An Obscenely Brief History of Geometry & Reason

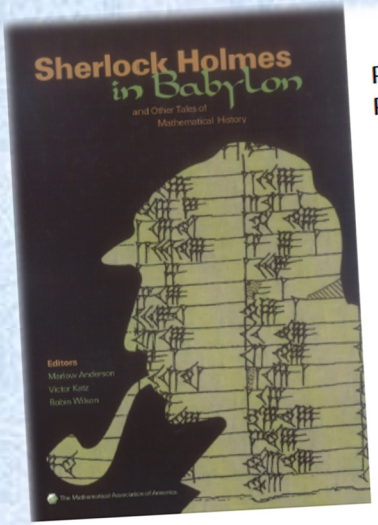
(A “first approximation” – context and a focused, not thorough, history. Deficit except for Theater Majors.)

A Path Through History

We will take a walk along one particularly narrow path---the development of geometric knowledge in Western Civilization, while acknowledging the importance of the influence of other cultures.

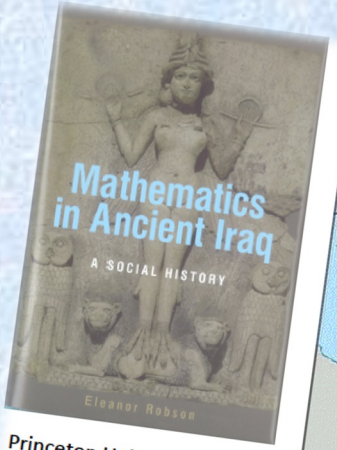
Ancient Babylon

- 2000-1600 B.C., roughly present day Iraq
- About the time of Jewish Patriarch Abraham
- Study of heavens (astrology, astronomy, mathematics was all one discipline, trigonometry)



Mathematical Association of America, 2004

Plimpton 322 (Columbia University), table of Pythagorean triples, circa 1700 BCE, about 9 by 13 cm



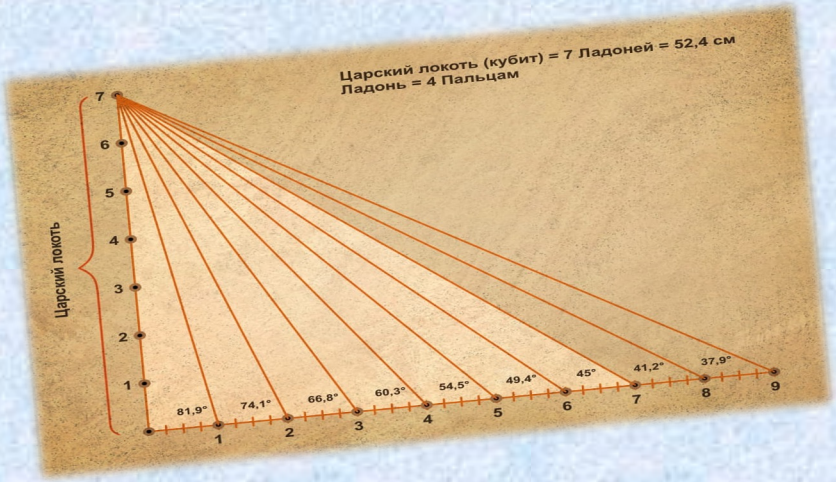
Princeton University Press, 2008

Old Babylonian Empire, 2000–1600 BCE

*Taken from Dr. David Bressoud's Talk at WSU during Fall 2013.

Ancient Egyptians

- "We owe geometry to the tax collector." ---J.L. Heilbron



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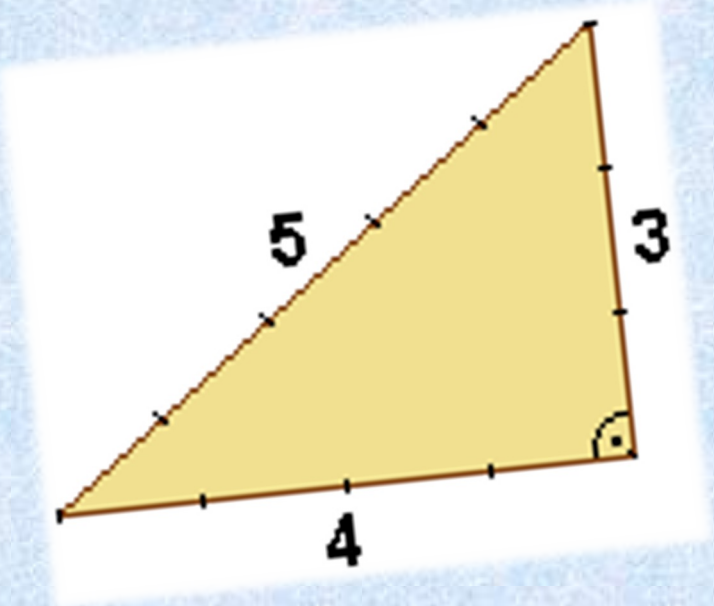
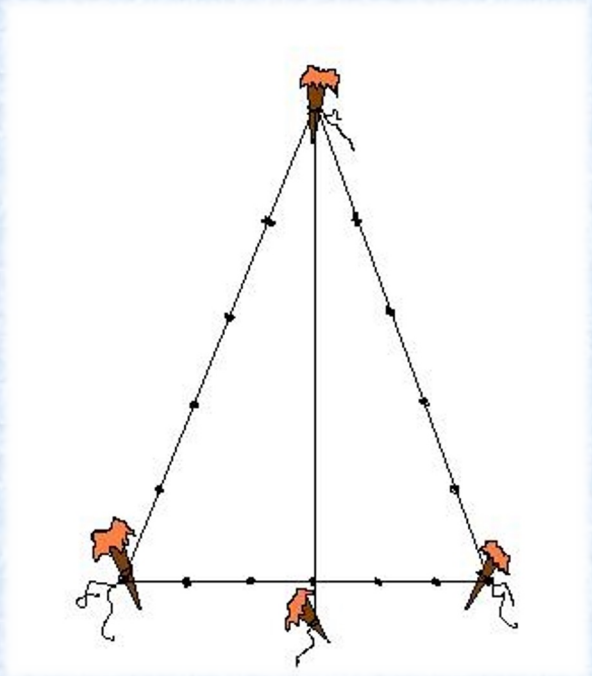
- Rope stretchers were responsible for re-constructing the boundaries of plots of land each year after the flood of the Nile. (Ken Galione)





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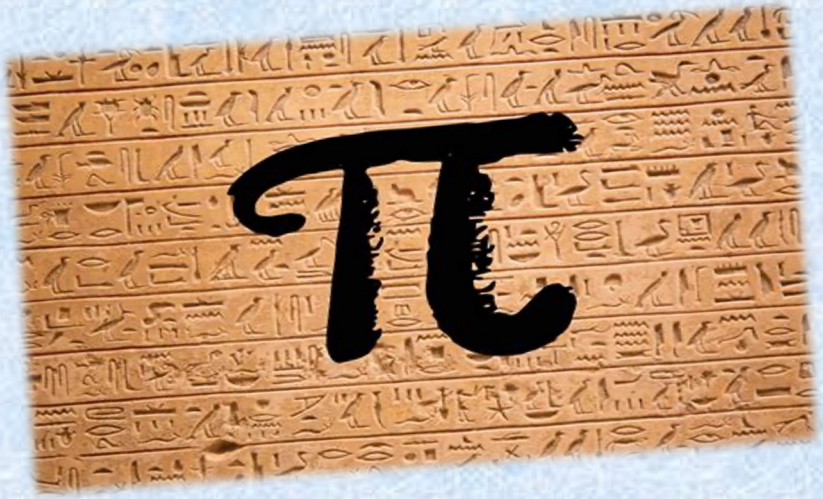
- The Egyptian view of mathematics was very concrete and practical. (van Hiele, Monsters Inc.)
- They had no concept of abstraction; for example, they did not distinguish between approximate and exact values. (pi, for example)



Greek Contribution

- Their main advantage over the Egyptians is that they classified objects and therefore could prove sweeping claims about entire classes of objects using deductive reasoning. (Prove infinite number of cases finite amount of work)

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- This type of reasoning would totally baffle Egyptians, who didn't think of the concept of "triangle" as any object with three straight sides.

Greek Contribution

- In contrast to the Egyptians, who reserved "knowledge" to a high priestly class, the Greeks established a vibrant marketplace of ideas, where ideas were openly and vigorously debated by anyone who cared to offer their thoughts – a democracy of knowledge or free market intellectualism. **(cf. SOC w/ Ant Colony, Bieberbach Conjecture, COVID, Richard Feynman – Follow Data not Experts, Aereopagus in Acts)**

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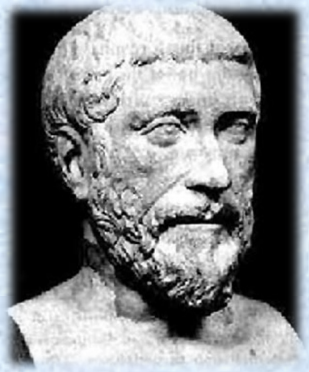
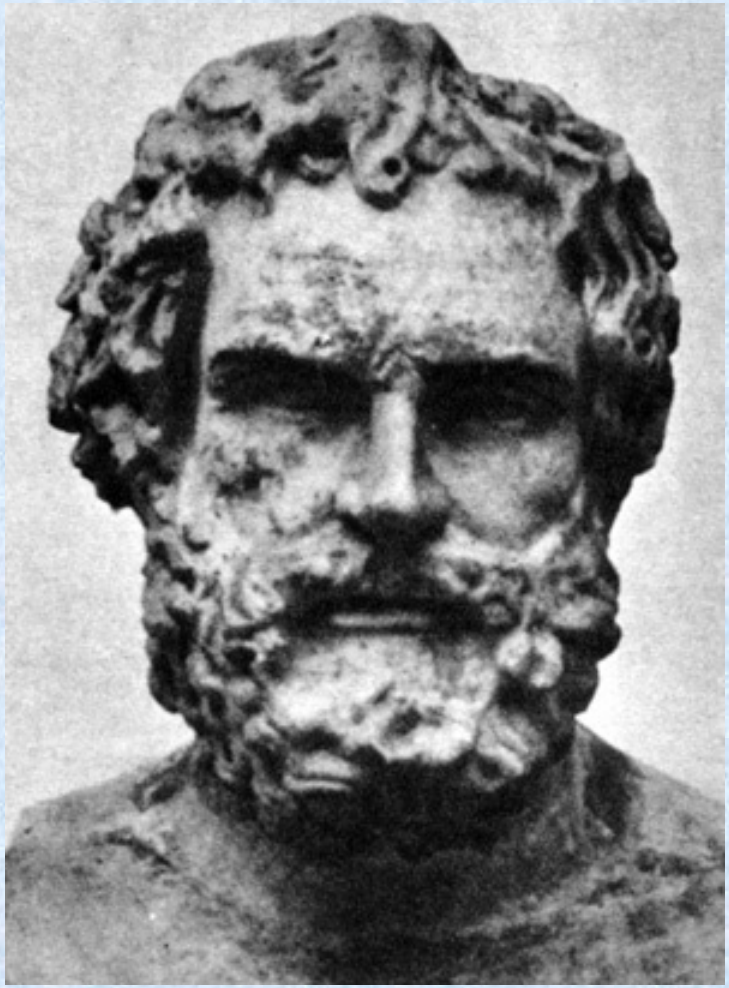
- Two main schools were the ***Ionian school by Thales of Miletus*** (624-548 B.C.) and the ***Pythagorean School by Pythagoras of Samos*** (580-500 B.C.).



Greek Contribution

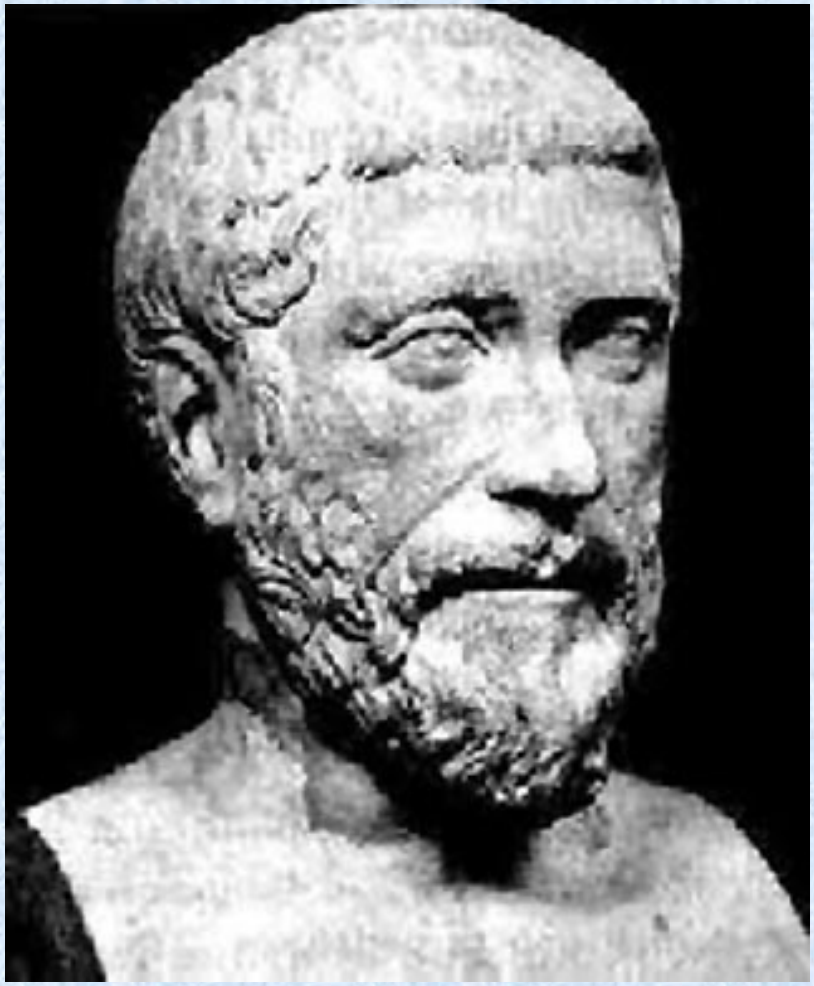
Thales (624-548 B.C.): first postulated that the universe was subject to universal truths, or laws, which could be discovered by abstraction in contrast to the view that the world was constantly at the whim of gods; often coined as the first mathematician.

(Dudes on Somsen 2nd Floor)



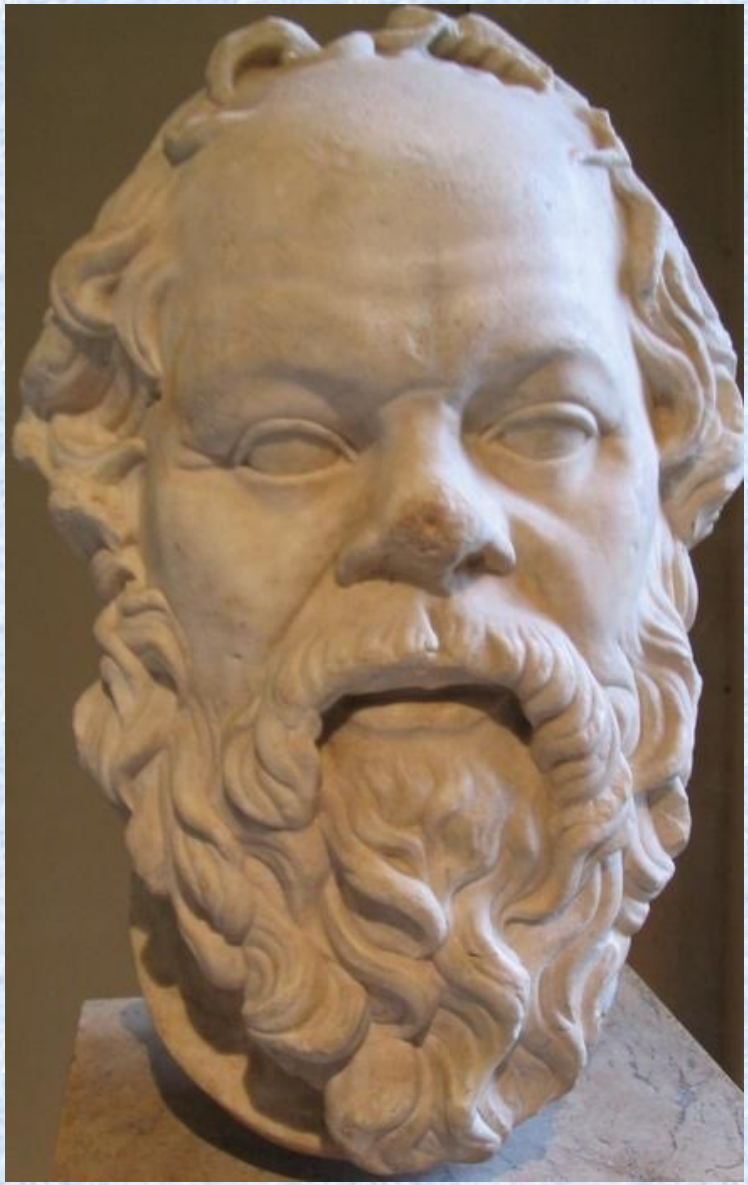
Greek Contribution

Pythagoras (580-500 B.C.): coined the terms "philosophy" (love of wisdom) and "mathematics" (that which is learned) and held that mathematics, religion, art, and music were interconnected as avenues to reality and truth. (cf. the Pythagoreans and that unfortunate Hippasus event.)



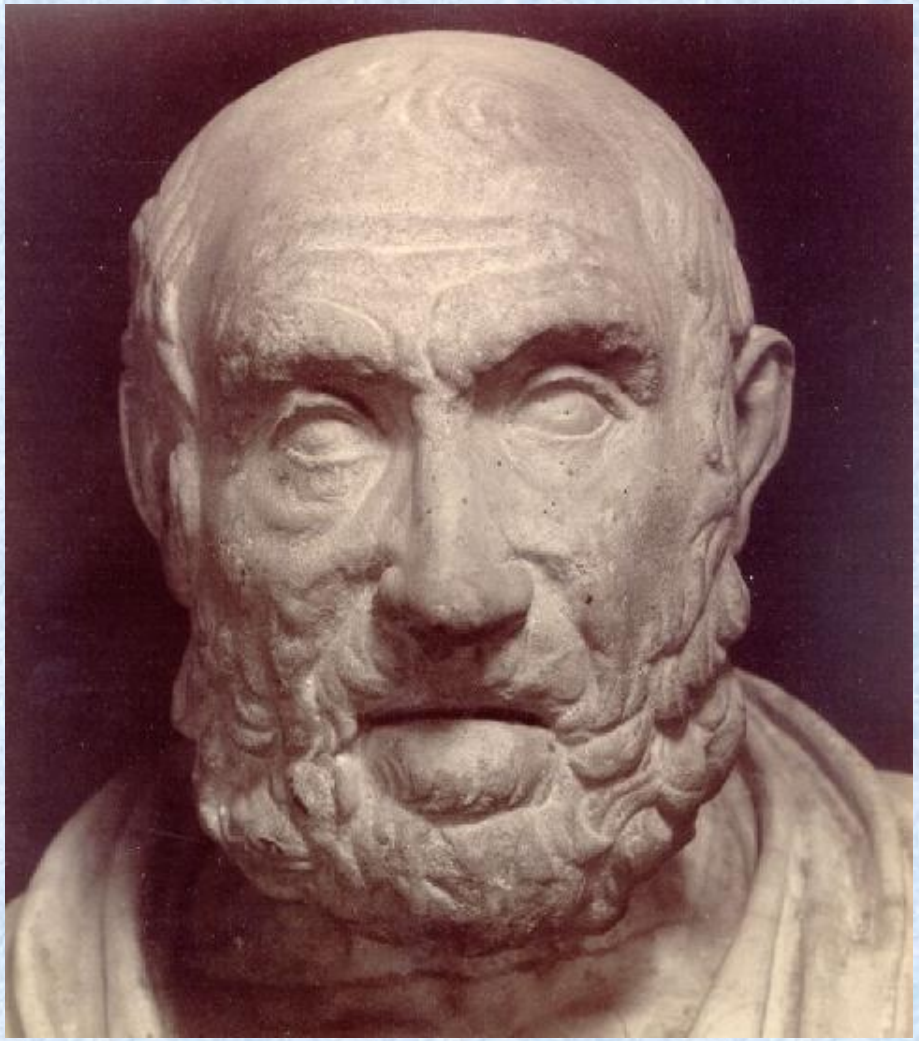
Greek Contribution

Socrates (469-399 B.C.): a prominent founder of Western philosophy. Best known for the Socratic Method of teaching, he wrote no treatises. Most of what is known about him is related through his followers, most notably Plato. He died for "corrupting the minds of the youth of Athens" (Sophists) and was condemned to death by poison Hemlock.



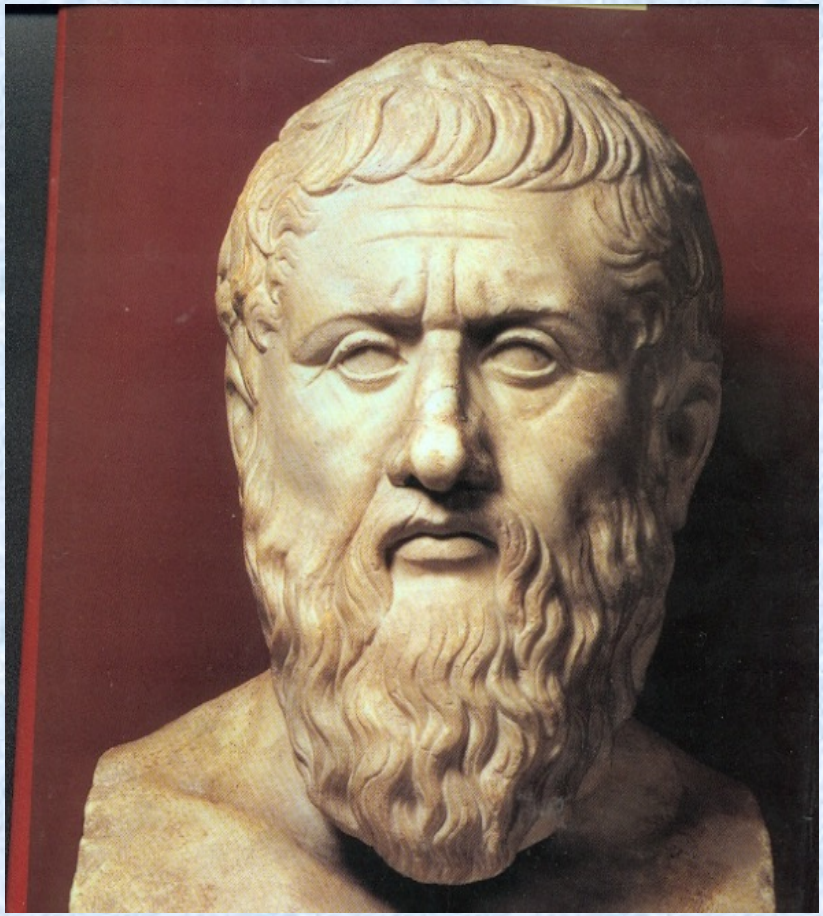
Greek Contribution

Hippocrates (460-375 B.C.): removed treatment of disease from the hands of religion, maintaining that it had natural causes which could be treated. (cf. Thales)



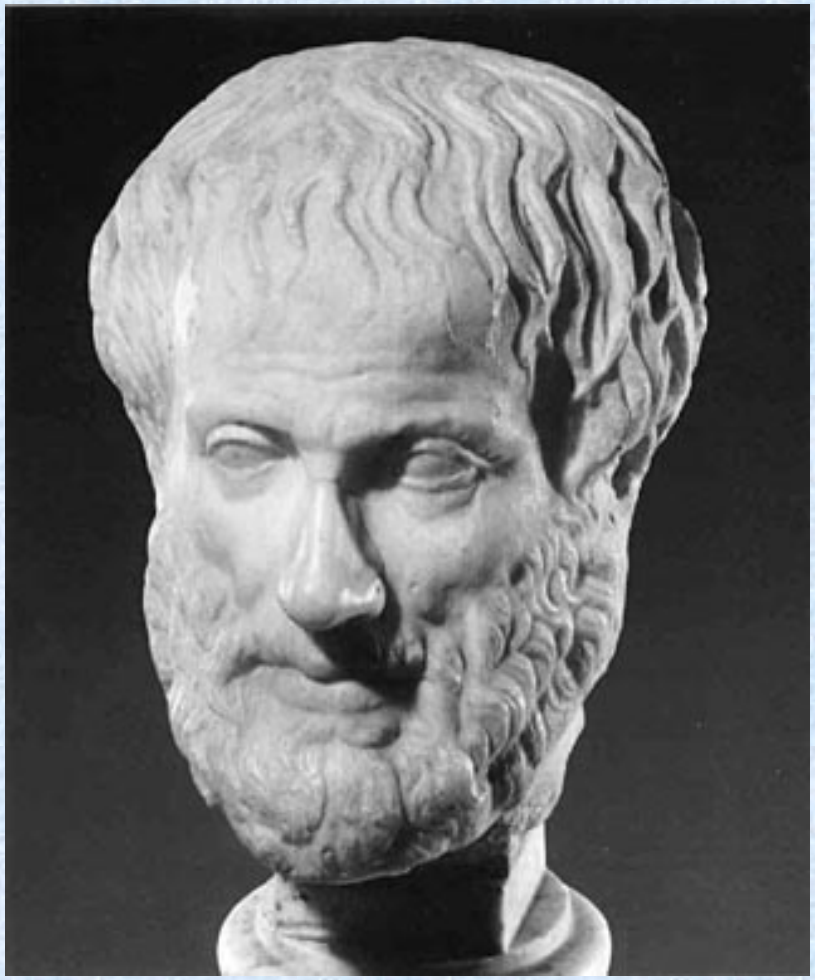
Greek Contribution

Plato (427-348 B.C.): student of Socrates, philosopher, writer of "Dialogues," in which he relates much of the teaching of Socrates, and founder of "The Academy," the first university in Europe (Athens). Plato had located ultimate reality in Ideals or eternal forms, knowable only through reflection and reason. (Allegory of the Cave, senses vs. ideals.)



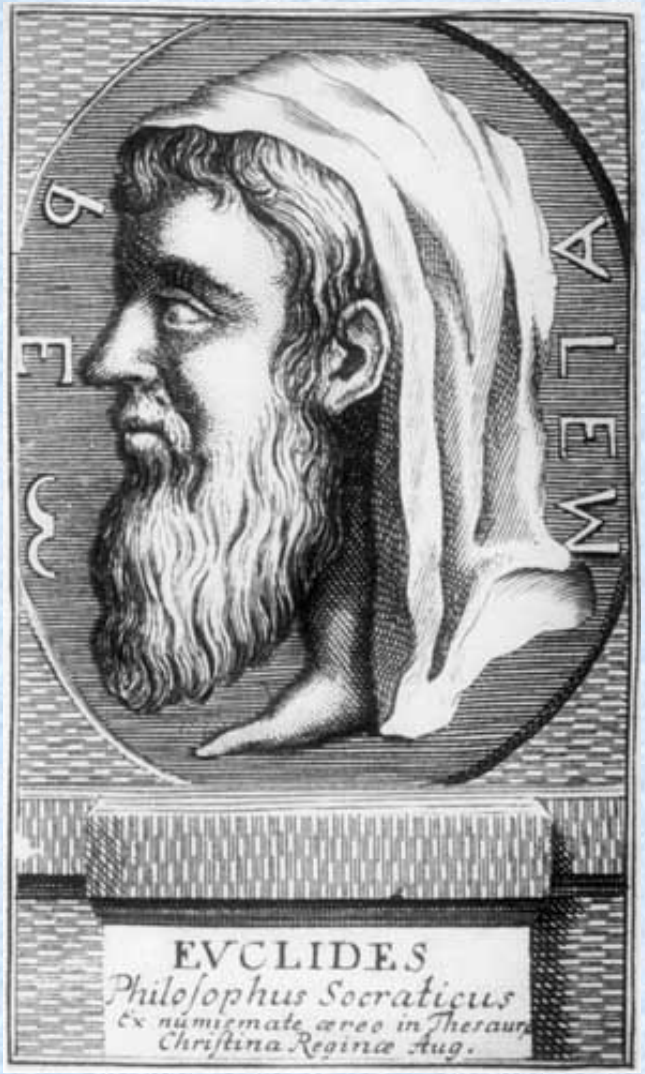
Greek Contribution

Aristotle (384-322 B.C.): a student of Plato. Whereas Plato had located ultimate reality in Ideals or eternal forms, knowable only through reflection and reason, Aristotle saw ultimate reality in physical objects, knowable through experience.



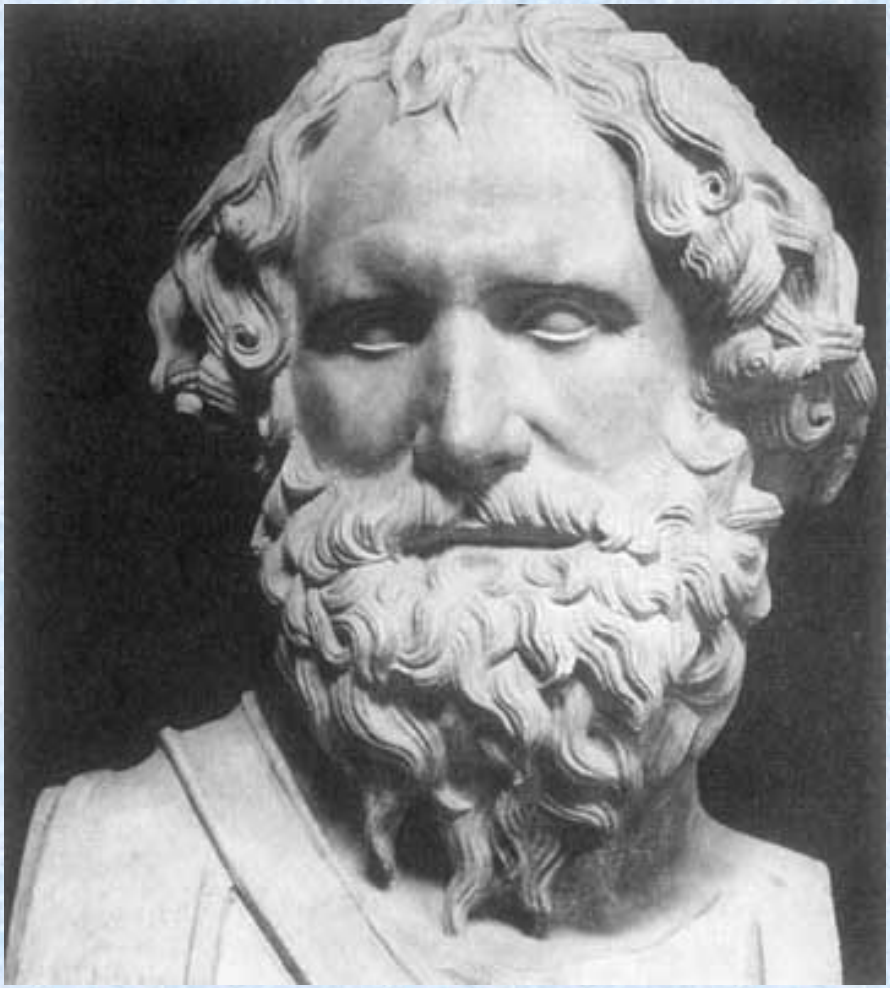
Greek Contribution

Euclid (365-280 B.C.): systematized the Greeks' knowledge of geometry in his magnum opus, "Elements," which consisted of 13 volumes and to this day forms the backbone of modern geometry. (Development of Axiomatic System.)



Greek Contribution

Archimedes (284-212 B.C.): made discoveries that had great practical value. He discovered the laws of the lever and of pulleys, he invented engines of war and the water screw, and he named the principle of buoyancy named after him. (Eureka!)



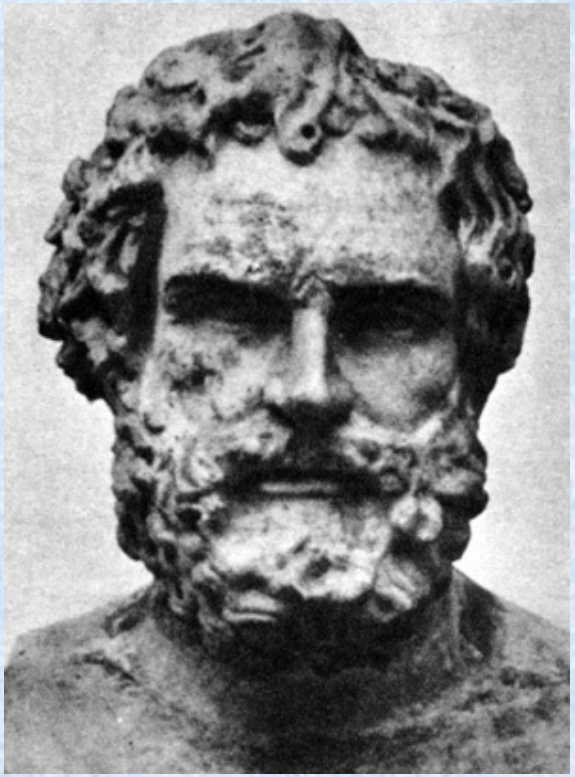
Greek Contribution

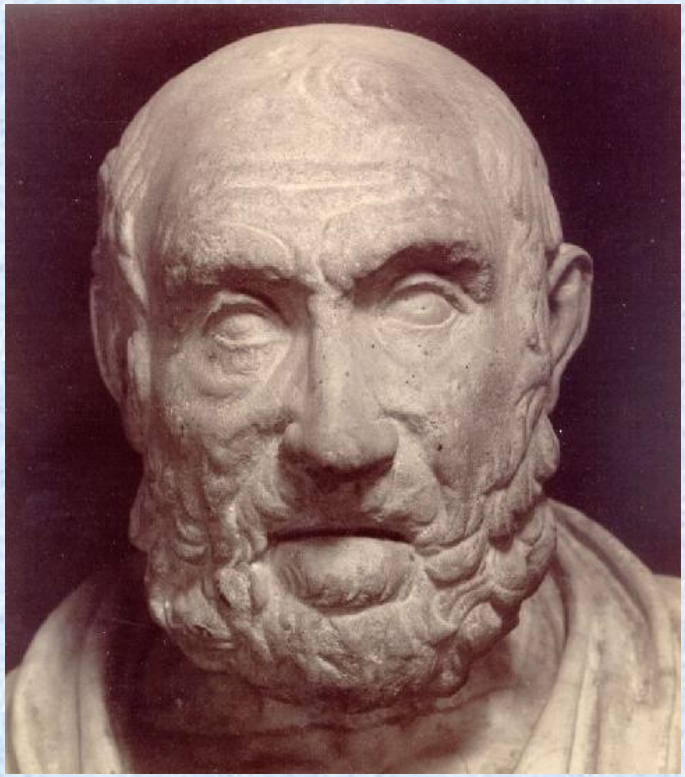
Eratosthenes (274-194 B.C.): was director of the great library in Alexandria. He calculated the circumference of the earth correctly using only geometric principles.

(Cyrene & Alexandria, Egypt)

Greek Contribution

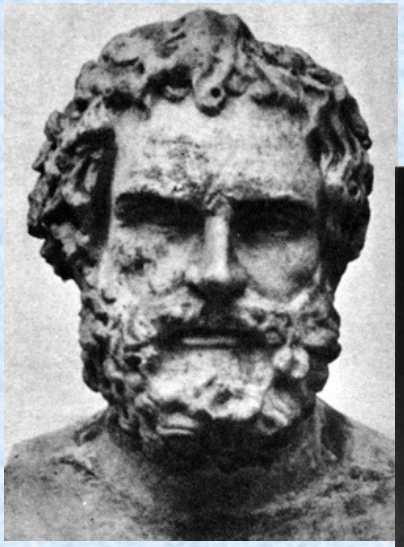
- **Thales/Hypocrates Connection:** Note that Thales first postulated that the universe was orderly and not at the whim of gods, and Hypocrates simply applied this reasoning in the area of medicine. (cf. modern psychology, addiction, mental illness)

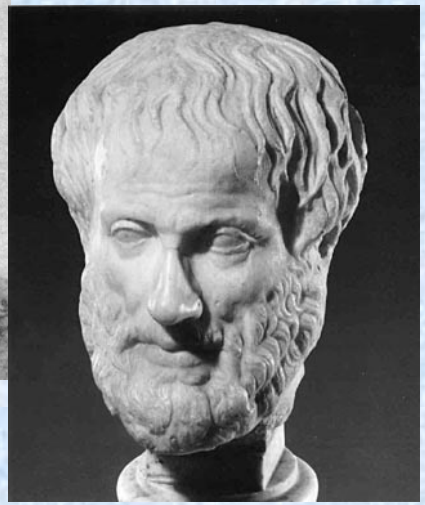


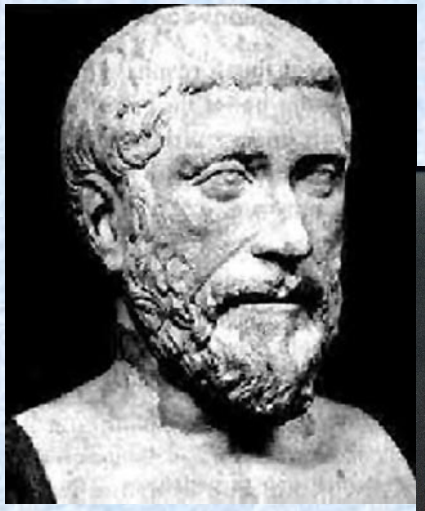


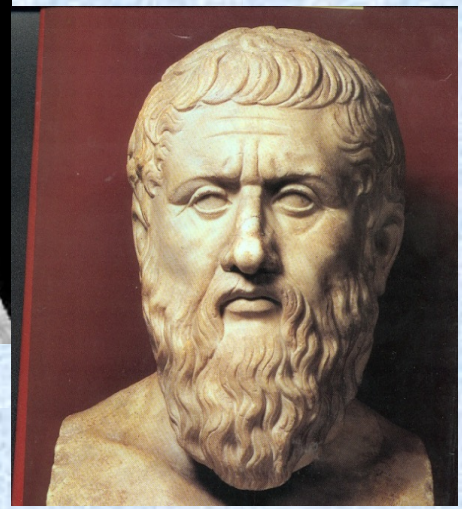
Greek Contribution

- **Thales-Aristotle vs. Pythagoras-Plato:** Notice that both Thales and Aristotle centered truth on the sensible world, believing that universal truths (Essences) could be derived by studying particular things. For Pythagoras and Plato, the realm of the mind and beauty were the locus of truth, and the particular physical manifestations of these Ideals in the material world were but flawed and deficient realizations of them.









Transition to Modern Era

Babylonian & Persian Connection

- **597 B.C.** – Jewish Exile to Babylon (Thales, Pythagoras)
- **539 B.C.** – Persia conquered Babylon, allowed religious freedom. Some Jews returned to Jerusalem and others remained in the Persian culture
- **323 B.C.** – Alexander the Great conquered Persia, and Seleucid presided over spread of Hellenistic culture
- **167-160 B.C.** – Revolt by Judas Maccabeus (Eratosthenes)
- **~6 B.C.** – Magi reportedly come from East, "following a star" (Herodotus (I, ci) and Early Church Fathers identify them as Magi, priests, from Persia)

Roman Contribution

- **Greco-Roman Republic:** began in about 509 B.C. (the time of Thales and Pythagoras) with the overthrow of the Roman monarchy and lasted until 49 B.C.
- **Maccabean Revolt:** at this time the Greco-Roman Republic occupied what we now call the Holy Land. The Jewish people overthrew them and regained control of the Jewish temple on the 25th day of Kislev in 164 B.C., which had been defiled by pagan sacrifices.

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Roman Contribution

- **Caesar:** began a civil war in 49 B.C. from which he emerged as the unrivaled leader of the Roman world. This began the reign of the Caesar's, who were venerated as gods. The Roman Republic has now become the Roman Empire.
- **Practicality:** The Roman Republic and Empire preserved the Greek knowledge and made it practical – engineers. (WSU scholar, Roman Arch, Aqueducts, Roads)

Christian Factor

- **Christianity:** into this world Christianity was born.
  - "We see as through a glass darkly" (1 Co 13:12)
  - Paul addresses the Areopagus, a group of Stoic and Epicurean philosophers (Acts 17:22)

Christian Factor

- **Gnosticism:** enters the Christian world as a claim that matter is inherently evil or deficient and therefore God would never have become a man. Suggests the Greek version of intermediate gods. Ends with Mary being declared "Mother of God" to emphasize that Jesus, a human being, was indeed the God of creation. (Strain of Platonic Thought)

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- Dark Ages (476-1000 A.D., not 1500 A.D.!). (cf. Golden Age of Islam, Dark Ages Europe w/ Perfection of Reason…)

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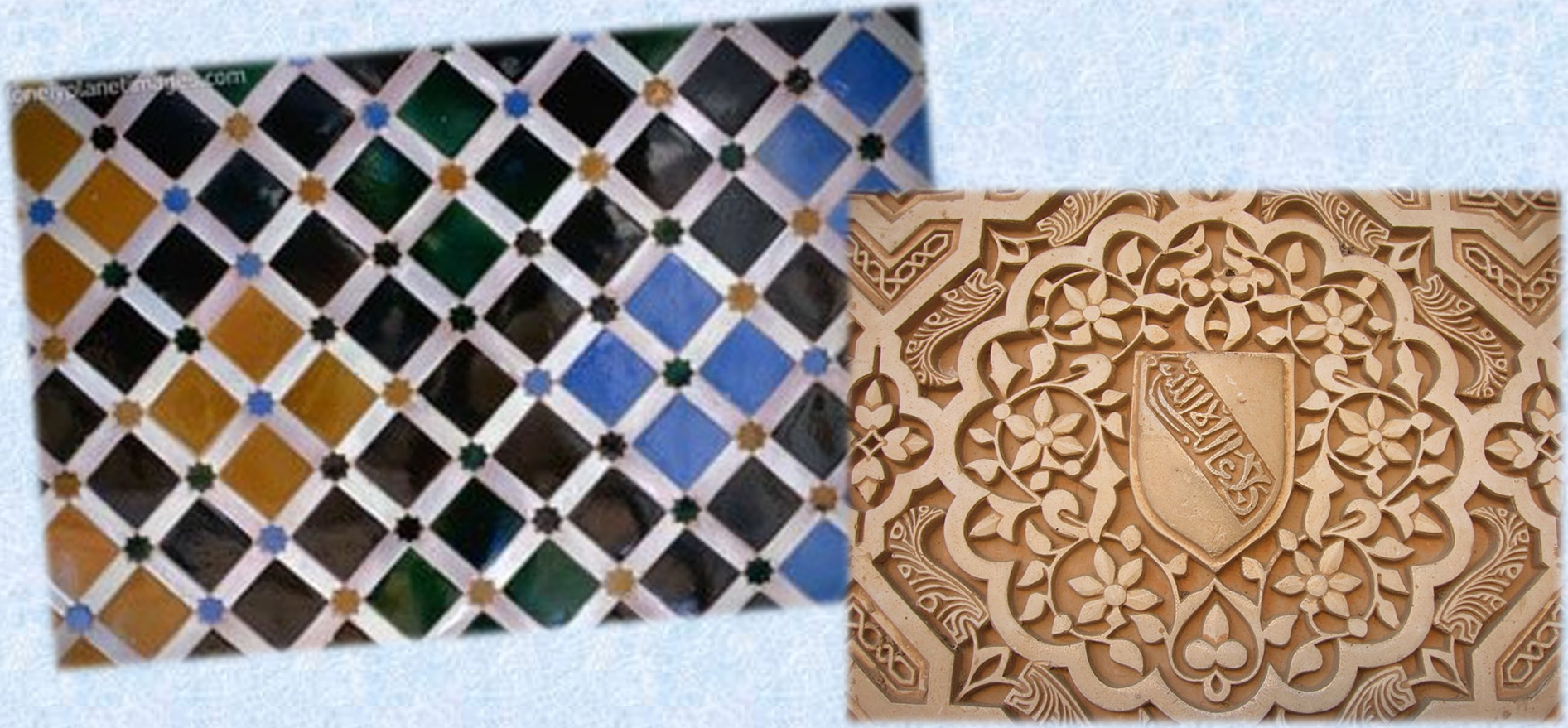
- Medieval Ages (476 A.D.-1400 A.D.)
  - Dark Ages (476-1000 A.D.)
  - High Middle Ages (1000-1400 A.D.)

Stewardship of the Knowledge

- Coupled with its absolute prohibition of graven images, this gives rise to a complex and intricate geometric art.



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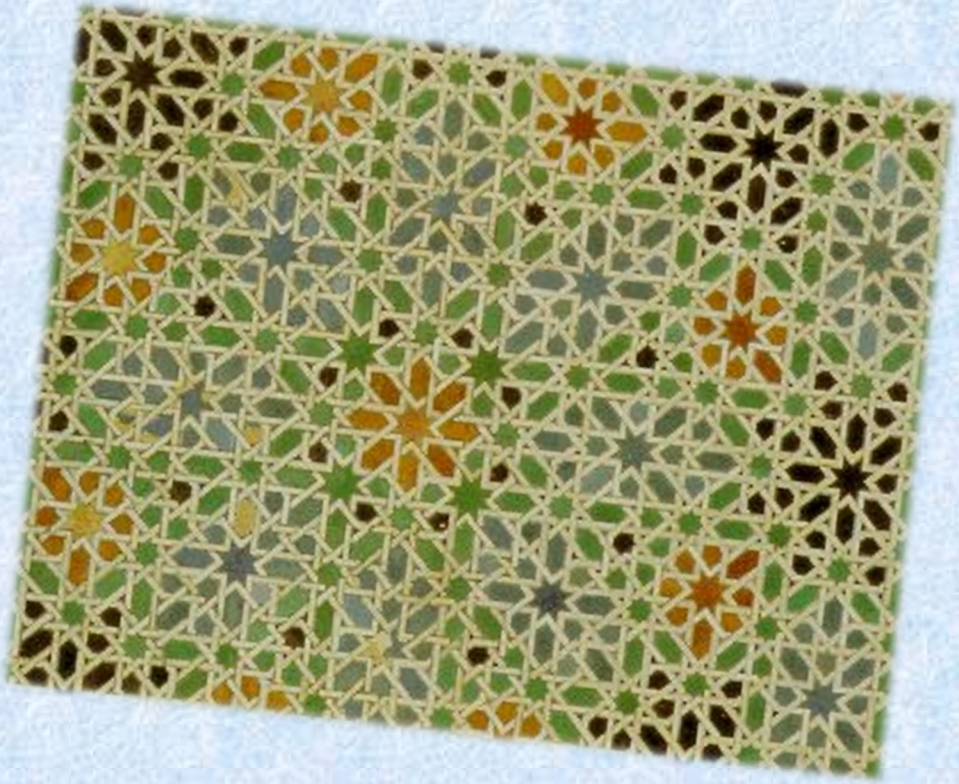


Stewardship of the Knowledge

- Coupled with its absolute prohibition of graven images, this gives rise to a complex and intricate geometric art. (Notice Greek/Roman influence, but goes beyond that.)

Stewardship of the Knowledge

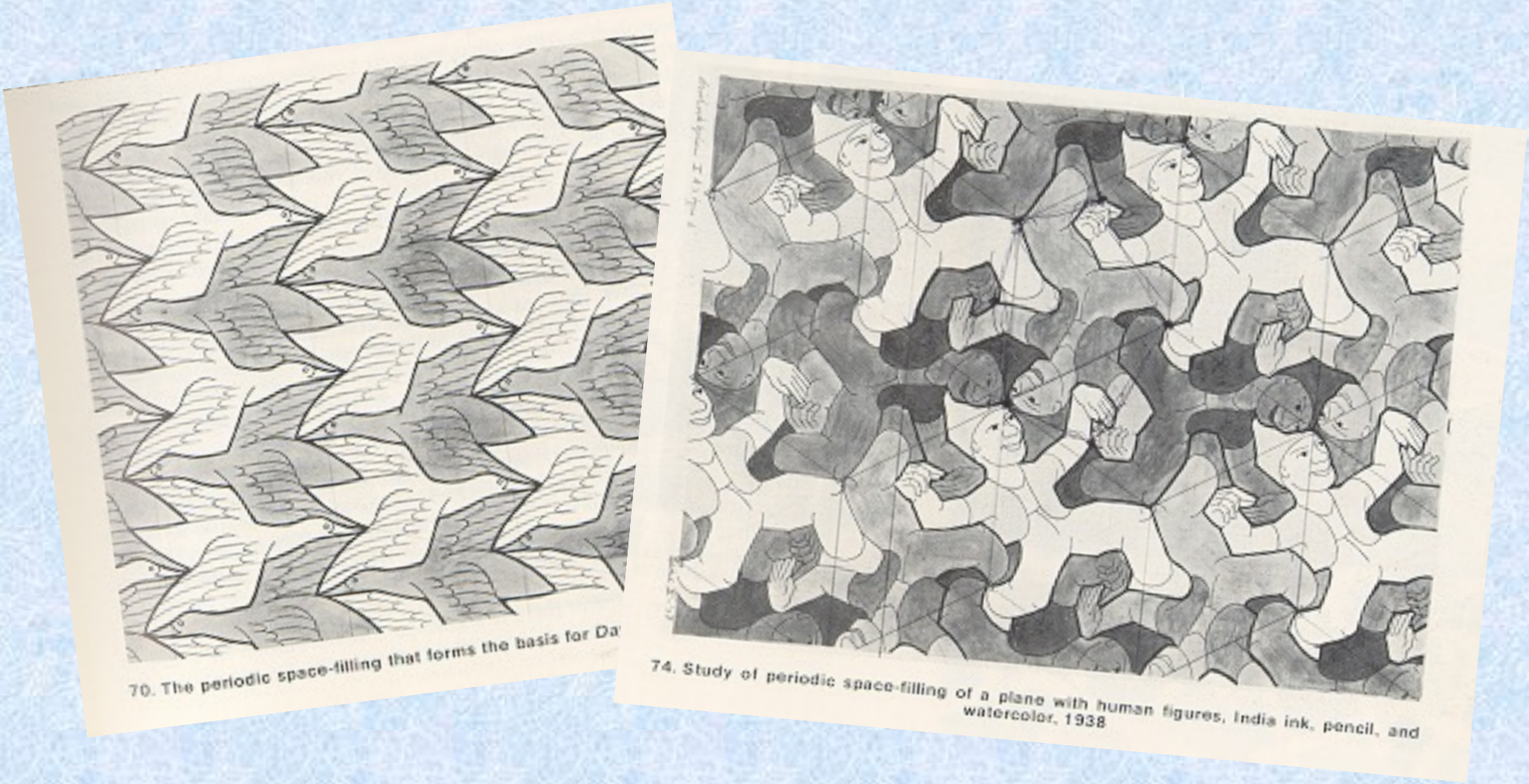
- As Muslims take custody of parts of Rome, Greece, and Southern Spain, they find this vast repository of knowledge.
- Coupled with its absolute prohibition of graven images, this gives rise to a complex and intricate geometric art.
- Islam preserves and nurtures this knowledge left by the Greco-Roman culture.

Stewardship of the Knowledge

- La Alhambra in Granada and the libraries of Cordoba, Spain are repositories of this knowledge in southern Spain (Moor occupied).

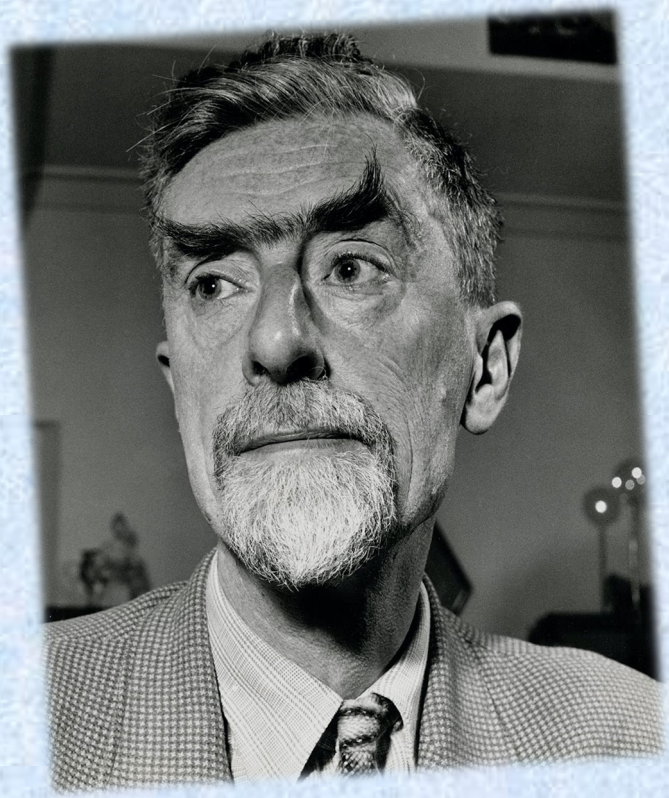
M.C. Escher

- Dutch artist most famous for his tessellations or tilings of the plane.



M.C. Escher

- In his notebooks, one sees evidence of his trip to La Alhambra in Spain to study the craftsmanship of the Moors.



Knowledge Lost---and Found Again

- Some learning preserved during the Dark Ages, mostly in monasteries.
- By the High Middle Ages, it began to bear fruit, and knowledge and learning were advancing in philosophy and science.
- Some scientists of note from this time: Albertus Magnus, Robert Grosseteste, Roger Bacon, John Peckham, Duns Scotus, Thomas Bradwardine, Walter Burley, William Heytesbury, Richard Swineshead, John Dumbleton, Richard of Wallingford, Nicholas Oresme, Jean Buridan and Nicholas of Cusa.
- But then, something happened to interrupt this…

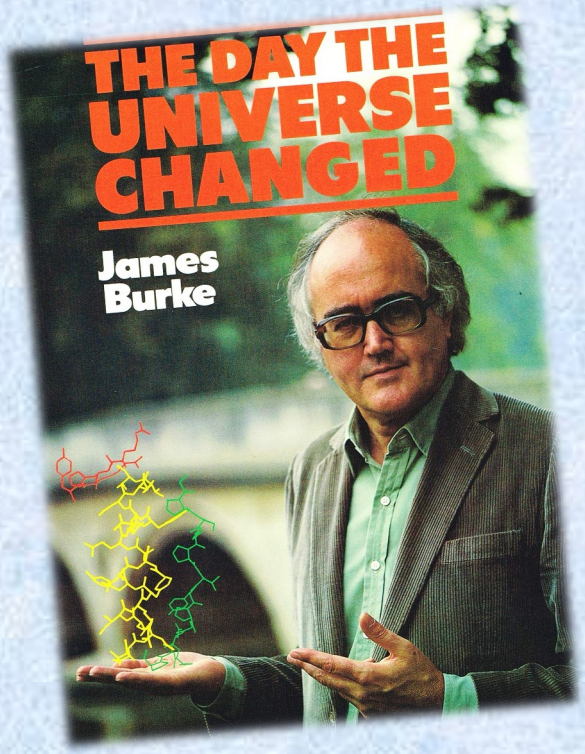
- **Albertus Magnus** – Helped establish empirical observation in natural philosophy and produced foundational works in biology, mineralogy, and botany.
- **Robert Grosseteste** – Developed an early scientific method grounded in mathematics and experimentation, especially in optics and light theory.
- **Roger Bacon** – Advocated for experimental science and made pioneering contributions to optics, including studies of lenses and vision.
- **John Peckham** – Advanced the geometric theory of optics, especially the propagation and reflection of light.
- **Duns Scotus** – Introduced influential metaphysical and logical analyses that shaped later medieval discussions of motion and causality.
- **Thomas Bradwardine** – Formulated the logarithmic "Bradwardine law," an early mathematical theory relating force, resistance, and motion.
- **Walter Burley** – Contributed to Aristotelian natural philosophy, particularly discussions of motion, place, and time.
- **William Heytesbury** – Developed the "mean speed theorem" and key logical analyses of kinematics within the Oxford Calculators tradition.
- **Richard Swineshead** – Applied advanced mathematics to physical problems in motion, velocity, and ratios, earning the name "The Calculator."
- **John Dumbleton** – Proposed mathematical analyses of light and motion, anticipating ideas about measurement and quantification of change.
- **Richard of Wallingford** – Designed sophisticated astronomical instruments and clocks, including the famous *Albion*, to model celestial motions.
- **Nicholas Oresme** – Pioneered graphical methods for representing changing quantities and proposed early ideas of Earth's rotation.
- **Jean Buridan** – Formulated the theory of impetus, a major step toward the modern concept of inertia.
- **Nicholas of Cusa** – Proposed bold cosmological ideas, including the infinity of the universe and motion of Earth, departing from Aristotelian cosmology.

Crusades

(1096 to 1487)

(cf. James Burke, "The Day the Universe Changed")

- From the perspective of Europe, these began as an effort to retake the Holy Land, secure safe passage for pilgrims to Jerusalem, and protect Europe from encroachment of the "Moors."



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- It is clear that eventually many atrocities occurred at the hands of the crusaders, even against Orthodox Christians. Children's Crusade, etc. Pretty messy history.

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- A recovery of a vast amount of knowledge from La Alhambra in Granada and the mosque and libraries of Cordova, Spain caused a rebirth of learning in Europe known as…**? ? ?**

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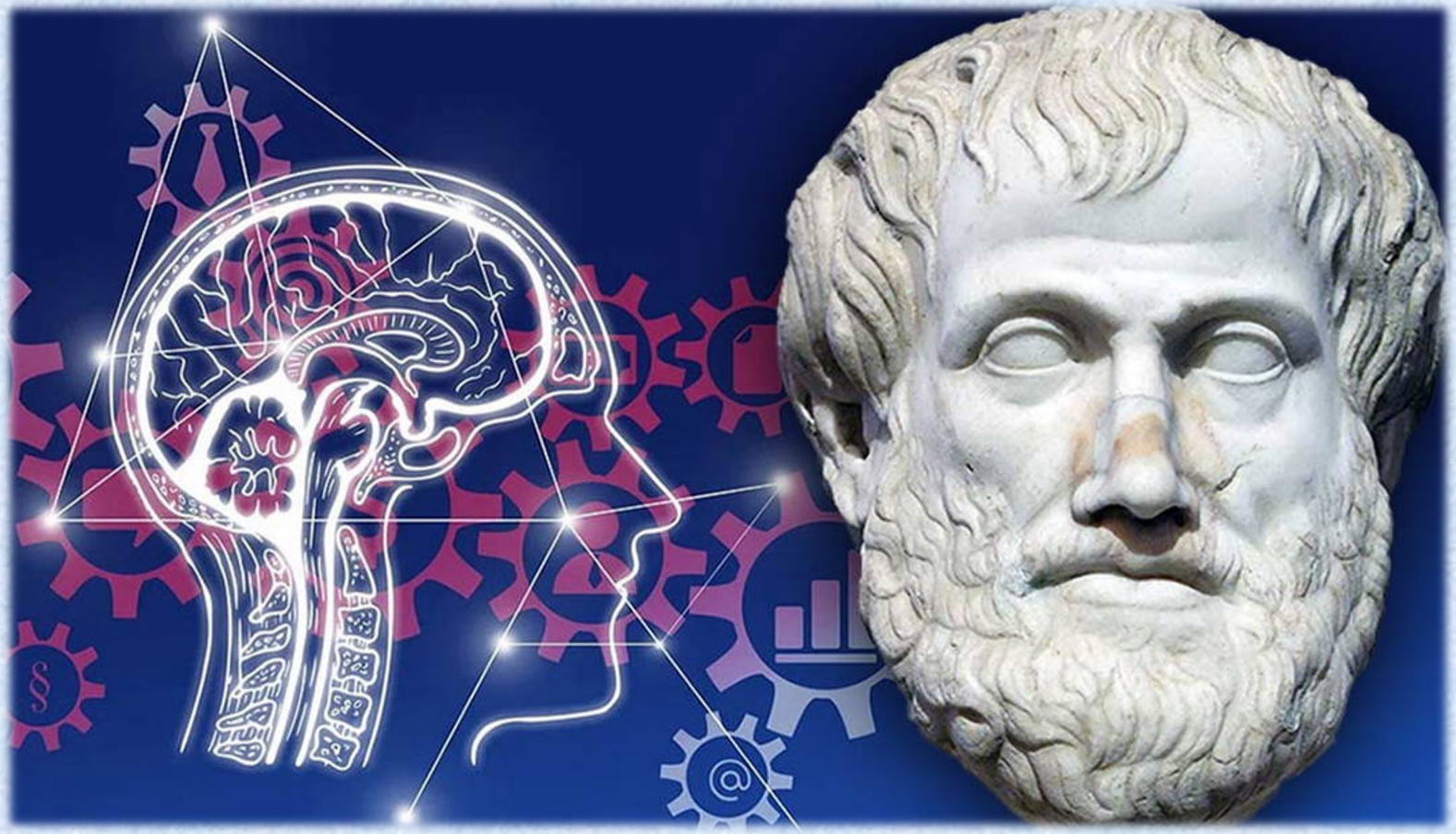
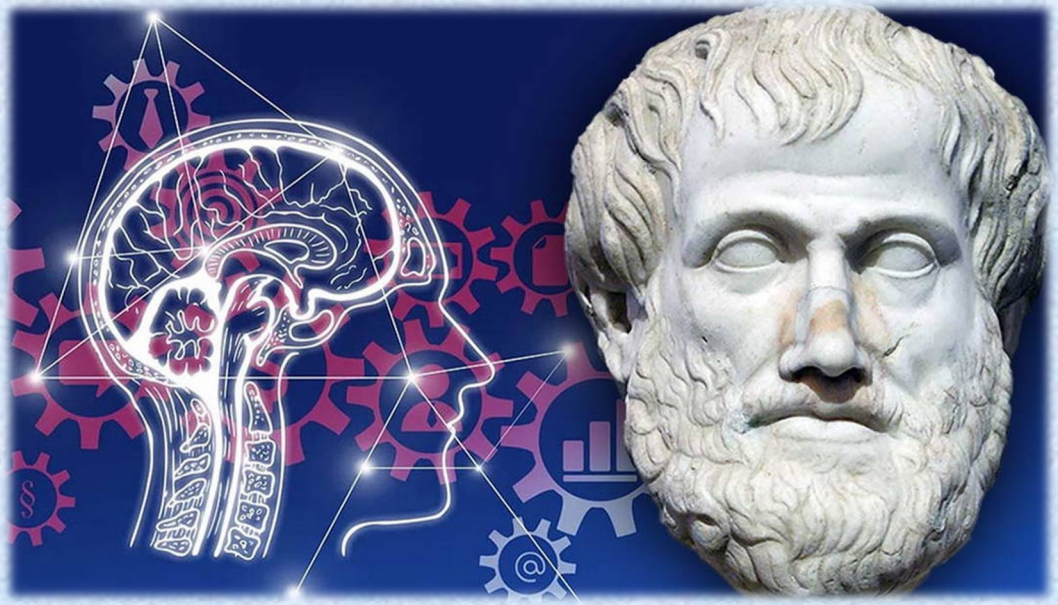
Renaissance

- Logic of Aristotle was revolutionary. (cf. systemization of thought was revolutionary → Scholasticism)



Renaissance

- Logic of Aristotle was revolutionary.
- Platonism and other aspects of Greek philosophy, which survived in modified form in the Catholic Church, was reinforced – and challenged.



Renaissance

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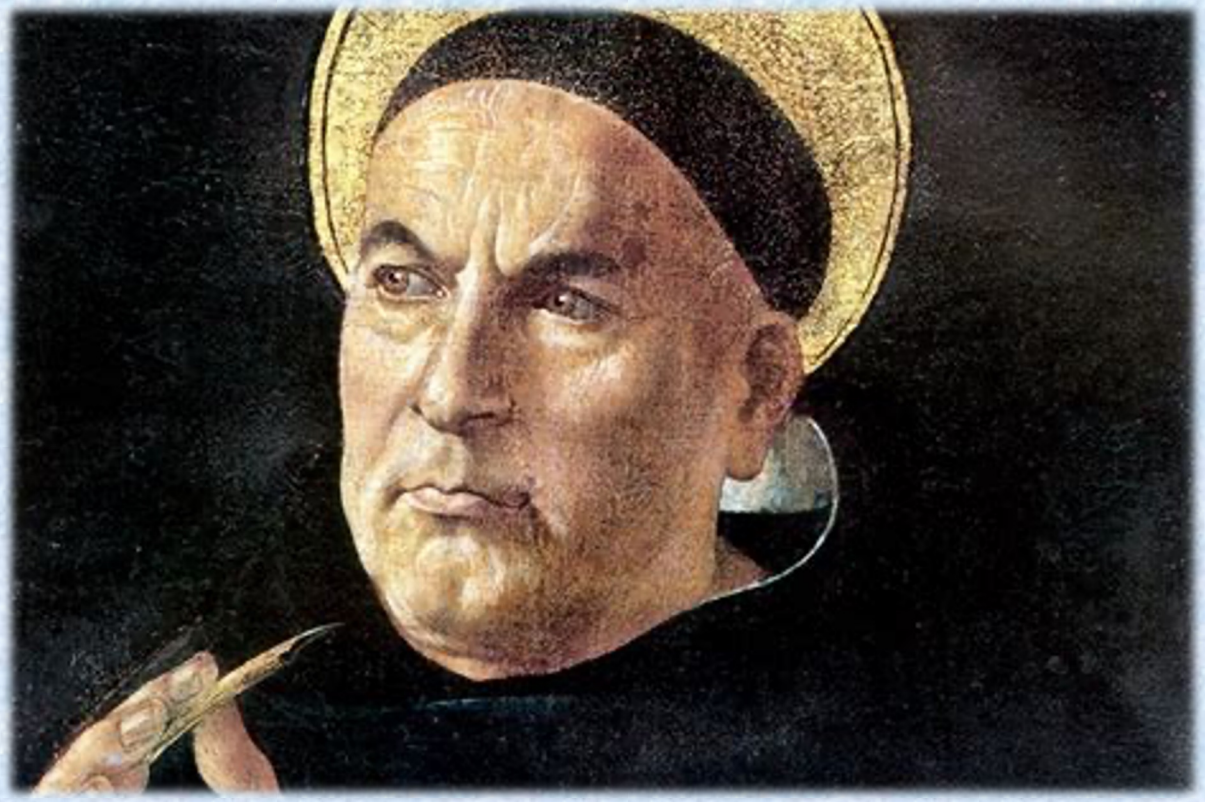
- Many began using Aristotle's thought to argue against the current knowledge of the High Middle Ages, Christianity, and even the existence of God.

Renaissance

- A lone monk took it upon himself to show that, in fact, the logic of Aristotle is, in reality, perfectly consonant with Christianity and enhances its rational dimension.



Renaissance

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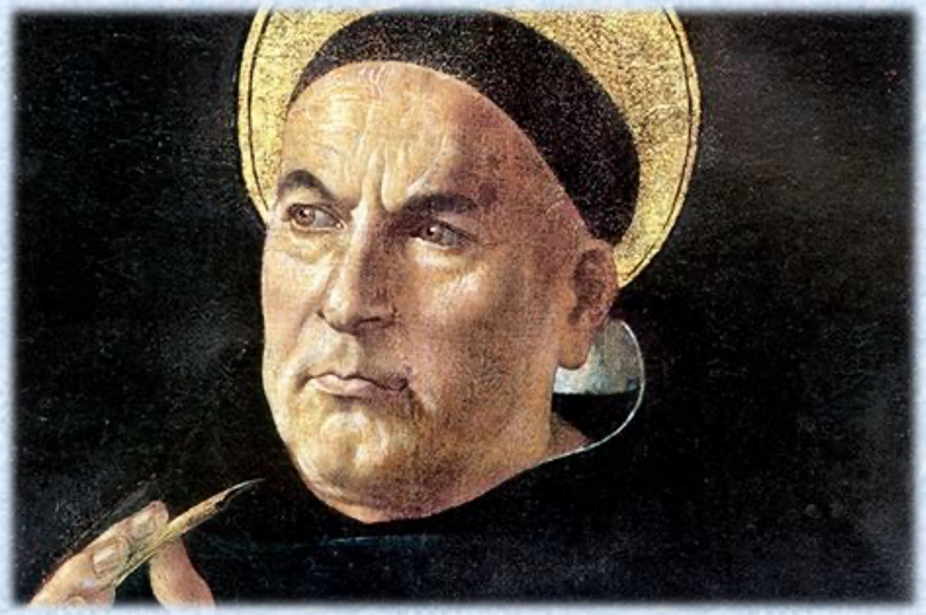
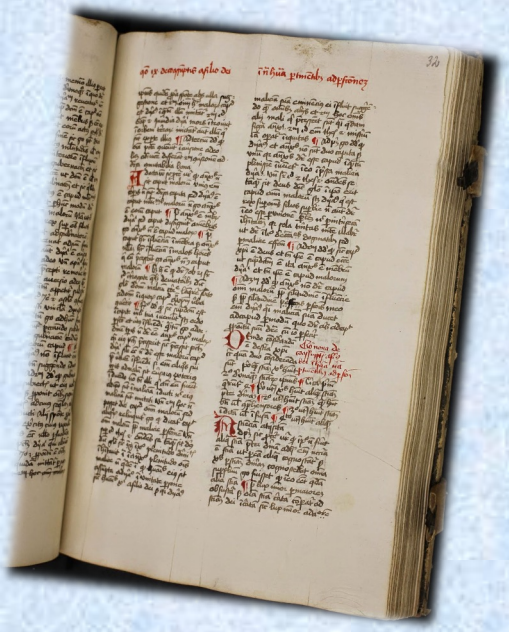
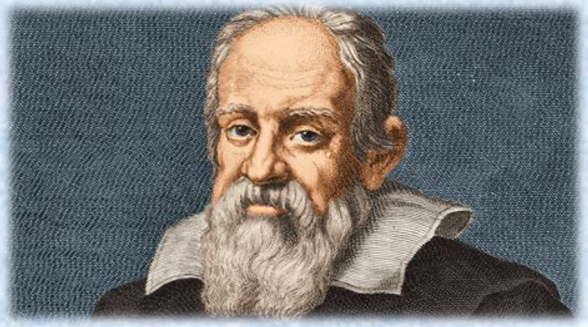
- St. Thomas Aquinas (13th century).
- Theology/Philosophy/Mathematics/Science all mixed; universities were for training religious and invented by the Church.





Birth of Empiricism

- Logic and considerations of beauty (cf. Pythagoras) were paramount in academic discussions.
- Sensory experience was considered unreliable (cf. Plato).
- The movement was actually conservative in that the knowledge of the ancients was venerated and considered "untouchable" – science was considered a body of knowledge rather than a process of inquiry.
- Enter Copernicus and Galileo. (tensions Platonic/Pythagorean and Thales/Aristotle schools playing out; cf. Kepler's fudged models)



(PAUSE & EXPLAIN)

The Galileo Affair

To the Greek and medieval mind, science was a kind of formalism, a means of coordinating data, which had no bearing on the ultimate reality of things. Different mathematical devices--such as the Ptolemaic cycles--could be advanced to predict the movements of the planets, and it was of no concern to the medieval astronomer whether such devices touched on the actual physical truth. The point was to give order to complicated data, and all that mattered was which hypothesis (a key word in the Galileo affair) was the simplest and most convenient…Astronomy and mathematics were regarded as the play things of *virtuosi*. They were accounted as having neither philosophical nor theological relevance… Owen Barfield, in his fascinating book *Saving the Appearances*, calls it "the real turning-point" in the history of science: "It took place when Copernicus (probably--it cannot be regarded as certain) began to think, and others, like Kepler and Galileo, began to affirm that the heliocentric hypothesis not only saved the appearances, but was physically true...It was not simply a new theory of the nature of celestial movements that was feared, but a new theory of the nature of theory; namely, that, if a hypothesis saves all the appearances, it is identical with truth."…

(saving appearances = organizing data; cf. Bohr Model of Atom, Electricity as Water Flowing, Geocentric Navigation, etc.)

The Galileo Affair

Copernicus had delayed the publication of his book for years because he feared, not the censure of the Church, but the mockery of academics. It was the hide-bound Aristotelians in the schools who offered the fiercest resistance to the new science. Aristotle was the Master of Those Who Know; perusal of his texts was regarded as almost superior to the study of nature itself. The Aristotelian universe comprised two worlds, the superlunary and the sublunary. The former consisted of the moon and everything beyond; it was perfect and imperishable. The latter was the terrestrial globe and its atmosphere, subject to generation and decay, the slagheap of the cosmos. Ptolemy's methodizing of Aristotle to explain the motion of the stars was part of this academic baggage. And it made perfect empirical sense; by using it, ships were able to navigate the seas and astronomers were able to predict eclipses. So why give up this time-honored system for a new, unproved cosmology which…contradicted common sense (as no less an authority than Francis Bacon averred)?...

The Galileo Affair

Galileo's belligerence probably had much to do with the fact that he knew there was no direct proof of heliocentricism. He could not even answer the strongest argument against it, which was advanced by Aristotle. If the earth did orbit the sun, the philosopher wrote, then stellar parallaxes would be observable in the sky. In other words, there would be a shift in the position of a star observed from the earth on one side of the sun, and then six months later from the other side. Galileo was not able with the best of his telescopes to discern the slightest stellar parallax. This was a valid scientific objection, and it was not answered until 1838, when Friedrich Bessel succeeded in determining the parallax of star 61 Cygni. Galileo's other problem was that he insisted, despite the discoveries of Kepler, that the planets orbit the sun in perfect circles. The Jesuit astronomers could plainly see that this was untenable. Galileo nonetheless launched his campaign with a series of pamphlets and letters which were circulated all over Europe. (George Sim Johnston, *The Galileo Affair*, Scepter Press, P.O. Box 1270, Princeton, NJ, 08542)

The Galileo Affair

THE MONUMENT

THE MONUMENT, DESIGNED BY ROBERT HOOKE FRS IN CONSULTATION WITH SIR CHRISTOPHER WREN, WAS BUILT 1671-1677, ON THE SITE OF ST MARGARET FISH STREET HILL,TO COMMEMORATE THE GREAT FIRE OF LONDON 1666. THE FIRE BURNT FROM 2 TO 5 SEPTEMBER, DEVASTATING TWO-THIRDS OF THE CITY, AND DESTROYED 13,200 HOUSES, 87 CHURCHES, AND 52 LIVERY COMPANY HALLS.

THE MONUMENT, A FREESTANDING FLUTED DORIC COLUMN TOPPED BY A FLAMING COPPER URN, IS 61M/202FT IN HEIGHT, BEING EQUAL TO THE DISTANCE WESTWARD FROM THE SITE OF THE BAKERY IN PUDDING LANE WHERE THE FIRE BROKE OUT. ITS CENTRAL SHAFT ORIGINALLY HOUSED LENSES FOR A ZENITH TELESCOPE, AND ITS BALCONY, REACHED BY AN INTERNAL SPIRAL STAIRCASE OF 311 STEPS, AFFORDS PANORAMIC VIEWS OF THE CITY. THE ALLEGORICAL SCULPTURE ON THE PEDESTAL ABOVE WAS EXECUTED BY CAIUS GABRIEL CIBBER AND SHOWS CHARLES II COMING TO ASSIST THE SLUMPED FIGURE OF THE CITY OF LONDON.

ST MAGNUS THE MARTYR

FISH STREET HILL, TO THE SOUTH, LEADS TO ST MAGNUS THE MARTYR, A WREN CHURCH, ALONGSIDE WHICH IS THE ANCIENT STREET WHICH LED TO THE MEDIEVAL LONDON BRIDGE.

www.themonument.org.uk

External Corroboration from an Atheist

"The proponents of the idea that the Church stifled science and reason in the Middle Ages have to wheel [Galileo] out, because without him they actually have absolutely zero examples of the Church persecuting anyone for anything to do with inquiries into the natural world. The common conception that Galileo was persecuted for being right about heliocentrism is a total oversimplification of a complex business, and one that ignores the fact that Galileo's main problem was not simply that his ideas disagreed with scriptural interpretation but also with the science of the time.

"Contrary to the way the affair is usually depicted, the real sticking point was the fact that the scientific objections to heliocentrism at the time were still powerful enough to prevent its acceptance. Cardinal Bellarmine made it clear to Galileo in 1616 that if those scientific objections could be overcome then scripture could and would be reinterpreted. But while the objections still stood, the Church, understandably, was hardly going to overturn several centuries of exegesis for the sake of a flawed theory. Galileo agreed to only teach heliocentrism as a theoretical calculating device, then promptly turned around and, in typical style, taught it as fact. Thus his prosecution by the Inquistion in 1633.

External Corroboration from an Atheist

"Hannam gives the context for all this in suitable detail in a section of the book that also explains how the Humanism of the 'Renaissance' led a new wave of scholars, who sought not only to idolize and emulate the ancients, but to turn their backs on the achievements of recent scholars like Duns Scotus, Bardwardine, Buridan, and Orseme. Thus many of their discoveries and advances were either ignored and forgotten (only to be rediscovered independently later) or scorned but quietly appropriated. The case for Galileo using the work of Medieval scholars without acknowledgement is fairly damning. In their eagerness to dump Medieval 'dialectic' and ape the Greeks and Romans - which made the 'Renaissance' a curiously conservative and rather retrograde movement in many ways - they discarded genuine developments and advancements by Medieval scholars."

(O'Neil, Timothy, *The Dark Age Myth: An Atheist Reviews "God's Philosophers*, www.strangenotions.com/gods-philosophers)

Modern Day

- **Birth of Modern Empiricism:** Aristotle and the value of observable data in settling disputes about the nature of the world.
- **Triumph of Materialism:** There is still vibrant debate today about the exact nature of knowledge and reality, of course, but the prevailing view seems to be that "reality" is what is physically and objectively present in the universe (materialism, and the resulting scientism). Some of this we can sense, and with that limited information we attempt to discover universal (mathematical) laws which reflect that reality. Because our minds and data are both limited, our "models" will necessarily not completely reflect reality but will be "approximations" of that reality. Any deficiency is presumed to be in our ideas about the world and not in the physical world itself. (Note that Scientism, the idea that only empirically verifiable statements provide useful knowledge, is not an empirically verifiable belief; inherently contradictory.)

Modern Day

- **Materialism (cont.):** This appears to be very non-Platonic, and it is. However, there is also this underlying assumption that there are things in this world that we cannot directly measure with our senses and scientific instruments but whose existence can be inferred by mathematical models (e.g. black holes, dark matter and energy whose existence must be inferred, not observed). So, a strain remains of using the power of idea to discern reality that escapes direct detection by our senses. Furthermore, there have been an increasing number of challenges to materialism in recent years.

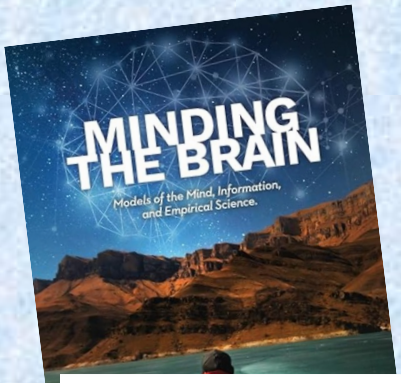
Contemporary Challenges to Materialism

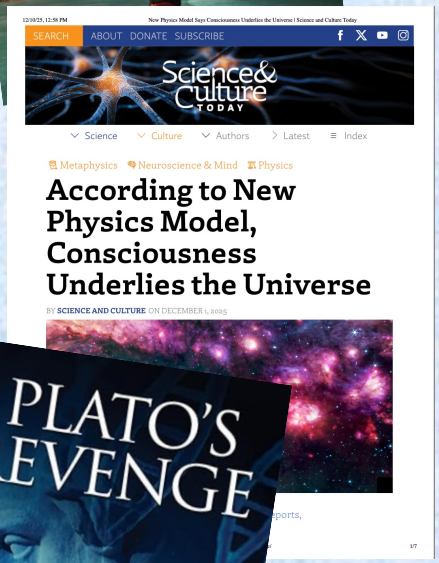
- **Anecdotes:**
  - Gustafson (house)
  - Exorcisms (Indiana, rise w/ Fr. Colletti)
  - Scientific American Article (radio)
- **More Formal Challenges:**
  - NDE Sneaker (Science of NDEs)
  - Psychiatrist Study
  - Lourdes
  - Guadalupe

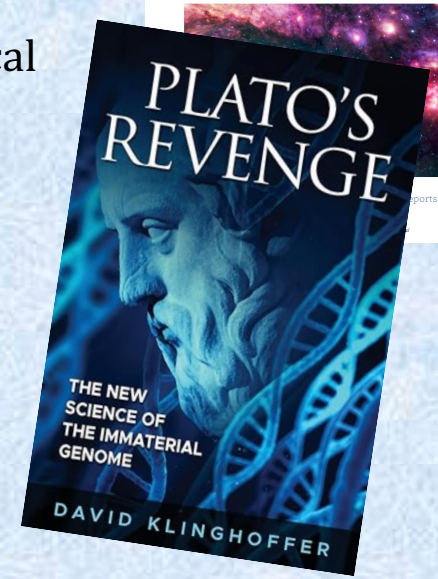
Contemporary Challenges to Materialism

- **Scientific Challenges:**
  - Minding the Brain
  - Immateriality of Genome & Levinthal Paradox

    If folding were a random search through all possible configurations, it would take longer than the age of the universe for a single protein to fold correctly. Yet, in reality, proteins fold in milliseconds to seconds. This suggests: (1) there must be pre-programmed informational constraints guiding folding, and (2) the amount of algorithmic information needed to specify correct folding far exceeds what can be encoded by physical chemistry alone (podcast).
  - Digital Physics, Information Theory, & the Fundamental "Stuff" of the Universe







Contemporary Challenges to Materialism

- **Principle:**
  - **Science –** a means of rigorous inquiry that prioritizes observable data and experimentation to establish the truth of a conjecture?
  - **Science –** a means of determining a materialistic or naturalistic explanation for phenomena?
  - **cf. Rizzi's Observation** about unconscious philosophy.
  - **Example:** William Dembski and SETI.

Parting Thoughts

- **Science vs. Mathematics:** will be a key theme moving forward, and this difference began in earnest with the Galileo affair. Until then, philosophy, mathematics, theology, and science were all intertwined. (Not all bad, as these do dovetail and complement one another, and the fragmentation of knowledge is one of the major challenges in our day. But, it is also important to understand the proper limits of each discipline.)
- **Mathematics and Philosophy:** we will also explore how advances in mathematical theory opened up new ways of understanding the world will also be a major theme.

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- Shelley, Bruce L., *Church History in Plain Language*, Thomas Nelson Publishers, 2008.
- Sources not delineated here are hyperlinked in the talk on the relevant slides.