



# 1822. From Louis to Pasteur 1895



Exhibition produced by the  
Institut Pasteur - Musée Pasteur on the occasion of the  
bicentenary of Louis Pasteur's birth.



# 1822 Birth of a scientist



Birth House of Louis Pasteur.

## A Jura native

**Louis Pasteur was born on December 27, 1822** in Dole in the Jura, France. Five years later, his father set up a tannery in Arbois, where the boy attended the local primary and secondary schools. Louis was a conscientious, diligent, though not particularly brilliant student, who discovered an early passion for drawing. Although his artworks brought him some degree of fame, his ambitions led him elsewhere: *“With science, one rises above the rest!”*.

1 - Louis Pasteur to his parents, January 26, 1840

Between the age of thirteen and twenty, Louis Pasteur made several pastel portraits of his friends, neighbors and parents.  
Jean-Joseph Pasteur, father of Louis Pasteur, pastel by Louis Pasteur in 1842. Jeanne-Étiennette Pasteur, mother of Louis Pasteur, pastel by Louis Pasteur in 1836.



# 1843

## A chemist

**In 1843, he was admitted to the École normale supérieure**, where he would later spend most of his career. On his graduation in 1846, one of his teachers, Professor Antoine Jérôme Balard took an interest in him, taking him on as a laboratory assistant. In 1847, the young man successfully defended his physics and chemistry theses, his first works, which explored the science of crystallography. During this period he made his first discovery.

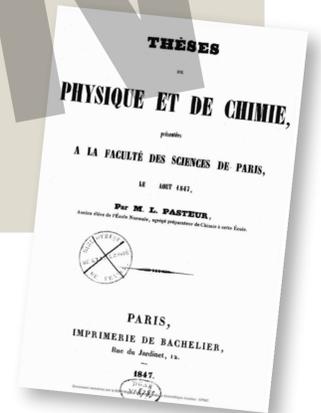
### Louis Pasteur's career at the École normale supérieure in Paris

- 1843:** Passed the entrance examination (4th place)
- 1844-1846:** Student.
- 1857:** Pasteur appointed administrator and director of scientific studies.
- 1858:** Pasteur sets up a laboratory in the attic.
- 1867:** Resignation of all directors including Pasteur. Pasteur's calls for a physiological chemistry laboratory to be established on Rue d'Ulm are successful.



École normale supérieure. Louis Pasteur as a student in 1843.

“Study of arsenites of potash, soda and ammonia.”  
Chemistry thesis by Louis Pasteur, 1847.



# 1857

## First discovery!

Pasteur discovered that tartrate, a compound deposited at the bottom of wine vats, can exist in two forms, resulting in asymmetric crystals which are mirror images of one another. He deduced that the molecules of these two forms, though composed of the same atoms, are distinguished by their spatial arrangement.

**This was the first time molecules had been considered as three-dimensional objects. In modern science, biological phenomena are explained by interactions between molecules determined by their three-dimensional structure.**



Like the crystals, the hand and its reflection in a mirror are mirror images of one another.

## Life is asymmetrical

This discovery of molecular asymmetry<sup>2</sup> in 1857, which Pasteur identified as a characteristic of living organisms' constituent molecules, earned him fame in chemistry circles. Louis was on the verge of becoming Pasteur.

2 - The term chirality is currently used.



# 1849

## A new branch of science

In 1849, Louis Pasteur was appointed professor at Strasbourg University, where he continued his work on molecular asymmetry. Soon after his arrival he met the rector's daughter, Marie Laurent. They married five months later. The couple had five children<sup>1</sup>, three of whom died prematurely. Marie Pasteur was the attentive and unassuming partner of a man whose life was devoted to science.

1 - Jeanne (1850-1859, died of typhoid fever), Jean-Baptiste (1851-1908) husband of Jeanne Boutroux, Cécile (1853-1866, died of typhoid fever), Marie-Louise (1858-1934) wife of René Vallery-Radot, Camille (1863-1865, died of a liver tumor).



Louis Pasteur in 1852 in Strasbourg.

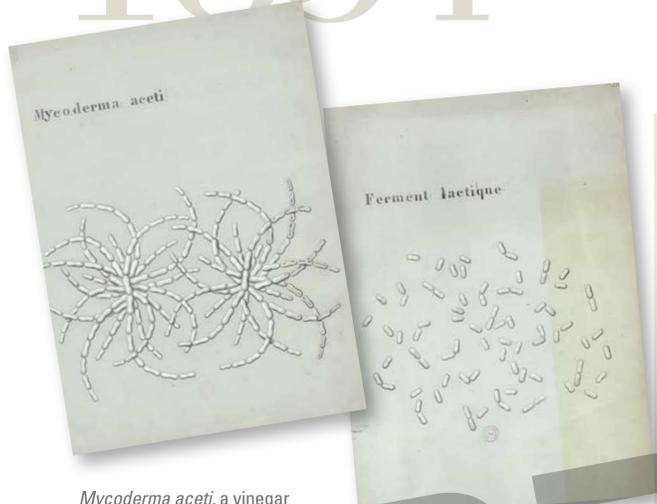


Photograph of three of the Pasteur offspring: Jean-Baptiste (1851-1908), Cécile (1853-1866) and Marie-Louise (1858-1934) around 1865.



Drawing of Marie Pasteur, née Marie Laurent (1826-1910) in 1874.

# 1854



*Mycoderma aceti*, a vinegar ferment and the cause of the wine disease acescence. Plate by Peter Lackerbauer from around 1870 representing microbes observed by Louis Pasteur in his research on fermentation.

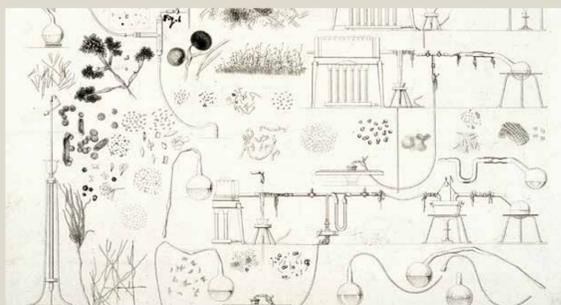
Plate by Peter Lackerbauer, "Lactic ferment," c. 1870. Illustration representing microbes observed by Louis Pasteur in his research on fermentation.

## Research on fermentation

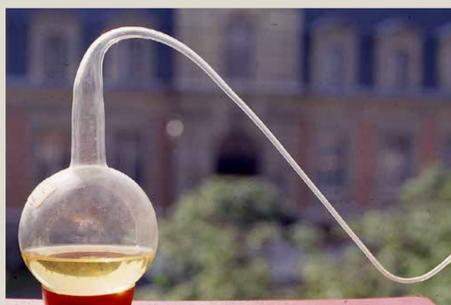
In 1854, Pasteur was appointed Dean of the Science Faculty in Lille. While in this post, he began his work on fermentation after a student described the problems his father was experiencing with producing alcohol from beetroot juice. He continued this work at the École normale supérieure in Paris. Pasteur revealed that fermentation results from microorganisms' metabolism. In alcoholic fermentation, yeasts feed on grape or beetroot sugar and multiply. Alcohol is a waste product of this metabolism. Pasteur defined how to culture these microorganisms, a major contribution to establishing a new branch of science: microbiology.

## Rebuttal of the spontaneous generation theory

So where do these microorganisms that cause fermentation come from? One fashionable theory of the day stated that they appear spontaneously in organic liquids. This is the theory of spontaneous generation which Pasteur rebutted by proving that fermentation is the result of contamination by microorganisms in the air carried by dust.



Figures taken from Louis Pasteur's "Paper on organized corpuscles that exist in the atmosphere. Examination of the doctrine of spontaneous generation," grouped together on a single page.



Swan neck flask used for Louis Pasteur's experiments challenging the spontaneous generation theory.



Louis Pasteur on the Sea of Ice (in the Alps) testing culture media at altitude. Watercolor drawing by E. Clair-Guyot.

## Microbes are everywhere!

The "swan neck flask" experiment suggested by his mentor Antoine Jérôme Balard is compelling proof of this. Following a prolonged scientific dispute, Pasteur was able to affirm in 1862 that: "spontaneous generation is a chimera; every time we believed in it, we were the plaything of a mistake".

Through further experimentation, he demonstrated that microorganisms are everywhere in the air, in the water, and on all objects surrounding us, which no one had previously suspected, since microorganisms are invisible to the naked eye.



# 1860 Fermentation control and “pasteurization”

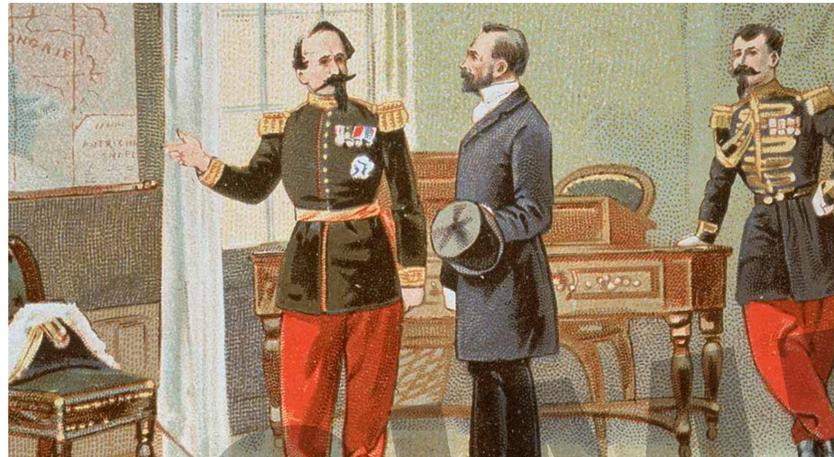
## Research on wine



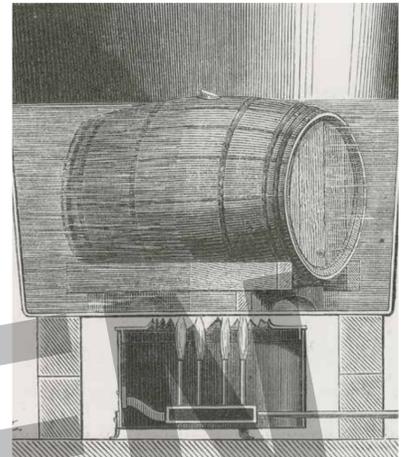
Louis Pasteur and his wife on a train, bringing back vine branches from Arbois for Pasteur's research on wine. Drawing by Pogel.

In 1860, the government of Napoleon III signed a free trade treaty with Queen Victoria's government opening up the British market to French wines. Unfortunately, these wines were affected by various “diseases”. Napoleon III called in Louis Pasteur to “research the causes of wine diseases and the means of preventing them.” For Pasteur, the only plausible explanation was that wine defects were the result of contaminant germs. He therefore devised a method to kill the majority of them: heating the wine for several minutes at temperatures of between 55 and 60°C.

**This process is now known as pasteurization. Although very rarely used for wine, it is still applied for preserving various other foods and beverages.**



Louis Pasteur in the office of Emperor Napoleon III. Image from a series of thumbnails illustrating the work of Louis Pasteur with text on the back, published around 1900 by La Chocolaterie of Aiguebelle, founded in 1869 (Monastery of La Trappe-Drôme).



Heating wine in barrels in “Études sur le vin” by Victor Masson et fils, 1866.

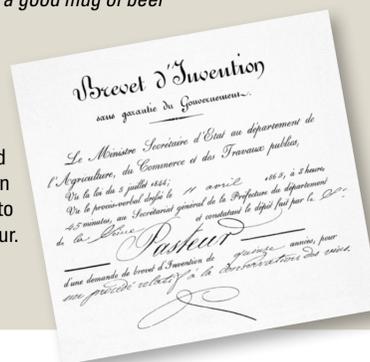
## Research on beer

Several years later, Pasteur was devastated by France's defeat in the Franco-Prussian War of 1870. As his contribution to the national recovery, he offered his support to an industry recognized as a German speciality: brewing. French beer, like the country's wine, was of variable quality and kept poorly due to the contaminant germs it contained. In Clermont-Ferrand, where he took refuge in the home of his student Émile Duclaux and later in Paris, Pasteur devised processes to control ferments during fermentation and pasteurization of the end product. “*I want any beer produced with my process to be named a Beer of National Revenge, in France!*” said Pasteur. All modern brewers recognize Pasteur's contribution to the brewing industry.



Louis Pasteur and his dear friend Pierre Augustin Bertin, a beer enthusiast who tested the quality of pasteurized beers. He would say to his friend: “*Give me a good mug of beer first, and then enlighten me!*”

Official patent application dated April 11, 1865, for the invention of a new process used to preserve wine by Louis Pasteur.



Louis Pasteur, wearing his Legion of Honor medal, with his granddaughter, Camille Vallery-Radot. Oil on canvas by Léon Bonnat in 1886. The painting was commissioned in 1885 by J.C. Jacobsen, director of the Carlsberg brewery in Copenhagen, as a gift for Louis Pasteur's wife. The Carlsberg brewery was the first to pasteurize beer.

1 - Œuvres de Pasteur. Vol. 5 / compiled by Pasteur Vallery-Radot, p346  
2 - La vie de Pasteur / René Vallery-Radot, p307

**Pasteur's discoveries on fermentation, wine, beer and vinegar would revolutionize the food industry.**



# 1865 Silkworm studies

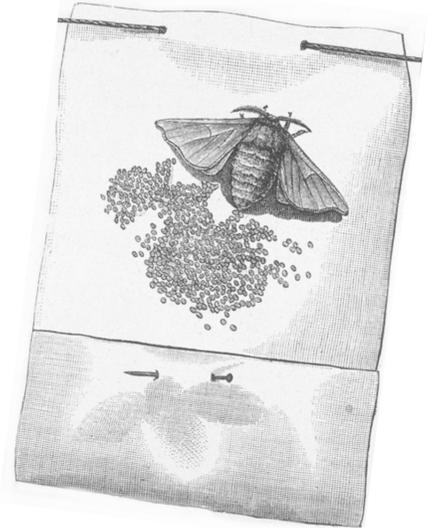
## The French silk industry must be saved!



Plate by Peter Lackerbauer taken from Louis Pasteur's "Studies on silkworm diseases."

In 1865, Louis Pasteur's former teacher, the chemist Jean-Baptiste Dumas, who had been elected senator for the Gard department, called on him to save the silk industry. Although France produced 10% of the world's silk, the silkworm population had been decimated in recent years by an epidemic disease. Pasteur accepted the challenge despite his lack of knowledge of silkworms. He discovered that silkworms were affected by two diseases (silkworm nosema disease and flacherie). Having deduced that the cause was microorganisms, he suggested hygiene measures that would save the silk industry both in France and abroad.

**These discoveries concerning silkworm diseases would guide subsequent research on contagious animal then human diseases.**



Cellular egg production method for female silkworm moths developed by Louis Pasteur to detect silkworm diseases, 1870.

## Family tragedies

**While Pasteur was conducting this research on silkworms, tragedy struck his family.** Typhoid fever had already claimed the life of his eldest daughter, Jeanne in 1859 at the age of nine. In 1865, Pasteur's father died. Just months later, his daughter Camille developed a liver tumor at the age of two, which claimed her life. The following year, a third daughter, Cécile was next to fall victim to typhoid fever aged thirteen. Fate struck again in 1868 when Pasteur himself suffered an almost fatal stroke that left him paralyzed on one side.



Louis Pasteur dictating to his wife a note to the French Academy of Sciences about silkworm diseases, at the silkworm nursery of Pont-Gisquet, near Alès.



Photograph of Marie Pasteur (1826-1910) with his daughter Camille (1863-1865) in 1864.

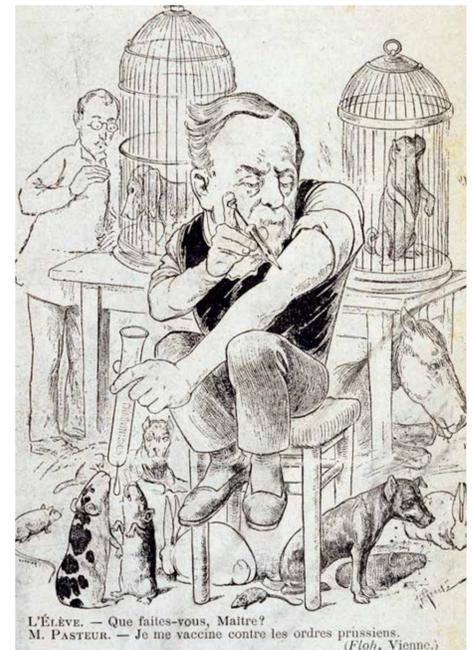
## The War of 1870

**On July 19, 1870 war broke out between France and Prussia.** Napoleon III was forced to surrender on September 2nd. Pasteur's previous admiration for the Germans was replaced by deep loathing. He wrote: "Each of my works will bear the following epigraph: *Hatred for Prussia, Revenge, Revenge*". This switch to a deeply nationalistic mindset left Pasteur with a hatred of all Germans that remained with him until his death. It also fueled the flames of his future rivalry with German physician Robert Koch, also a pioneer of microbiology.

1 - Louis Pasteur to Jules Raulin, September 17, 1870

Photograph of Jean-Baptiste Pasteur (1851-1908) in uniform in 1870, sent by J.B. Pasteur to his mother in November 1870.

Cartoon of Pasteur vaccinating himself against Prussian orders, by F. Graetz in May 1895.





# 1876

## Microbes, infectious diseases and hygiene

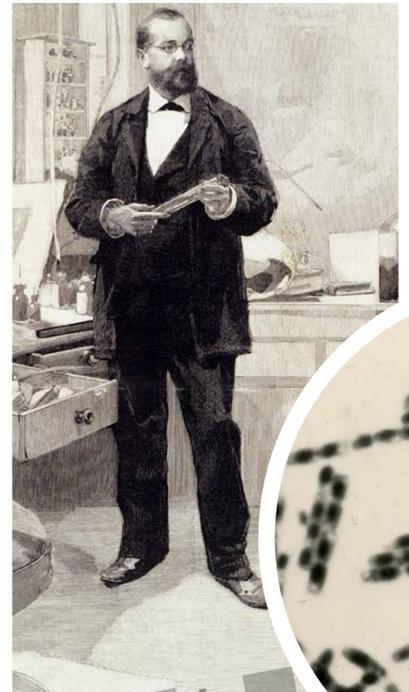
### Microbes and pathogens

Louis Pasteur quickly reached the conclusion that, like fermentation, infectious diseases were caused by microorganisms.

A theory corroborated by his work on silkworms. However, it was Robert Koch, a German rural physician who demonstrated this for the first time in 1876 for anthrax, a disease killing entire flocks of sheep and cattle herds. Koch believed the cause to be a specific microorganism. Taking little joy in his theory being proved by this German physician, Pasteur proclaimed his findings unconvincing. He then performed a different experiment ... which corroborated them!

**The work by Koch and Pasteur on anthrax provided initial experimental proof of a contagious disease caused by a "microbe\*," the new name given to microorganisms.**

Following this initial breakthrough, microbes were identified for many other diseases including tuberculosis by Koch (1882), cholera by Koch (1883), pneumococcal disease by Pasteur and George M. Sternberg (1881), diphtheria by Koch's student, Friedrich Loeffler (1884), and plague by Pasteurian Alexandre Yersin (1894).



Robert Koch in his laboratory.  
The anthrax bacillus and its spores: this bacillus produces spores, which are like seeds with resistant capsules, potentially explaining its annual recurrence in certain fields considered "cursed".

\*The word "microbe" or "microorganism" was coined in 1878 by military surgeon Charles-Emmanuel Sédillot and approved by Émile Littré: A micro-organism or microorganism or microbe is a microscopic living organism. Generally invisible to the naked eye, it can only be observed using a microscope. (Le Littré dictionary, 1880).

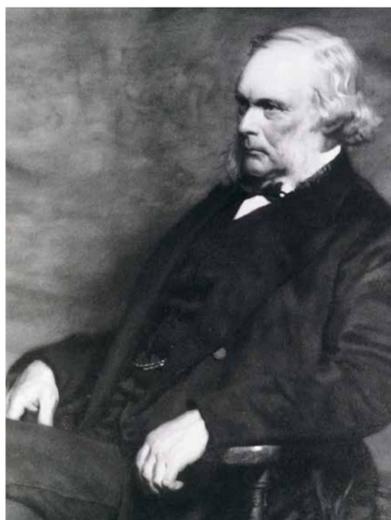


### Hygiene and aseptic techniques<sup>1</sup>

Having demonstrated that all contagious diseases are caused by microbes, Pasteur established hygiene rules that would prove vital for preventing infections, particularly those occurring after surgery, which posed a significant threat at the time. When applied to our everyday lives, these principles were to have implications for a number of areas. Although hygiene and aseptic techniques predate Pasteur, these concepts now had a solid theoretical basis and their development sped up significantly. **Improvements in personal and collective hygiene were a key factor in rising life expectancy over the course of the 20th century.**

<sup>1</sup> - Aseptic techniques: All measures taken to prevent invasion of live tissue or inert environments by exogenous microorganisms or viruses. (Larousse Médical)

Allegory of the cholera outbreak in Turkey.



### Joseph Lister and Ignaz Semmelweis

Lord Joseph Lister (1827-1912), a British physician and surgeon considered **to be one of the founders of antiseptic surgery**. (unlike aseptic techniques, antiseptic techniques involve the use of chemicals to destroy microbes.). His work drew on Louis Pasteur's discoveries on the origin of germs and diseases.

Ignaz Semmelweis (1818-1865), the Hungarian physician **who defined the first hygiene rules for hospitals, in particular hand washing**.



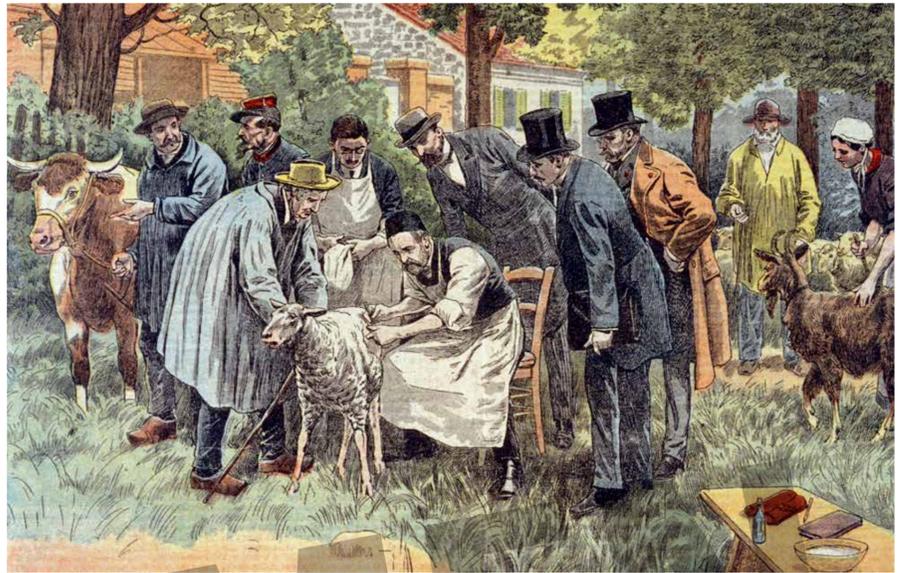


# 1880

## Vaccinate, vaccinate, vaccinate!

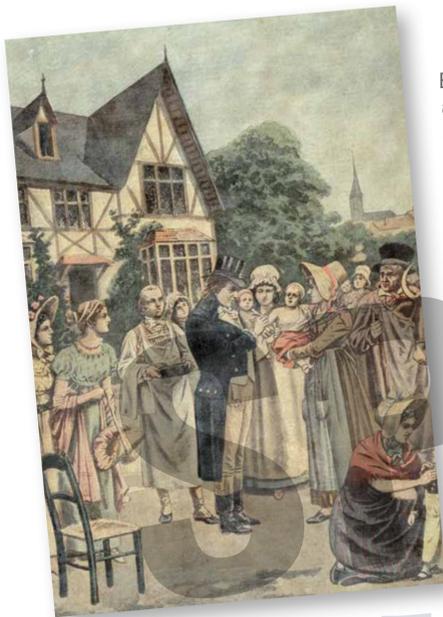
### Could an attenuated form of a microbe protect against disease?

In the late 18th century, British scientist **Edward Jenner** had demonstrated that immunity to smallpox could be achieved through inoculation with the harmless cattle disease, cowpox, which is similar to smallpox. Based on his knowledge that contagious diseases are caused by microbes, Pasteur formed the theory that the cowpox microbe could be an attenuated form of the smallpox microbe. Could attenuated forms of microbes causing other diseases therefore be isolated and used as protection against virulent forms? This is precisely what Pasteur achieved in 1880 with fowl cholera. He repeated the procedure in 1881 for anthrax in sheep and cattle.

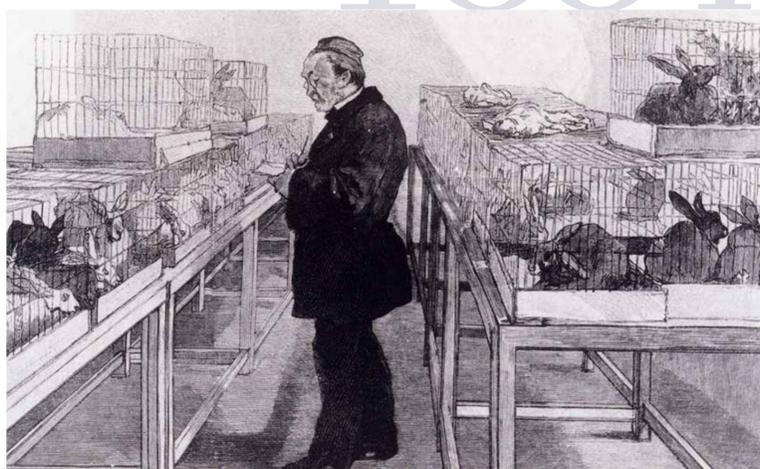


Edward Jenner and cowpox. Illustration of a public smallpox vaccination session in around 1800, published in *Le Petit Journal* on May 13, 1901.

Public vaccination of sheep against anthrax in Pouilly-le-Fort: Louis Pasteur performed a spectacular demonstration of vaccination's efficacy on a farm in Seine-et-Marne. Fifty sheep were provided. He vaccinated half of them and then inoculated the whole group with the virulent microbe several weeks later. Only the vaccinated animals survived. Colored pen and ink drawing by Damblans, imagined scene printed in *Le Pèlerin*.

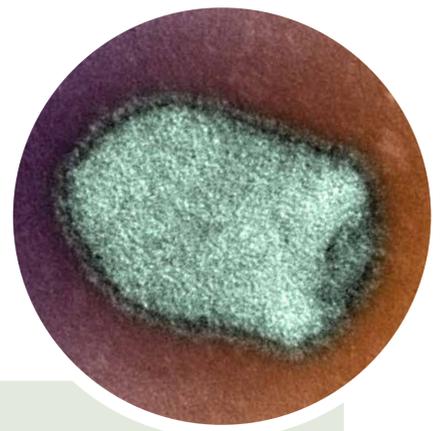


# 1884



Louis Pasteur taking notes on rabbits inoculated against rabies, around 1884. Although rare in Europe, rabies was a terrifying disease. By tackling it, Pasteur earned extraordinary acclaim for his work. Drawing by Renouard.

Electron microscopy image of the rabies virus in 1974. In Pasteur's day, microscopes were not powerful enough to see the virus. It was first observed almost a century later, in 1962, following the advent of electron microscopy.

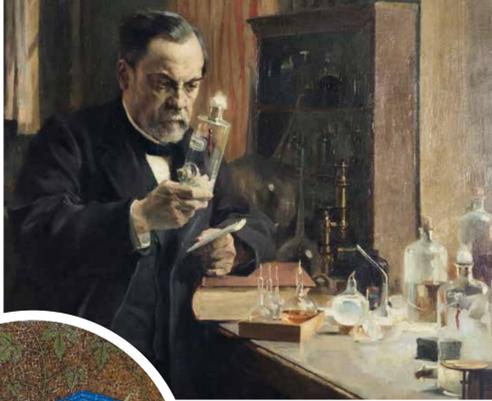


## The challenge of rabies!

Rabies is a disease that can be contracted following a bite by a rabid animal. Since rabies is primarily an animal disease, it was possible for Pasteur to experiment on dogs before switching to humans. However, he was unable to identify the causative microbe. He could neither see it under a microscope nor culture it in any kind of medium. As we now know, this is because it is a virus rather than a bacterium like the pathogens identified for fowl cholera and anthrax. Viruses are infinitely smaller than bacteria, and therefore invisible under an optical microscope. Moreover, they can only multiply inside living cells. This posed a real problem.



# 1885 Overcoming rabies



## From animals...

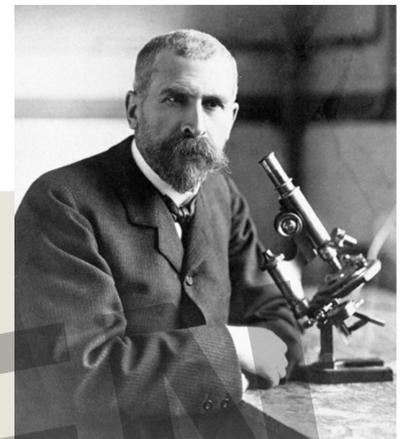
Since Pasteur was unable to culture the virus, he maintained it by transmitting it between rabbits, a less dangerous alternative to dogs, for his research. Moreover, the physician Pierre-Henri Duboué had recently demonstrated that its infectious potential lay in the nervous system. Pasteur consequently used the rabbits' spinal cords to transmit rabies between animals. The spinal cords of rabbits that had died of rabies were left to dry for several days to attenuate the virus. The attenuated spinal cord was then ground, suspended in a sterile liquid, and injected into dogs. Several successive inoculations were performed with decreasingly attenuated spinal cords. The dogs subsequently survived inoculation with fresh, virulent, pathogenic spinal cords. They were ... vaccinated!



Oil on canvas by Albert Edelfelt in 1886 – Louis Pasteur in his laboratory at the École Normale Supérieure in 1885 holding a flask containing the spinal cord of a rabbit inoculated with the rabies virus.

Detail of the mosaic in the crypt where Louis Pasteur is buried. The rabbits illustrate Pasteur's work on rabies.

Emile Roux (1853-1933) in his laboratory around 1900.



**Émile Roux**, the only physician on the team, played a key role in producing this rabies vaccine. He was a French physician and biologist, and a remarkable teacher whose personal work on serotherapy paved the way for a new era in diphtheria and tetanus treatment. His life was closely intertwined with the Institut Pasteur serving as its director for 30 years and notably supervising construction of the Institut Pasteur hospital, which officially opened in 1900.

## To humans!

Then came the historic vaccination of **Joseph Meister**, a boy from Alsace severely bitten by a rabid dog. His mother brought him to Pasteur's laboratory at the École normale on July 5, 1885. Pasteur decided to apply the same protocol to young Joseph that he had used for dogs. Three months later, while in the early stages of vaccinating another child, the shepherd Jean-Baptiste Jupille, Pasteur announced to the academies that Joseph Meister had not contracted rabies. The press was virtually unanimous in its celebration of his triumph over rabies. Pasteur would now be known as a "benefactor of humanity". He had achieved glory!

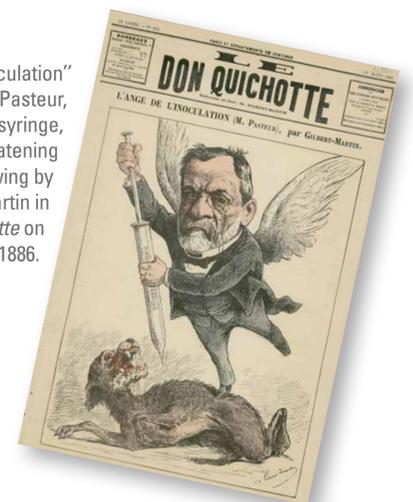


Joseph Meister (1876-1940) in around 1885, when his life was saved by the rabies vaccine developed by Louis Pasteur.



Inoculation with the rabies vaccine in Louis Pasteur's vaccination room at the École normale supérieure. Dr. Joseph Grancher administers vaccinations while Louis Pasteur takes a register of bite victims. Drawing by Bayard, 1886.

"The angel of inoculation" a winged Louis Pasteur, armed with a huge syringe, inoculates a threatening rabid dog. Drawing by Charles Gilbert-Martin in *Le Don Quichotte* on March 13, 1886.



Following vaccines for fowl cholera and anthrax in sheep and cattle, the rabies vaccine could be used in humans, paving the way for the development of vaccinology and the discovery of numerous vaccines that have saved countless lives.





# 1892

## “Benefactor of humanity”

### A hero in his lifetime

**On December 27, 1892, Louis Pasteur's seventieth birthday was celebrated at the Sorbonne with due ceremony.**

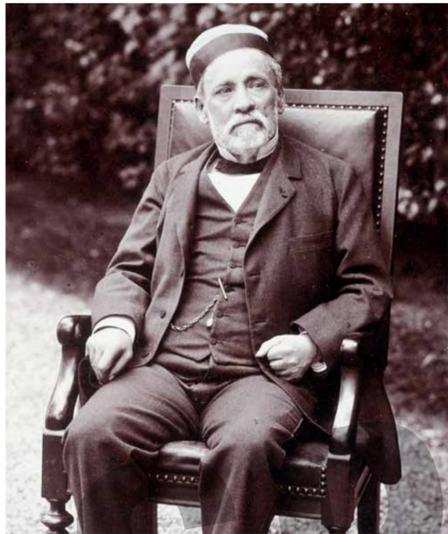
Nearly a thousand guests from around the world flocked to the Grand Amphithéâtre. Pasteur entered on the arm of French President, Sadi Carnot, to a long ovation. British surgeon Joseph Lister, representing the international scientific community, opened the tributes. Overwhelmed by emotion and physically frail, Pasteur asked his son Jean-Baptiste to read his response: “You bring me the deepest joy that can be felt by a man whose invincible belief is that science and peace will triumph over ignorance and war...”



The jubilee of Pasteur at the Sorbonne on December 27, 1892. Lister addressing Pasteur: “Truly, there is no individual in the entire world to whom the medical sciences owe more...”. Oil on canvas by Jean-André Rixens in 1902.



The jubilee of Pasteur at the Sorbonne, cover of “Le petit Journal” on January 14, 1893.



Photograph of Pasteur by Henri Mairet in 1895, in the gardens of the Institut Pasteur. The final photograph of Pasteur.

### 1894

### Final hour

**On November 1, 1894, Pasteur was overcome by an attack of uremia.**

Despite a slight improvement in subsequent weeks, his condition ultimately worsened. On June 13, 1895, too frail for his usual trip to Arbois, he traveled by car to the Villeneuve l'Étang estate in Marnes-la-Coquette on the outskirts of Paris. The government had provided the estate for Pasteur's rabies experiments. Although able to rest in the grounds in the peaceful shade of “purple beeches”, his condition rapidly deteriorated. Louis Pasteur died on September 28, 1895 in a sparse room furnished only by a bed, table and armchair.

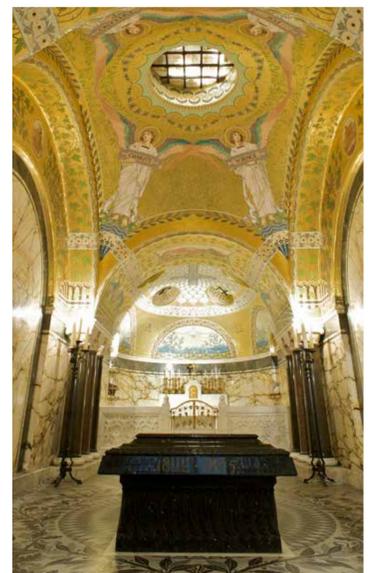
### State funeral

**On the announcement of his death, the government ordered a state funeral.**

On October 5, the hearse drawn by six caparisoned horses departed for Notre-Dame Cathedral in a procession comparable to Victor Hugo's funeral ten years earlier. Countless people crowded along the route of the funeral procession. According to his family's wishes, Pasteur was interred at the Institut Pasteur beneath a plain granite tombstone overarched by a dome of colorful mosaic tiles on a golden background featuring allegorical images of animals and interlaced foliage. Each of Pasteur's discoveries engraved on the precious marble wall panels represent victories over ignorance.



Official delegation on the forecourt of Notre-Dame Cathedral at Louis Pasteur's funeral on October 5, 1895. State funeral: Raymond Poincaré, Minister of Education, gave the only official speech “... Posterity will rank him among the glorious line of apostles of goodness and truth.”



The Neo-Byzantine crypt by Charles-Louis Girault where Louis Pasteur is buried, Institut Pasteur, Paris. At the center, Louis Pasteur's tomb in Swedish granite.



# 2022 The legacy

## The Pasteurian spirit

In addition to his discoveries, Louis Pasteur has also bequeathed us a specific notion of science sometimes referred to as the “Pasteurian spirit”.

Its components include a rigorous approach to research combining intuition and critical thinking. Maintaining a permanent link between the most fundamental research and its applications is also a key aspect. The final component is a global vision summed up by Pasteur’s expression “science knows no country<sup>1</sup>,” reflected in the founding and development of what is now known as the Pasteur Network. This “Pasteurian spirit” has clearly been kept most alive in the institute he founded and the international network.

Louis Pasteur’s legacy was also partly forged by his «lieutenants,» the inner circle of scientists who helped him found the Institut Pasteur and guided its development between the late 19th century and early 20th century: Émile Roux, Émile Duclaux, Charles Chamberland, Joseph Grancher, Ilya Mechnikov, followed by a new generation of younger scientists in subsequent years: Albert Calmette, Alexandre Yersin, Étienne and Edmond Sergent, Charles Nicolle, etc.

1 - Louis Pasteur, Inaugural speech for the Institut Pasteur, November 14, 1888.



Louis Pasteur surrounded by his colleagues in 1894 in the Institut Pasteur library. Seated from left to right: Albert Calmette, Louis Martin, Émile Roux, Louis Pasteur, Edmond Nocard, Henri Pottevin, Félix Mesnil. Standing from left to right: Eugène Viala, Charles Paul Rebour, Marcel Mérieux, Auguste Fernbach, Auguste Chaillou, Amédée Borrel, Louis Marmier, Auguste Charles Marie, Adrien Veillon, Ernest Fernbach.

Émile Roux, Albert Calmette, Alexandre Yersin, Émile Duclaux.



Pasteurian Nobel laureates. In more than a century, ten Nobel Prizes in Physiology or Medicine have been awarded to Institut Pasteur scientists for their research.

## Discoveries spanning more than 130 years

Since the founding of the institute in Paris and the international network, a succession of major discoveries has taken place. As a brief recap: the discovery of the plague bacillus and the first diphtheria treatment based on serotherapy, both occurring in 1894; the tuberculosis vaccine (BCG) and vaccines for diphtheria and tetanus developed in the 1920s; the polio vaccine developed in 1955; and the AIDS virus identified in 1983. Alongside these major advances for medicine and public health, there have been key contributions to basic research including those made by François Jacob and Jacques Monod in 1961 on gene expression involving discovery of messenger RNA which, 60 years later, led to the development of COVID-19 vaccines in record time.

## Understanding the living world, improving health for all people

For over 130 years, the institute has constantly pursued the missions set out by Pasteur in 1887. Today it is a biomedical research institution of international renown and a recognized leader in the fields of infectious diseases, microbiology and immunology. Its work relates not only to infectious diseases, but also to certain forms of cancer, neurological diseases and neurodegenerative disorders. The Institut Pasteur is a non-profit foundation with recognized charitable status. It is funded in virtually equal measure by the French state, revenue from research applications, and public generosity in the form of donations, legacies, and sponsorship.



Photos of the Institut Pasteur buildings, 28 rue du Docteur Roux, in 1981 and 2013.