



Reflections on Discovery in Science

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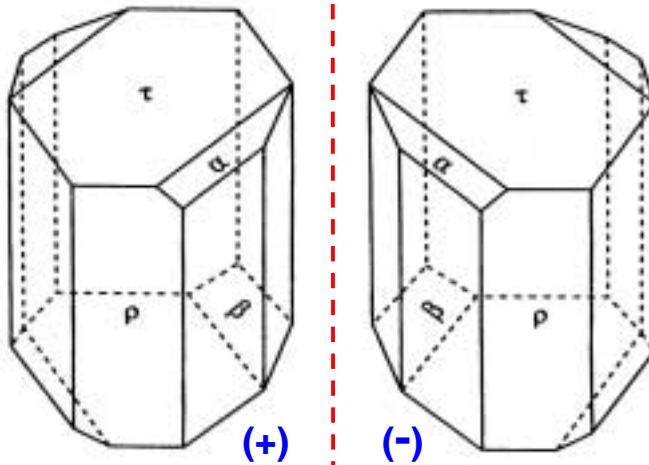


Louis Pasteur

**(27.12.1822-
28.09.1895)**

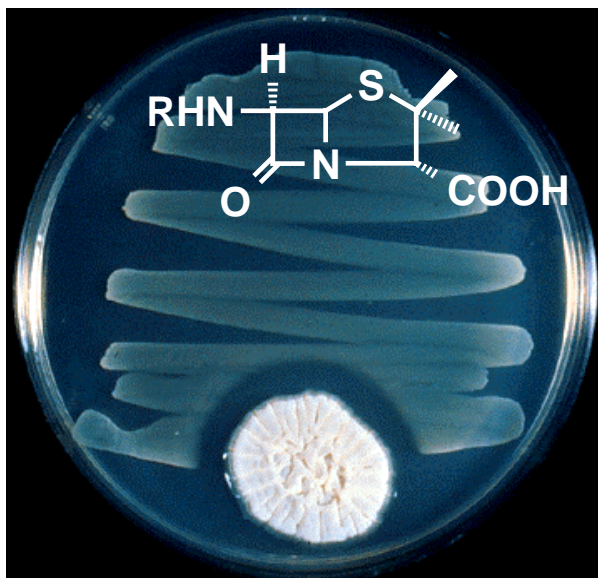
**1848 Prof.
in Dijon,
Strasbourg,
Lille
1857 Paris**

Mechanical Separation of Sodium Ammonium Tartrate Crystals (Louis Pasteur, 1848)



Only few compounds crystallize as separate stereoisomers.

Effect only observed at ambient temperature.



„Penicillin happened, it came out of the blue.“

A. Fleming, 1930

Chance, Good Luck and the Prepared Mind

Serendipity: Sir Horace Walpole, 1754

As Their Highnesses [re: the Princes of Serendip] travelled, they were always making discoveries, by accidents and sagacity, of things which they were not in quest of.

Louis Pasteur, 1854

Dans les champs de l'observation, le hasard ne favorise que les esprits préparés.

Albert Szent-Györgi (1893-1986)

Discovery consists of seeing what everybody else has seen and thinking what nobody else has thought.



Travel of the Three Young Sons of the King of Serendip

title page of the Italian translation of an old Persian fairy tale (approved by the Pope and by the Senate of Venice)

Discovery by Careful Observation: The Three Princes of Serendip

On their way through foreign countries,
the princes meet a man who lost his camel.

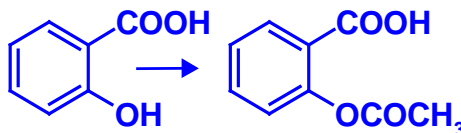


“Was your camel blind
on one eye, had it a
tooth missing, and was
it lame?”
- yes, yes, yes.

The very next day, they
meet this man again.

“Your camel had a load
of butter on one side
and honey at the other;
in addition, it carried a
pregnant woman”
- yes, yes, yes.

Aspirin[®], the Magic Bullett (Felix Hoffmann, 1897)





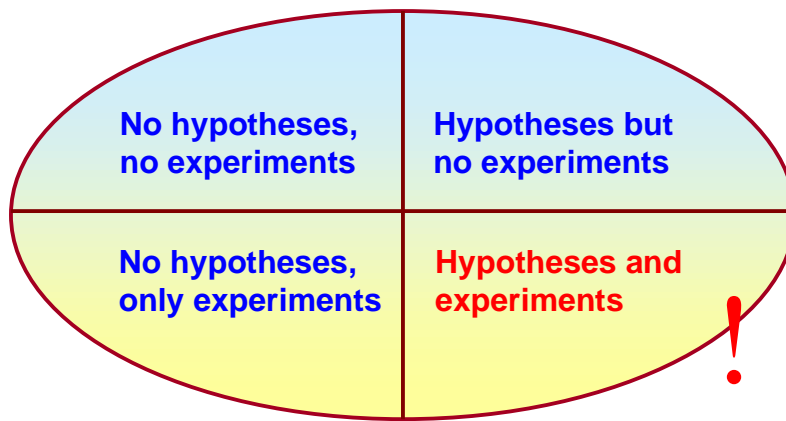
José Ortega y Gasset
★1883 Madrid, † 1955 Madrid



¿Qué importa no ser más rico que otros, si el mundo lo es y le proporciona magníficos caminos, ferrocarriles, telégrafos, hoteles, seguridad corporal y aspirina?

"La rebelión de las masas"

Four Possible Strategies in Research



Rolf Zinkernagel (Nobel prize in Medicine 1996)



Good and Poor Science

[one has to] „differentiate between science and pseudoscience, knowing very well that science often errs and that pseudoscience may happen to stumble on the truth"

Sir Karl Popper

★ 1902 Vienna, † 1998 London

Hypotheses and Their Validation (Karl Popper)

- it is easy to obtain confirmations - if one looks for them;
- confirmations should count only if they are the result of risky predictions;
- every "good" scientific theory is a prohibition;
- a theory which is not refutable ... is non-scientific;
- every genuine test of a theory is an attempt to falsify it;
- confirming evidence should not count except when it is the result of the test of the theory;
- some testable theories, when found to be false, are still upheld by their admirers - for example by introducing some auxiliary assumption, or by reinterpreting the theory *ad hoc* in such a way that it escapes refutation.

Conjectures and Refutations, 1962 (already formulated in 1919)

