

# A Brief Overview of the History of Science

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NRC 601

*Research Concepts in Natural Resources*

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Fall 2009

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## *Science as it is known today:*

- a relatively modern construct; in current form only since the last 400 years
- traditions reach back beyond recorded history
- roots lie in the technology of early tool-making and other crafts

## *Scientific theory:*

- was once a part of philosophy and religion
- was encouraged by the need of technology
- remains intertwined with technology

## Science . . .

. . . (1) a body of empirical, theoretical, and practical knowledge about the natural world, (2) produced by a global community of researchers (3) making use of scientific methods, (4) which emphasize the observation, experimentation, and (5) explanation of real world phenomena.

*Science* has been said to have dual status as both objective knowledge and as a human construct.

*From Wikipedia, the free encyclopedia*

Some terms:

Empirical = knowledge arises from experience and evidence.

Theory = a testable model of a set of natural phenomena, capable of prediction and tested through experiment or verified through empirical observation.

(In common usage signifies conjecture, opinion, speculation.)

Scientific method = a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge.

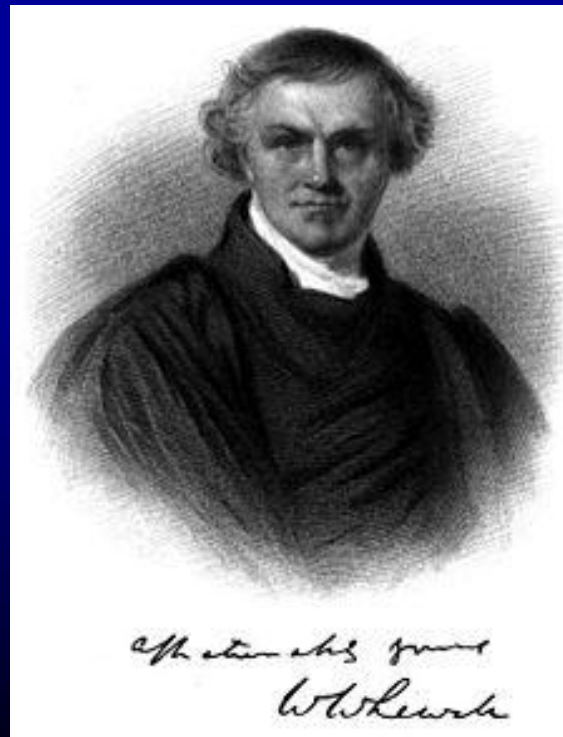
It consists of the collection of data through observation and experimentation, and the formulation and testing of hypotheses.

*Research = a systematic investigation designed to produce generalized knowledge.*

*UMass Human Subjects Training web site*

The term "scientist" was first coined by William Whewell ("hew-el") in the 19<sup>th</sup> century.

Previously people investigating nature called themselves "natural philosophers."



# Science as a philosophy was not always present in human history

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-- Origins with the Greeks  
>2,500 years ago



- first to discard supernatural explanations of how the universe and natural world worked
- first to employ observable evidence and reason

# Ancient Egypt . . .

- developments in mathematics and astronomy
- beginnings of the science of medicine



-- In China and India,  
scientific thinking emerged from medicine



- scientific theories subservient  
to main schools of philosophy  
& theology

- paper invented 2nd century A.D.

- alphabetic script developed

- numeral system including zero



# Two ways of perceiving the Universe

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## -- *spiritual belief*

helped early humans to explain their world

## -- *scientific thinking*

based on what humans could observe and explain

# Time Line for the Development of Scientific Thinking

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## (1) Mesopotamia (~10,000 yrs ago; 8,000 yrs BC or BCE)

Mesopotamia ("*between the rivers*")

- region between the Tigris and Euphrates Rivers
- most of the region located in modern Iraq

# Development of agriculture and domestication



- knowledge and prediction of seasons
- pioneered astronomy and mathematics



## Ancient Greece --- 3 Milestones in the development of scientific thinking:

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- (a) acknowledged curiosity; willingness to investigate without the aid of the supernatural
- (b) accepted human senses to perceive and the human mind to interpret and understand
- (c) recognized value of methodical observation and verifiable evidence

Much wild speculation among  
ancient Greek philosophers . . .



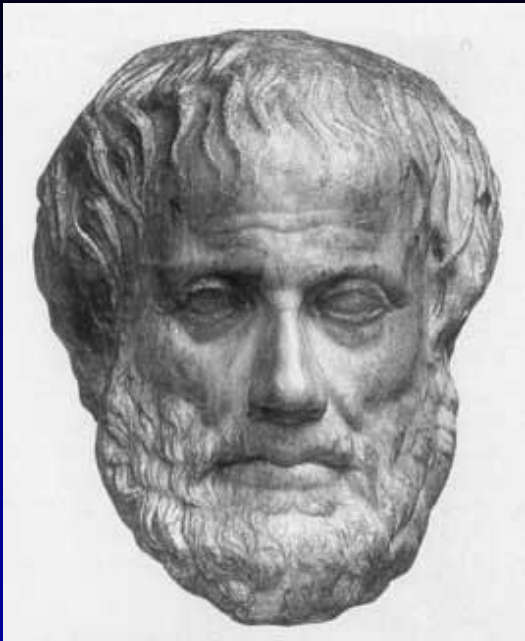
- *based on intricate argument*
  - *believed intellect alone could provide answers*
    - *relied on intellect without objective observations*

... but there were many insightful perceptions as well:

- Thales of Miltus (ca. 624-547 BC) --- *earthquakes come from disturbances beneath the surface of the earth, like waves in the ocean.*
- Anaximander (ca. 611-547 BC) --- *land animals are descendants of fish-like ancestors.*
- Pythagoras (ca. 582-500 BC) --- *relationships in nature could be described with numbers.*
- Xenophanes (ca. 576-490 BC) --- *earth and sea had changed places in the past and would likely do so again.*
- Heraclitus (ca. 556-469 BC) --- *nature exists as a balance of changing forces.*

# The development of Empirical Thought:

- Parmenides (ca. 500-450 BC) --- *suggested humans sense the world as an illusion.*
- Empedocles (ca. 492-432 BC) --- *held that human senses are valid interpreters of reality.*
- advanced *EMPIRICISM*
  - our senses → accumulate evidence → base explanations
  - *a crucial ingredient in the development of science*



# Aristotle (ca. 384-322 BC)

- most prominent contributor
- wrote *Natural History of Animals*

## Believed in:

- (1) close and accurate observations
- (2) respect for facts
- (3) systematic collection of evidence
- (4) deductions from facts

## Contributed:

- (1) method of empirical evidence and deduction
- (2) enormous collection of biological knowledge

*Fact* = a pragmatic truth or statement that can, at least in theory, be checked and confirmed.

Contrasted with *opinions* and *beliefs*, which are held to be true but are not amenable to confirmation.

*Wikipedia.org (2009)*

# Alexander the Great (ca. 356-323 BC)



- founded Alexandria at the mouth of the Nile
- established the Library at Alexandria

- supported scholars in physics, medicine, astronomy, geography, mathematics, biology
- Carl Sagan estimated half a million volumes
- lasted for centuries

# Time Line . . . .

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## (3) The Roman Empire (146 BC - 395 AD)

Theodosius, Roman emperor

- burned the library to the ground
- a period of intellectual darkness

Rome eventually sacked

- Attila the Hun; northern Europe
- beginning of Middle Ages



# Time Line . . .

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## (4) The Middle Ages (ca 395 AD - 1300s)

- secular (separate from religion) inquiry nearly extinguished
- Christianity ascended to become the source of explanation of the world
- Socrates and Aristotle accused of "impiety" (irreverence)
  - Socrates voluntarily drank poison hemlock
  - Aristotle died in exile after escaping a death sentence

# Time Line . . .

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## (5) The Renaissance (1300-1600)

- French for "rebirth"
- science & independent thought became politically acceptable
- assisted by invention of Johann Guttenberg's printing press
- gave rise to people like:
  - Leonardo Da Vinci (1452-1519) - "Renaissance man"
  - Nicholas Copernicus (1473-1543) - heliocentric theory
  - Galileo Galilei (1564-1642) - first telescope
  - Johannes Kepler (1571-1630) - predicted motion of planets

# Time Line . . .

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## (6) Modern Science (1600s)



Sir Francis Bacon  
(1561-1639)

- originator of modern scientific approach
- believed in experimentation
- saw previous scholars as mired in explanation without data

# Bacon proposed these principles:

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- (a) actively formulate questions  
*questions give focus and purpose*
- (b) exhaustively collect data  
*stay focused on the question*
- (c) recognize and promote "negative instances"  
*more efficient to disprove an idea*  
*impossible to prove anything beyond a doubt*  
*best ideas cannot be shown to be incorrect*

# Sir Isaac Newton (1642-1727)

-perhaps the first true  
and greatest  
modern scientist



- explained effects of gravitation and motion of planets
- developed branch of mathematics called calculus

## Milestones in the life sciences, beyond a passive study of nature . . .

- Robert Hooke (1635-1703) --- *development of the cell theory.*
- Louis Pasteur (1822-1895) --- *microbiology; spontaneous generation.*
- Charles Darwin (1809-1882) and Alfred Russell Wallace (1823-1913)  
--- *development of the theory of evolution by natural selection.*
- Johan Gregor Mendel (1822-1884) --- *foundation of modern genetics.*
- James Watson (1928-) & Francis Crick (1916-) --- *structure of DNA.*
- Carl von Linnaeus (1707-1778) --- *binomial nomenclature.*
- Ernst Haeckel (1834-1919) --- *"ecology" 1869; quantitative ecology.*