

# What is Science?

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# “Science” is frequently in the News

- Climate change
- Medical breakthroughs
- New species discovered
  
- Science under attack
  - Creationism vs Evolution
  
- Some news not so good
  - Faked results
  
- Some news not so scientific
  - Leading University’s “miracle” weight loss

# A Dictionary Definition

## sci·ence

/ˈsiːəns/ 

*noun*

the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.

"the world of science and technology"

*synonyms:* branch of knowledge, body of knowledge/information, area of study, [discipline](#), [field](#)

"the science of criminology"

- a particular area of this.

plural noun: sciences

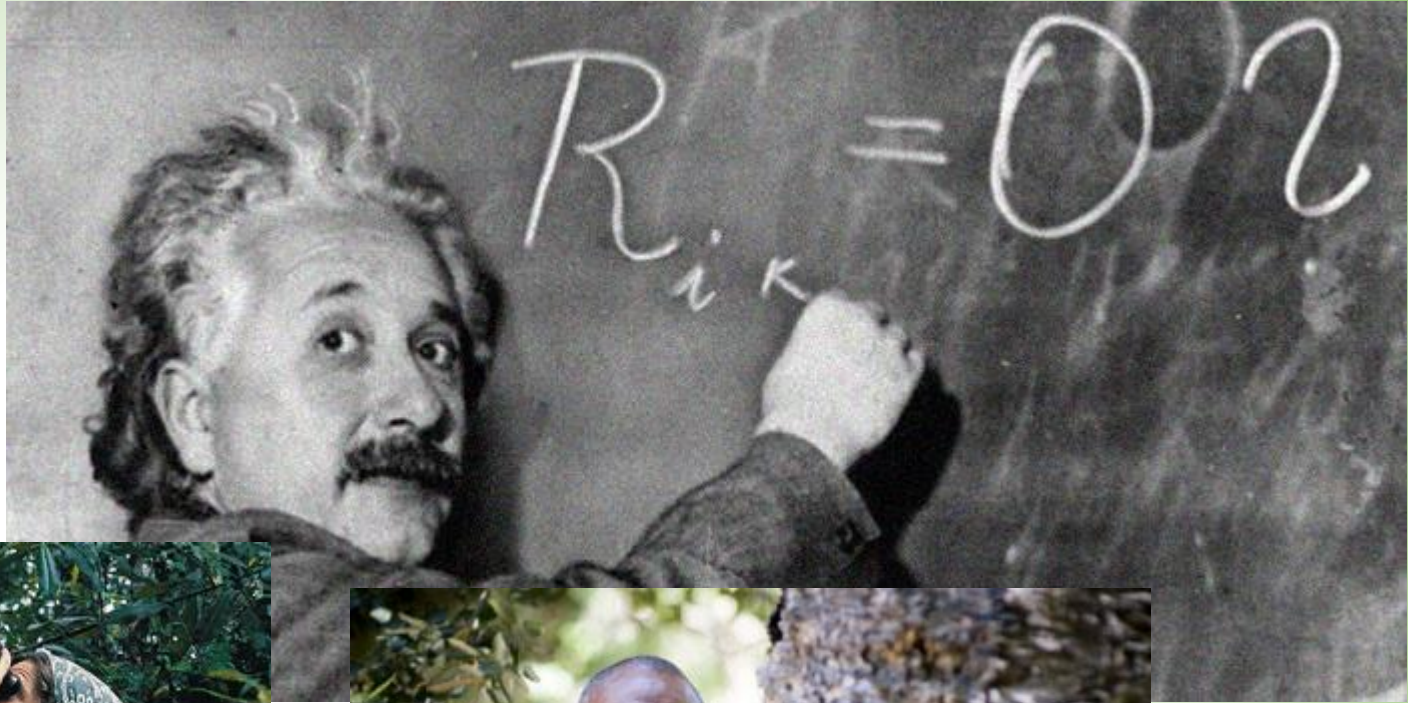
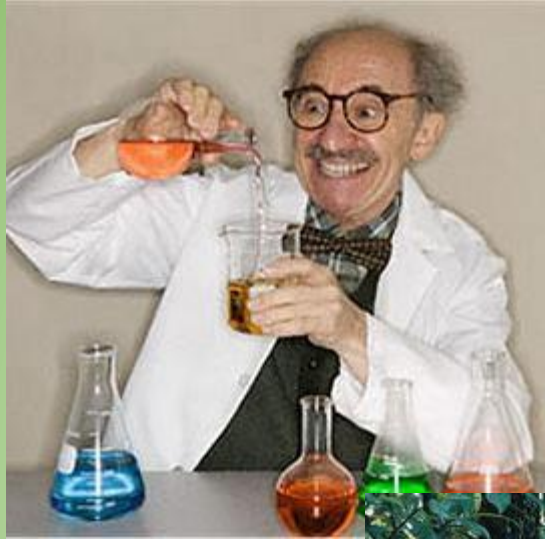
"veterinary science"

- a systematically organized body of knowledge on a particular subject.

"the science of criminology"

*synonyms:* [physics](#), [chemistry](#), [biology](#); [More](#)





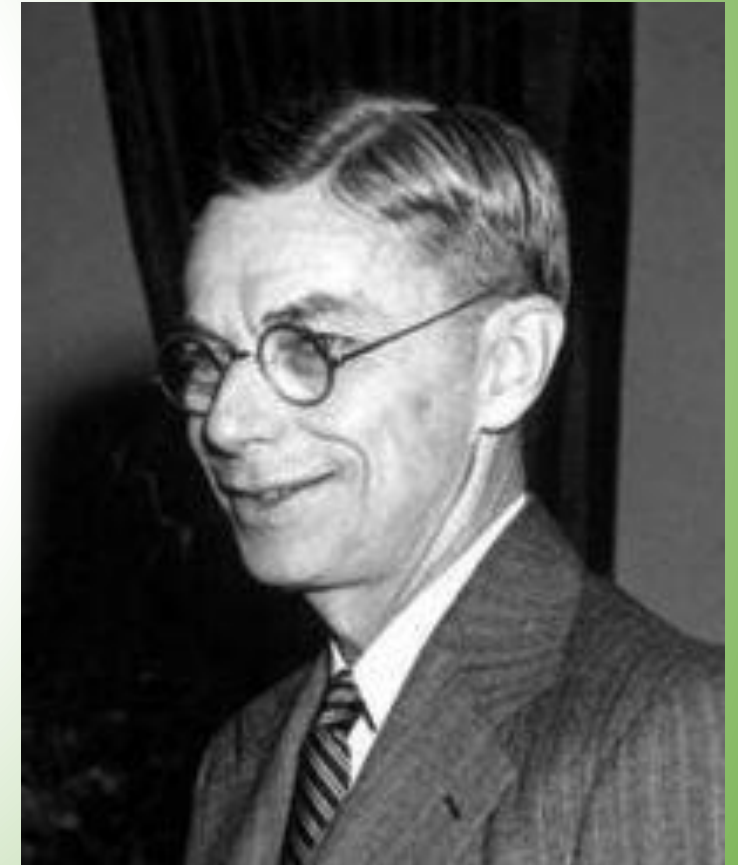
# So what, then, is Science?

- Lots of scientists, lots of views
- George Gaylord Simpson
  - *"There is a whole library of attempts to define science."*
  - Science is based on observation
  - Observations are on material objects or phenomenon
  - Science seeks natural, orderly relationships
  - Science is self-testing
  - [Science. 1963 139\(3550\)81-88](#)



# So what, then, is Science?

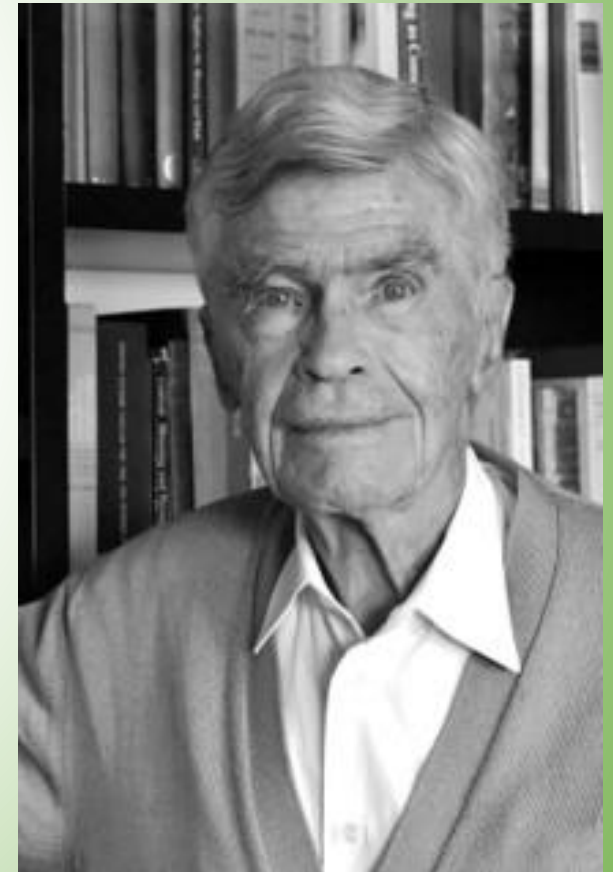
- James Bryant Conant
  - *"An interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation."*
  - The aim of science is to seek and verify general ideas, relationships, and interconnections among phenomena
  - Science begins with observations, not ends
  - **Scientific Principles and Moral Conduct.**  
Cambridge University Press. 1967



# So what, then, is Science?

- Mario Bunge

- *"Science is a style of thinking and acting – indeed the most recent, universal, and rewarding of styles."*
- Distinguishes between:
  - The work (research) of science and
  - The end product (knowledge) of science
- **Scientific Research, I. The Search for System. 1967. Springer-Verlag**



# So what, then, is Science?

- Thomas Kuhn
  - Two “kinds” of science
  - “Normal” Science
    - Rooted firmly in existing paradigms
    - Accumulation of supporting facts or knowledge
    - Puzzle solving
  - “Paradigm shifts” or Scientific Revolutions
  - [The Structure of Scientific Revolutions. 1970. University of Chicago Press](#)





# So what, then, is Science?

- Alexander Bird
  - Aim of science is the generation of scientific knowledge
  - Evidence worthy of belief
  - So a principle product of science is scientific belief
  - Bird, A. 2010. The epistemology of science—A bird's-eye view. *Sythese*. 175:5–16.



**So what, then, is Science?**

# So what, then, is Science?

- Science is both a body of knowledge and a process
- Science is exciting
- Science is useful
- Science is ongoing
- Science is a global human endeavor

# A Scientific Check List

*(How scientific is this science?)*

## Science checklist: How scientific is it?

- Focuses on the natural world
- Aims to explain the natural world
- Uses testable ideas
- Relies on evidence
- Involves the scientific community
- Leads to ongoing research
- Benefits from scientific behavior

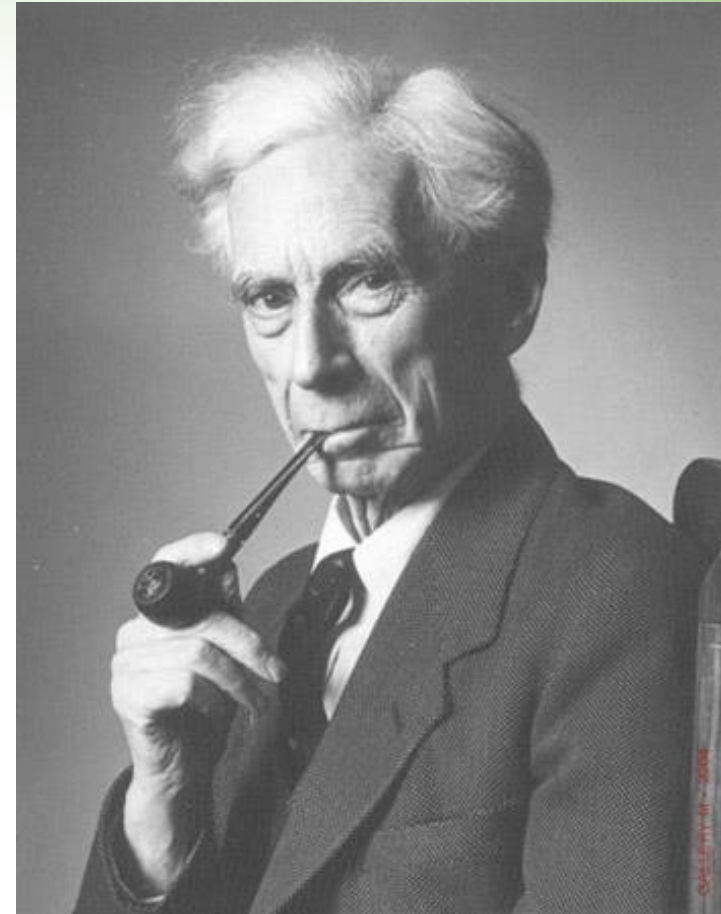
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To have ‘knowledge’ is to believe something and that something is ‘true’.

# What is Knowledge?

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- “Knowledge [is] true beliefs based on **sound reasons** (not lucky guesses) and **displayed in statements.**” H. Cassidy 1962



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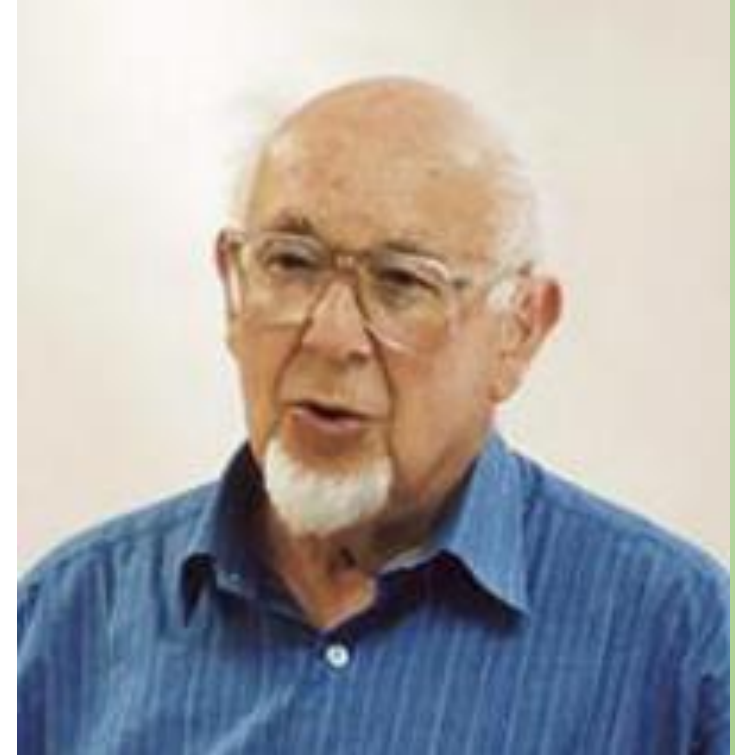
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- “...knowledge is **justified** true belief...” (Giere 1984, pg 26)
- “The goal of science is more than knowledge – it is public knowledge...” (Ziman 1978)



# What is Knowledge?

- Takeaway: scientific knowledge is **true belief** that has been **justified** (using methods of science) and has been **scrutinized by the public** (mostly other scientists).

# Knowledge

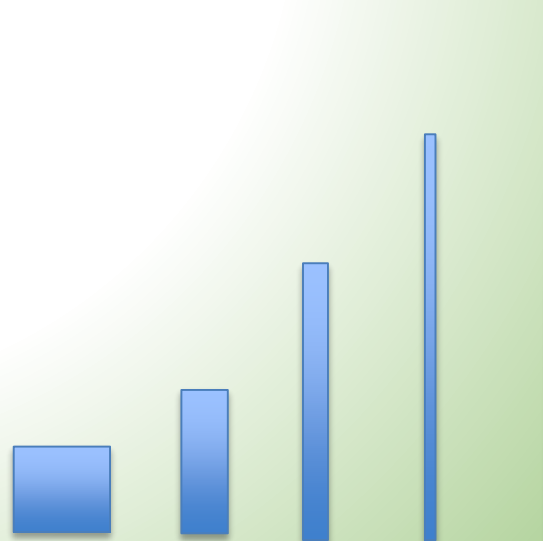
Philosophers



Scientists

A scientist is someone who knows more and more about less and less until s/he knows everything about nothing.  
(Lorenz/Ziman)

John Ziman. 1987. Knowing everything about nothing.  
Cambridge University Press. 196 pp.



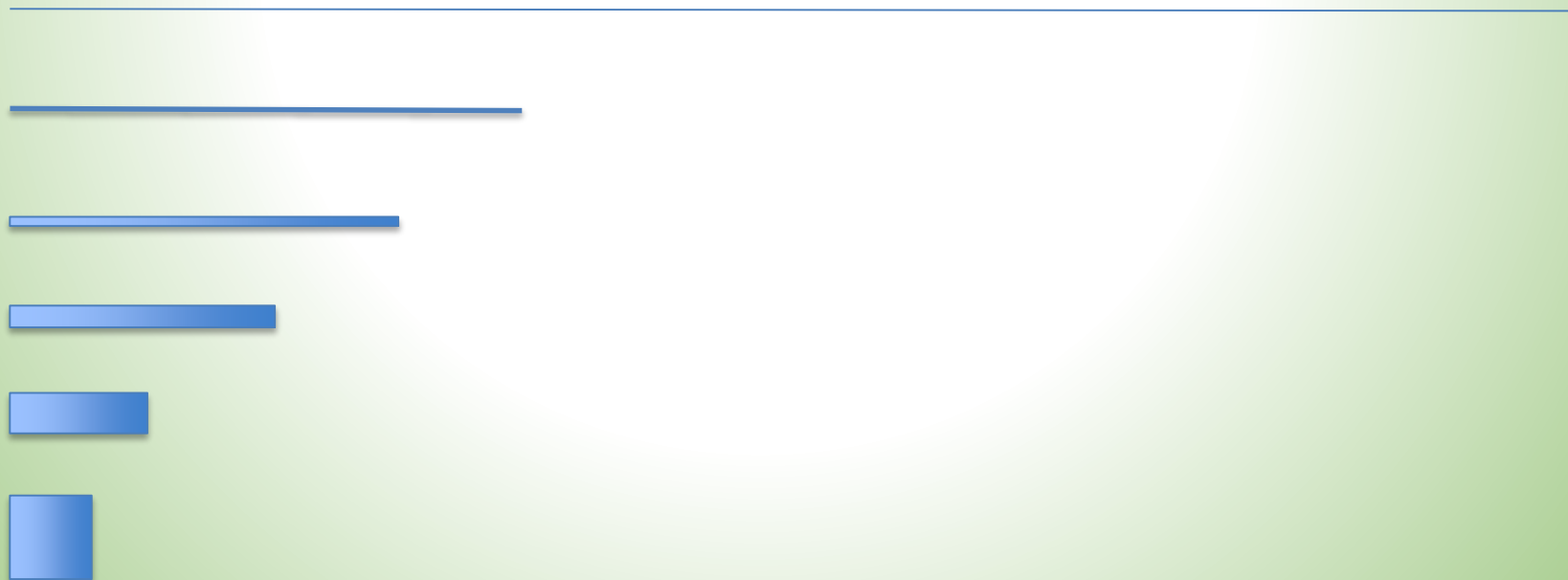
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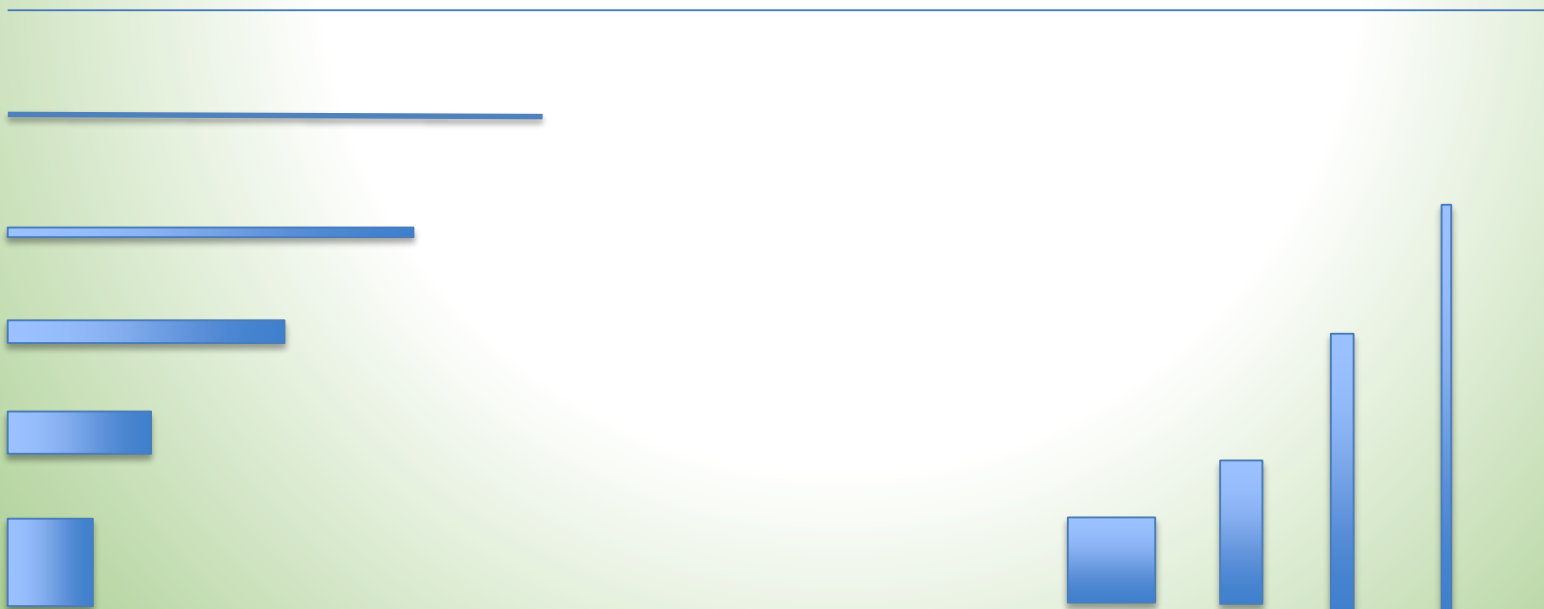
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A scientist is someone who knows more and more about less and less until s/he knows everything about nothing.  
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Recall, Bunge says: "Science is a style of **thinking** and **acting** .... and we should distinguish ...

a) the **work** (research) from the

b) **end product** (knowledge)."

**'Knowledge'** must be in the **mission statements** for every scientific research organization!

Right?

How about **USDA Forest Service Research**, a branch of the United States Forest Service?

“The mission of Forest Service Research is to develop the scientific **information** needed to protect, manage, and use the renewable natural resources of the Nation’s forests and rangelands....” USDA, Forest Service 1987.

USDA Forest Research ...

...we strive to make sure the **information** presented is accurate and timely.

...publications are peer reviewed and our forest resource **data**, must attain vigorous quality control and quality assurance review before being made available through published and electronic media.

...reliability of **information** is a hallmark for Forest Service Research and Development.



# What about Universities?

- **University of New Brunswick**
  - 5 of 8 Faculties do not have mission statements on their website
  - Science Faculty
    - ... create and disseminate scientific knowledge
  - Forestry and Environmental Management Faculty
    - ... develop the knowledge and skills needed to manage and protect our natural resources

# Data, Information, Knowledge

- Are They different?
- Is so, what are the differences?
- SHOULDn't knowledge be in the mission statement of every research organization?

# Science of science

- External
- Internal

# Science of science

- External
  - *Sociology of science*
    - How science is conducted in organizations
    - The lone (not 'loan') investigator
    - Big science vs. little science
    - Process of peer review
- [Robert K. Merton. \(1973\) The Sociology of Science Theoretical and Empirical Investigations. Univeristy of Chicago Press. 636 pages.](#)

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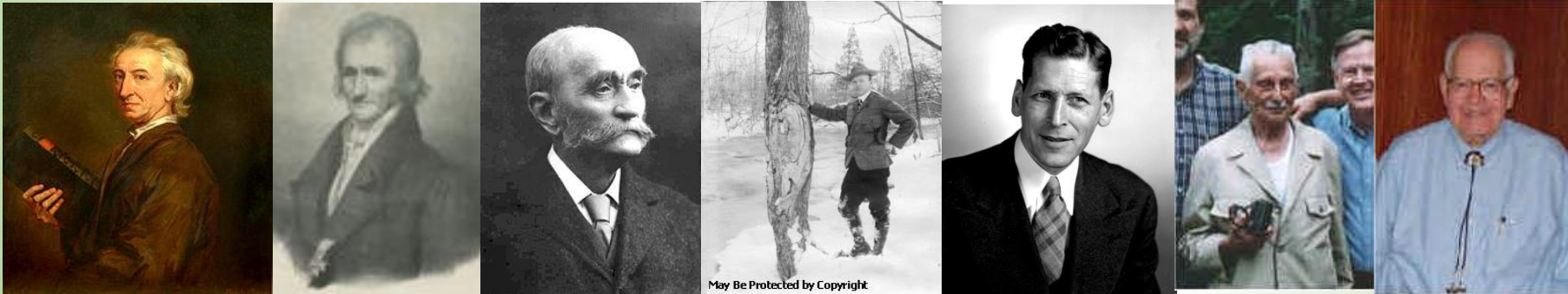
- External
  - *Sociology of science*
  - *History of science*
    - **Macro**, e.g., Newton, Darwin, Mendel, Curie, Mendeleev, Franklin, etc.



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# Science of science

- External
  - *Sociology of science*
  - *History of science*
  - *Psychology of scientists*

# Science of science

- External
- Internal
  - *Logic of science*
    - Deals with the logical **structure of scientific constructs**:
      - concepts, propositions, theories
    - Deals with syllogistic **structure of arguments**:
      - conditional argument structures:  
*Modus tollens, Modus ponens*  
*Extensive treatment in Bunge (1967), Chapter 15*



# Science of science

- External
- Internal
  - *Logic of science*
  - *Philosophy of science*
    - Focuses on **evaluating knowledge claims**
    - Concerned especially with epistemology and ontology
      - 'epistemology' is .... the theory of knowledge, esp. with regard to its methods, validity, and scope
    - Is the source of many '—isms' in the literature

# Science of science

- External
- Internal
  - *Logic of science*
  - *Philosophy of science*
  - *Methodology of science*
    - Many **phases** of research
    - **Finding** problems
    - Strategy **and** tactics
    - Discovery **vs.** justification

# Technology and Science

- Technology

- How to?

- Science

- What is the character of?
- What if?
- Why?

# Science and the Arts (H. Cassidy 1962)

<u>Basis of comparison</u>	<u>Arts/Artists</u>	<u>Sciences/Scientists</u>
• <b>Scope</b>	universal	universal
• <b>Emphasis</b>	truth-to felt experiences acquaintance with reality	truth-about knowledge of reality
• <b>Methods</b>	Cassidy found "marked distinctions between the way creative thoughts come to scientists and how they come to artists ."	
•discovery		
•experiment	"to achieve that perfection of form and style that gives qualitative precision to his product."	"to remove the unique, to eliminate the particular and uncontrolled variable—...to <b>achieve maximum generality.</b> "

# Science and the Arts

	Arts/artists	Sciences / Scientists
<ul style="list-style-type: none"><li>• <b>Results</b></li></ul>		
<ul style="list-style-type: none"><li>• investigator's role</li></ul>	subjective	personal and public objectivity
<ul style="list-style-type: none"><li>• precision attained</li></ul>	qualitative	quantitative
<ul style="list-style-type: none"><li>• thinking/communicating tools</li></ul>	words with connotational richness	austere discursive symbol
<ul style="list-style-type: none"><li>• how relations are handled</li></ul>	analogy and metaphor	numerical ratio
<ul style="list-style-type: none"><li>• <b>breadth</b></li></ul>	<b>particular</b>	<b>generality</b>
<ul style="list-style-type: none"><li>• authority and relation to it</li></ul>	no commonly accepted authority	assents to objective tests
<ul style="list-style-type: none"><li>• <b>patterns sought</b></li></ul>	<b>individual and unique</b>	<b>general and repeatable</b>

# Science has Limits

*(Things science does NOT do.)*

- Science does not make moral judgements
- Science does not make aesthetic judgments
- Science does not tell you how to use scientific knowledge
- Science does not draw conclusions about supernatural explanations

# Take away Messages

1. Science has a **goal** (public knowledge) and a **method** (research).
2. Science has **external** and **internal** branches
3. Science and Technology have co-evolved
4. Science seeks 'truth about', art seeks 'truth to'
5. Science does not make moral judgement