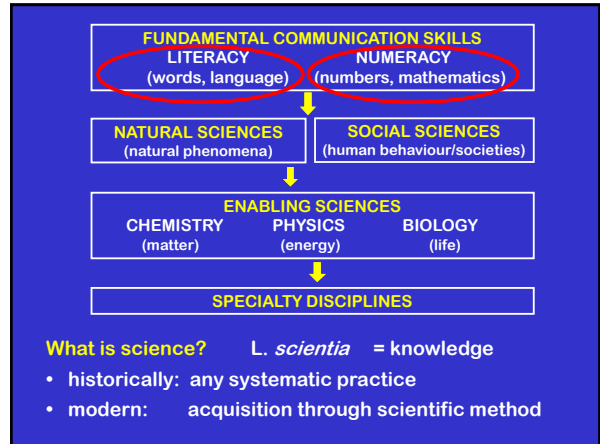


# Science and Philosophy

1



2

## Science

Universe can be studied by observation and experimentation  
 (sets science apart from theology, philosophy and the arts)

3

## Science: basic concepts

Basic principles shared by all sciences (apply to everyday life)

- gravity, force, motion [Newton's laws]
- energy, entropy [Laws of thermodynamics]
- electromagnetism [radiation, light, wave/particle]
- atomic structure [matter, strong/weak forces]

Natural systems

- subatomic particles follow basic rules governing matter and energy
- stars move as predicted by Newton's laws, burn according to laws of thermodynamics, fuelled by nuclear reactions converting mass into energy, produce light as consequence of electromagnetism
- living things conform to 7 basic principles
  - ecosystems recycle matter while energy flows through
  - use many strategies to grow and reproduce
  - obey laws of chemistry and physics
  - incorporate molecular building blocks
  - made of cells
  - use genetic code
  - evolve by natural selection

4

## Enabling sciences

<b>CHEMISTRY (matter)</b>	
• atoms/molecules	periodic table, moles, concentrations
• states of matter	solid/liquid/gas
• reactions	catabolism, anabolism, catalysts
<b>PHYSICS (energy)</b>	
• motion	kinematics, Newton's laws
• energy	thermodynamics, convertible, perform work
• forces	big bang
• universe	astronomy/cosmology
<b>BIOLOGY (life)</b>	
• macromolecules	cells
• genetic code	heredity, metabolism
• evolution	natural selection
• ecology	collective coexistence

5

## Enabling sciences

<b>MATHEMATICS</b>	
• quantities	numbers, special numbers ( $\pi$ , $e$ )
• units	SI
• arithmetic	BODMAS
• geometry	1-, 2-, 3-D
• trigonometry	angles, arcs, identities
• algebra	fractions, exponents, logarithms
• functions	linear, quadratic, periodic, power, exponential
• calculus	differentiation, integration
• statistics	distribution, variance, probability
• modelling	ISO
<b>Applications</b>	
• Chronobiology (periodic biological phenomena)	
• Population ecology (modelling population changes, simple influx/efflux models, exponential growth, logistic growth, stage-structured growth (differential equations))	
• Ecological interactions (examine species-species interactions, such as competition, predation and symbiosis, using differential equations and rates of change)	

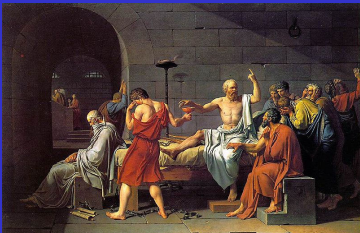
6

## Philosophy

“love of wisdom”

study of general problems concerning matters such as existence, knowledge, truth, beauty, justice, validity, mind, and language.

distinguished by its critical, systematic approach and its reliance on reasoned argument.



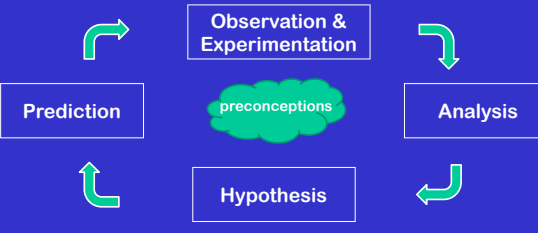
7

## Philosophy of Science

What is philosophy?	[love of wisdom, thinking about thinking]
What is science?	[systematic knowledge/practice][cf. pseudoscience]
What is maths?	[absolute?]
THE scientific method	[O+E → analysis → hypothesis → prediction →]
Reason and Experience	[a priori v. posteriori] [analytic v. synthetic] [necessary v. contingent]
Historical Ages	[Ancient Greeks/classical] [Enlightenment/Age of Reason/Reform] [Modernism/Postmodernism] [contemporary science, prevailing theories v. facts]
Logic (rational argument)	[deduction, problem of premise regress] [induction, problem of induction] [conjecture, falsification, problem of demarcation] [clinical reasoning, diagnosis by exclusion]
Definitions	[hypothesis, theory, law]

8

## Scientific Method



- start anywhere
- endless cycle
- must be testable
- reproducible
- be creative
- preconceptions OK

9

<b>REASON</b> (rationalist)	<b>and</b>	<b>EXPERIENCE</b> (empiricist)
<b>a priori</b> (reasoned without experience) [2 + 2 = 4]	v.	<b>posteriori</b> (need experience) [coal is black]
<b>analytic</b> (all meaning contained) [all spinsters are unmarried]	v.	<b>synthetic</b> (brings together concepts) [all spinsters are miserable]
<b>necessary</b> (true in all circumstances) [if A=B and B=C, then A=C]	v.	<b>contingent</b> (depends) [most boys are naughty]

10

ERA	PHILOSOPHY OF SCIENCE
classical (Plato)	deductive inference (conceptualize eternal truths)
↓	<i>but, problem of premise regress (poor foundations)</i>
reform (Bacon)	inductive inference (from O+E, conclusion probable)
↓	<i>but, problem of induction (cannot prove claims)</i>
modern (Popper)	conjecture/refutation (can prove hypotheses false)
↓	<i>but, problem of demarcation (claims must be testable)</i>
	<b>SCIENTIFIC METHOD (hypothetico-deductive logic)</b>

11

## LOGIC

(reasoned argument)

argument  
premises → conclusion

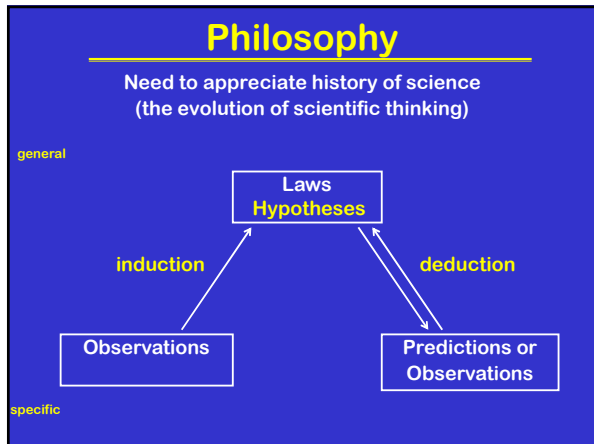
---

**Inductive reasoning:**  
particular case → generalization  
(belief in 'uniformity of Nature')  
(argument not valid)

---

**Deductive reasoning:**  
general → particular  
(if ... and ..., then ...)  
(argument valid)

12



13


## Review - PHILOSOPHY

**Definitions:**

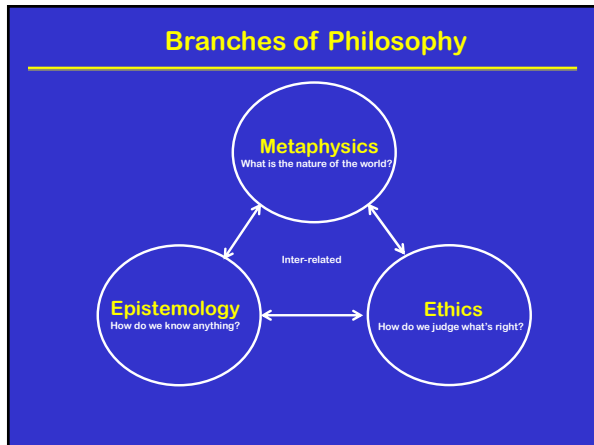
- Theory: - complex interconnected set of laws
- Law: - general regularity described by causal hypotheses
- Hypothesis: - testable claim

**Testable:**

- Mill's joint method of agreement and differences
  - controlled trial, cause/effect (++) or --)
- Mill's method of concomitant variation
  - positive/negative correlation (≠ causation)
- Hypothesis
  - acceptance (confirmation) (≠ proof)
  - rejection (falsification)
  - ranking (testable, explains, consistent, simple)



14



15