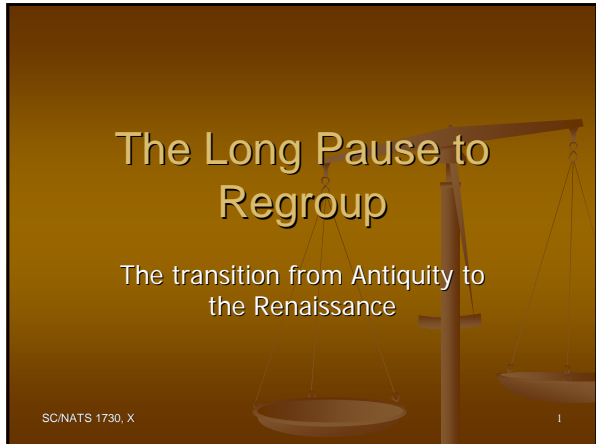


The Long Pause to Regroup

The transition from Antiquity to the Renaissance

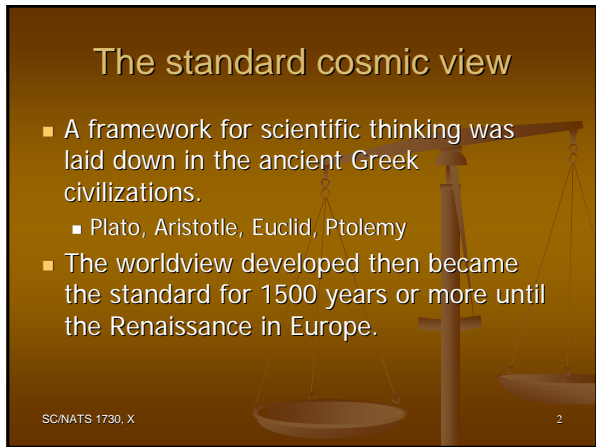
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The standard cosmic view

- 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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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 Nimes in France.

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4

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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5

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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6

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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7

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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8

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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9

The Roman Empire at its height



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10

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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11

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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12

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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13

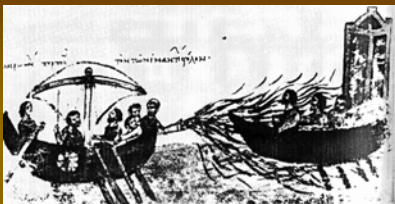
The Byzantine Empire

- 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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14

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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15

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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16

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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17

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 15th 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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18

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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19

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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20

The Heavy Plough



- Innovation of the 6th 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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21

The horse in warfare

- The introduction of the stirrup (invented in Asia) to Europe in the 7th 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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22

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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23

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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24

Crop rotation

- In the early middle ages, farmers learned that better crops were achieved if two fields were used in alternate years.
- In the 8th 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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26

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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27

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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28

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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29

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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30

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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31

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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32

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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33

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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34

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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35

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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36

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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