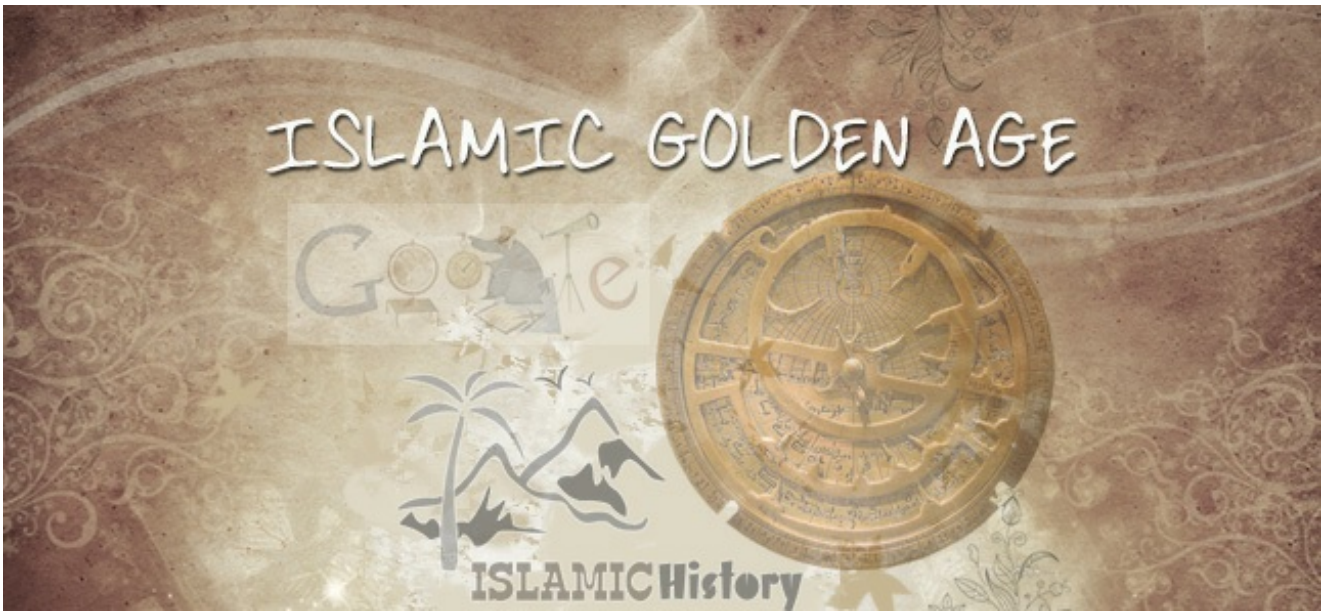
Islamic Golden Age

islamichistory.org/islamic-golden-age/

March 11, 2012



The Islamic Golden Age is traditionally dated from the mid-7th century to the mid-13th century at which Muslim rulers established one of the largest empires in history.

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. Also at that time the Muslim world became a major intellectual centre for science, philosophy, medicine and education. In Baghdad they established the "**House of Wisdom**", where scholars, both Muslim and non-Muslim, sought to gather and translate 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 ancientMesopotamia, 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. The Islamic empire 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 Morocco and then to Spain 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.

Islamic ethics

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 toconvert 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!”
Early proto-environmentalist treatises were written in Arabic 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, and municipal solid waste mishandling. Cordoba, al-Andalus also had the first waste containers and waste disposal facilities for litter collection.

Institutions

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.

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.
“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

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

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 as the world’s leading extensive economic power throughout the 7th–13th centuries.

Agricultural

The Islamic Golden Age witnessed a fundamental transformation in agriculture known as the “Arab Agricultural Revolution”. Muslim traders enabled the diffusion of many crops andfarming 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, vegetationcover, 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.

Market Economy

Early forms of proto-capitalism and free markets were present in the empire time 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

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 Spain (al-Andalus) and North Africa to the Middle East and Central Asia. Muslim engineers also inventedcrankshafts 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 miningof 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

The labour force in the Islamic empire 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 monopolyover 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-intensiveplantations; 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

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, distilledalcohol, 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 city of Baghdad was the capital of the Abbasid Leaders and a major center of learning and trade in the world.
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 andbathing facilities.
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 life spans 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 oralto 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 paperbooks 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 theMaktab and Madrasah educational institutions.

Science

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 a pioneer of experimental physics, which some place in the experimental tradition of Ptolemy. Others see his use of experimentation and quantification to distinguish between competing scientific theories as an innovation in scientific method. 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 development 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 firstobservatory 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 andMo'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 employed geometrical constructions that had been developed previously by the Maragheh school, and that his arguments for the Earth's rotation were similar to those of Nasīr al-Dīn Tūsī and Ali Qushji.

Chemistry

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 introduced by Sind ibn Ali, the invention of all thetrigonometric 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 ofsymbolic algebra by Abū al-Hasan ibn Alī al-Qalasādī, and numerous other advances in algebra, arithmetic, calculus, cryptography, geometry, number theory and trigonometry.

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 humorismfalse.

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 ofcatgut, 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 ofquarantine 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 ofarteries 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 forceand 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 ofimpetus 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.

Architecture

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 hypostylearchitecture 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 (see Moors). 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

Main articles: Islamic literature, Arabic literature, Arabic epic literature, and Persian 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.

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 lovemuch 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 inPhilosophus 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 asspontaneous 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") concerningMuhammad'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 MoorishOthello 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

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 ofviolin) 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 orfistula (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, tambura, sitar, the harpand 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). See as well the gifted Ziryab (Abu l-Hasan 'Ali Ibn Nafi').

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 philosopherMoses 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 asPhilosophus 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, theQuakers, and Samuel Hartlib.

Al-Ghazali also had an important influence on Jewish thinkers like Maimonidesand 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 ofTranscendent 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 thephilosophy 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

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 Leader 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. 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 empire and Persian IslamicKhwarezm, 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 17th 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 Muslims 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.

Decline

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'stranscendent theosophy; and the social sciences, notably Ibn Khaldun's Muqaddimah (1370), which itself points out that though science was declining in Iraq, Al-Andalus andMaghreb, 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 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 Sulaymand 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 polemicdebates 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 was not 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.