Richard W. Franke
Anth 140: Non Western Contributions to the Western World
Week 12, Lecture 02: The Golden Age of Islam

Week 12
Lecture 02

The Golden Age of Islam:

Arab-Islamic Contributions to Astronomy, Mathematics, Physics, Medicine and Philosophy 750 to 1258 CE

Richard W. Franke
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This slideshow was last updated:

January 10, 2020
October 06, 2017
January 26, 2016

The Golden Age of Islam

The learning objectives for week 12 part 02 are:

- To become aware of and understand several important scientific and medical achievements of the Islamic caliphates during part of the European Middle Ages: from the years 750 to 1258 C.E.;
- to appreciate how the Islamic caliphates saved and improved on the science of the ancient Greeks and handed those materials back to the West during the European renaissance

The Golden Age of Islam

The learning objectives for week 12 part 02… continued…

- To appreciate the role of religious and cultural tolerance in the Islamic caliphates that may have contributed to the great achievements during the Golden Age of Islam;
- To understand how scholars during this golden age may have created the essential components of the scientific method;
- To learn a few basic facts about the religion called "Islam;"

The Golden Age of Islam

Week 12 Lecture 02 Sources:

Al-Hassani, Salim T. S. (Chief Editor). N.d. *1001 Inventions: The Enduring Legacy of Muslim Civilization*. Third edition. Washington, D. C.: National Geographic. Official Companion to the Exhibition. The editors of this book maintain a website where you can find lots of photos and information: https://www.1001inventions.com/

Al-Khalili, Jim. 2010. *The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance*. New York: Penguin Books.

Ali, Tariq. 2002. *The Clash of Fundamentalisms: Crusades, Jihads and Modernity*. New York: Verso.

de Bellaigue, Christopher. 2017. *The Islamic Enlightenment: The Struggle Between Faith and Reason – 1798 to Modern Times. New York: Liveright Publishing.*

Bernal, J. D. 1954. *Science in History*. London: Watts & Co.

Conner, Clifford D. 2005. *A People's History of Science: Miners, Midwives, and "Low Mechanicks."* New York: Nation Books (Avalon).

Hellemans, Alexander, and Bryan Bunch. 1988. *The Timetables of Science: A Chronology of the Most Important People and Events in the History of Science*. New York: Simon and Schuster.

English: the International Language of Science

Today, from 80% up to 98% of all scientific studies are published in English – which has become the international language of science.

Source: https://www.popsci.com/article/science/fyi-how-did-english-get-be-international-language-science

Scientific use of languages such as Latin, French, German and Russian have faded – to be read and have any impact in science, one must publish in English today.

Source: https://www.theatlantic.com/science/archive/2015/08/english-universal-language-science-research/400919/

Why is this the case?

For much of the European renaissance – 1300 to 1700 **CE*** –

Latin was the European language of science. During the Middle Ages in Europe Latin had functioned as the language of the (Roman Catholic) Church but little scientific progress took place.

In the ancient world, the Greek language held sway, even to the point of being the language of science during much of the Roman Empire.

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***CE** stands for "Common Era," and replaces the earlier Latin "AD," or Anno Domini" – "year of our Lord."
The previous "BC," which stood for "Before Christ," is now written as BCE – "Before the Common Era."
However, the dates are the same – ie. 1300 AD is the same as 1300 CE.
See: https://www.gotquestions.org/BC-AD.html

Note that the Muslim and Jewish calendars differ from both of these above. Many other religious and non religious calendars are used locally around the world and in different historical times.

But for 500 years and more, starting in about the year 750, the world scientific language was Arabic.

This change began with the Collapse of the Roman Empire

Geographical Tour: A Tour of Empire

Source:

https://wps.ablongman.com/wps/media/objects/262/268312/art/figures/KISH106.jpg

On September 4, in the Christian calendar year A. D. 476 (C.E. 476), the Western Roman Empire collapsed when a Germanic soldier named Odoacer deposed the last Emperor, Romulus Augustulus.

Following this event, most of Europe fell into 1,300 years of food shortages, trade breakdown, epidemics, invasions, and general public insecurity.

The great achievements of the ancient world, from the Egyptian pyramids, their mathematical, astronomical and medical developments as well as those of the ancient Babylonians – faded into oblivion. [Recall that in Weeks 07 and 08 we surveyed some of these achievements. Starting next week in Week 13 we will survey some of the Chinese knowledge, some of which may overlap with the Muslim golden age.]

Also lost was much of the technical and scientific progress of the Greek "Golden Age," (600 BCE to 300 BCE which includes the famous figures of Socrates, Plato and Aristotle) and the Roman Empire (main empire 50 BCE but as early as 499 BCE) itself.

Loss of the Knowledge in the Greek Manuscripts –

The Greeks had developed philosophy, mathematics, art and architecture to great heights. Even though much of their knowledge had come from Egypt, it was now mostly available in Greek manuscripts. In fact, by around 600 C.E., the language of ancient Egypt had disappeared, only to be rediscovered in the 19th century.

Thousands of important Greek language manuscripts lay scattered in monasteries, libraries and private collections throughout the disintegrating Roman Empire and to some extent in the "Eastern" Roman Empire that continued in Constantinople (Byzantium).

Two plus centuries passed from 476 B.C.E. to about 750 BCE, with continuing food shortages, trade brake down, epidemics, invasions, and general public insecurity.

Then, an astonishing thing happened.

Rediscovery of the Greek Manuscripts

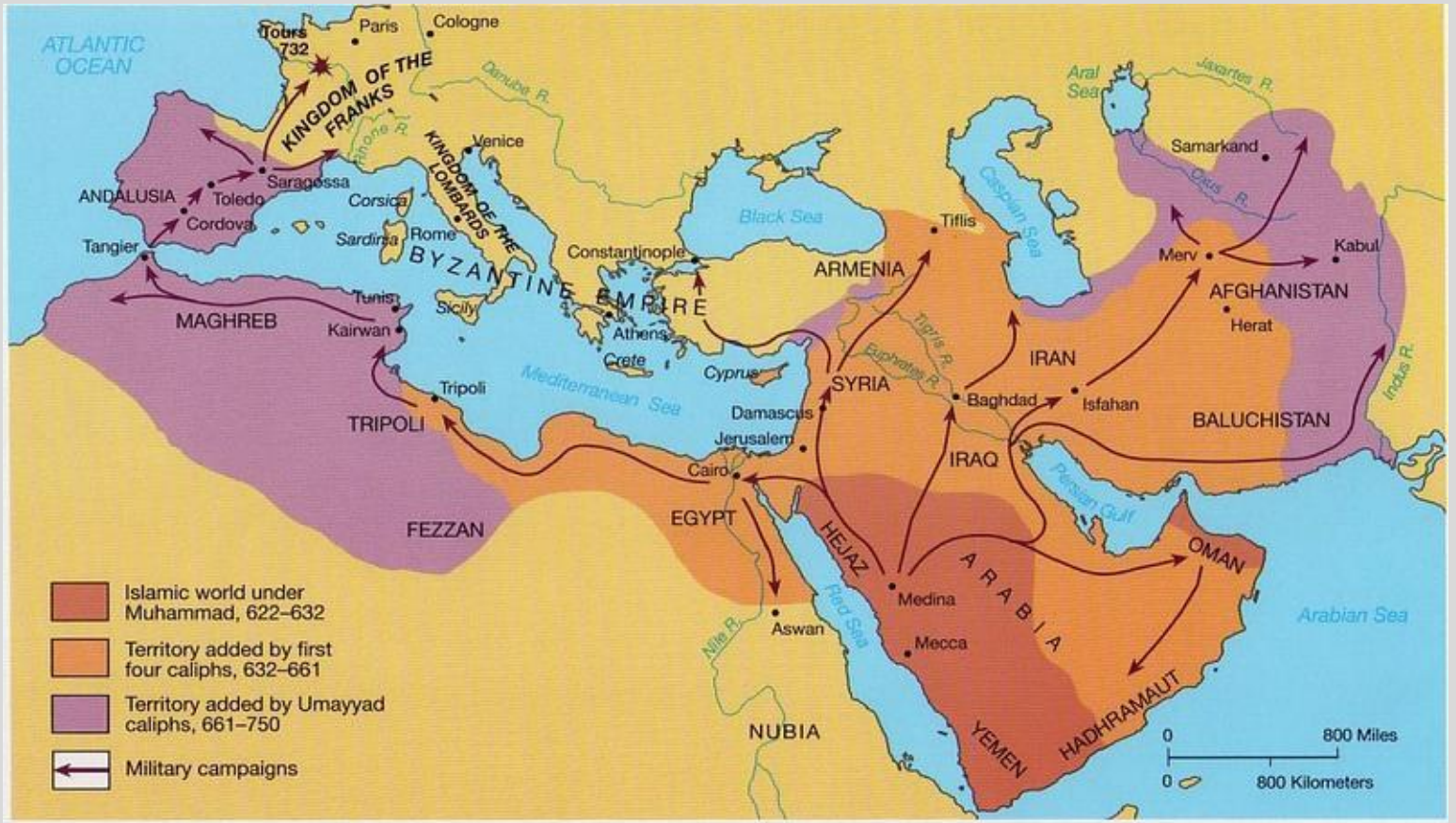
All across the Mediterranean world, buyers appeared seeking and offering money for Greek texts.

While Europe languished in its "dark ages," these Greek texts were taken away to the Muslim world, translated, discussed and improved upon.

They were translated into Arabic – the language of the rapidly spreading religion called "Islam."*

This process began around 762 C.E., the year the city of Baghdad was founded – the year 762 approximately defines the beginning of what many observers call "The Golden Age of Islam."

*Islam means "submission," as in "submission to God."



▲ The Spread of Islam

This "golden age" lasted for 500 years, during which Moslem caliphates* controlled an area overlapping much of the former Roman Empire (minus France, Italy and Britain) until about 1258 C.E., when the Mongol armies conquered much of the area.

*Caliph comes from the Arabic word "Khalafa," which means "successor," in the sense of "successor to the Prophet Muhammed."

Then came another astonishing development…

For 500 years, inside these caliphates there was an amazing flowering of science, mathematics, medicine, astronomy, philosophy and technical developments

The manuscripts were read, translated, reread, talked about, criticized, defended, modified, cited in new manuscripts in which brilliant Arab-Muslim, Christian, Jewish and Zoroastrian intellectuals carried forward the process of accumulation of knowledge that the ancient world had begun but that post-Roman-Empire Europe had lost.

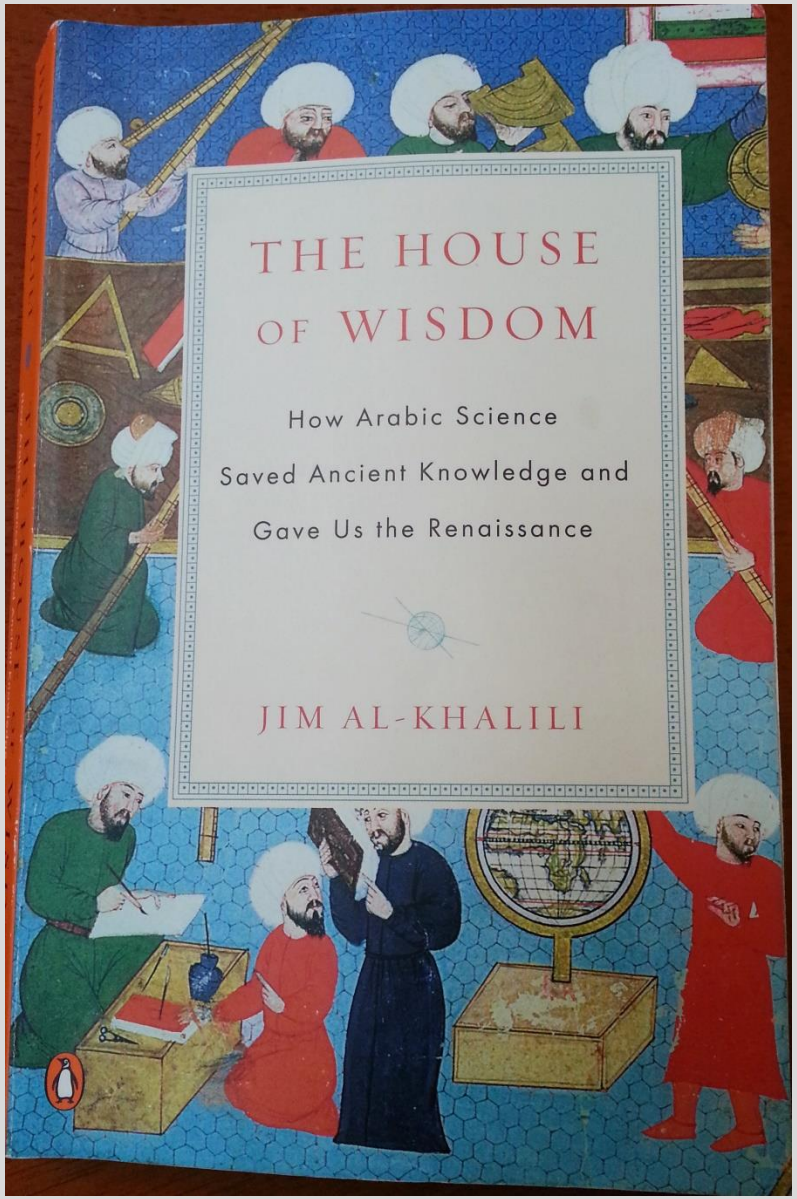
Then came another astonishing development…

As the great Islamic caliphates declined or were destroyed by Mongol and other invaders towards and around the year 1258 C.E...

…and especially via the Spanish city of Córdoba, that had been a center of the Golden Age of Islam…

…the knowledge from the ancient Mediterranean world – now greatly enhanced and expanded by Arab and Islamic scholars, was translated from Arabic into Latin and other European languages, thus causing the great achievements of ancient Greece and its own forebears to be handed back to Europe's people – along with much more.

Those Arabic manuscripts provided much of the basis of the scientific revolution in Europe that has given us the modern world.

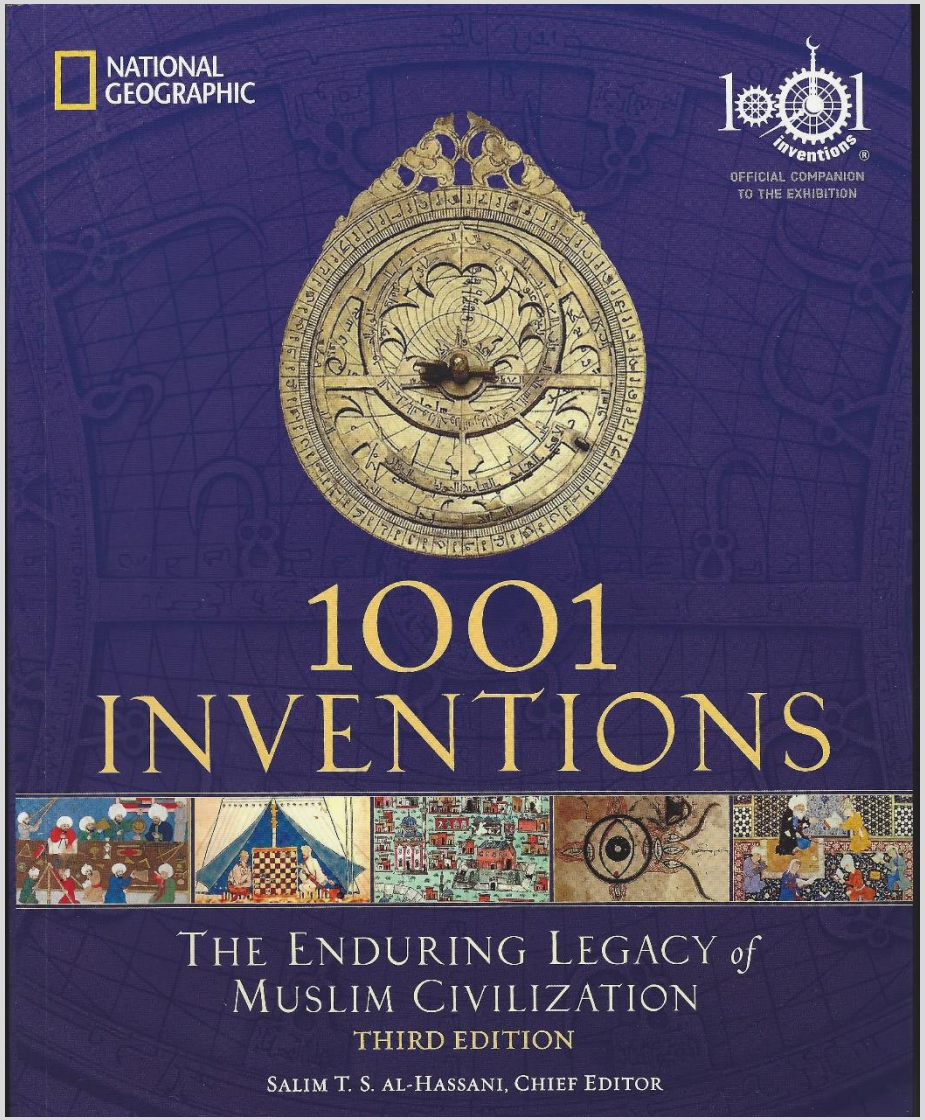


This idea of the important role of the Golden Age of Islam in laying the basis for modern science is now widely acknowledged…and has been laid out in some detail by a recent book by an Iraqi-British physicist.

As well as in recent museum exhibitions, including one sponsored by the *National Geographic*.

If you google "Golden Age of Islam," you can also find dozens of slideshows developed by secondary school teachers around the U.S. covering this topic in various ways.

The editors of this book maintain a website where you can find lots of photos and information: https://www.1001inventions.com/



Because of the vast number of the contributions made during the golden age of Islam, we shall limit ourselves to a summary of the work of seven of the greatest minds spread over most of the 500-year period.

The table on the next slide gives an overview of these scholars, their birth and death years (sometimes approximate) and one or two of their most significant areas of contribution.

Selected Major Thinkers of the Golden Age of Islam

No.	Name	Years (C.E.)	Location	Major Fields
1	al-Khwarizmi	780-850	Baghdad	Algebra, decimals, numerals, cartography
2	al-Razi	854-925	Baghdad, Rayy	Medicine, chemistry, scientific method
3	Ibn al-Haytham	965-1039	Cairo	Optics, astronomy, scientific method
4	al-Biruni	973-1048	Gorgan, Rayy	Earth sciences, history, anthropology
5	Ibn Sina (Avicenna)	980-1037	Bukhara, Hamadan (Iran)	Medicine, philosophy
6	Omar Khayyam	1048-1131	Samarkand, Bukhara	Poetry, algebra, cubic equations
7	Maimonides	1135-1204	Córdoba, Cairo	Medicine, philosophy

The Golden Age of Islam: Selected Major Thinkers:

See brief examples on the next 7 slides…

1. al-Khwarizmi: 780 – 850

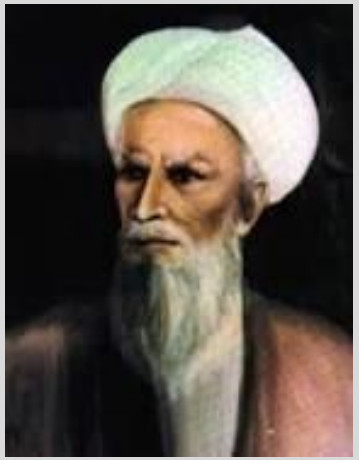
Wrote the first known use of the decimal point, made advances in introducing Indian (what we call "Arabic") numbers, developed procedures in arithmetic leading to the word "algorithm" being derived from the Latin pronunciation of his name.

Most famous for inventing algebra, based on his book *Al-Jebr* that describes a method of setting two sets of numbers across an equals sign (developed later) and re-arranging them to solve for an unknown. "Jebr" means "completion."

Source with more details including info of likely interest to math students: Al-Khalili, Jim. 2010. *The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance*. New York: Penguin Books. Pages 93–123.

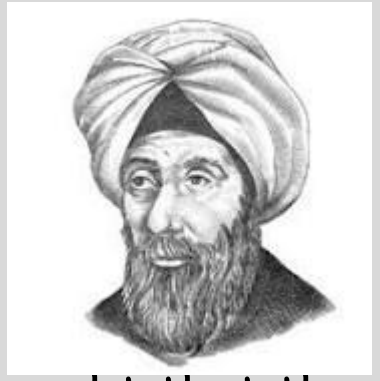
2. al-Razi: 854 – 925

Considered one of the greatest clinicians of the Middle Ages. Administrator of several Baghdad hospitals, improved standards of care, wrote on medical ethics. Wrote studies of small pox and measles – that became widely read in translations in Europe for many years.
Developed classification of substances into animal, vegetable, mineral, and derivatives of these: based on experimental observations rather than philosophical speculation. Went beyond the Greek classification of phenomena into earth, air, water fire. Wrote a medical textbook that was used in Europe for centuries. Worked with Christian and Jewish physicians.



Wrote the first known scientific study using the design procedure of a control group – now one of the essential features of epidemiology and other fields.
Today Iran still celebrates "Razi" day or "Pharmacy Day" on 27 August.

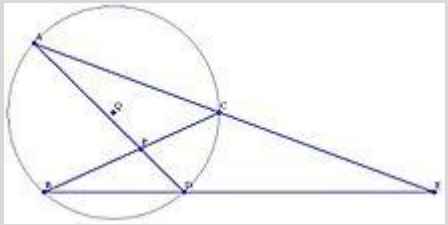
Source with more details: Al-Khalili, Jim. 2010.
The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance.
New York: Penguin Books. Pages 65 and143–151.



3. Ibn al-Haytham: 965 – 1039

First person to correctly explain how vision works. Previously it had been thought that the human eye sends out light to objects to view them, but al-Haytham showed that light comes from the object and/or around the object to the eye. Made many advances in the mathematical aspects of optics. His "book of optics" was translated into Latin in England in the 12-13 century and had a big impact on the famous scientist Roger Bacon.

Made advances in astronomy and in the mathematics and geometry of light refraction and light dispersion. Advanced the mathematics of planetary motion. Helped develop the basic features of the scientific method – emphasizing painstaking experimentation and the careful recording of results.



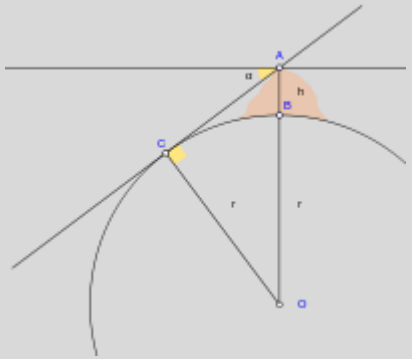
"Al-Hatham's Problem": a famous mathematical achievement of his in which he developed a method for summing fourth powers to explain certain features of light and vision.

Source with more details including info of likely interest to math students:
Al-Khalili, Jim. 2010. *The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance*. New York: Penguin Books. Pages 152–171.

4. al-Biruni: 973 – 1048

Mathematician, earth scientist and historian, al-Biruni wrote a masterpiece of history called *The Chronology of Ancient Nations* which is a major source of information about the medieval period. He furthered the basic idea of science that conclusions had to be based on empirical data; he made studies of the geographical coordinates of many cities and developed mathematical models of the movement of heavenly bodies. He is famous for developing an ingenious means of using triangles to measure the height of a mountain which then became the basis for a highly accurate estimate of the circumference of the earth.

Part of al-Biruni's famous method for determining the circumference of the earth using a double set of triangle comparisons and the height of a mountain also figured out using comparative triangles. For details of how this problem was solved, see



Al-Khalili, Jim. 2010. *The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance*. New York: Penguin Books. Pages 184–188.

Source for the diagram: By Nevit Dilmen (talk) - Own work Using Geogebra and Inkscape, CC BY-SA 3.0.

5. Ibn Sīnā (Avicenna): 980 – 1037

Is thought to have written up to 450 treatises. His books, *Canon of Medicine* and *Book of Healing* influenced European medicine for centuries; was especially important for treating broken bones. Developed the "floating man" argument that fascinated philosophers for decades in thinking through the relationship between existence and consciousness. Maimonides, Roger Bacon, Rene Descartes and David Hume were all influenced by his logical arguments.

Attempted to reconcile Islamic metaphysical beliefs with more scientific ideas. Wrote in both Arabic and Persian (Farsi); was ethnically Persian himself. Wrote a critique of astrology. Ibn Sīnā used distillation to produce essential oils such as rose essence, forming the foundation of what later became aromatherapy.

6. Omar Khayyam: 1048 – 1131

As a poet, is famous for supposedly authoring up to 1,000 rubaiyat(s), 2-line complete poems with two parts to each line making the poem four parts. Many were translated into English in 1859 as *The Rubaiyat of Omar Khayyam* by the British writer Edward FitzGerald. One of its most famous lines is well known in English: "A Jug of Wine, a Loaf of Bread—and Thou." Omar's Rubaiyat has been translated into dozens of languages and many of the lines are now familiar quotations – similar to those of Shakespeare that have become universal quotes across many languages.

As a mathematician Khayyam worked with cubic equations and developed a geometrical solution that could eventually be generalized to higher power equations. He also made one of the most accurate calculations of the length of the solar year.

Unlike most of the golden age scholars, Omar Khayyam wrote in Persian (Farsi: an Indo European language).

7. Maimonides: 1135 – 1204

Moshe ben Maimon was a celebrated Jewish Torah interpreter and philosopher. He wrote 10 medical texts in Arabic including one on asthma and others on toxicology and pharmacopeia.

He wrote detailed ethical and practical advice to physicians and surgeons. An example of the benefits of the celebrated tolerance of most of the golden age caliphates.

His famous *Guide for the Perplexed* reviewed several logical and moral problems facing religious believers (not only Jews) such as the problem of evil which he explained using a version of human free will. His work influenced later major European philosophers such as Spinoza.

Other Golden Age Contributions

Residents of the Golden Age caliphates contributed many inventions, food and products along with the intellectual achievements we are emphasizing in this slideshow. Among them:

- Surgical instruments: al Zahrawi (936—1013) in Córdoba, Spain, developed more than 200 advanced surgical instruments – many of which are in use today in only slightly altered forms (*1001 Inventions*, pp. 160—65).
- Pharmacies were "invented" in Baghdad around 900 C.E. (*1001 Inventions*, pp. 182—3).
- All kinds of improvements in: architecture, glass blowing, pottery, textiles, windmills, water pumps and irrigation, and crops…(*1001 Inventions, p. 111)…*

  Many of these crops were brought from India and were transplanted into Southern Europe, especially Sicily and Spain: (next slide)…

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Page from a 1531 Latin translation by Peter Argellata of Al-Zahrawi's treatise on surgical and medical instruments.

Source: Wikipedia entry on al-Zahrawi.

Islamic Golden Age Crops Brought to Europe

bananas
peaches
plums
apricots
cotton
artichokes
eggplants

sugarcane
oranges and other citrus fruits (word "orange" comes from Persian--Farsi language)

rice
saffron
silk

Source: Al-Hassani, Salim T. S. (Chief Editor). N.d. *1001 Inventions: The Enduring Legacy of Muslim Civilization*. Third edition. Washington, D. C.: National Geographic. Official Companion to the Exhibition. Pages 110 and 111.

House of Wisdom

The House of Wisdom was a library or institute that attracted scholars from surrounding continents. Al-Ma'mun is credited for bringing scholars to the institute to share information about the diversity of their cultures and ethnic backgrounds. The house was a center for the study of different fields ranging from humanities to astronomy, chemistry, literature and mathematics. Scholars made contributions to these fields and collected a world of knowledge.

Academies and Libraries

The "House of Wisdom," a research academy with a massive library of Greek, Persian, Indian and later Arabic writings in Baghdad, was founded by Caliph Harun al-Rashid (reigned 786–809) and culminated under his son al-Ma'mun (reigned 813–833). It was destroyed in the sack of the city following the Mongol Siege of Baghdad (1258). It may have been the greatest collection of knowledge in the world for about 500 years.

A similar library in Córdoba, Spain during this period is thought to have had 600,000 volumes.

Source: Al-Hassani, Salim T. S. (Chief Editor). N.d. *1001 Inventions: The Enduring Legacy of Muslim Civilization*. Third edition. Washington, D. C.: National Geographic. Official Companion to the Exhibition. Pages 72 and 77.

Islam and Its Golden Age

To fully appreciate the contributions of the Islamic Golden Age, it might be useful for non Muslims to learn a few basic, simple facts about the religion called Islam.

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Islam

There are approximately 1.6 billion followers of Islam in the world today. Adherence to this religion makes one a "Muslim."

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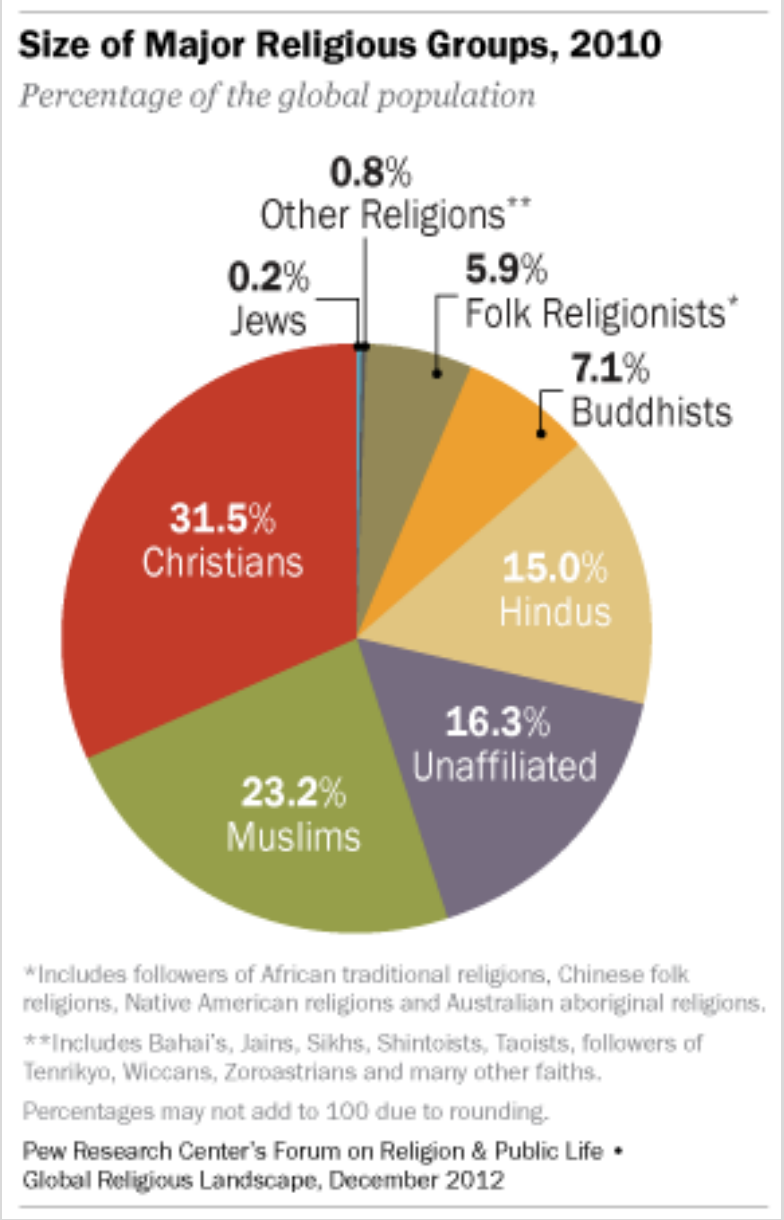
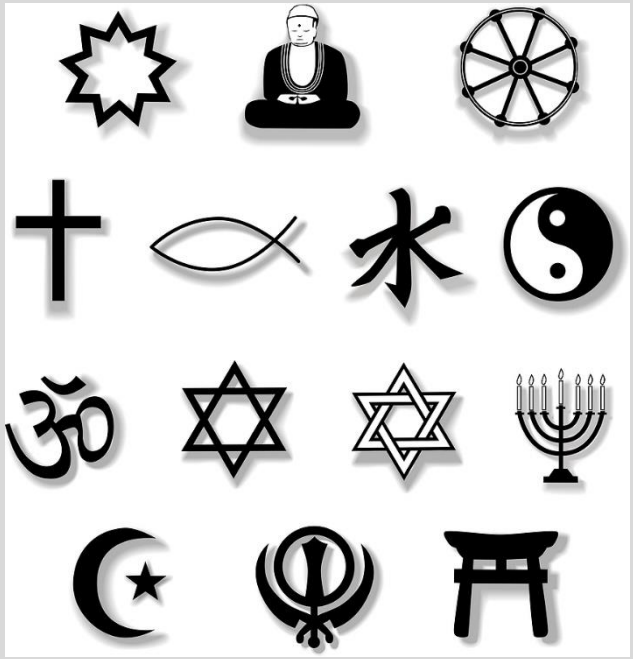
"Muslim" or "Moslem:" the Arabic roots of the two words are very different. A Muslim in Arabic means "one who gives himself to God," and is by definition, someone who adheres to Islam. By contrast, a Moslem in Arabic means "one who is evil and unjust" when the word is pronounced, as it is in English, Mozlem with a z. - See more at:

https://historynewsnetwork.org/article/524#sthash.2gfRLASE.dpuf

Source for the numbers and the chart to the right:
https://www.pewforum.org/2012/12/18/global-religious-landscape-exec/?utm_content=bufferf682f&utm_source=buffer&utm_medium=twitter&utm_campaign=Buffer



Islam in America



Most of the world's Muslims live in Asia, North Africa and the Middle East – see the next slide for a map of the main Muslim areas.

As of 2017, it is estimated there are 3.45 million Muslims in the United States, making up 1% of the U.S. population.

Source: https://en.wikipedia.org/wiki/Islam_in_the_United_States

About 1.8% of New Jersey residents are estimated to be Muslims

Source: https://www.bestplaces.net/religion/state/new_jersey

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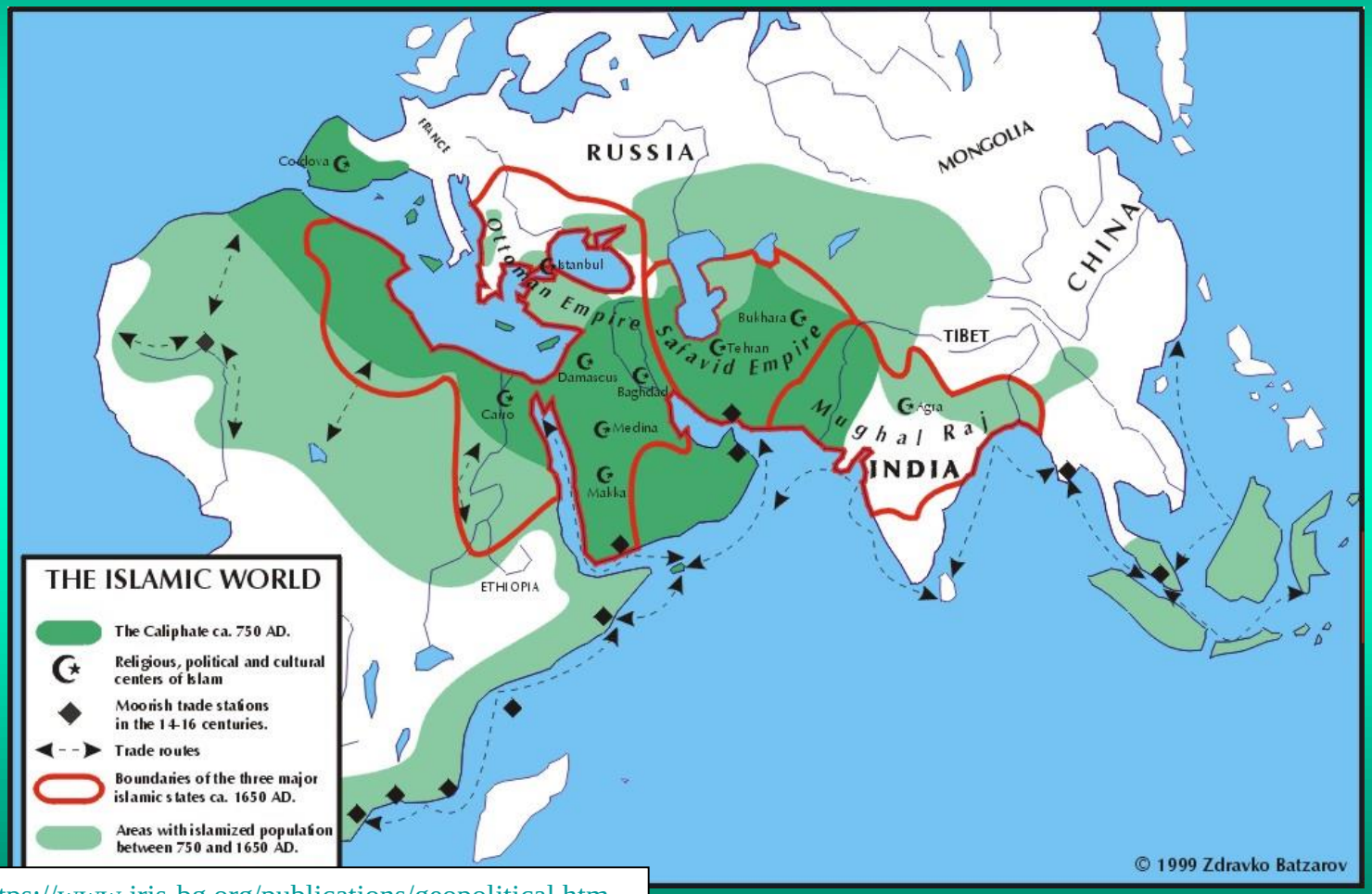

https://www.iris-bg.org/publications/geopolitical.htm

Islam

Islam is a monotheistic (one God) religion founded in what today is Saudi Arabia in 622 C.E.

The founder of Islam is the prophet Muhammed.

Muhammed had worked first as a shepherd and then as a merchant. He came to believe that the people had forgotten the message of the prophet Abraham (same as the one in the Jewish Torah and the Christian Bible) to worship one God. Muhammad loved to pray and meditate in the mountains. On one of those occasions, in the year 610 CE, when he was about 40 years old, he claimed he received a revelation from God through the angel Jibril (Gabriel). He continued to receive messages from God throughout his life and he began preaching to others what he had learned.

Source: https://www.uri.org/kids/world_isla_basi.htm

The main book of Islam is the *Qu'ran* or Koran ("Recitation") – it consists of 114 "suras," or chapters revealed to Muhammed over a 23-year period, ending with his death in 632 C.E.

Islam

Another important document is the *Hadith* – "sayings of the prophet," a compilation of verbal pronouncements which includes the texts of the five daily prayers to be recited by Muslims.

For the non Muslim, one of the most basic features of Islam are the practices called the "five pillars."

We came across the first pillar, the "declaration of faith," or "Shahada," in Lecture 01 [slide 58] of this week when mentioning the Sufi mystics of Islam who may have helped facilitate the introduction of coffee into the Eastern Mediterranean.

Here is the Shahada written in Arabic with English transliteration and English translation. Click on the "audio" to hear the shahada spoken correctly by an Arabic speaker

لا إله إلا الله محمد رسول الله

lā ʾilāha ʾillā-llāh, muḥammadur-rasūlu-llāh

There is no god but God. Muhammad is the messenger of God.[1][2][3]

Audio (prefaced by the phrase *(wa) ašhadu ʾan* —"(and) I testify, that") audio (help·info)

The other four pillars are:

2. Pray 5 times daily at prescribed hours.
3. The Zakat or alms giving for the poor.
4. Fasting from dawn to sunset during the month of Ramadan.
5. The hajj, or visit to the Islamic holy city of Mecca at least once during one's lifetime.

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There are many more beliefs, a range of subgroups, and other features of Islam beyond the 5 pillars.

You can read more details of each of the five pillars of Islam and many other more specific pieces of information on Wikipedia pages or dozens of other internet sites. In my personal experience, Muslim friends and/or colleagues appreciate that someone makes an attempt at a basic understanding of their beliefs – especially at this time in our history when many non Muslims express fears and anxieties about followers of this major world religion.

Want to know more about the Golden Age of Islam?

The BBC has an informative and enjoyable youtube video on **What Islamic World Did For Us - Documentary over ancient Islamic inventions**

https://www.youtube.com/watch?v=J1btMSGeZfA

Update: October 06, 2017

Want to know more about the Golden Age of Islam?

Why Did the Muslim Countries Eventually Decline and End Up Mostly Conquered by European Powers?

Update: October 06, 2017

In other words…

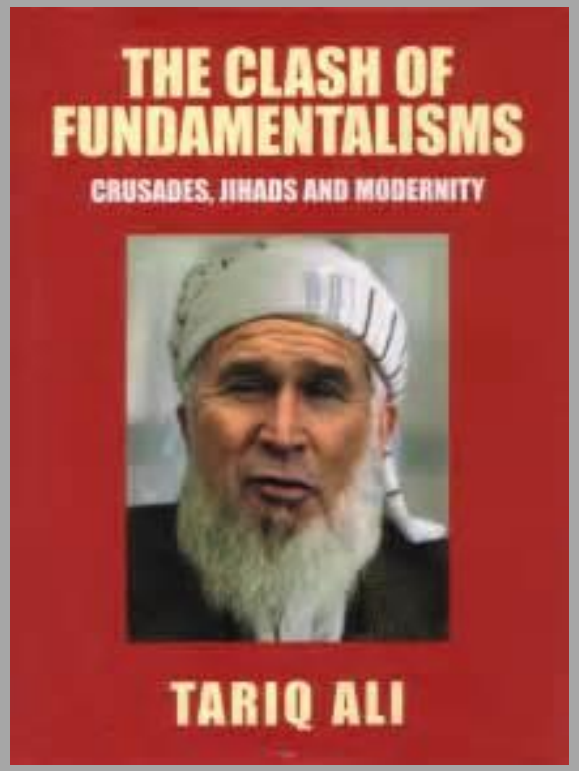
How did the modern situation come about?

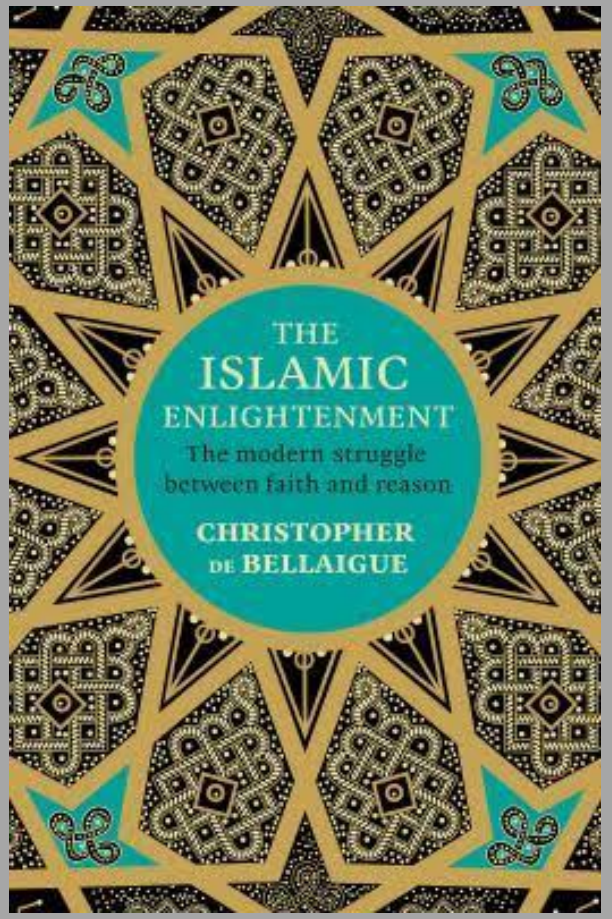
Here are two books by very different authors with very different attempts to answer this question…

Update: October 06, 2017

The famous Pakistani/British intellectual Tariq Ali argues that the absence of a "reformation" in Islam similar to that in Christian Europe is the most identifiable causal factor.

There is much more in his book beyond that main idea.





Update: October 06, 2017

Similarly and yet by contrast, journalist Christopher de Bellaigue argues that in Islam the struggle between faith and reason developed differently in the Muslim world owing in part to the nature of the political regimes there.

Read a review of de Bellaigue's book in the July 23, 2017 NY Times book review section:

https://www.nytimes.com/2017/07/19/books/review/the-islamic-enlightenment-christopher-de-bellaigue.html

Update: October 06, 2017

Both books together might not completely solve the mystery but they offer a beginning and could make the basis of a really terrific term paper!

End of Week 12

Lecture 02

The Golden Age of Islam