and repetitive art (arabesque).

- The use of muqarnas, a unique Arabic/Islamic space-enclosing system, for the decoration of domes, minarets and portals. Used at the Alhambra.(Compare mocárabe.) Modern muqarnas designs

- The use of decorative Islamic calligraphy instead of pictures which were haram (forbidden) in mosque architecture. Note that in secular architecture, human and animal representation was indeed present.

- Central fountains used for ablutions (once used as a wudu area for Muslims).

- The use of bright color, if the style is Persian or Indian (Mughal); paler sandstone and grey stones are preferred among Arab buildings. Compare the Registan complex of Uzbekistan to the Al-Azhar University of Cairo.

- Focus both on the interior space of a building and the exterior

Chapter- 7

Philosophy & Science in Islam

Philosophy

Averroes, founder of the Averroism school of philosophy, was influential in the rise of secular thought in Western Europe.

Islamic philosophy

Islamic philosophy is a branch of Islamic studies, and is a longstanding tradition in the compatibility between aql (reason) and iman (faith).

Introduction

Islamic philosophy refers to philosophy produced in an Islamic society. It is not necessarily concerned with religious issues, nor exclusively produced by Muslims. [Oliver Leaman, Routledge Encyclopedia of Philosophy]

Formative influences

Islamic philosophy as the name implies refers to philosophical activity within the Islamic milieu. The main sources of classical or early Islamic philosophy are the religion of Islam itself (especially ideas derived and interpreted from the Quran), Greek philosophy which the early Muslims inherited as a result of conquests when Alexandria, Syria and Jundi-shapur came under Muslim rule, along with pre-Islamic Indian philosophy and Iranian philosophy. Many of the early philosophical debates centered around reconciling religion and reason, the latter exemplified by Greek philosophy. One aspect which stands out in Islamic philosophy is that, the philosophy in Islam travels wide but comes back to conform it with the Quran and Sunna.

Early Islamic philosophy

In early Islamic thought, which refers to philosophy during the "Islamic Golden Age", traditionally dated between the 8th and 12th centuries, two main currents may be distinguished. The first is Kalam, that mainly dealt with Islamic theological questions, and the other is Falsafa, that was founded on interpretations of Aristotelianism and Neoplatonism. There were attempts by later philosopher-theologians at harmonizing both trends, notably by Ibn Sina (Avicenna) who founded the school of Avicennism, Ibn Rushd (Averroës) who founded the school of Averroism, and others such as Ibn al-Haytham (Alhacen) and Abū Rayhān al-Bīrūnī,

Kalam

Kalām (Arabic: علم الكلام) is the philosophy that seeks Islamic theological principles through dialectic. In Arabic the word literally means "speech".

Independent minds exploiting the methods of ijtihad sought to investigate the doctrines of the Qur'an, which until then had been accepted in faith on the authority of divine revelation. One of first debates was that between partisan of the *Qadar* (Arabic: qadara, to have power), who affirmed free will, and the *Jabarites* (jabar, force, constraint), who maintained the belief in fatalism.

At the second century of the Hijra, a new movement arose in the theological school of Basra, Iraq. A pupil, Wasil ibn Ata, who was expelled from the school because his answers were contrary to then orthodox Islamic tradition and became leader of a new school, and systematized the radical opinions of preceding sects, particularly those of the Qadarites. This new school was called *Mutazilite* (from i'tazala, to separate oneself, to dissent).

The Mutazilites, compelled to defend their principles against the orthodox Islam of their day, looked for support in philosophy, and are one of the first to pursue a rational theology called *Ilm-al-Kalam* (Scholastic theology); those professing it were called *Mutakallamin*. This appellation became the common name for all seeking philosophical

demonstration in confirmation of religious principles. The first Mutakallamin had to debate both the orthodox and the non-Muslims, and they may be described as occupying the middle ground between those two parties. But subsequent generations were to large extent critical towards the Mutazilite school, especially after formation of the Asharite concepts.

Falsafa

From the ninth century onward, owing to Caliph al-Ma'mun and his successor, Greek philosophy was introduced among the Persians and Arabs, and the Peripatetic school began to find able representatives among them; such were Al-Kindi, Al-Farabi, Ibn Sina (Avicenna), and Ibn Rushd (Averroës), all of whose fundamental principles were considered as criticized by the Mutakallamin. Another trend, represented by the Brethren of Purity, used Aristotelian language to expound a fundamentally Neoplatonic and Neopythagorean world view.

During the Abbasid caliphate a number of thinkers and scientists, some of them heterodox Muslims or non-Muslims, played a role in transmitting Greek, Hindu, and other pre-Islamic knowledge to the Christian West. They contributed to making Aristotle known in Christian Europe. Three speculative thinkers, al-Farabi, Ibn Sina (Avicenna) and al-Kindi, combined Aristotelianism and Neoplatonism with other ideas introduced through Islam.

From Spain Arabic philosophic literature was translated into Hebrew and Latin, contributing to the development of modern European philosophy.

Some differences between *Kalam* and *Falsafa*

Aristotle attempted to demonstrate the unity of God; but from the view which he maintained, that matter was eternal, it followed that God could not be the Creator of the world. To assert that God's knowledge extends only to the general laws of the universe, and not to individual and accidental things, is tantamount to denying prophecy. One other part of Aristotle's theory shocked the faith of the Mutakallamin — the Aristotelian theory of the soul. According to Aristotelianism, the human soul is simply man's substantial form, the set of properties that make matter into a living human body. This seems to imply that the human soul cannot exist apart from the body. Indeed, Aristotle writes, "It is clear that the soul, or at least some parts of it (if it is divisible), cannot be separated from the body. [...] And thus, those have the right idea who think that the soul does not exist without the body." In Aristotelianism, at least one psychological force, the active intellect, can exist apart from the body. However, according to many interpretations, the active intellect is a superhuman entity emanating from God and enlightening the human mind, not a part of any individual human soul. Thus, Aristotle's theories seem to deny the immortality of the individual human soul.

Wherefore the Mutakallamin had, before anything else, to establish a system of philosophy to demonstrate the creation of matter, and they adopted to that end the theory

of atoms as enunciated by Democritus. They taught that atoms possess neither quantity nor extension. Originally atoms were created by God, and are created now as occasion seems to require. Bodies come into existence or die, through the aggregation or the sunderance of these atoms. But this theory did not remove the objections of philosophy to a creation of matter.

For, indeed, if it be supposed that God commenced His work at a certain definite time by His "will," and for a certain definite object, it must be admitted that He was imperfect before accomplishing His will, or before attaining His object. In order to obviate this difficulty, the Motekallamin extended their theory of the atoms to Time, and claimed that just as Space is constituted of atoms and vacuum, Time, likewise, is constituted of small indivisible moments. The creation of the world once established, it was an easy matter for them to demonstrate the existence of a Creator, and that God is unique, omnipotent, and omniscient.

Main protagonists of Falsafa and their critics

The twelfth century saw the apotheosis of pure philosophy and the decline of the Kalam, which latter, being attacked by both the philosophers and the orthodox, perished for lack of champions. This supreme exaltation of philosophy may be attributed, in great measure, to Al-Ghazali (1005–1111) among the Persians, and to Judah ha-Levi (1140) among the Jews. It can be argued that the attacks directed against the philosophers by Ghazali in his work, "Tahafut al-Falasifa" (The Incoherence of the Philosophers), not only produced, by reaction, a current favorable to philosophy, but induced the philosophers themselves to profit by his criticism. They thereafter made their theories clearer and their logic closer. The influence of this reaction brought forth the two greatest philosophers that the Islamic Peripatetic school ever produced, namely, Ibn Bajjah (Avempace) and Ibn Rushd (Averroës).

Since no idea and no literary or philosophical movement ever germinated on Persian or Arabian soil without leaving its impress on the Jews, the Persian Ghazali found an imitator in the person of Judah ha-Levi. This poet also took upon himself to free his religion from what he saw as the shackles of speculative philosophy, and to this end wrote the "Kuzari," in which he sought to discredit all schools of philosophy alike. He passes severe censure upon the Mutakallamin for seeking to support religion by philosophy. He says, "I consider him to have attained the highest degree of perfection who is convinced of religious truths without having scrutinized them and reasoned over them" ("Kuzari," v.). Then he reduced the chief propositions of the Mutakallamin, to prove the unity of God, to ten in number, describing them at length, and concluding in these terms: "Does the Kalam give us more information concerning God and His attributes than the prophet did?" (Ib. iii. and iv.) Aristotelianism finds no favor in Judah ha-Levi's eyes, for it is no less given to details and criticism; Neoplatonism alone suited him somewhat, owing to its appeal to his poetic temperament.

Ibn Rushd or Ibn Roshd (Averroës), the contemporary of Maimonides, was one of the last of the Islamic Peripatetics. The theories of Ibn Rushd do not differ fundamentally from

those of Ibn Bajjah and Ibn Tufail, who only follow the teachings of Ibn Sina (Avicenna) and Al-Farabi. Like all Islamic Peripatetics, Ibn Rushd admits the hypothesis of the intelligence of the spheres and the hypothesis of universal emanation, through which motion is communicated from place to place to all parts of the universe as far as the supreme world—hypotheses which, in the mind of the Arabic philosophers, did away with the dualism involved in Aristotle's doctrine of pure energy and eternal matter.

But while Al-Farabi, Ibn Sina (Avicenna), and other Persian and Muslim philosophers hurried, so to speak, over subjects that trenched on traditional beliefs, Ibn Rushd delighted in dwelling upon them with full particularity and stress. Thus he says, "Not only is matter eternal, but form is potentially inherent in matter; otherwise, it were a creation *ex nihilo*" (Munk, "Mélanges," p. 444). According to this theory, therefore, the existence of this world is not only a possibility, as Ibn Sina (Avicenna) declared, but also a necessity.

Islamic philosophy found an audience with the Jews, to whom belongs the honor of having transmitted it to the Christian world. A series of eminent men—such as the Ibn Tibbons, Narboni, Gersonides—joined in translating the Arabic philosophical works into Hebrew and commenting upon them. The works of Ibn Rushd especially became the subject of their study, due in great measure to Maimonides, who, in a letter addressed to his pupil Joseph ben Judah, spoke in the highest terms of Ibn Rushd's commentary.

It should be mentioned that this depiction of intellectual tradition in Islamic Lands is mainly dependent upon what West could understand and received (or was willing to understand) from this long era. In contrast, there are some historians and philosophers who do not agree with this account and describe this era in a completely different way. Their main point of dispute is on the influence of different philosophers on Islamic Philosophy, especially the comparative importance of eastern intellectuals such as Ibn Sina (Avicenna) and of western thinkers such as Ibn Rushd.

Judeo-Islamic philosophies

The oldest Jewish religio-philosophical work preserved in Arabic is that of Saadia Gaon (892-942), *Emunot ve-Deot*, "The Book of Beliefs and Opinions". In this work Saadia treats the questions that interested the Mutakallamin, such as the creation of matter, the unity of God, the divine attributes, the soul, etc. Saadia criticizes other philosophers severely. For Saadia there was no problem as to creation: God created the world *ex nihilo*, just as the Bible attests; and he contests the theory of the Mutakallamin in reference to atoms, which theory, he declares, is just as contrary to reason and religion as the theory of the philosophers professing the eternity of matter.

To prove the unity of God, Saadia uses the demonstrations of the Mutakallamin. Only the attributes of essence (*sifat al-dhatia*) can be ascribed to God, but not the attributes of action (*sifat-al-fi'aliya*). The soul is a substance more delicate even than that of the celestial spheres. Here Saadia controverts the Mutakallamin, who considered the soul an "accident" '*arad* (compare Guide for the Perplexed i. 74), and employs the following one of their premises to justify his position: "Only a substance can be the substratum of an

accident" (that is, of a non-essential property of things). Saadia argues: "If the soul be an accident only, it can itself have no such accidents as wisdom, joy, love," etc. Saadia was thus in every way a supporter of the Kalam; and if at times he deviated from its doctrines, it was owing to his religious views.

Later Islamic philosophy

The death of Ibn Rushd (Averroës) effectively marks the end of a particular discipline of Islamic philosophy usually called the *Peripatetic Arabic School*, and philosophical activity declined significantly in western Islamic countries, namely in Islamic Spain and North Africa, though it persisted for much longer in the Eastern countries, in particular Iran and India. Contrary to the traditional view, Dimitri Gutas and the Stanford Encyclopedia of Philosophy consider the period between the 11th and 14th centuries to be the true "Golden Age" of Arabic and Islamic philosophy, initiated by Al-Ghazali's successful integration of logic into the Madrasah curriculum and the subsequent rise of Avicennism.

Since the political power shift in Western Europe (Spain and Portugal) from Muslim to Christian control, the Muslims naturally did not practice philosophy in Western Europe. This also led to some loss of contact between the 'west' and the 'east' of the Islamic world. Muslims in the 'east' continued to do philosophy, as is evident from the works of Ottoman scholars and especially those living in Muslim kingdoms within the territories of present day Iran and India, such as Shah Waliullah and Ahmad Sirhindi. This fact has escaped most pre-modern historians of Islamic (or Arabic) philosophy. In addition, logic has continued to be taught in religious seminaries up to modern times.

After Ibn Rushd, there arose many later schools of Islamic Philosophy. We can mention just a few, such as the those founded by Ibn Arabi and Mulla Sadra. These new schools are of particular importance, as they are still active in the Islamic world. The most important among them are:

- School of Illumination (*Hikmat al-Ishraq*)
- Transcendent Theosophy (*Hikmat Muta'aliah*)
- Sufi philosophy
- Traditionalist School

Illuminationist school

Illuminationist philosophy was a school of Islamic philosophy founded by Shahab al-Din Suhrawardi in the 12th century. This school is a combination of Avicenna’s philosophy and ancient Iranian philosophy, with many new innovative ideas of Suhrawardi. It is often described as having been influenced by Neoplatonism.

In logic in Islamic philosophy, systematic refutations of Greek logic were written by the Illuminationist school, founded by Shahab al-Din Suhrawardi (1155-1191), who

developed the idea of "decisive necessity", an important innovation in the history of logical philosophical speculation.

Transcendent school

Transcendent Theosophy is the school of Islamic philosophy founded by Mulla Sadra in the 17th century. His philosophy and ontology is considered to be just as important to Islamic philosophy as Martin Heidegger's philosophy later was to Western philosophy in the 20th century. Mulla Sadra bought "a new philosophical insight in dealing with the nature of reality" and created "a major transition from essentialism to existentialism" in Islamic philosophy, several centuries before this occurred in Western philosophy.

The idea of "essence precedes existence" is a concept which dates back to Ibn Sina (Avicenna) and his school of Avicennism as well as Shahab al-Din Suhrawardi and his Illuminationist philosophy. The opposite idea of "Existence precedes essence" was thus developed in the works of Averroes and Mulla Sadra as a reaction to this idea and is a key foundational concept of existentialism.

For Mulla Sadra, "existence precedes the essence and is thus principle since something has to exist first and then have an essence." This is primarily the argument that lies at the heart of Mulla Sadra's Transcendent Theosophy. Sayyid Jalal Ashtiyani later summarized Mulla Sadra's concept as follows:

"The existent being that has an essence must then be caused and existence that is pure existence ... is therefore a Necessary Being."

More careful approaches are needed in terms of thinking about philosophers (and theologians) in Islam in terms of phenomenological methods of investigation in ontology (or onto-theology), or by way of comparisons that are made with Heidegger's thought and his critique of the history of metaphysics.

Logic

Al-Ghazali's successful integration of logic into the Madrasah curriculum in the 11th century led to increased activity in logic, mainly focusing on Avicennian logic.

Ibn Hazm (994-1064) wrote the *Scope of Logic*, in which he stressed on the importance of sense perception as a source of knowledge. Al-Ghazali (Algazel) (1058–1111) had an important influence on the use of logic in theology, making use of Avicennian logic in Kalam. Despite the logical sophistication of al-Ghazali, the rise of the Ash'ari school in the from the 12th century slowly suffocated original work on logic in much of the Islamic world, though logic continued to be studied in some Islamic regions such as Persia and the Levant.

Fakhr al-Din al-Razi (b. 1149) criticised Aristotle's "first figure" and developed a form of inductive logic, foreshadowing the system of inductive logic developed by John Stuart

Mill (1806–1873). Systematic refutations of Greek logic were written by the Illuminationist school, founded by Shahab al-Din Suhrawardi (1155–1191), who developed the idea of "decisive necessity", an important innovation in the history of logical philosophical speculation. Another systematic refutation of Greek logic was written by Ibn Taymiyyah (1263–1328), the *Ar-Radd 'ala al-Mantiqiyyin* (*Refutation of Greek Logicians*), where he argued against the usefulness, though not the validity, of the syllogism and in favour of inductive reasoning.

Philosophy of history

The first detailed studies on the subject of historiography and the first critiques on historical methods appeared in the works of the Arab Ash'ari polymath Ibn Khaldun (1332–1406), who is regarded as the father of historiography, cultural history, and the philosophy of history, especially for his historiographical writings in the *Muqaddimah* (Latinized as *Prolegomena*) and *Kitab al-Ibar* (*Book of Advice*). His *Muqaddimah* also laid the groundwork for the observation of the role of state, communication, propaganda and systematic bias in history, and he discussed the rise and fall of civilizations.

Franz Rosenthal wrote in the *History of Muslim Historiography*:

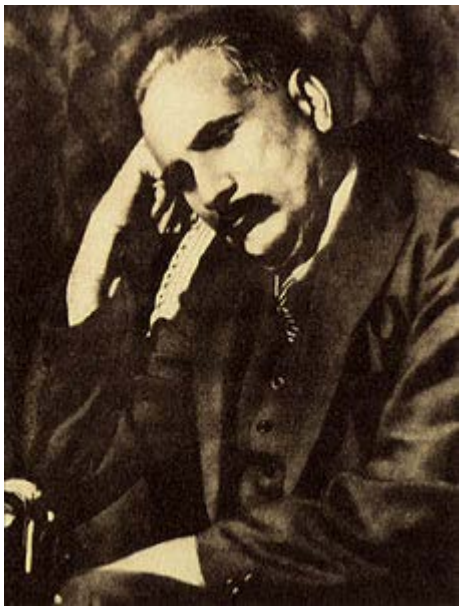
"Muslim historiography has at all times been united by the closest ties with the general development of scholarship in Islam, and the position of historical knowledge in MusIim education has exercised a decisive influence upon the intellectual level of historicai writing....The Muslims achieved a definite advance beyond previous historical writing in the sociological understanding of history and the systematisation of historiography. The development of modern historical writing seems to have gained considerably in speed and substance through the utilization of a Muslim Literature which enabled western historians, from the seventeenth century on, to see a large section of the world through foreign eyes. The Muslim historiography helped indirectly and modestly to shape present day historical thinking."

Social philosophy

The most famous social philosopher was the Ash'ari polymath Ibn Khaldun (1332–1406), who was the last major Islamic philosopher from North Africa. In his *Muqaddimah*, he developed the earliest theories on social philosophy, in formulating theories of social cohesion and social conflict.

His *Muqaddimah* was also the introduction to a seven volume analysis of universal history. He is considered the "father of sociology", "father of historiography", and "father of the philosophy of history", for being the first to discuss the topics of sociology, historiography and the philosophy of history in detail.

Contemporary Islamic philosophy



Dr. Allama Muhammad Iqbal (1877-1938), a notable Muslim philosopher, poet and scholar from (then British India)

The tradition of Islamic Philosophy is still very much alive today despite the belief in many Western circles that this tradition ceased after the golden ages of Suhrawardi's *Hikmat al-Ishraq* (Illumination Philosophy) or, at the latest, Mulla Sadra's *Hikmat-e-Mota'aliye* or Transcendent (Exalted) Philosophy. Another unavoidable name is Allama Muhammad Iqbal who reshaped and revitalized Islamic philosophy amongst the Muslims of the Indian sub-continent in the early 20th century. Beside his Urdu and Persian poetical work, The Reconstruction of Religious Thought in Islam is a milestone in the modern political philosophy of Islam.

In contemporary Islamic Lands, the teaching of *hikmat* or *hikmah* has continued and flourished.

Among the traditional masters of Islamic philosophy most active during the past two decades may be mentioned

- *Riaz Ahmed Gohar Shahi* founder of International Spiritual Movement Anjumaan Serfaroshan-e-Islam and author of many books of on Islam, Spiritualism. Particularly his book "**The Religion of God**" is one of the best of his piece of work, in this book he has given a philosophy of Divine Love of God and how it can be developed or attained. Gohar Shahi was in favor of divine love and considers it most important for an approach to God and no discrimination of caste, creed, nation or religion is accepted for Divine Love of God as every human has been gifted with an ability to develop spiritual power to approach to the essence

of God. According to his view this will not just provide a platform for all religions but it will remove the differences between religions as well.

- Ayatullah Ruhollah Khomeini, founder of the Islamic Rebublic of Iran, was a famous teacher of the philosophical school of Hikmat-ul-Mutaliya. Before the victory of the Islamic Revolution, he was one of the few who formally taught philosophy at the Religious Seminary at Qum.
- the Iranian علامه طباطبائی or *Allameh Tabatabaei*, the author of numerous works including the twenty seven-volume Quranic commentary *al-Mizan* (المرزان),
- *Murtaza Motahhari*, the best student of Allamah Tabatabai, a martyr of the Iran Islamic Revolution; and author of numerous books (an incomplete compilation of his works consists of 25 volumes). He, like his teachers Allama Tabatabai and Ayatullah Khomeini, belong to the philosophical schools of Hikmat-ul-Mutaliya
- Sayyid Abul Ala Maududi, who is credited with creating modern Islamist political thought in the 20th century, was the founder of "Jamaat e Islami" and spent his life in attempting to revive the Islamic Intellectual Tradition.
- Muhammad Hamidullah (February 9, 1908 - December 17, 2002) belonged to a family of scholars, jurists, writers and sufis. He was a world-renowned scholar of Islam and International Law from India, who was known for contributions to the research of the history of Hadith, translations of the Qur'an, the advancement of Islamic learning, and to the dissemination of Islamic teachings in the Western world.
- Fazlur Rahman was professor of Islamic thought at the University of Chicago, and an expert in Islamic philosophy.

- Seyyed Hossein Nasr.
- Imran Nazar Hosein.- Author of Jerusalem in the Quran
- Javed Ahmad Ghamidi is a well-known Pakistani Islamic scholar, exegete, and educator. A former member of the Jamaat-e-Islami, who extended the work of his tutor, Amin Ahsan Islahi.
- In Malaysia, Syed Muhammad Naquib al-Attas is a prominent metaphysical thinker.;
- In Southern/South East Europe the teachings of the skeptic *Al-Ibn Theodorakis* have found considerable favour.

Criticism

Philosophy as such has not been without criticism amongst Muslims, both contemporary and past. The imam Hanbali, for whom the Hanbali school of thought is named, rebuked philosophical discussion, once telling proponents of it that he was secure in his religion, but that they were "in doubt, so go to a doubter and argue with him (instead)." Today, Islamic philosophical thought has also been criticized by scholars of the modern Salafi movement.

There would be many Islamic thinkers who were not as enthusiastic about its potential. But it would be incorrect to assume that they opposed philosophy simply because it was a

"foreign science". Oliver Leaman, an expert on Islamic philosophy, points out that the objections of notable theologians are rarely directed at philosophy itself, but rather at the conclusions the philosophers arrived at. Even al-Ghazali, who is famous for his critique of the philosophers, was himself an expert in philosophy and logic. And his criticism was that they arrived at theologically erroneous conclusions. The three most serious of these, in his view, were believing in the co-eternity of the universe with God, denying the bodily resurrection, and asserting that God only has knowledge of abstract universals, not of particular things (but it should be noted that not all philosophers subscribed to these same views).

In recent studies by *Muslim contemporary thinkers* that aim at 'renewing the impetus of philosophical thinking in Islam', Nader El-Bizri offers a critical analysis of the conventions of methodology and historiography that dominate the mainstream academic and epistemic approaches in studying 'Islamic philosophy' from 'archival' standpoints, within Oriental and Mediaevalist Studies, which fail to recognize the fact that 'philosophy in Islam' can still be a living intellectual tradition, and that its renewal requires a radical reform in ontology and epistemology within Islamic thought.

Contemporary Islamic philosophy

Aziz Abbassi's English translation found in the following pages was made from the French Introduction à la critique de la raison Arabe, translated from Arabic to French by Ahmed Mahfoud and Marc Geoffroy, published by La Découverte in 1994.The occasion of this French publication was an effort to provide an introduction to al-Jabri's thought prior to publication of a translation of his three-volume Naqdd al-'aql al-'Arabi referred to earlier. The essays contained were selected from al-Jabri's earlier work, especially his collection Nahnu wa-al-Tuath. The author helped and advised in the selection of the texts and revised the French edition, thus making it authoritative. And, although the present text was translated from the French, it was compared with the Arabic original.

During the past few years, al-Jabri has published essays and shorter monographs on issues ranging from democracy and human rights in the Arab World to further elaboration and discussions of his main theses in his previously published work. Because al-Jabri's work is a direct and critical intervention in problems and issues that are central to modern and contemporary Arab thought, and because his interpretations and readings of modern and classical Arab thought in more than one instance challenge that thought, I will not only summarize some of his ideas but also discuss briefly the main trends that have dominated intellectual discussions in the Arab world during the past few decades

Also contemporary Islamic philosophy revives some of the trends of medieval Islamic philosophy, notably the tension between Mutazilite and Asharite views of ethics in science and law, and the duty of Muslims and role of Islam in the sociology of

knowledge and in forming ethical codes and legal codes, especially the fiqh (or "jurisprudence") and rules of jihad (or "just war").

Key figures of modern Islamic philosophy

Key figures representing important trends include:

- **Fazlur Rahman** was professor of Islamic thought at the University of Chicago and McGill University, and an expert in Islamic philosophy. Not as widely known as his scholar-activist contemporary Ismail Raji al-Faruqi, he is nonetheless considered an important figure for Islam in the 20th century. He argued that the basis of Islamic revival was the return to the intellectual dynamism that was the hallmark of the Islamic scholarly tradition (these ideas are outlined in *Revival and Reform in Islam: A Study of Islamic Fundamentalism* and his magnum opus, *Islam*). He sought to give philosophy free rein, and was keen on Muslims appreciating how the modern nation-state understood law, as opposed to ethics; his view being that the shari'ah was a mixture of both ethics and law. He was critical of historical Muslim theologies and philosophies for failing to create a moral and ethical worldview based on the values derived from the Qur'an: 'moral values', unlike socioeconomic values, 'are not exhausted at any point in history' but require constant interpretation. Rahman was driven to exile from his homeland, Pakistan, where he was part of a committee which sought to interpret Islam for the fledging modern state. Some of his ideas from English (which he claimed were from the Islamic tradition) were reprinted in Urdu and caused outrage among conservative Muslim scholars in Pakistan. These were quickly exploited by opponents of his political paymaster, General Ayyub Khan, and led to his eventual exile in the United States.
- **Muhammad Iqbal** sought an Islamic revival based on social justice ideals and emphasized traditional rules, e.g. against usury. He argued strongly that dogma, territorial nationalism and outright racism, all of which were profoundly rejected in early Islam and especially by Muhammad himself, were splitting Muslims into warring factions, encouraging materialism and nihilism. His thought was influential in the emergence of a movement for independence of Pakistan, where he was revered as the national poet. Indirectly this strain of Islam also influenced Malcolm X and other figures who sought a global ethic through the Five Pillars of Islam. Iqbal can be credited with at least trying to reconstruct Islamic thought from the base, though some of his philosophical and scientific ideas would appear dated to us now. His basic ideas concentrated on free-will, which would allow Muslims to become active agents in their own history. His interest in Nietzsche (who he called 'the Wise Man of Europe') has led later Muslim scholars to criticise him for advocating dangerous ideals that, according to them, have eventually formed in certain strains of pan-Islamism. Some claim that the Four Pillars of the Green Party honor Iqbal and Islamic traditions.

- **Muhammad Hamidullah** (9 February, 1908 - 17 December, 2002) belonged to a family of scholars, jurists, writers and sufis. He was a world-renowned scholar of

Islam and International Law from India, who was known for contributions to the research of the history of Hadith, translations of the Qur'an, the advancement of Islamic learning, and to the dissemination of Islamic teachings in the Western world.

- **Morteza Motahhari** was a lecturer at Tehran University. Motahhari is considered important for developing the ideologies of the Islamic Republic. He wrote on exegesis of the Qur'an, philosophy, ethics, sociology, history and many other subjects. In all his writings the real object he had in view was to give replies to the objections raised by others against Islam, to prove the shortcomings of other schools of thought and to manifest the greatness of Islam. He believed that in order to prove the falsity of Marxism and other ideologies like it, it was necessary not only to comment on them in a scholarly manner but also to present the real image of Islam.
- **Ali Shariati** was a sociologist and a professor of Mashhad University. He was one of the most influential figures in the Islamic world in the 20th century. He attempted to explain and provide solutions for the problems faced by Muslim societies through traditional Islamic principles interwoven with and understood from the point of view of modern sociology and philosophy. Shariati was also deeply influenced by Mowlana and Muhammad Iqbal.
- **Musa al-Sadr** was a prominent Muslim intellectual and one of the most influential Muslim philosophers of 20th century. He is most famous for his political role, but he was also a philosopher who had been trained by Allameh Tabatabaei. As Professor Seyyed Hossein Nasr said: "his great political influence and fame was enough for people to not consider his philosophical attitude, although he was a well-trained follower of long living intellectual tradition of Islamic Philosophy". One of his famous writings is a long introduction for the Arabic translation of Henry Corbin's *History of Islamic Philosophy*.
- Syed Zafarul Hasan was a prominent twentieth-century Muslim philosopher. From 1924 to 1945 he was professor of philosophy at the Muslim University, Aligarh - where he also served as Chairman of the Department of Philosophy and Dean of the Faculty of Arts. There, in 1939, he put forward the 'Aligarh Scheme'. From 1945 until the partition of the sub-continent, Dr Hasan was Emeritus Professor at Aligarh. Dr. Zafarul Hasan was born on February 14, 1885. He died on June 19, 1949.
- Ismail al-Faruqi looked more closely at the ethics and sociology of knowledge, concluding that no scientific method or philosophy could exist that was wholly ignorant of a *theory of conduct* or the consequences a given path of inquiry and technology. His "Islamization of knowledge" program sought to converge early Muslim philosophy with modern sciences, resulting in, for example, Islamic economics and Islamic sociology.
- Seyyed Hossein Nasr, a political ecologist, argues that khalifa in Islam is fundamentally compatible with ideals of the ecology movement and peace movement, more so than conventional interpretations of Islam. He argues for an ecology-based ecumenism that would seek unity among the faiths by concentrating on their common respect for life as a Creation, i.e. the Earth's biosphere, Gaia, or whatever name. Pope John Paul II has made similar suggestions that

"mankind must be reconciled to the Creation", and there is a *Parliament of World Religions* seeking a "global ethic" on similar grounds.

- Akbar S. Ahmed is an anthropologist, filmmaker and an outstanding scholar on Islam, International Relations/Politics and Contemporary Islamic philosophy from Pakistan. He is Ibn Khaldun Chair of Islamic Studies at the American University in Washington DC and was the High Commissioner of Pakistan to UK. He has advised Prince Charles and met with President George W. Bush on Islam. His numerous books, films and documentaries have won awards. His books have been translated into many languages including Chinese and Indonesian. Ahmed is "the world's leading authority on contemporary Islam" according to the BBC.
- **Javed Ahmad Ghamidi** is a well-known Pakistani Islamic scholar, exegete, and educator. A former member of the Jamaat-e-Islami, who extended the work of his tutor, Amin Ahsan Islahi. He is frequently labeled a modernist for his insistence on the historical contextualization of Muhammad's revelation in order to grasp its true moral import.
- Imam Feisal Abdul Rauf is a well-known proponent of cultural reconciliation between the Muslim World and the West, basing his views on Classical Islamic governance's similarity to Western governance models in terms of religious freedoms and democratic inclination. Abdul Rauf is a highly-visible American-Egyptian Imam at New York's Masjid al-Farah in addition to being Founder and Chairman of Cordoba Initiative, a non-profit organization seeking to bridge the divide between the Muslim world and the West.
- Mohammad Azadpur is an associate professor of philosophy at San Francisco State University. He teaches courses on Islamic philosophy, mysticism, and political philosophy. His research focuses on Alfarabi and Avicenna, and he does comparative work between Islamic and Heideggerian thought as well.

Science in Medieval Islam

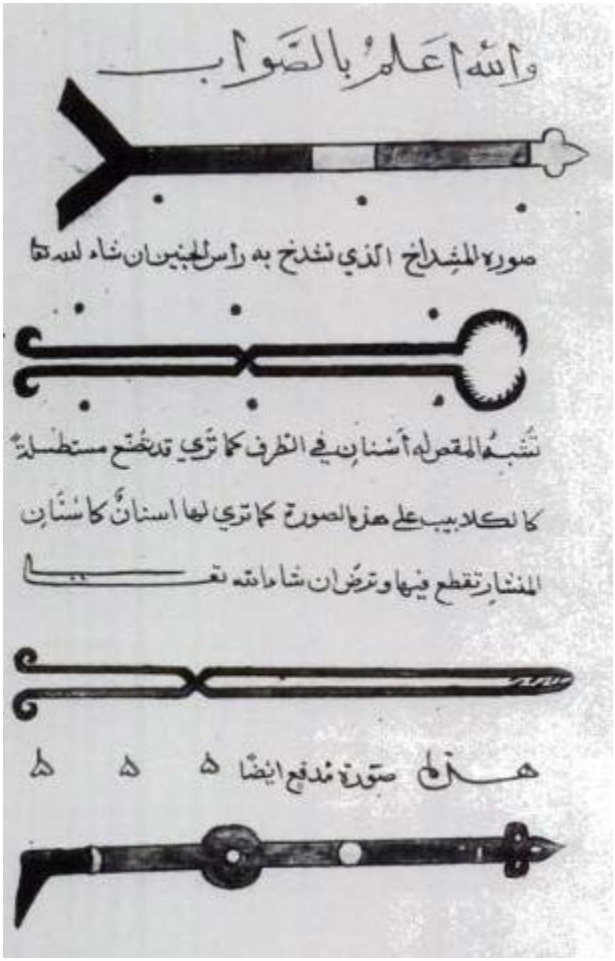


Illustration of medieval Muslim surgical instruments from physician Abu al-Qasim al-Zahrawi's 11th century medical encyclopedia: *Kitab al-Tasrif*.

Science in medieval Islam, also known as **Islamic** or **Arabic science**, is a term used in the history of science to refer to the science developed in the Islamic world prior to the modern era, particularly during what is known as the Islamic Golden Age (dated variously between the 7th and 15th centuries). In the course of the expansion of the Islamic world, Muslim scholars encountered the science, mathematics, and medicine of antiquity through the works of Aristotle, Archimedes, Galen, Ptolemy, Euclid, and others. These works and the important commentaries on them were the wellspring of science during the Medieval period. They were translated into Arabic, the *lingua franca* of this period; scientists within the Islamic civilization were of diverse ethnicity (a great portion were Persians and Arabs, in addition to Berbers, Moors and Turks) and diverse religious backgrounds (mostly Muslims, in addition to many Christians and Jews, as well as Sabians, Zoroastrians and the irreligious).

Overview

Historiography of Islamic science

The history of science in the Islamic world, like all history, is filled with questions of interpretation. Historians of science generally consider that the study of Islamic science, like all history, must be seen within the particular circumstances of time and place. A. I. Sabra opened a recent overview of Arabic science by noting, "I trust no one would wish to contest the proposition that all of history is local history ... and the history of science is no exception."

Some scholars avoid such local historical approaches and seek to identify essential relations between Islam and science that apply at all times and places. The Pakistani physicist, Pervez Hoodbhoy, portrayed "religious fanaticism to be the dominant relation of religion and science in Islam". Sociologist Toby Huff claimed that Islam lacked the "rationalist view of man and nature" that became dominant in Europe. The Persian philosopher and historian of science, Seyyed Hossein Nasr saw a more positive connection in "an Islamic science that was spiritual and antisecular" which "point[ed] the way to a new 'Islamic science' that would avoid the dehumanizing and despiritualizing mistakes of Western science."

Nasr identified a distinctly Muslim approach to science, flowing from Islamic monotheism and the related theological prohibition against portraying graven images. In science, this is reflected in a philosophical disinterest in describing individual material objects, their properties and characteristics and instead a concern with the ideal, the Platonic form, which exists in matter as an expression of the will of the Creator. Thus one can "see why mathematics was to make such a strong appeal to the Muslim: its abstract nature furnished the bridge that Muslims were seeking between multiplicity and unity."

Some historians of science, however, question the value of drawing boundaries that label the sciences, and the scientists who practice them, in specific cultural, civilizational, or linguistic terms. Consider the case of Nasir al-Din Tusi (1201–1274), who invented his mathematical theorem, the Tusi Couple, while he was director of Maragheh observatory. Tusi's patron and founder of the observatory was the non-Muslim Mongol conqueror of Baghdad, Hulagu Khan. The Tusi-couple "was first encountered in an Arabic text, written by a man who spoke Persian at home, and used that theorem, like many other astronomers who followed him and were all working in the "Arabic/Islamic" world, in order to reform classical Greek astronomy, and then have his theorem in turn be translated into Byzantine Greek towards the beginning of the 14th century, only to be used later by Copernicus and others in Latin texts of Renaissance Europe."

Views of historians and scholars

There are several different views on Islamic science among historians of science. The traditionalist view, as exemplified by Bertrand Russell, holds that Islamic science, while admirable in many technical ways, lacked the intellectual energy required for innovation

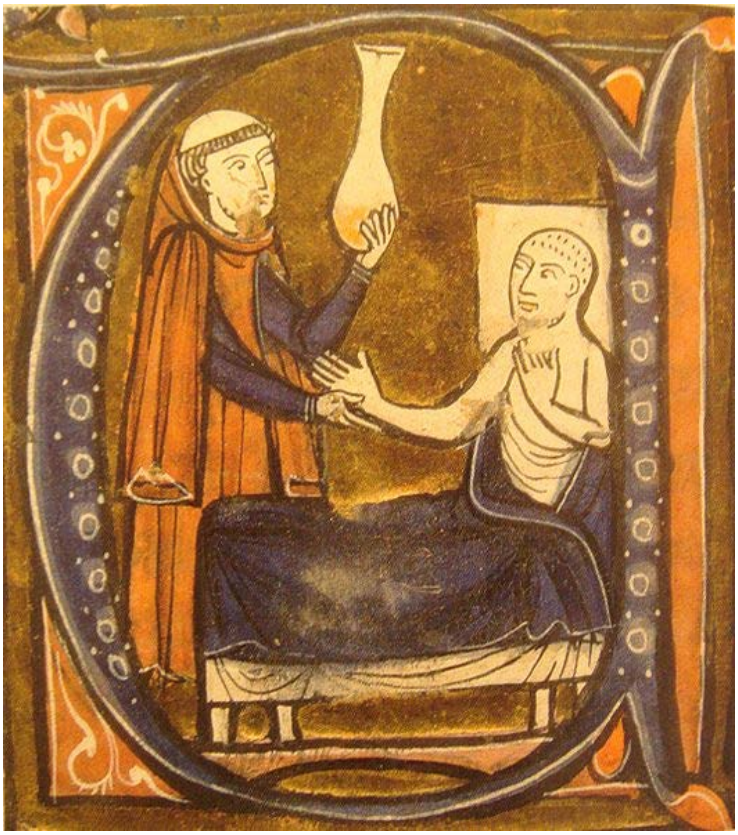
and was chiefly important as a preserver of ancient knowledge and transmitter to medieval Europe. The revisionist view, as exemplified by Abdus Salam, George Saliba and John M. Hobson holds that a Muslim scientific revolution occurred during the Middle Ages, an expression with which scholars such as Donald Routledge Hill and Ahmad Y Hassan express the view that Islam was the driving force behind the Muslim achievements, while Robert Briffault even sees Islamic science as the foundation of modern science. The most prominent view in recent scholarship, however, as exemplified by Toby E. Huff, Will Durant, Fielding H. Garrison, Muhammad Iqbal, Hossein Nasr and Bernard Lewis, holds that Muslim scientists did help in laying the foundations for an experimental science with their contributions to the scientific method and their empirical, experimental and quantitative approach to scientific inquiry, but that their work cannot be considered a Scientific Revolution, like that which occurred in early modern Europe and led to the emergence of modern science.

Chapter- 8

Inventions in Medieval Islam

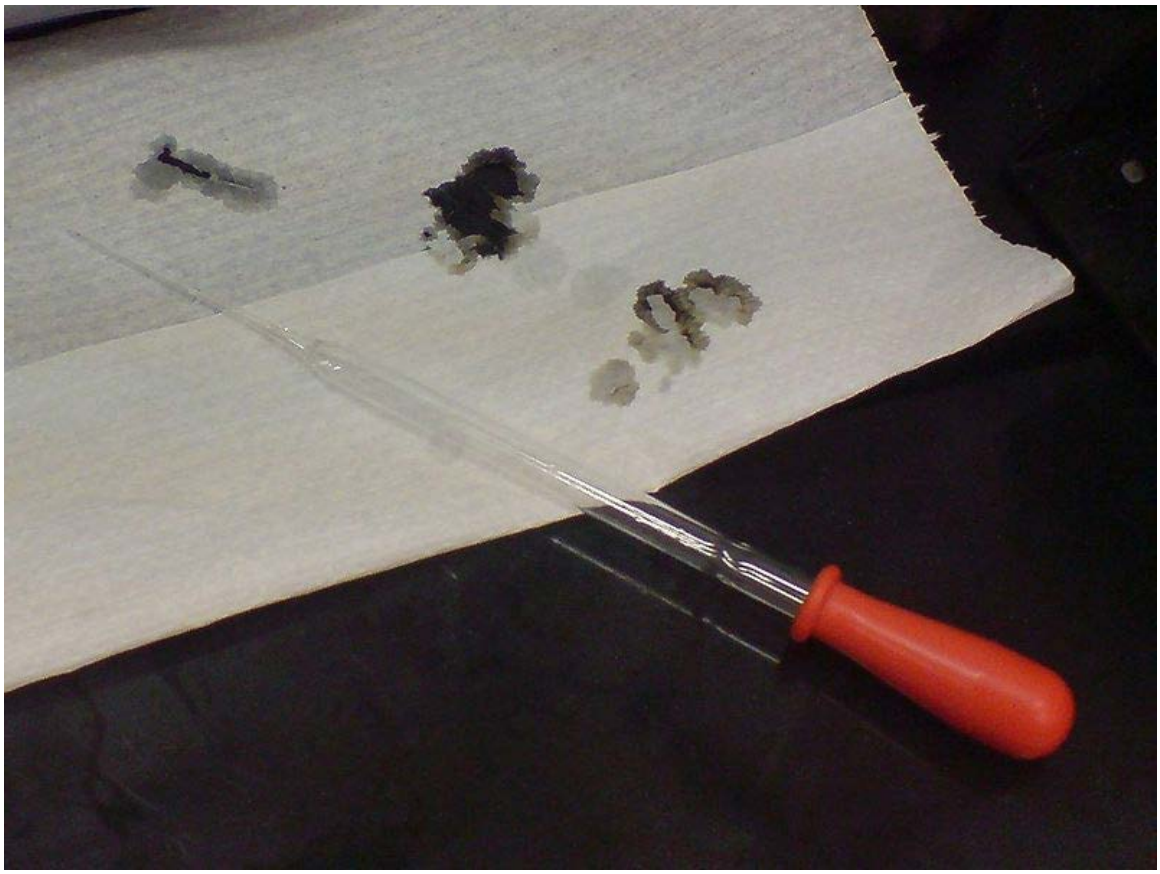
A number of **inventions** were developed **in the medieval Islamic world**, a geopolitical region that has at various times extended from Spain and Africa in the west to the Indian subcontinent in the east. The inventions listed here were developed during the medieval Islamic world, which covers the period from the early Caliphate to the later Ottoman, Safavid and Mughal empires. In particular, the majority of inventions here date back to the Islamic Golden Age, which is traditionally dated from the 8th to the 13th centuries.

Chemical industries



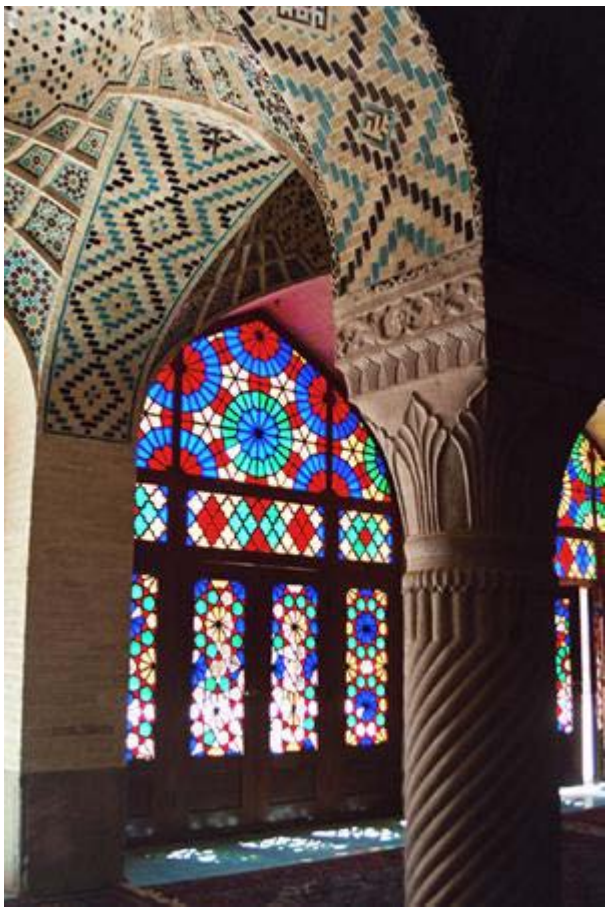
Muhammad ibn Zakariya ar-Razi (Rhazes) isolated many chemical substances, produced many medications, and described many laboratory apparatus.

Aqua regia was first isolated by Jābir ibn Hayyān



Sulfuric acid, a mineral acid, was first isolated by Jābir ibn Hayyān

Arsenic, a chemical element, was first isolated by Jābir ibn Hayyān in the 8th century



Coloured stained glass windows in the Nasir al-Mulk mosque in Shiraz, Iran

Early forms of distillation were known to the Babylonians, Greeks and Egyptians since ancient times, but it was Muslim chemists who first invented pure distillation processes which could fully purify chemical substances. They also developed several different variations of distillation (such as dry distillation, destructive distillation and steam distillation) and introduced new distillation aparatus (such as the alembic, still, and retort), and invented a variety of new chemical processes and over 2,000 substances.

Will Durant wrote in *The Story of Civilization IV: The Age of Faith*:

"Chemistry as a science was almost created by the Muslim; for in this field, where the Greeks (so far as we know) were confined to industrial experience and vague hypothesis, the Saracens introduced precise observation, controlled experiment, and careful records. They invented and named the alembic (al-anbiq), chemically analyzed innumerable substances, composed lapidaries, distinguished alkalis and acids, investigated their affinities, studied and manufactured hundreds of drugs. Alchemy, which the Moslems inherited from Egypt, contributed to chemistry by a thousand incidental discoveries, and by its method, which was the most scientific of all medieval operations."

Robert Briffault wrote in *The Making of Humanity*:

"Chemistry, the rudiments of which arose in the processes employed by Egyptian metallurgists and jewellers combining metals into various alloys and 'tinting' them to resemble gold, processes long preserved as a secret monopoly of the priestly colleges, and clad in the usual mystic formulas, developed in the hands of the Arabs into a widespread, organized passion for research which led them to the invention of distillation, sublimation, filtration, to the discovery of alcohol, of nitric and sulphuric acids (the only acid known to the ancients was vinegar), of the alkalis, of the salts of mercury, of antimony and bismuth, and laid the basis of all subsequent chemistry and physical research."

Chemical processes

The following chemical processes were invented by Muslim chemists:

- **Cocotion** (or digestion), **ceration**, **lavage**, and **mixture**.
- **Dry distillation**
- **Purification** and **oxidisation**: Invented by Jābir ibn Hayyān.
- **Steam distillation**: Invented by Avicenna in the early 11th century for the purpose of producing essential oils.

Chemical substances

- **Ethanol**: Isolated by Arabic chemists.
- **Lead carbonatic**: Isolated by Jābir ibn Hayyān.
- **Medicinal substances**: Muslim chemists discovered 2,000 medicinal substances.

Acids

- **Carboxylic acids**: Jābir ibn Hayyān isolated **Acetic acid** from vinegar. He is also credited with the discovery and isolation of **Citric acid**, the sour component of lemons and other unripe fruits.
- **Mineral acids**: The mineral acids—**nitric acid**, **sulfuric acid**, and **hydrochloric acid**—were first isolated by Jābir ibn Hayyān. He originally referred to sulfuric acid as the **oil of vitriol**.
- **Organic acids**: Jābir ibn Hayyān isolated **Tartaric acid** from wine-making residues.

Elements

- **Arsenic**: Isolated by Jābir ibn Hayyān in the 8th century.
- **Antimony**: Isolated by Jābir ibn Hayyān.

Food and drink

- **Coffee**: The earliest credible evidence of either coffee drinking or knowledge of the coffee tree appears in the middle of the fifteenth century, in the Sufi

monasteries of the Yemen in southern Arabia. It was in Yemen that coffee beans were first roasted and brewed as they are today. From Mocha, coffee spread to Egypt and North Africa, and by the 16th century, it had reached the rest of the Middle East, Persia and Turkey. From the Muslim world, coffee drinking spread to Italy, then to the rest of Europe, and coffee plants were transported by the Dutch to the East Indies and to the Americas.

- **Confectionery**: Due to advances in sugar production and the invention of sugar refineries, this led to the production of early confectioneries by the Arabs.
- **Pure distilled alcohol and ethanol**: First isolated by Al-Kindi (Alkindus) in the 9th century.
- **Restaurant and three-course meal**: The earliest restaurants came into existence throughout the Islamic world from the 10th century, shortly before restaurants appeared in China in the 11th century. The Islamic world had "restaurants where one could purchase all sorts of prepared dishes." These restaurants were mentioned by Al-Muqaddasi (born 945) in the late 10th century. Restaurants in medieval Islamic Spain served three-course meals, which was earlier introduced in the 9th century by Ziryab, who insisted that meals should be served in three separate courses consisting of soup, the main course, and dessert.
- **Sugar refinery**:

Glass industry

- '**Silica glass**: The production of silica glass was pioneered by Abbas Ibn Firnas in the 9th century.

Oil industry

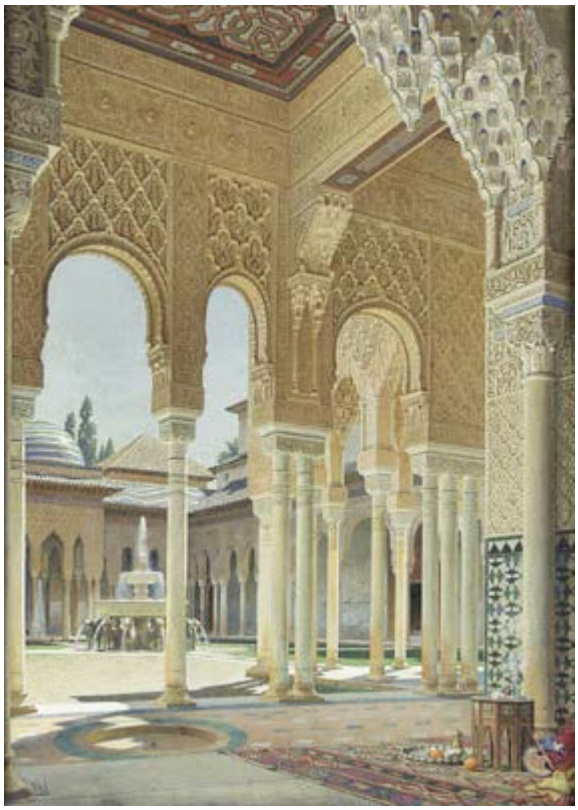
- **Essential oil**: Invented by Abū Alī ibn Sīnā (Avicenna) in the 11th century.
- **Kerosene**: Invented by Muhammad ibn Zakarīya Rāzi in the 9th century.
- **Oil field, petroleum industry, naphtha,** and **tar**: An early petroleum industry was established in the 8th century, when the streets of Baghdad were paved with tar, derived from petroleum through destructive distillation. In the 9th century, oil fields were first exploited in the area around modern Baku, Azerbaijan, to produce naphtha. These fields were described by al-Masudi in the 10th century, and by Marco Polo in the 13th century, who described the output of its oil wells as hundreds of shiploads.
- **Petrol**: Muslim chemists were the first to produce petrol from crude oil.

Pottery

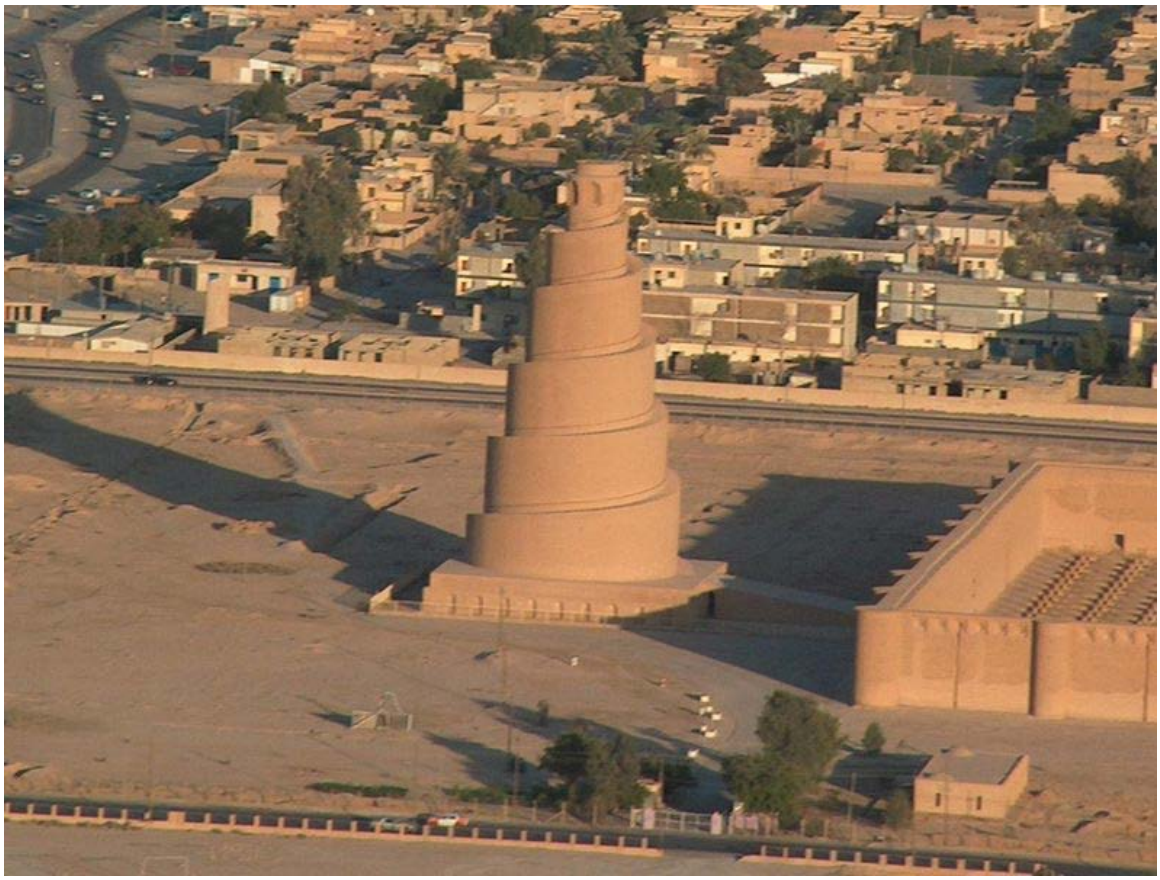
- **Albarello**: An albarello is a type of maiolica earthenware jar originally designed to hold apothecaries' ointments and dry drugs. The development of this type of pharmacy jar had its roots in the Islamic Middle East. Brought to Italy by Hispano-Moresque traders, the earliest Italian examples were produced in Florence in the 15th century.

- **Fritware**: It refers to a type of pottery which was first developed in the Near East, where production is dated to the late first millennium AD through the second millennium AD. Frit was a significant ingredient. A recipe for "fritware" dating to c. 1300 AD written by Abu'l Qasim reports that the ratio of quartz to "frit-glass" to white clay is 10:1:1. This type of pottery has also been referred to as "stonepaste" and "faience" among other names. A ninth century corpus of "proto-stonepaste" from Baghdad has "relict glass fragments" in its fabric.
- **Hispano-Moresque ware**: This was a style of Islamic pottery created in Islamic Spain, after the Moors had introduced two ceramic techniques to Europe: glazing with an opaque white tin-glaze, and painting in metallic lusters. Hispano-Moresque ware was distinguished from the pottery of Christendom by the Islamic character of it decoration.
- **Iznik pottery**: Produced in Ottoman Turkey as early as the 15th century AD. It consists of a body, slip, and glaze, where the body and glaze are "quartz-frit." The "frits" in both cases "are unusual in that they contain lead oxide as well as soda"; the lead oxide would help reduce the thermal expansion coefficient of the ceramic. Microscopic analysis reveals that the material that has been labeled "frit" is "interstitial glass" which serves to connect the quartz particles.
- **Lusterware**: Lustre glazes were applied to pottery in Mesopotamia in the 9th century; the technique soon became popular in Persia and Syria. Lusterware was later produced in Egypt during the Fatimid caliphate in the 10th-12th centuries. While the production of lusterware continued in the Middle East, it spread to Europe—first to Al-Andalus, notably at Málaga, and then to Italy, where it was used to enhance maiolica.
- **Stonepaste ceramic**: Invented in 9th-century Iraq, it was a vitreous or semi-vitreous ceramic ware of fine texture, made primarily from non-refactory fire clay.
- **Tin-glazing**: The tin-glazing of ceramics was invented by Muslim potters in 8th-century Basra, Iraq. Tin-opacified glazing was one of the earliest new technologies developed by the Islamic potters. The first examples of this technique can be found as blue-painted ware in 8th-century Basra.
- **Tin-glazed pottery**: The earliest tin-glazed pottery appears to have been made in Iraq in the 9th century, the oldest fragments having been excavated during the First World War from the palace of Samarra about fifty miles north of Baghdad. From there, it spread to Egypt, Persia and Spain, before reaching Italy in the Renaissance, Holland in the 16th century, and England, France and other European countries shortly after.

Civil engineering

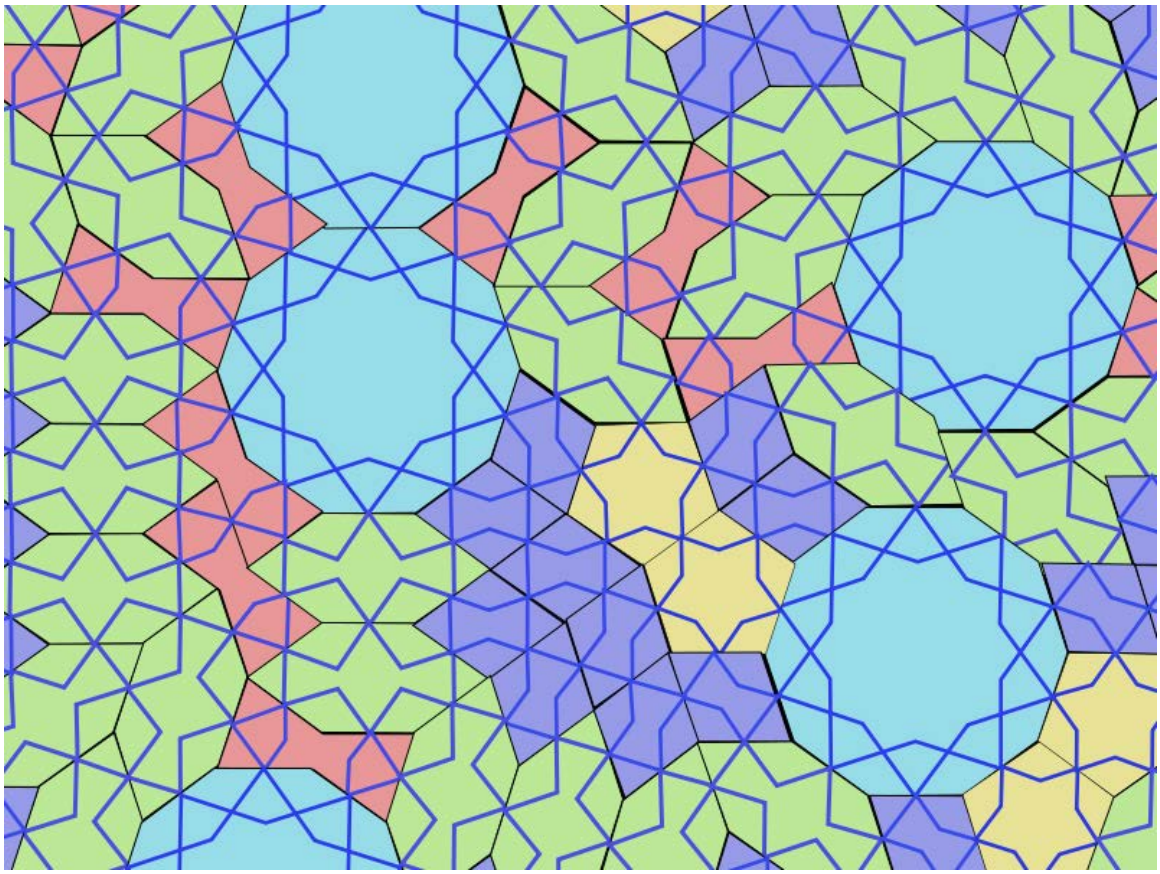


The interiors of the Alhambra in Spain are decorated with arabesque designs



The minaret is a distinct feature of Islamic architecture. The spiralling minaret located at the Great Mosque of Samarra, Iraq built in 852, is one of the oldest.

At 72.5 meters, the Qutab Minar was the tallest minaret until the 20th century, and remains the tallest brick and stone minaret in the world.



An illustration of patterned Girih tiles, found in Islamic architecture dating back over five centuries ago. These featured the first quasicrystal patterns and self-similar fractal quasicrystalline tilings.

During the Muslim Agricultural Revolution, the early Muslim Arab Empire was ahead of its time regarding domestic water systems such as water cleaning systems and advanced water transportation systems resulting in better agriculture, something that helped in issues related to Islamic hygienical jurisprudence. Al-Jazari invented a variety of machines for raising water in 1206, as well as water mills and water wheels with cams on their axle used to operate automata in the late 12th century.

- **Kerosene lamp**: The first kerosene lamp was invented by Muhammad ibn Zakarīya Rāzi in the 9th century.
- **Litter collection facilities**: Córdoba had the first facilities and waste containers for litter collection.
- **Surveying instruments**: Muslim engineers invented a variety of surveying instruments for accurate levelling, including a wooden board with a plumb line and two hooks, an equilateral triangle with a plumb line and two hooks, and a "reed level". They also invented a rotating alidade used for accurate alignment, and a surveying astrolabe used for alignment, measuring angles, triangulation, finding the width of a river, and the distance between two points separated by an impassable obstruction.

Architecture

- **Arabesque**: An elaborative application of repeating geometric forms often found decorating the walls of mosques. Geometric artwork in the form of the Arabesque was not used in the Middle East or Mediterranean Basin until the Islamic Golden Age. Euclidean geometry as expounded on by Al-Abbās ibn Said al-Jawharī (ca. 800-860) in his *Commentary on Euclid's Elements*, the trigonometry of Aryabhata and Brahmagupta as elaborated on by Muhammad ibn Mūsā al-Khwārizmī (ca. 780-850), and the development of **spherical geometry** by Abū al-Wafā' al-Būzjānī (940–998) and **spherical trigonometry** by Al-Jayyani (989-1079) for determining the Qibla (direction to Mecca) and times of Salah prayers and Ramadan, all served as an impetus for the art form that was to become the Arabesque.
- **Central heating through underfloor pipes**: The hypocaust heating system used by the Romans continued to be in use around the Mediterranean region during late Antiquity and by the Umayyad caliphate. By the 12th century, Muslim engineers in Syria introduced an improved central heating system, where heat travelled through underfloor pipes from the furnace room, rather than through a hypocaust. This central heating system was widely used in bath-houses throughout the medieval Islamic world.
- **Geared and hydropowered water supply system**: Al-Jazari developed the earliest water supply system to be driven by gears and hydropower, which was built in 13th century Damascus to supply water to its mosques and Bimaristan hospitals. The system had water from a lake turn a scoop-wheel and a system of gears which transported jars of water up to a water channel that led to mosques and hospitals in the city.
- **Girih tiles, quasicrystal pattern, and self-similar fractal quasicrystalline tiling**: Geometrical quasicrystal patterns were first employed in the girih tiles found in medieval Islamic architecture dating back over five centuries ago. In 2007, Professor Peter Lu of Harvard University and Professor Paul Steinhardt of Princeton University published a paper in the journal *Science* suggesting that girih tilings possessed properties consistent with self-similar fractal quasicrystalline tilings such as the Penrose tilings, predating them by five centuries.
- **High-rise roof garden**: The medieval Egyptian city of Fustat had a number of high-rise buildings that Nasir Khusraw in the early 11th century described as rising up to 14 stories, with roof gardens on the top story complete with ox-drawn water wheels for irrigating them.
- **Minaret**: The minaret is a distinctive architectural feature of Islamic architecture, especially mosques, dating back to the early centuries of Islam. Minarets are generally tall spires with onion-shaped crowns, usually either free standing or much taller than any surrounding support structure. The tallest minaret in pre-modern times was the Qutub Minar, which was 72.5 meters (237.9 ft) tall and was built in the 12th century, and it remains the tallest brick and stone minaret in the world.

- **Prefabricated home** and **movable structure**: The first prefabricated homes and movable structures were invented in 16th century Mughal India by Akbar the Great. These structures were reported by Arif Qandahari in 1579.

Industrial milling

A variety of industrial mills were active in the medieval Islamic world, including fulling mills, gristmills, hullers, paper mills, sawmills, stamp mills, steel mills, sugar mills, some of which were driven by watermills and others by early windmills. By the 11th century, every province throughout the Islamic world had these industrial mills in operation, from Al-Andalus and North Africa to the Middle East and Central Asia. These advances made it possible for many industrial operations that were previously driven by manual labour in ancient times to be driven by machinery instead in the Islamic world. The transfer of these technologies to medieval Europe later laid the foundations for the Industrial Revolution in 18th century Europe.

- **Bridge mill**: The bridge mill was a unique type of watermill that was built as part of the superstructure of a bridge. The earliest record of a bridge mill is from Córdoba, Spain in the 12th century.
- **Geared and wind-powered gristmills with trip hammers**: The first geared gristmills were invented by Muslim engineers in the Islamic world, and were used for grinding corn and other seeds to produce meals, and many other industrial uses such as fulling cloth, husking rice, papermaking, pulping sugarcane, and crushing metallic ores before extraction. Gristmills in the Islamic world were often made from both watermills and windmills. In order to adapt water wheels for gristmilling purposes, cams were used for raising and releasing trip hammers to fall on a material. The first wind-powered gristmills driven by windmills were built in what are now Afghanistan, Pakistan and Iran in the 9th and 10th centuries.
- **Hulling mill**: Early Islamic societies made early use of watermills for hulling rice.
- **Hydropowered forge and finery forge**: The first forge to be driven by a hydropowered water mill rather than manual labour, also known as a finery forge, was invented in 12th century Islamic Spain.
- **Mechanical fulling mill**: The first clear references to fulling mills are reported in Persia from the 10th century. By the time of the Crusades in the 11th century, fulling mills were active throughout the Islamic world, from Islamic Spain and North Africa to Central Asia. They appear to have originated in 9th or 10th century in the Islamic world, either in the Middle East or North Africa. Mechanical fulling was subsequently disseminated into Western Europe through Islamic Spain and Italy in the 11th and 12th centuries.
- **Spiral scoop-wheel**: The earliest known appearance of the spiral scoop-wheel dates back to the Islamic world, at some time no later than the 12th century.
- **Sugar refinery**: The first sugar refineries were built by Muslim engineers. They were first driven by water mills, and then windmills from the 9th and 10th centuries in Afghanistan, Pakistan, and Iran.

- **Underground watermill**: Another innovation that was unique to the Islamic world includes the situation of watermills in the underground irrigation tunnels of a *qanat* and on the main canals of valley-floor irrigation systems.
- **Vertical-axle windmill**: A small wind wheel operating an organ is described as early as the 1st century AD by Hero of Alexandria. Similarly, small wind wheels were used in Tibet and China since the 4th century in the form of prayer wheels. The first windmills were eventually built in Sistan, Afghanistan, sometime between the 7th and 9th centuries, as described by Muslim geographers. These were **vertical-axle windmills**, which had long vertical driveshafts with rectangle shaped blades. The first windmill may have been constructed as early as the time of the second Rashidun caliph Umar (634-644 AD), though some argue that this account may have been a 10th century amendment. Made of six to twelve sails covered in reed matting or cloth material, these windmills were used to grind corn and draw up water, and used in the gristmilling and sugarcane industries. The first horizontal windmills were built in what are now Afghanistan, Pakistan and Iran in the 9th and 10th centuries. They had a variety of uses, such as grinding grain, pumping water, and crushing sugar-cane. Horizontal axle windmills of the type generally used in Europe today were developed in Northwestern Europe in the 1180s.

Cosmetics

A number of hygienic cosmetics were invented by Muslim chemists, cosmetologists and physicians.

- **Beauty parlour** and **cosmetology school**: In the 9th century, Ziryab opened the first beauty parlour and "cosmetology school" for women near Alcázar, Al-Andalus."
- **Chemical depilatory for hair removal**: In the 9th century, Ziryab taught women in Al-Andalus "the shaping of eyebrows and the use of depilatories for removing body hair".
- **Pomade**: Produced by Arabs.

Hygiene

- **Modern soap**: The soap now used in modern times is made of vegetable oils (such as olive oil) with sodium hydroxide and aromatics (such as thyme oil). This formula was invented by Muslim chemists, and differed from the earlier soap-like detergents used in ancient times. Sodium lye (*al-soda al-kawia*), perfumed and colored soaps, and liquid and solid soaps, were also produced by Muslim chemists.
- **Soap bar**: The first hard soap bars were produced by Muslim chemists. They gave recipes for soaps made from sesame oil, potash, alkali, lime, and molds, leaving hard soap.
- **Toothpaste, functional and pleasant**: In the 9th century, the Persian musician and fashion designer Ziryab is known to have invented a type of toothpaste, which

he popularized throughout Islamic Spain. The exact ingredients of this toothpaste are not currently known, but unlike the earlier Egyptian and Roman toothpastes, Ziryab's toothpaste was reported to have been both "functional and pleasant to taste."

Perfumery

Perfume usage was recorded in the Arabian Peninsula since the 7th century, and Muslims made many advances in perfumery in the proceeding centuries. This included the extraction of numerous fragrances, as well as the cheap mass-production of incenses. Muslim scientists such as Al-Kindi elaborated a vast number of recipes for a wide range of perfumes, cosmetics and pharmaceuticals.

- **Perfume industry**: Established by Jābir ibn Hayyān (b. 722, Iraq) and Al-Kindi (b. 801, Iraq). Jabir developed many techniques, including distillation, evaporation and filtration, which enabled the collection of the odour of plants into a vapour that could be collected in the form of water or oil. Al-Kindi carried out extensive research and experiments in combining various plants and other sources to produce a variety of scent products.
- **Deodorants, under-arm and roll-on**: In the 9th century, Ziryab invented under-arm deodorants in Al-Andalus. In *circa* 1000, another under-arm deodorant was described in Al-Andalus by Abulcasis, who also invented perfumed stocks, rolled and pressed in special moulds, similar to modern roll-on deodorants.
- **Extraction of fragrances through steam distillation**: Introduced by Abū Alī ibn Sīnā (Avicenna) in the 11th century.
- **Ghaliya**: The preparation of a perfume called *ghaliya*, which contained musk, amber and other ingredients, and the use of various drugs and apparatus, was produced by al-Kindi.
- **Musk and floral perfumes**: Produced in the 11th-12th centuries in the Arabian Peninsula.
- **Jasmine and citrus perfumes**: Muslims introduced new raw ingredients in perfumery, which were produced from different spices, herbals, and other fragrance materials, which are still used in modern perfumery. These included jasmine from South and Southeast Asia, and citrus fruits from East Asia.

Institutions

A number of important economic, educational, legal and scientific institutions previously unknown in the ancient world have their origins in the medieval Islamic world.

- **Agency** and **Aval**: The first agencies were the *Hawala*, mentioned in texts of Islamic jurisprudence as early as the 8th century. *Hawala* itself later influenced the development of the agency in common law and in civil laws such as the *Aval* in French law and the *Avallo* in Italian law. The words *Aval* and *Avallo* were themselves derived from *Hawala*. The transfer of debt, which was "not permissible under Roman law but became widely practiced in medieval Europe,

especially in commercial transactions", was due to the large extent of the "trade conducted by the Italian cities with the Muslim world in the Middle Ages." The agency was also "an institution unknown to Roman law" as no "individual could conclude a binding contract on behalf of another as his agent." In Roman law, the "contractor himself was considered the party to the contract and it took a second contract between the person who acted on behalf of a principal and the latter in order to transfer the rights and the obligations deriving from the contract to him." On the other hand, Islamic law and the later common law "had no difficulty in accepting agency as one of its institutions in the field of contracts and of obligations in general."

- **College**: The origins of the college lie in the medieval Islamic world. The *madrasah* was a medieval Islamic college of law and theology, usually affiliated with a mosque, and was funded by early charitable trusts known as *Waqf*, the origins of the trust law.
- The first **University** in the world and **Ijazah-granting Madrasah**: The earliest mosque schools were the Madrasa of Al-Karaouine in Fez, Morocco, (founded 859) and the Al-Azhar in Cairo, Egypt ((founded around 970).

The first observatories to serve as research institutes were built by Muslim astronomers. The most famous was the Maragheh observatory, the current status of which is pictured here.

- **Observatory as a research institute**: As opposed to a private observation post as was the case in ancient times, the astronomical observatories in the Islamic world were the first true observatories, in the sense that they functioned as early research institutes, like modern observatories. The Islamic observatory was the first specialized astronomical institution with its own scientific staff, director, astronomical program, large astronomical instruments, and building where astronomical research and observations are carried out. Islamic observatories were also the first to employ enormously large astronomical instruments in order to improve the accuracy of their observations. Famous examples include the observatories at Baghdad and Ray, Iran, the Maragheh observatory, Ulugh Beg's observatory at Samarqand, and the Istanbul observatory of Taqi al-Din.

- **charitable trust**: The *Waqf* in Islamic law, which developed in the Islamic world from the 7th to 9th centuries, were the first charitable trust. Every *waqf* was required to have a *waqif* (founder), *mutawillis* (trustee), *qadi* (judge) and beneficiaries. Under both a *waqf* and a trust, "property is reserved, and its usufruct appropriated, for the benefit of specific individuals, or for a general charitable purpose; the corpus becomes inalienable; estates for life in favor of successive beneficiaries can be created" and "without regard to the law of inheritance or the rights of the heirs; and continuity is secured by the successive appointment of trustees or *mutawillis*."

Medical institutions

- **Apothecary, Drugstore, and Pharmacy**: The first drugstores and pharmacies were opened by Muslim pharmacists in Baghdad in 754, while the first apothecary shops were also founded by Muslim practitioners at the time.
- **Medical school**: The Islamic Bimaristans were not only hospitals, but also medical schools to issue diplomas. The first of these institutions was opened in Baghdad during the time of Harun al-Rashid. They then appeared in Egypt from 872 and then in Islamic Spain, Persia and the Maghreb thereafter. Physicians and surgeons at Islamic hospital-universities gave lectures to medical students and diplomas were issued to students who completed their education and were qualified to be doctors of medicine.
- **Public hospital**: The Islamic Bimaristans were the first free public hospitals, and replaced the healing temples and sleep temples found in ancient times. They were hospital in the modern sense, an establishment where the ill were welcomed and cared for by qualified staff. In this way, Muslim physicians were the first to make a distinction between a hospital and other different forms of sleep and healing temples, hospices, and leper-houses, all of which in ancient times were more concerned with isolating the sick and the mad from society "rather than to offer them any way to a true cure." The medieval Bimaristan hospitals are thus considered "the first **hospitals**" in the modern sense of the word.

Mechanical technology

Purpose of mechanical inventions

Al-Jazari (1136-1206)

Questions have arisen about the place, purpose and motivations of these inventions in their societal context. Certain scholars point out that many inventions created during the medieval period by Muslim inventors, such as the Banu Musa or Al-Jazari were in a sense "toys" and were only created for purposes of amusement. This view states that as impressive and complex that these machines were they did not contribute any real function to their society. Various hydraulic machines, clocks and automata invented by inventors may only have had a superficial purpose, related to amusement or luxury. The extravagance of certain machines is seen to be evidence of inventors not being motivated to make practical machines. The "usefulness" of certain inventions poses questions about the role they played in society, if they did play any significant role beyond entertaining wealthy patrons.

However, such a view may be limited in scope, and may not properly assess the context in which the inventors work. In many cases, wealthy patrons supported inventors to create machines, such as clocks and water-raising devices, that would benefit society as a whole. These devices, such as those invented by Al-Jazari, may have been aesthetically appealing at the same time as they were useful. Also the fact that certain automata and other entertaining technologies were described or created illustrates the strong economic situation of certain Medieval Islamic societies. George Saliba notes, in the minds of many scientists the art of mechanics did not make a strong distinction between technology that was "useful" and that which was "toy-like." Further study will serve to situate the role of mechanical technology in the economic and social context of Islamic society.

Automata

The programmable humanoid robot band of Al-Jazari

An artist rendition based on a description of a programmable humanoid robot band described to be designed by Al-Jazari in 1206.

Mark E. Rosheim summarizes the advances in robotics made by Arab engineers as follows:

"Unlike the Greek designs, these Arab examples reveal an interest, not only in dramatic illusion, but in manipulating the environment for human comfort. Thus, the greatest contribution the Arabs made, besides preserving, disseminating and building on the work of the Greeks, was the concept of practical application. This was the key element that was missing in Greek robotic science."
"The Arabs, on the other hand, displayed an interest in creating human-like machines for practical purposes but lacked, like other preindustrial societies, any real impetus to pursue their robotic science."

- **Wind-powered fountain**: In the 9th century, the Banū Mūsā brothers designed the earliest known wind-powered fountains. Their *Book of Ingenious Devices* described the construction of several wind-powered fountains, one of which incorporated a **worm-and-pinion** gear.
- **Mercury-powered automata**: One of the clocks invented by Ibn Khalaf al-Muradi in 11th-century Spain incporated a "complicated and ingenious system which, at the top of each hour, puts into motion a series of mechanical automata, including mechanical snakes, women and men which function through a system based on water, mercury and pulleys." This was the earliest known use of **mercury in hydraulic linkages** to power automata.

- **Programmable analog computer**:
- **Programmable humanoid robot band**: Al-Jazari (1136–1206) created the first recorded designs of a programmable humanoid robot in 1206, as opposed to the non-programmable automata in ancient times. Al-Jazari's robot was originally a boat with four automatic musicians that floated on a lake to entertain guests at royal drinking parties. His mechanism had a programmable drum machine with pegs (cams) that bump into little levers that operate the percussion. The drummer could be made to play different rhythms and different drum patterns if the pegs were moved around. According to Charles B. Fowler, the automata were a "robot band" which performed "more than fifty facial and body actions during each musical selection."
- **Peacock fountain with automated humanoid servants**: Al-Jazari's "peacock fountain" was a sophisticated hand washing device featuring humanoid automata as servants which offer soap and towels. Mark E. Rosheim describes it as follows: "Pulling a plug on the peacock's tail releases water out of the beak; as the dirty water from the basin fills the hollow base a float rises and actuates a linkage which makes a servant figure appear from behind a door under the peacock and offer soap. When more water is used, a second float at a higher level trips and causes the appearance of a second servant figure — with a towel!"

Pumps

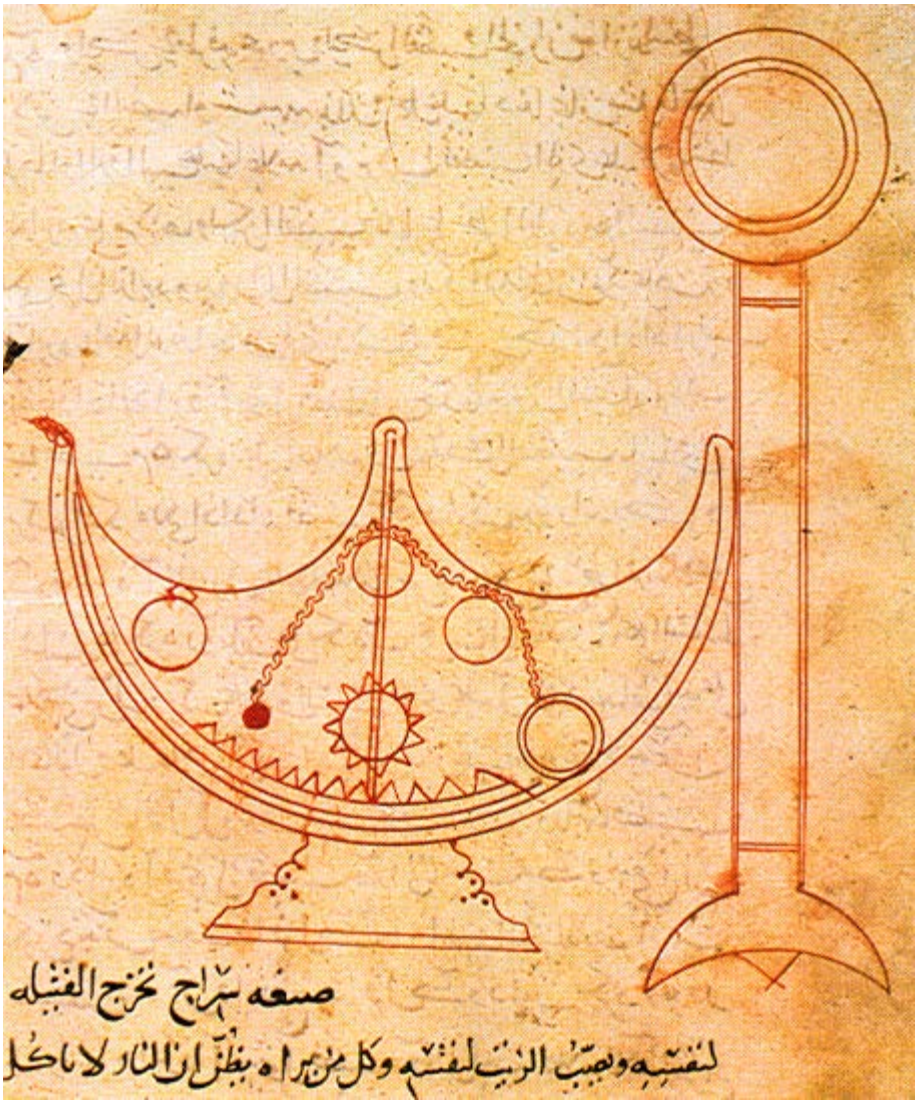
- **Crankshaft-driven and hydropowered saqiya chain pumps**: The first known use of a crankshaft in a chain pump was in one of Al-Jazari's saqiya machines described in 1206. Al-Jazari also constructed a water-raising saqiya chain pump which was run by hydropower rather than manual labour, though the Chinese

were also using hydropower for other chain pumps prior to him. Saqiya machines like the ones he described have been supplying water in Damascus since the 13th century up until modern times, and were in use throughout the medieval Islamic world.

- **Crankshaft-driven screw and screwpump**: In ancient times, the screw and screwpump were driven by a treadwheel, but from the 12th and 13th centuries, Muslim engineers operated them using the crankshaft.
- **Double-action piston suction pump with reciprocating motion**: In 1206, al-Jazari demonstrates the first suction pipes and suction piston pump, the first use of double-action, and one of the earliest valve operations, when he invented a twin-cylinder double-action reciprocating suction piston pump, which seems to have had a direct significance in the development of modern engineering. This pump is driven by a water wheel, which drives, through a system of gears, an oscillating slot-rod to which the rods of two pistons are attached. The pistons work in horizontally opposed cylinders, each provided with valve-operated suction and delivery pipes. The delivery pipes are joined above the centre of the machine to form a single outlet into the irrigation system. This pump is remarkable for being the earliest known use of a true suction pipe in a pump.
- **Six-cylinder 'Monobloc' pump**: In 1559, Taqi al-Din invented a six-cylinder 'Monobloc' pump. It was a hydropowered water-raising machine incorporating valves, suction and delivery pipes, piston rods with lead weights, trip levers with pin joints, and cams on the axle of a water-driven scoop wheel.
- **Weight-driven pump**: Most ancient and medieval pumps were either driven by manual labour or hydraulics. The first weight-driven pump was described as part of a perpetual motion water-raising machine in a medieval Arabic manuscript written some time after Al-Jazari. It featured a mercury-powered clockwork escapement mechanism and had two out gear-wheels driven by lead weights which mesh with a large central gear-wheel.
- **Wind-powered pump**: Windmills were used to pump water since at least the 9th century in what is now Afghanistan, Iran and Pakistan.

Other mechanical devices

Al-Jazari's candle clock employed a bayonet fitting for the first time in 1206



Drawing of the self-trimming lamp in Ahmad ibn Mūsā ibn Shākir's 9th century Arabic treatise on mechanical devices, the *Book of Ingenious Devices*.

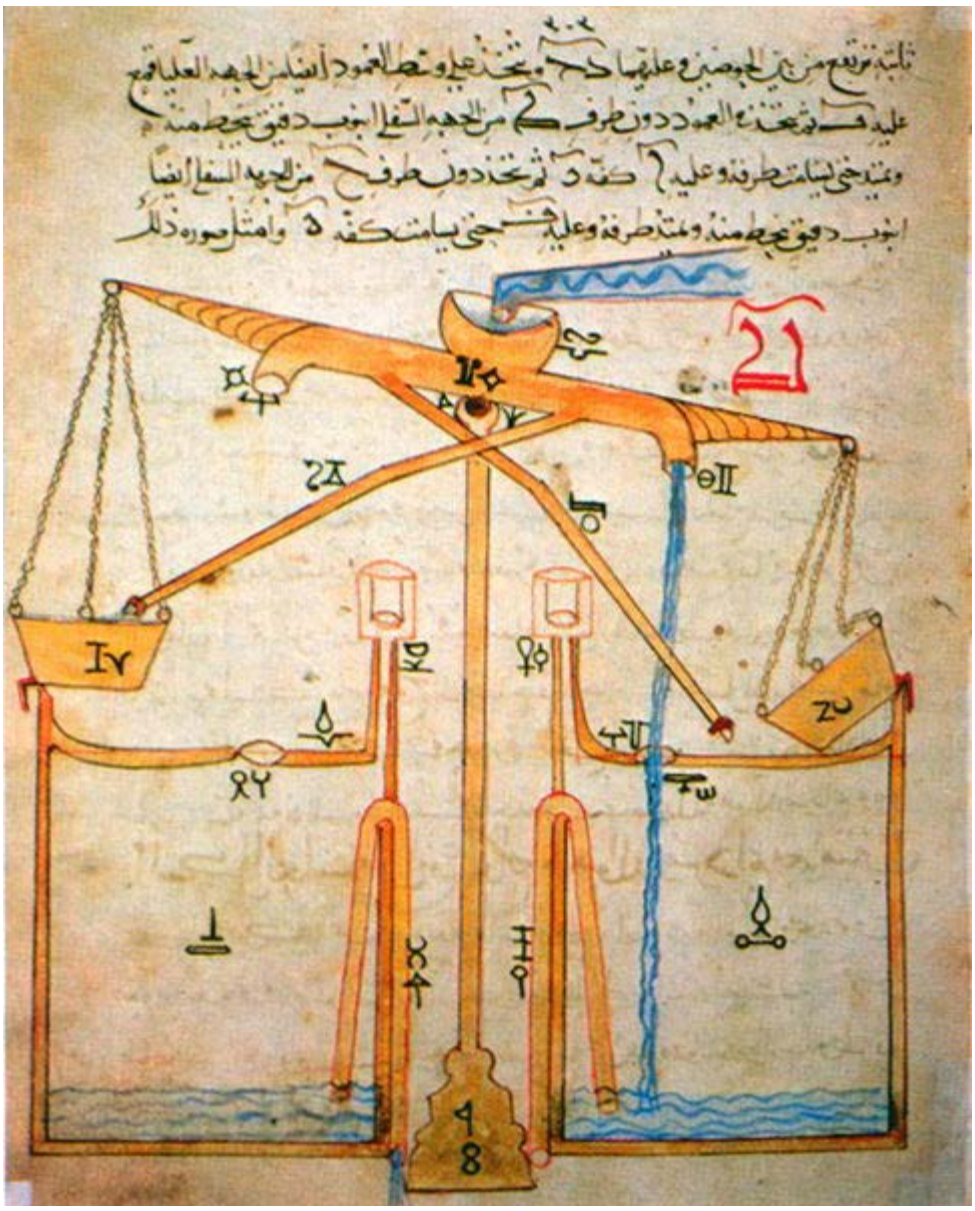


Diagram of a hydropowered water-raising machine from *The Book of Knowledge of Ingenious Mechanical Devices* by Al-Jazari in 1206.

- **Artificial thunder, lightning and weather simulation**: Abbas Ibn Firnas invented an artificial weather simulation room, in which spectators saw stars and clouds, and were astonished by artificial thunder and lightning, which were produced by mechanisms hidden in his basement laboratory.
- **Bayonet fitting**: Al-Jazari's candle clock in 1206 employed, for the first time, a bayonet fitting, a fastener mechanism still used in modern times.
- **Boiler with tap**: The Banu Musa brothers' *Book of Ingenious Devices* describes a boiler with a tap to access **hot water**. The water is heated through cold water being poured into a pipe which leads to a tank at the bottom of the boiler, where

the water is heated with fire. A person can then access hot water from the boiler through a tap.

- **Bolted lock and mechanical controls**: According to Donald Routledge Hill, Al-Jazari first described several early mechanical controls, including "a large metal door...and a lock with four bolts."
- **Complex segmental and epicyclic gearing**: Segmental gears ("a piece for receiving or communicating reciprocating motion from or to a cogwheel, consisting of a sector of a circular gear, or ring, having cogs on the periphery, or face.") and epicyclic gears were both first invented by the 11th century Arab engineer Ibn Khalaf al-Muradi from Islamic Spain. He employed both these types of gears in the gear trains of his mechanical clocks and automata. Simple gears have been known before him, but this was the first known case of complex gears used to transmit high torque. His mechanisms were the most sophisticated geared devices until the mechanical clocks of the mid-14th century. Segmental gears were also later employed by Al-Jazari in 1206. Professor Lynn Townsend White, Jr. wrote: "Segmental gears first clearly appear in Al-Jazari, in the West they emerge in Giovanni de Dondi's astronomical clock finished in 1364, and only with the great Sienese engineer Francesco di Giorgio (1501) did they enter the general vocabulary of European machine design." Al-Muradi's work was known to scholars working under Alfonso X of Castile.
- **Conical valve**: This was a mechanism developed by the Banu Musa and of particular importance for future developments. It was used in a variety of different applications, including its use as "in-line" components in flow systems, the first known use of conical valves as **automatic controllers**.
- **Control engineering**: The work of the Banu Musa brothers, which included innovations involving subtle combinations of pneumatics and aerostatics, closely parallels the modern fields of control engineering and pneumatic instrumentation.
- **Crank-slider mechanism**: A crank-driven water pump by Al-Jazari employed the first known crank-slider mechanism.
- **Design and construction methods**: According to Donald Routledge Hill, "We see for the first time in Al-Jazari's work several concepts important for both design and construction: the **lamination** of timber to minimize warping, the **static balancing** of wheels, the use of **wooden** (a kind of pattern), the use of **paper models** to establish designs, the **calibration of orifices**, the **grinding of the seats and plugs of valves together with emery powder** to obtain a watertight fit, and the **casting of metals in closed mold boxes with sand**."
- **Elevated battering ram**: In 1000, the *Book of Secrets* by the Arab engineer Ibn Khalaf al-Muradi in Islamic Spain described the use of an elevator-like lifting device, in order to raise a large battering ram to destroy a fortress.
- **pedal-operated loom**: The foot pedal was originally invented for the purpose of operating a loom, for use in weaving. The first such devices appeared in Syria, Iran and Islamic parts of East Africa, where "the operator sat with his feet in a pit below a fairly low-slung loom." By 1177, it was further developed in Islamic Spain, where having the mechanism was "raised higher above the ground on a more substantial frame." This type of loom spread to the Christian parts of Spain and soon became popular all over medieval Europe.

- **Fountain pen**: The earliest historical record of a reservoir pen dates back to the 10th century. In 953, Al-Muizz Lideenillah, the caliph of Egypt, demanded a pen which would not stain his hands or clothes, and was provided with a pen which held ink in a reservoir and delivered it to the nib, though the method of operation is unknown and no examples survive. As recorded by Qadi al-Nu'man al-Tamimi (d. 974) in his *Kitdb al-Majalis wa 'l-musayardt*, al-Mu'izz instructed and commissioned the construction of a fountain reservoir pen.
- **Gas mask**: The Banu Musa brothers in the 9th century invented an early gas mask, for protecting workers in polluted wells. They also described *bellows that remove foul air* from wells. They explained that these instruments allow a worker to "descend into any well he wishes for a while and he will not fear it, nor will it harm him, if God wills may he be exalted."
- **Gate operator**: The first automatic doors were created by Hero of Alexandria and Chinese engineers under Emperor Yang of Sui prior to Islam. This was followed by the first hydraulics-powered automatic gate operators, invented by Al-Jazari in 1206. Al-Jazari also created automatic doors as part of one of his elaborate water clocks.
- **Grab**: The mechanical grab, specifically a **clamshell grab**, is an original invention by the Banu Musa brothers that does not appear in any earlier Greek works. The grab they described was used to extract objects from underwater, and recover objects from the beds of streams.
- **Intermittent working**: The concept of minimizing intermittent working is first implied in one of al-Jazari's saqiya chain pumps, which was for the purpose of maximising the efficiency of the saqiya chain pump.
- **Spinning wheel**: The earliest clear illustrations of the spinning wheel come from Baghdad (drawn in 1237), and then from China (*c.* 1270) and Europe (*c.* 1280). There is evidence that spinning wheels had already come into use in the Islamic world long before that, as can be seen in an Islamic description of the spinning wheel dating from before 1030, while the earliest Chinese description dates from around 1090.
- **Trip hammer in papermaking**: Muslim engineers introduced the use of trip hammers in the production of paper, replacing the traditional Chinese mortar and pestle method of papermaking. In turn, the trip hammer method was later employed by the Chinese in papermaking.
- **Two-step level discontinuous variable structure controls**: Two-step level controls for fluids, an early form of discontinuous variable structure controls, was developed by the Banu Musa brothers.

In the 9th century, the Banū Mūsā brothers invented a number of automata (automatic machines) and mechanical devices, and they described a hundred such devices in their *Book of Ingenious Devices*. Some of the devices that make their earliest known appearance in the *Book of Ingenious Devices* include:

- **Differential pressure**
- **Double-concentric siphon**
- **Fail-safe system**

- **Float chamber**
- **Float valve**
- **Hurricane lamp**
- **Self-feeding lamp** and **self-trimming lamp**: Invented by the eldest brother Ahmad ibn Mūsā ibn Shākir.
- **Trick drinking vessels**
- **Plug valve**.
- **Self-operating valve**

In 1206, Al-Jazari also described over fifty mechanical devices in six different categories in *The Book of Knowledge of Ingenious Mechanical Devices*, most of which he invented himself, along with construction drawings. Along with his other mechanical inventions described above, some of the other mechanical devices he first described include: **phlebotomy measures**, **linkage**, **water level**, and devices able to elevate water from shallow wells or flowing rivers.

Medical products

Drugs and medications

Muslim physicians pioneered a number of drugs and medications for use in medicine, including:

- **Alcohol as an antiseptic**: The application of pure alcohol to wounds as an antiseptic agent, and the use of alcohol as a solvent and antiseptic, was introduced by Muslim physicians and surgeons in the 10th century.
- **Clinical pharmacology, clinical trial, randomized controlled trial,** and **efficacy test**: The origins of clinical pharmacology date back to Avicenna's *The Canon of Medicine* in 1025. His emphasis on tested medicines laid the foundations for an experimental approach to pharmacology. The *Canon* laid out the rules and principles for testing the effectiveness of new drugs and medications, which still form the basis of clinical pharmacology and modern clinical trials, randomized controlled trials and efficacy tests.
- **Cough medicine and syrup**: The use of syrups for treating coughs originates from medieval Arabic physicians.
- **Drugs, foods, herbs, plants and chemical substances**: In antiquity, Dioscorides listed about 500 plants in the 1st century. Muslim botanists, chemists and pharmacists discovered many more during the Middle Ages. For example, Al-Dinawari described more than 637 plant drugs in the 9th century, and Ibn al-Baitar described at least 1,400 different plants, foods and drugs, 300 of which were his own original discoveries, in the 13th century. In total, at least 2,000 medicinal substances were discovered by Muslim botanists, chemists and pharmacists.
- **Medicinal-grade alcohol**: Produced through distillation. These distillation devices for use in chemistry and medicine were manufactured on a large scale in the 10th century.

- **Parasitology**: Parasites were first discovered by Ibn Zuhr (Avenzoar), when he discovered the cause of scabies. He recommended specific substances to destroy microbes, and the application of sulfur topically specifically to kill the scabies mite.
- **Phytotherapy, Taxus baccata, and calcium channel blocker**: Avicenna's *The Canon of Medicine* introduced the medicinal use of Taxus baccata L. He named this herbal drug "Zarnab" and used it as a cardiac remedy. This was the first known use of a calcium channel blocker drug, which were not used in the Western world until the 1960s.

- **Sexual dysfunction and erectile dysfunction drugs**: Muslim physicians identified the issue of sexual and erectile dysfunction, and they were the first to prescribe medication for the treatment of the problem. They developed several methods of therapy for this issue, including the single drug method where a drug is prescribed, and a "combination method of either a drug or food." These drugs were also occasionally used for recreational drug use to improve male sexuality in general by those who did not suffer from sexual dysfunctions. Most of these drugs were oral medication, though a few patients were also treated through topical and transurethral means. Sexual dysfunctions were being treated with tested drugs in the Islamic world since the 9th century until the 16th century by a number of Muslim physicians and pharmacists, including al-Razi, Thabit bin Qurra, Ibn Al-Jazzar, Avicenna (*The Canon of Medicine*), Averroes, Ibn al-Baitar, and Ibn al-Nafis (*The Comprehensive Book on Medicine*).

Surgical instruments

Page from a 1531 Latin translation by Peter Argellata of Abu al-Qasim al-Zahrawi's *Al-Tasrif* on surgical and medical instruments.

A wide variety of surgical instruments and techniques were invented in the Muslim world, as well as the refinement of earlier instruments and techniques. In particular, over 200 surgical instruments were listed by Abu al-Qasim al-Zahrawi (Abulcasis) in the *Al-Tasrif* (1000), many of which were never used before by any previous surgeons. Hamidan, for example, listed at least twenty six innovative surgical instruments that Abulcasis introduced.

- **Adhesive bandage and plaster**: Introduced by Abulcasis.
- **Bone saw**: Invented by Abulcasis.
- **Cancer surgery**: Another method for treating cancer first described by Avicenna's *The Canon of Medicine* was a surgical treatment. He stated that the excision should be radical and that all diseased tissue should be removed, which included the use of amputation or the removal of veins running in the direction of the tumor. He also recommended the use of cauterization for the area being treated if necessary.
- **Cataract extraction, hypodermic needle, injection syringe, and suction**: In *circa* 1000, the Muslim ophthalmologist Ammar ibn Ali of Mosul was the first to successfully extract cataracts. He invented a hollow metallic syringe hypodermic

needle, which he applied through the sclerotic and successfully extracted the cataracts through suction.

- **Catgut suture**: The use of catgut for internal stitching was introduced by Abulcasis. It is still used today in modern surgery. The catgut appears to be the only natural substance capable of dissolving and is acceptable by the body. Salim Al-Hassani considers it to be one of the most important Muslim medical contributions.
- **Cotton dressing and bandage**: The earliest known use of cotton (derived from the Arabic word *qutn*) as a dressing for controlling hemorrhage, was described by Abulcasis.
- **Fetus extraction**: Abulcasis, in his *Al-Tasrif* (1000), first described the surgical procedure of extractiing a dead fetus using forceps.
- **General anaesthesia, general anaesthetic, oral anesthesia, inhalational anaesthetic, and narcotic-soaked sponge**: Surgeries under inhalant anesthesia with the use of narcotic-soaked sponges which were placed over the face, were introduced by the Muslim anesthesiologists, Abu al-Qasim (Abulcasis) and Ibn Zuhr, in Islamic Spain. Sigrid Hunke wrote: "The science of medicine has gained a great and extremely important discovery and that is the use of general anaesthetics for surgical operations, and how unique, efficient, and merciful for those who tried it the Muslim anaesthetic was. It was quite different from the drinks the Indians, Romans and Greeks were forcing their patients to have for relief of pain. There had been some allegations to credit this discovery to an Italian or to an Alexandrian, but the truth is and history proves that, the art of using the anaesthetic sponge is a pure Muslim technique, which was not known before. The sponge used to be dipped and left in a mixture prepared from cannabis, opium, hyoscyamus and a plant called Zoan."
- **Ligature**: Introduced by Abulcasis in the *Al-Tasrif*, for the blood control of arteries in lieu of cauterization.
- **Surgical suture**: Abulcasis in his *Al-Tasrif*.
- **Tracheotomy, correct description of**: While tracheostomy may have possibly been portrayed on ancient Egyptian tablets, the first clear and correct description of the tracheotomy operation for suffocating patients was described by Ibn Zuhr (Avenzoar) in the 12th century.

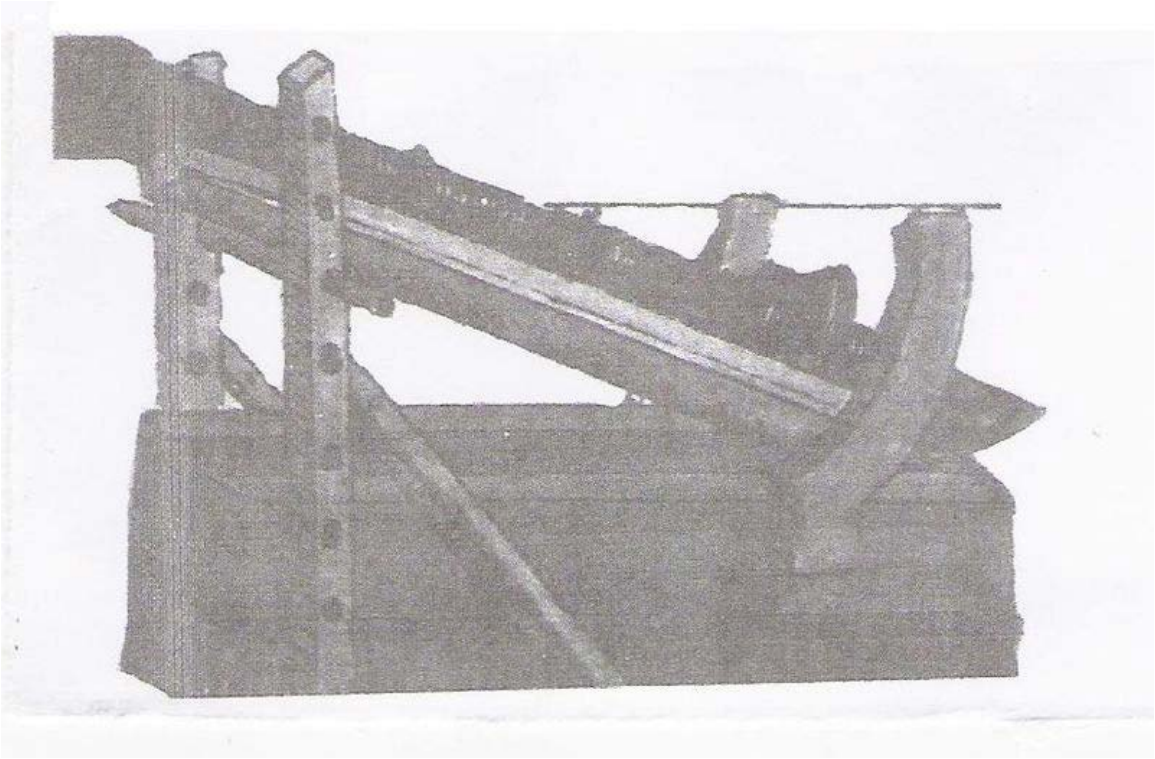
Military

- **Marching band and military band**: The marching band and military band both have their origins in the Ottoman military band, performed by the Janissary since the 16th century.
- **Horseman's axe**: An early type of **war hammer** that was of Islamic origin. The *Tirant lo Blanch* in the 15th century maintained that it was "the deadliest weapon when fighting in full armour, when it was hung from a cavalryman's saddle-bow."

Defense

- **Adarga**: A hard leather shield used originally by the Moors of Islamic Spain. The adarga was a traditional defense employed by the Moorish light horseman who used it along with the lance. Throughout the 14th and 15th centuries the adarga was also used by Spanish Christian soldiers including their own light cavalry (*la jineta*) some of whom adopted Moorish fighting patterns. The adarga was in widespread use until the 16th century and the progress of firearms.
- **Camail**: It was used as part of the **mighfar**, an Islamic helmet. It was in use from the 8th to the 14th century.
- **Fireproof clothing**: In 1260, Egyptian Mamluk soldiers at the Battle of Ain Jalut wore fireproof clothing to protect themselves from gunpowder fires as well as chemicals in gunpowder warfare. Their clothing consisted of a silk tunic (still worn by Formula One drivers underneath their Nomex fire suits), aketon (from the Arabic *al-qutn* "the cotton"), and mainly a woolen overtunic that protects against fires and chemical weapons, similar to the clothing worn by modern soldiers for protection against biological, chemical and nuclear weapons. Due to the effectiveness of their fireproof clothing, the Egyptian soldiers were able to attach gunpowder cartridges and incendiary devices to their clothing.
- **Short-hemmed and short-sleeved hauberk**: The short-hemmed, short-sleeved hauberk is thought to be of Islamic origin. It was usually worn with a mail.

Gunpowder technology



A picture of a 15th century Granadian siege cannon from the book *Al-izz wal rifa'a*.

- **Abus gun**: The Abus gun was an early form of howitzer created by the Ottoman Empire. Abus guns were a significant part of the Ottoman Empire's artillery, and could perhaps even be referred to as the signature piece of artillery during the height of their power, in the 16th and 17th centuries.
- **Iron-cased and metal-cylinder rocket artillery**: The first iron-cased and metal-cylinder rocket artillery were developed by Tipu Sultan, a Muslim ruler of the South Indian Kingdom of Mysore, and his father Hyder Ali, in the 1780s. He successfully used these metal-cylinder rockets against the larger forces of the British East India Company during the Anglo-Mysore Wars. The Mysore rockets of this period were much more advanced than what the British had seen, chiefly because of the use of iron tubes for holding the propellant; this enabled higher thrust and longer range for the missile (up to 2 km range). After Tipu's eventual defeat in the Fourth Anglo-Mysore War and the capture of the Mysore iron rockets, they were influential in British rocket development, inspiring the Congreve rocket, which was soon put into use in the Napoleonic Wars. According to Stephen Oliver Fought and John F. Guilmartin, Jr. in *Encyclopædia Britannica* (2008): "Hyder Ali, prince of Mysore, developed war rockets with an important change: the use of metal cylinders to contain the combustion powder. Although the hammered soft iron he used was crude, the bursting strength of the container of black powder was much higher than the earlier paper construction. Thus a greater internal pressure was possible, with a resultant greater thrust of the

propulsive jet. The rocket body was lashed with leather thongs to a long bamboo stick. Range was perhaps up to three-quarters of a mile (more than a kilometre). Although individually these rockets were not accurate, dispersion error became less important when large numbers were fired rapidly in mass attacks. They were particularly effective against cavalry and were hurled into the air, after lighting, or skimmed along the hard dry ground. Hyder Ali's son, Tippu Sultan, continued to develop and expand the use of rocket weapons, reportedly increasing the number of rocket troops from 1,200 to a corps of 5,000. In battles at Seringapatam in 1792 and 1799 these rockets were used with considerable effect against the British." Tippu Sultan wrote a military manual on his rocket artillery, the *Fathul Mujahidin*.

- **Purified potassium nitrate**: Muslim chemists were the first to purify potassium nitrate (saltpetre; *natrun* or *barud* in Arabic) to the weapons-grade purity for use in gunpowder, as potassium nitrate needs to be purified to be used effectively. This purification process was first described by Ibn Bakhtawayh in his *al-Muqaddimat* in 1029. The first complete purification process for potassium nitrate is described in 1270 by the Arab chemist and engineer Hasan al-Rammah of Syria in his book *al-Furusiyya wa al-Manasib al-Harbiyya* ('The Book of Military Horsemanship and Ingenious War Devices', a.k.a. the *Treatise on Horsemanship and Stratagems of War*). He first described the use of potassium carbonate (in the form of wood ashes) to remove calcium and magnesium salts from the potassium nitrate. Hasan al-Rammah also describes the purifying of saltpetre using the chemical processes of solution and crystallization, and this was the first clear method for the purification of saltpetre. Bert S. Hall, however, disputes the efficacy of al-Rammah's formula for the purification of potassium nitrate.

Swordmaking

- **Damascus steel**: One of the most famous steels produced in the medieval Near East was Damascus steel used for swordmaking, and mostly produced in Damascus, Syria, in the period from 900 to 1750. This was produced using the crucible steel method, based on the earlier Indian wootz steel. This process was further refined in the Middle East using locally produced steels. The process allowed carbides to precipitate out as micro particles arranged in sheets or bands within the body of a blade. The carbides are far harder than the surrounding low carbon steel, allowing the swordsmith to make an edge which would cut hard materials with the precipitated carbides, while the bands of softer steel allowed the sword as a whole to remain tough and flexible. A team of researchers based at the Technical University of Dresden that uses x-rays and electron microscopy to examine Damascus steel discovered the presence of cementite nanowires and carbon nanotubes. Peter Paufler, a member of the Dresden team, says that these nanostructures give Damascus steel its distinctive properties and are a result of the forging process.
- **Flyssa and Kaskara**: The swords developed in early Islamic Morocco and the Baguirmi Sultanate, respectively.

- **Grip**: In the late 12th century, the figure of a Turkish cavalryman was depicted holding a sabre which was carried using what would later be known in Europe as the 'Italian Grip'.
- **Kilij**: A sabre developed by the Turks in Central Asia, it came into widespread use by the 15th century. Polish sabres of the 17th century (known as *pallash* or *palache*) were derived from this weapon.
- **Nimcha**: An Arab short sabre with a knuckle guard developed in Morocco.
- **Pulwar, Qama,** and **Quaddara**: The *pulwar* is a form of talwar that was developed in Islamic India. The *qama* was a sword developed in Islamic Georgia, and is probably the origin of the Cossack **kindjal**. The *quaddara* was a Persian **broadsword**, like a long kindjal, used in the Caucasus.
- **Sabre and Saif**: The sabre and the Arab *saif* were developed in the early Islamic world.
- **Scimitar and Shamshir**: The earliest evidence of the scimitar, or curved sword, is from the 9th century, when it was used among soldiers in the Khurasan region of Persia. The Persian *shamshir* in its current form dates to the 15th century.
- **Shashka and Shotel**: Developed in the Caucasus and Abyssinia, respectively.
- **Takouba, Talwar,** and **Yatagan**: The *takouba* was developed by the Taureg people of the Sahara. The *talwar* is an Indian sword based on the Persian *shamshir*. The *yatagan* was developed in Turkey.

Navigational technology

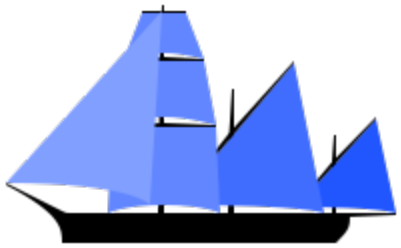
Instruments

- **Cartographic Qibla indicators**: These were brass instruments with Mecca-centred world maps and cartographic grids engraved on them. They were invented in 17th-century Safavid Iran.
- **Cartographic Qibla indicator with sundial and compass**: This was a Qibla instrument with a sundial and compass attached to it, and was invented by Muhammad Husayn in 17th century Safavid Iran.

Transport

- **Kamal**: Arab navigators invented a rudimentary sextant known as a kamal, used for celestial navigation and for measuring the altitudes and latitudes of the stars, in the late 9th century. They employed in the Indian Ocean from the 10th century, and it was adopted by Indian navigators soon after, followed by Chinese navigators some time before the 16th century. The invention of the kamal allowed for the earliest known latitude sailing, and was thus the earliest step towards the use of quantitative methods in navigation.
- **Qarib**: The origins of the **caravel** ship, used for long distance travel by the Spanish and Portuguese since the 15th century, date back to the *qarib*.
- **Rudder with tackle, permanent sternpost-mounted**: The Arabs used a sternpost-mounted rudder which differed technically from both its European and Chinese counterparts. On their ships "the rudder is controlled by two lines, each

attached to a crosspiece mounted on the rudder head perpendicular to the plane of the rudder blade." The earliest evidence comes from the *Ahsan al-Taqasim fi Marifat al-Aqalim* ('The Best Divisions for the Classification of Regions') written by al-Muqaddasi in 985. According to Lawrence V. Mott, the "idea of attaching the rudder to the sternpost in a relatively permanent fashion, therefore, must have been an Arab invention independent of the Chinese."



Sail plan for a polacca-xebec, first built by the Barbary pirates around the 16th century

- **Xebec and Polacca**: The xebec and polacre sailing ships used around the Mediterranean from the 16th to the 19th centuries originated from the Barbary pirates, who successfully used them for naval warfare against European ships at the time. A combination of the fore and aft sails and aerodynamics, along with the improved square sail on the Polacca, allowed these ships to sail much closer to the wind than European and American ships. An expert on the Barbary pirates said that their ships had guns at the bow and stern. "They would approach, pounding away, and it took too long for our square riggers to bring the broadside guns around. The Arabs had oars and a sail arrangement that meant they were able to turn more quickly and could flee closer to the wind than we could chase them."

Aviation

- **Attempt at gliding**: According to the 17th century historian Ahmed Mohammed al-Maqqari, Abbas Ibn Firnas of Islamic Spain made in 875 the first − unsuccessful − attempt at a heavier-than-air glider flight in aviation history. It may have inspired the attempt by Eilmer of Malmesbury between 1000 and 1010 in England, recorded by the medieval historian William of Malmesbury in about 1125, although there is no evidence that the earlier recorded event in Anglo-Saxon England took place with foreign stimulus.

Scientific instruments

Muslim astronomers developed a number of astronomical instruments, including several variations of the astrolabe, originally invented by Hipparchus in the 2nd century BCE, but with considerable improvements made to the device in the Muslim world.

Analogue computers

The astrolabe was invented by Abū Ishāq Ibrāhīm al-Zarqālī (Arzachel) in Islamic Spain *circa* 1015. The one shown here is from Persia in the 18th century

The spherical astrolabe was invented by Muslim astronomers. This is the earliest surviving example from the 14th century.

- **Equatorium**: Invented by Abū Ishāq Ibrāhīm al-Zarqālī (Arzachel) in Islamic Spain *circa* 1015, it was a mechanical analog computer device for finding the longitudes and positions of the moon, sun, and planet's, without calculation using a geometrical model to represent the celestial body's mean and anomalistic position.
- **Saphaea**: An astrolabe, invented by Abū Ishāq Ibrāhīm al-Zarqālī (Arzachel) in 11th century Islamic Spain.
- **Zuraqi**: A heliocentric astrolabe where the Earth is in motion rather than the sky, by al-Sijzi in the 11th century.
- **Fixed-wired knowledge processing machine**: Abū Rayhān al-Bīrūnī's **hodometer** was an early example of a fixed-wired knowledge processing machine in the early 11th century.
- **Mechanical lunisolar calendar computer**: Featured a gear train and gear-wheels, and was invented by Abū Rayhān al-Bīrūnī.
- **Mechanical geared astrolabe**: Invented by Ibn Samh (c. 1020).
- **Linear astrolabe** ("staff of al-Tusi"): Invented by Sharaf al-Dīn al-Tūsī in the 12th century.
- **Programmable analog computer**: The **castle clock**, an astronomical clock invented by Al-Jazari in 1206, is considered to be the earliest programmable analog computer. It displayed the zodiac, the solar and lunar orbits, a crescent moon-shaped pointer travelling across a gateway causing automatic doors to open every hour, and five robotic musicians who play music when moved by levers operated by a camshaft attached to a water wheel. The length of day and night could be re-programmed every day in order to account for the changing lengths of day and night throughout the year.
- **Mechanical geared astrolabe with calendar computer**: Invented by Abi Bakr of Isfahan in 1235.
- **Plate of Conjunctions**: A computing instrument used to determine the time of day at which planetary conjunctions will occur, and for performing linear interpolation, invented by al-Kashi in the 15th century.
- **Planetary computer**: The Plate of Zones, a mechanical planetary computer which could graphically solve a number of planetary problems, was invented by al-Kashi in the 15th century. It could predict the true positions in longitude of the sun and moon, and the planets in terms of elliptical orbits; the latitudes of the Sun, Moon, and planets; and the ecliptic of the Sun. The instrument also incorporated an alidade and ruler.

Laboratory apparatus

- **Aerometer**: Abū Rayhān al-Bīrūnī in the 11th century.
- **Conical measure**: Abū Rayhān al-Bīrūnī in the 11th century.
- **Laboratory flask** and **pycnometer**: Abū Rayhān al-Bīrūnī.
- **Refrigerated coil** and **refrigerated tubing**: In the 11th century, Avicenna invented the refrigerated coil, which condenses aromatic vapours. This was a breakthrough in distillation technology and he made use of it in his steam distillation process, which requires refrigerated tubing, to produce essential oils.

Mural instruments

The first sextant was built in Ray, Iran by Abu-Mahmud al-Khujandi in 994. The earliest surviving sextant is Ulugh Beg's mural "Fakhri Sextant" constructed in Samarkand, Uzbekistan, during the 15th century, pictured above.

- **Mural instrument**: Invented by Al-Khwarizmi in 9th century Baghdad, Iraq.
- **Horary quadrant**: For specific latitudes, by al-Khwarizmi in 9th century Baghdad.
- **Sine quadrant**: - also known as the "Sinecal Quadrant", the Arabic term for it is "Rubul Mujayyab" – used for solving trigonometric problems and for astronomical calculations, by al-Khwarizmi in 9th century Baghdad.
- **Almucantar quadrant**: Invented in the medieval Islamic world. It employed the use of trigonometry. The term "almucantar" is itself derived from Arabic.
- **Quadrans Vetus**: Meaning "Old Quadrant", this was a universal horary quadrant which could be used for any latitude and at any time of the year to determine the time, as well as the times of Salah, invented by al-Khwarizmi in 9th century Baghdad. This was the second most widely used astronomical instrument during the Middle Ages after the astrolabe. One of its main purposes in the Islamic world was to determine the times of Salah prayers.

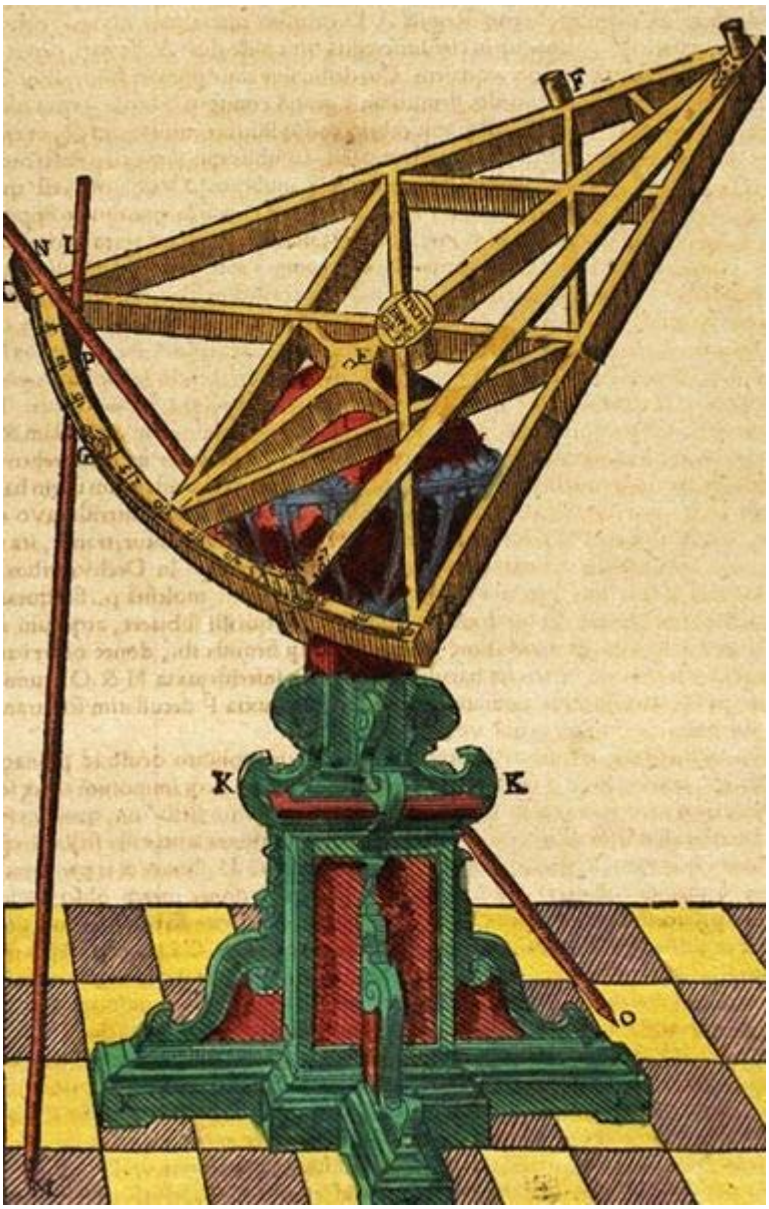
- **Quadrans Novus**: An astrolabic quadrant invented in Egypt in the 11th century or 12th century, and later known in Europe as the "Quadrans Novus" (New Quadrant).
- **Sextant**: The first sextant was constructed in Ray, Iran, by Abu-Mahmud al-Khujandi in 994. It was a very large sextant that achieved a high level of accuracy for astronomical measurements, which he described his in his treatise, *On the obliquity of the ecliptic and the latitudes of the cities*. In the 15th century, Ulugh Beg constructed the mural "Fakhri Sextant", which had a radius of approximately 36 meters. Constructed in Samarkand, Uzbekistan, the arc was finely constructed with a staircase on either side to provide access for the assistants who performed the measurements.

Optical instruments

- **Observation tube**: The "observation tube" (without lens) was invented by al-Battani (Albatenius) (853-929) and first described by al-Biruni (973-1048). These observation tubes were later adopted in Europe, where they influenced the development of the telescope.
- **Intromission theory of vision**: Ibn al-Haytham (Alhazen), with his *Book of Optics* (1021), refuted the emission theory of vision, and correctly explained and proved the modern intromission theory of vision, through extensive experiment-tation. and visual perception,.
- **Camera obscura**: Ibn al-Haytham worked out that the smaller the hole, the better the picture, and set up the first camera obscura, a precursor to the modern camera.
- **Pinhole camera**: Ibn al-Haytham first described pinhole camera after noticing the way light came through a hole in window shutters.
- **Magnifying glass**: The earliest evidence of "a magnifying device, a convex lens forming a magnified image", dates back the *Book of Optics* published by Ibn al-Haytham in 1021. The Latin translation of his work was instrumental to the later inventions of eyeglasses, the telescope, and the microscope.

Other instruments

- **Compendium instrument**: A multi-purpose astronomical instrument, first constructed by the Muslim astronomer Ibn al-Shatir in the 13th century. His compendium featured an alidade and polar sundial among other things. Al-Wafa'i developed another compendium in the 15th century which he called the "equatorial circle", which also featured a horizontal sundial. These compendia later became popular in Renaissance Europe.



Framed sextant similar to what Tycho Brahe later used as shown in the picture

- **Framed sextant**: At the Istanbul observatory of Taqi al-Din between 1577 and 1580, Taqi al-Din invented the *mushabbaha bi'l manattiq*, a framed sextant with cords for the determination of the equinoxes similar to what Tycho Brahe later used.
- **Seamless globe and celestial globe**: Considered one of the most remarkable feats in metallurgy, they were invented in Kashmir by Ali Kashmiri ibn Luqman in 998 AH (1589-90 CE), and twenty other such globes were later produced in Lahore and Kashmir during the Mughal Empire. Before they were rediscovered in the 1980s, it was believed by modern metallurgists to be technically impossible to produce metal globes without any seams, even with modern technology. These

Mughal metallurgists pioneered the method of **lost-wax casting** while producing these seamless globes.

- **Shadow square**: An instrument used to determine the linear height of an object, in conjunction with the alidade for angular observations, invented by Muhammad ibn Mūsā al-Khwārizmī in 9th-century Baghdad.

Timekeeping devices

The elephant clock from Al-Jazari's manuscript in 1206. This was the earliest clock to employ a flow regulator, a closed-loop system, and an automaton like a cuckoo clock.

Astronomical clocks

Muslim astronomers and engineers constructed a variety of highly accurate astronomical clocks for use in their observatories.

- **Geared mechanical astrolabe**: Featured a calendar computer and gear-wheels, and was invented by Abi Bakr of Isfahan in 1235.
- **Monumental water-powered astronomical clocks**: Al-Jazari invented monumental water powered astronomical clocks which displayed moving models of the sun, moon, and stars. His largest astronomical clock displayed the zodiac and the solar and lunar orbits. Another innovative feature of the clock was a pointer which travelled across the top of a gateway and caused automatic doors to open every hour.
- **Observational clock measured in seconds**

Clocks with gears and escapements

- **Weight-driven mercury clock**: A mercury clock, employing a mercury escapement mechanism and a clock face similar to an astrolabe dial, was described in a Spanish language work for Alfonso X in 1277, compiled from earlier Arabic sources that likely date back to the 11th century. The Jewish author of the relevant section, Rabbi Isaac, constructed the mercury clock using principles described by a philosopher named "Iran", identified with Heron of Alexandria (fl. 1st century AD), on how heavy objects may be lifted. Knowledge of the mercury clock was later transmitted to other parts of Europe through translations.
- **Weight-driven water-powered scribe clock**: In 1206, Al-Jazari invented some of the earliest weight-driven water clocks, including the water-powered scribe clock. This water-powered portable clock was a meter high and half a meter wide. The scribe with his pen was synonymous to the hour hand of a modern clock. This is an example of an ingenious water system by Al-Jazari. Al-Jazari's famous water-powered scribe clock was reconstructed successfully at the Science Museum (London) in 1976.

Dials

- **Navicula de Venetiis**: A universal horary dial used for accurate timekeeping by the sun and stars, and could be observed from any latitude, invented in 9th century Baghdad. This was later considered the most sophisticated timekeeping instrument of the Renaissance.
- **"jewel box" device**: In the early 14th century, Ibn al-Shatir invented a timekeeping device incorporating both a universal sundial and a magnetic compass to find the times of Salah prayers.

Mechanical clocks

- **Observational clock, measured in seconds**: Taqi al-Din invented the "observational clock", which he described as "a mechanical clock with three dials which show the hours, the minutes, and the seconds." This was the first clock to measure time in seconds, and was used for astronomical purposes, specifically for measuring the right ascension of the stars. This is considered one of the most important innovations in 16th century practical astronomy, as previous clocks were not accurate enough to be used for astronomical purposes.

Automatic castle clock of Al-Jazari, 12th century

Water clocks

- **Elephant clock**: The elephant clock described by al-Jazari in 1206 is notable for several innovations. The float regulator employed in the clock later had an important influence during the Industrial Revolution of the 18th century, when it was employed in the boiler of a steam engine and in domestic water systems.

- **Programmable castle clock**: Analog computers above.
- **Weight-driven water clock**: Clocks with gears and escapements above.
- **Weight-driven water-powered scribe clock**: Clocks with gears and escapements above.
- **Monumental water-powered alarm clock**: In 1235, an early monumental water-powered alarm clock that "announced the appointed hours of prayer and the time both by day and by night" was completed in the entrance hall of the Mustansiriya Madrasah in Baghdad.

New water clocks have recently been discovered in Ibn Khalaf al-Muradi's *Book of Secrets* (1000), as shown in the Museum of Islamic Art, Doha, Qatar.

Other inventions

Al-Kindi's 9th century *Manuscript on Deciphering Cryptographic Messages* was the first book on cryptanalysis and frequency analysis.

Geomantic instrument, Egypt or Syria, 1241-1242 CE, made by Muhammad ibn Khutlukh al Mawsuli. British Museum.

The lute was adopted from the Arab world. 1568 print

The Arabic rebab was the ancestor of the rebec and the violin

Other inventions from the Islamic world include:

- **Airmail system utilizing homing pigeons** by the Fatimid Caliph Aziz, and advances in **music theory** and **irrigation techniques**.
- **Algebra**: While the roots of algebra can be traced back to earlier civilizations, where mathematicians solved linear and quadratic equations using arithmetic and geometric methods, it was Muhammad ibn Mūsā al-Khwārizmī's *al-Kitāb al-muḫtaṣar fī ḥisāb al-jabr wa-l-muqābala* (*The Compendious Book on Calculation by Completion and Balancing*) which established algebra as an independent mathematical discipline in its own right. Al-Khwarizmi was the first to clearly establish algebra as a discipline that is independent of geometry and arithmetic.

The name he coined for the discipline, *al-jabr*, referred to the underlying method of "reduction" and "balancing" he introduced, meaning the transposition of subtracted terms to the other side of an equation, that is, the cancellation of like terms on opposite sides of the equation.

- **Biographical dictionary**: In the medieval Islamic civilization, biographies began being produced on a large scale with the advent of paper. This led to the introduction of a new literary genre: the biographical dictionary. The first biographical dictionaries were written in the Muslim world from the 9th century onwards. They contain more social data for a large segment of the population than that found in any other pre-industrial society. The earliest biographical dictionaries initially focused on the lives of the prophets of Islam and the their companions, with one of the earliest examples being *The Book of The Major Classes* by Ibn Sa'd al-Baghdadi, and then began documenting the lives of many other historical figures (from rulers to scholars) who lived in the medieval Islamic world.
- **Check reading**: The medieval Islamic world also developed a unique method of reproducing reliable copies of a book in large quantities, known as check reading, in contrast to the traditional method of a single scribe producing only a single copy of a single manuscript, as was the case in other societies at the time. In the Islamic check reading method, only "authors could authorize copies, and this was done in public sessions in which the copyist read the copy aloud in the presence of the author, who then certified it as accurate." With this check-reading system, "an author might produce a dozen or more copies from a single reading," and with two or more readings, "more than one hundred copies of a single book could easily be produced."
- **Cryptanalysis** and **frequency analysis**: In cryptology, the first known recorded explanation of cryptanalysis was given by 9th-century Arabian polymath, Al-Kindi (also known as "Alkindus" in Europe), in *A Manuscript on Deciphering Cryptographic Messages*. This treatise includes the first description of the method of frequency analysis. It has been suggested that close textual study of the Qur'an first brought to light that Arabic has a characteristic letter frequency. Its use spread, and similar systems were widely used in European states by the time of the Renaissance.
- **Diary**: In the medieval Near East, Arabic diaries were written from before the 10th century. The earliest surviving diary which most resembles the modern diary was that of Ibn Banna in the 11th century. His diary is the earliest known to be arranged in order of date (*ta'rikh* in Arabic), very much like modern diaries.
- **Experimental psychology**: Ibn al-Haytham (Alhazen) is considered to be the founder of experimental psychology, for his experimental approach to the psychology of visual perception and optical illusions.
- **Geomancy**: The most widely accepted origin for this practice is in the medieval Arabic world.
- **Persian carpet**
- **Scientific method, experimental science, and experimental physics**: The scientific method was pioneered by the Muslim scientist and physicist, Ibn al-Haytham (Alhazen), who emphasized the role of experimentation and mathe-

matics in obtaining the results in his *Book of Optics* (1021). Due to his formulation of a modern quantitative, empirical and experimental approach to physics and science, he is also considered the pioneer of experimental science and experimental physics, and some have described him as the "first scientist" for these reasons.

Equipment

- **Fireproof paper, glow-in-the-dark ink, rust-free iron**, and **waterproof textile**: According to Ismail al-Faruqi and Lois Lamya al-Faruqi, "In response to Jafar al-Sadik's wishes, [Jabir ibn Hayyan] invented a kind of paper that resisted fire, and an ink that could be read at night. He invented an additive which, when applied to an iron surface, inhibited rust and when applied to a textile, would make it water repellent."
- **Fustian**: The original medieval fustian was a stout but respectable cloth with a cotton weft and a linen warp, derived from *El-Fustat*, the name of a suburb of Cairo where this cloth was originally manufactured.
- **Jinete**: A short-stirrup riding style that was adopted by Spanish riders from the Moors during Islamic rule in Spain. American cowboys in turn adopted the *jinete* riding style from the Spanish tradition.
- **Graph paper** and **orthogonal and regular grids**: The first known use of graph paper dates back to the medieval Islamic world, where weavers often carefully drew and encoded their patterns onto graph paper prior to weaving. Islamic quadrants used for various astronomical and timekeeping purposes from the 10th century also introduced markings with orthogonal and regular grids that are still identical to modern graph paper.

Musical instruments

- **Albogue, alboka, hornpipe, clarinets, and single-reed instrument**: The earliest known hornpipes, clarinets and single-reed instruments were the albogue and alboka, both derived from the "al-bûq" (**قوبلا**) (literally "the trumpet" or "the horn") used in medieval Arabic music and Islamic music. The instrument was brought into Iberia by the Arab conquest.
- **Guitar, lute, and oud**: The modern guitar (*qitar* in Arabic) is descended from the four-string oud brought by the Moors after the Umayyad conquest of Hispania in the 8th century, and which evolved into the modern lute. The four-string guitar introduced by the Moors had eventually evolved into two types in Spain: the *guitarra morisca* (Moorish guitar) which had a rounded back, wide fingerboard and several soundholes, and then by 1200, the *guitarra latina* (Latin guitar) which resembled the modern guitar with one soundhole and a narrower neck.
- **Hurdy gurdy** and **stringed keyboard instrument**: The earliest stringed instrument with a musical keyboard, an ancestor of the **piano**, was the hurdy gurdy, but its origins are uncertain. According to a theory proposed by Marianne Bröcker, an instrument similar to the hurdy gurdy is first mentioned in an Arabic musical compendium written by Al Zirikli in the 10th century.

- **Mechanical musical instrument** and **automatic hydraulic organ**: In the 9th century, the Banū Mūsā brothers invented "the earliest known mechanical musical instrument", in this case a hydropowered organ which played interchangeable cylinders automatically. According to Charles B. Fowler, this "cylinder with raised pins on the surface remained the basic device to produce and reproduce music mechanically until the second half of the nineteenth century."
- **Programmable automatic flute player**: In the 9th century, the Banū Mūsā brothers invented an automatic flute player which appears to have been the first programmable machine, and which they described in their *Book of Ingenious Devices*. The flute sounds were produced through hot steam and the user could adjust the device to various patterns so that they could get various sounds from it.
- **Timpani, naker, and naqareh**: The modern timpani (kettle drum) evolved from the naker, the direct ancestor of most timpani, were derived from the Arabic naqareh and brought to 13th century Continental Europe by Saracens and Crusaders.
- **Rebec** and **rebab**: The rebec was in use since the 10th century, and was derived from the rebab which originated in medieval Arabic music and Islamic music.