

# The Long Pause to Regroup

The transition from Antiquity to the Renaissance



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# The standard cosmic view

- A framework for scientific thinking was laid down in the ancient Greek civilizations.
  - Plato, Aristotle, Euclid, Ptolemy
- The worldview developed then became the standard for 1500 years or more until the Renaissance in Europe.



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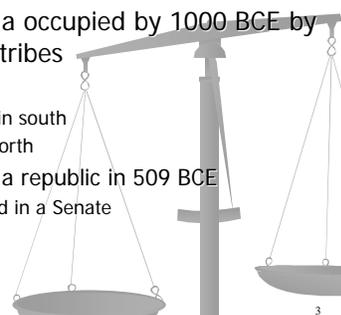
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# Rome

- Italian peninsula occupied by 1000 BCE by Latin speaking tribes
  - 800 BCE:
    - Greeks arrive in south
    - Etruscans in north
  - Rome became a republic in 509 BCE
    - Power invested in a Senate



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## Roman Technology

- Romans were great engineers
  - Roads, aqueducts, buildings, cities
- The Rule of Law
  - The authority of Roman government was based upon written laws enacted by its senate.



A surviving Roman aqueduct at Nîmes in France.

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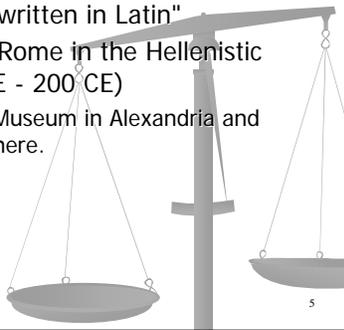
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## Roman Science

- "Greek science written in Latin"
- Transmitted to Rome in the Hellenistic period (300 BCE - 200 CE)
  - Mostly via the Museum in Alexandria and those trained there.



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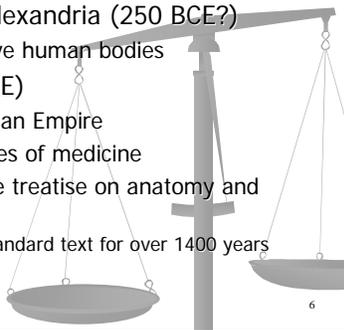
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## Biological Science

- Herophilus of Alexandria (250 BCE?)
  - Dissection of live human bodies
- Galen (b. 129 CE)
  - Worked in Roman Empire
  - Sought principles of medicine
  - Wrote definitive treatise on anatomy and physiology
    - Became the standard text for over 1400 years



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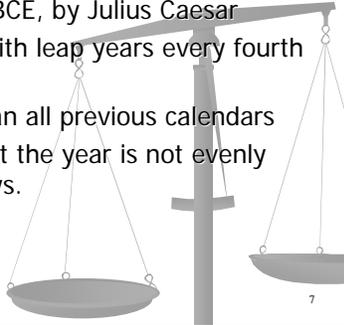
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## The Julian Calendar

- Introduced 45 BCE, by Julius Caesar
- 365-day year with leap years every fourth year
- Much better than all previous calendars
- Recognition that the year is not evenly divided into days.

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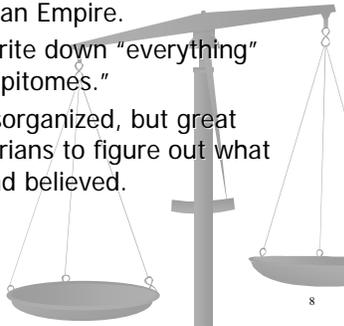
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## Encyclopaedists

- In the late Roman Empire.
- Attempted to write down "everything" they knew in "Epitomes."
- Often totally disorganized, but great source for historians to figure out what people knew and believed.

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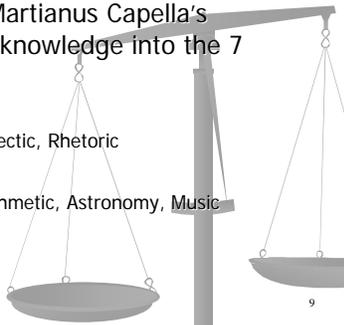
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## Martianus Capella

- An exception: Martianus Capella's organization of knowledge into the 7 Liberal Arts
  - Trivium
    - Grammar, Dialectic, Rhetoric
  - Quadrivium
    - Geometry, Arithmetic, Astronomy, Music

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## The Roman Empire at its height



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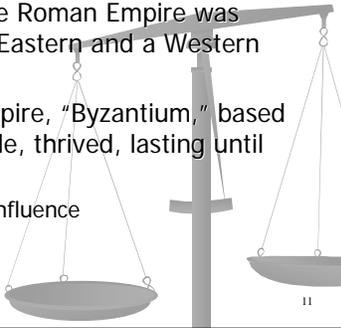
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## Byzantium

- In 395 C. E., the Roman Empire was divided into an Eastern and a Western branch.
- The Eastern Empire, "Byzantium," based in Constantinople, thrived, lasting until 1453.
  - Largely Greek influence

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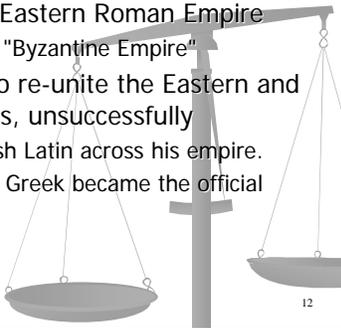
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## Emperor Justinian 527-565

- Emperor of the Eastern Roman Empire
  - Called later the "Byzantine Empire"
- Justinian tried to re-unite the Eastern and Western empires, unsuccessfully
  - Tried to establish Latin across his empire.
  - After his death, Greek became the official language.

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## The Corpus Juris

- Justinian commissioned a summary of Roman Law.
  - Part of his effort to re-unite the empire.
  - Was completed by a team of scholars in only eight years, but was a fraction of the body of law.
- Centuries later, in the west, the *Corpus Juris* was taken to be the final and perfect expression of Roman Law.

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## The Byzantine Empire

- Successfully defended itself from attack from North, East, and West when other cultures fell.
  - Superior knowledge of military technologies, *not* involving guns.
- Finally fell to the Ottoman Turks in 1453
  - Famous victory for guns.
  - One of the traditional dates for the end of the Middle Ages and the beginning of the Modern Era.

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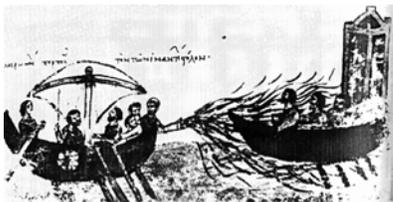
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## Greek Fire



- A Byzantine terror weapon.
- A petroleum based liquid.
  - Caught fire when it hit the water. It was a mainstay of Byzantine defence from both Arabs and Slavs from as early as the 7th century.

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## The Decline of the (Western) Roman Empire



- The Roman Empire had spread across Europe, North Africa, and the Near East during the thousand years from 500 BCE to 500 CE.
- The western empire then collapsed, leaving a governmental void across much of Western civilization.

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## The Fall of Rome

- Many reasons are given for the fall of the Roman Empire.
- Possibly they were no longer able to feed themselves by importing food from their colonies.



Ruins of Leptis Magna (now in Libya). A great city in a region that supplied food to Rome. Overfarming made the land unproductive. It is now a desert.

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## Europe in the Dark Ages

- The period between antiquity (ancient times), marked by the fall of Rome around 500 C.E., and the beginning of the modern era (around the middle of the 15<sup>th</sup> century) is called the Medieval period, or the Middle Ages.
  - The first 500 years of that is called the Dark Ages (about 500-1000 C.E.).
- During this time Europe was overrun by nomadic tribes from the north and west.
- Literacy was lost, farming techniques forgotten, infrastructure deteriorated.
- Villages became isolated from each other.

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## Charlemagne

- Europe began to recover under Charles the Great (*Charlemagne*).
- In 800 he was crowned Holy Roman Emperor.
- He saw illiteracy as one of the major problems facing Europe.



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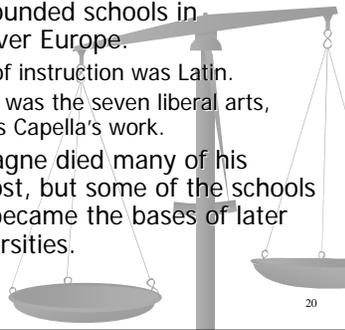
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## Schools

- Charlemagne founded schools in cathedrals all over Europe.
  - The language of instruction was Latin.
  - The curriculum was the seven liberal arts, using Martianus Capella's work.
- When Charlemagne died many of his reforms were lost, but some of the schools remained and became the bases of later European universities.



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## The Heavy Plough



- Innovation of the 6<sup>th</sup> century.
- Had a curved blade that lifted the soil onto a *mouldboard*, which flipped it over.
- Good for breaking up the heavy clay-laden soils of northern Europe.
- Required about 8 oxen to pull.
- Fostered small collectives of farmers to afford a plough.

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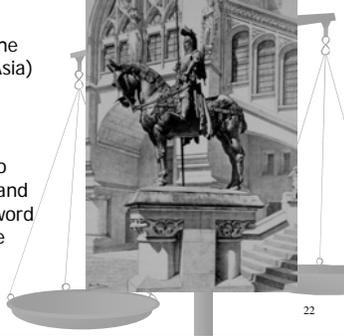
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## The horse in warfare

- The introduction of the stirrup (invented in Asia) to Europe in the 7<sup>th</sup> century made horses suitable for warfare.
- A rider could ride into battle on horseback and fight with lance or sword without falling off the horse.



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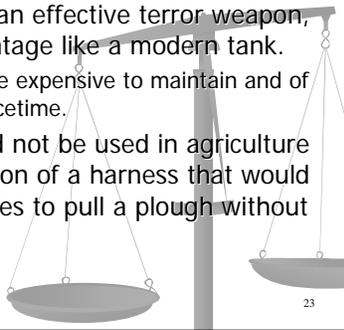
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## The horse harness

- The horse was an effective terror weapon, giving an advantage like a modern tank.
  - But horses were expensive to maintain and of less use in peacetime.
- The horse could not be used in agriculture until the invention of a harness that would enable the horses to pull a plough without choking.



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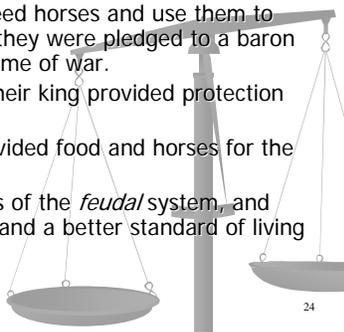
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## Symbiosis and the feudal system

- Farmers could breed horses and use them to pull ploughs, but they were pledged to a baron when needed in time of war.
- The barons and their king provided protection for the peasants.
- The peasants provided food and horses for the barons.
- This was the basis of the *feudal system*, and provided stability and a better standard of living for Europe.



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## Crop rotation

- In the early middle ages, farmers learned that better crops were achieved if two fields were used in alternate years.
- In the 8<sup>th</sup> century, a third field was added with a rotation as follows:

	Year 1	Year 2	Year 3
Field 1	Winter crops	Summer crops	Fallow
Field 2	Summer crops	Fallow	Winter crops
Field 3	Fallow	Winter crops	Summer crops

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## Crop rotation, 2

- Three-field crop rotation had great benefits
  - 2/3 of farm land was under cultivation each year.
  - Summer crops (legumes) fixed nitrogen in the soil and improved its fertility.
  - Legumes made a more balanced diet.
- Result: The population rose from 9 million in 700 to 36 million in 1300.

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## The Recovery of Europe

- By the early 1400s, Europe had pulled itself out of its disorganization after the fall of Rome.
- The feudal system provided stable government and protection from raiders.
- The economy was flourishing and the population rising and in good health.
- But there was little literacy and almost no knowledge of ancient science.

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## The Rise of Islam

- Before Mohammed
  - Arab culture disorganized
    - nomadic, polytheistic
    - centered in Mecca
- Mohammed
  - born 570 in Mecca
  - at age of 40 had revelation, became prophet and fled Mecca in 622 (traditional date for start of Islam)
- Mohammed's revelations = the Koran (*Qu'ran*)
  - One God, one Prophet, one Book

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## The Spread of Islam



- In 100 years (630-730) Islam spread from Arabia to India in the East and to Spain in the West.

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## Islamic Science

- Arab scholars took great interest in the learning of all lands they conquered.
- In particular, they were interested in the scientific and philosophical works of ancient Greece.
  - These they translated into Arabic and stored in their great libraries in Baghdad and other capitals.

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## The Crusades

- The Byzantine Empire, feeling threatened by the encroaching Islamic Caliphate appealed to Christian Europe for military assistance.
- Thus began the Crusades to free the Holy Land, starting in 1092, and lasting about 300 years.

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## The Surprise Discovery

- Much to the surprise of the invading Christians, the Muslim world was much more literate and culturally advanced than Europe.
- Europeans discovered a wealth of literature, much of it originally written in Greek, that was unknown in medieval Europe.
  - Among these were works of Euclid, Ptolemy, and much of Aristotle.

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## The Great Translation Project

- A huge project was undertaken to translate much of this literature from Arabic into Latin to be accessible to European scholars.
  - At Toledo, Spain, over 150 years.
  - The typical process:
    - Jewish rabbis, fluent in Arabic and Spanish, translated into Spanish.
    - Christian scholars, fluent in Spanish and Latin, translated from Spanish to Latin.
- The translated works were sent to Italy and became the foundation for scholarship at the new European universities.

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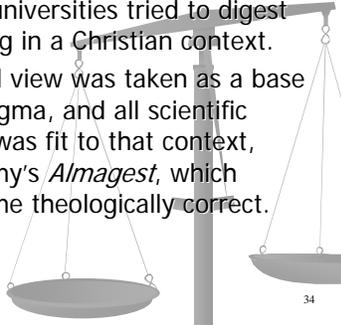
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## Scholasticism

- The European universities tried to digest the new learning in a Christian context.
- Aristotle's world view was taken as a base for Christian dogma, and all scientific understanding was fit to that context, including Ptolemy's *Almagest*, which therefore became theologically correct.

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## The Black Death

- Bubonic plague hit Europe in **1346**.
  - This is the second one of the eight dates you must remember in this course.
- The Black Death eliminated 1/3 to 1/2 of population of Europe.



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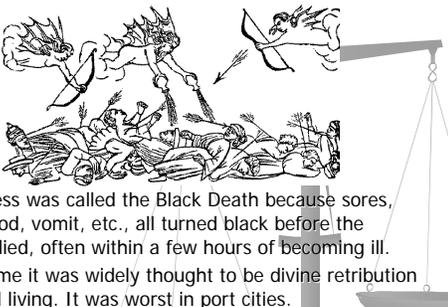
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## The Black Death as Retribution



- This illness was called the Black Death because sores, skin, blood, vomit, etc., all turned black before the patient died, often within a few hours of becoming ill.
- At the time it was widely thought to be divine retribution for sinful living. It was worst in port cities.

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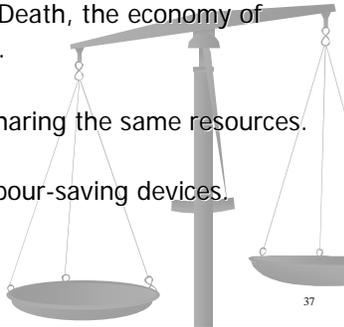
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## A New Beginning for Europe

- After the Black Death, the economy of Europe took off.
- Fewer people sharing the same resources.
- Emphasis on labour-saving devices.



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