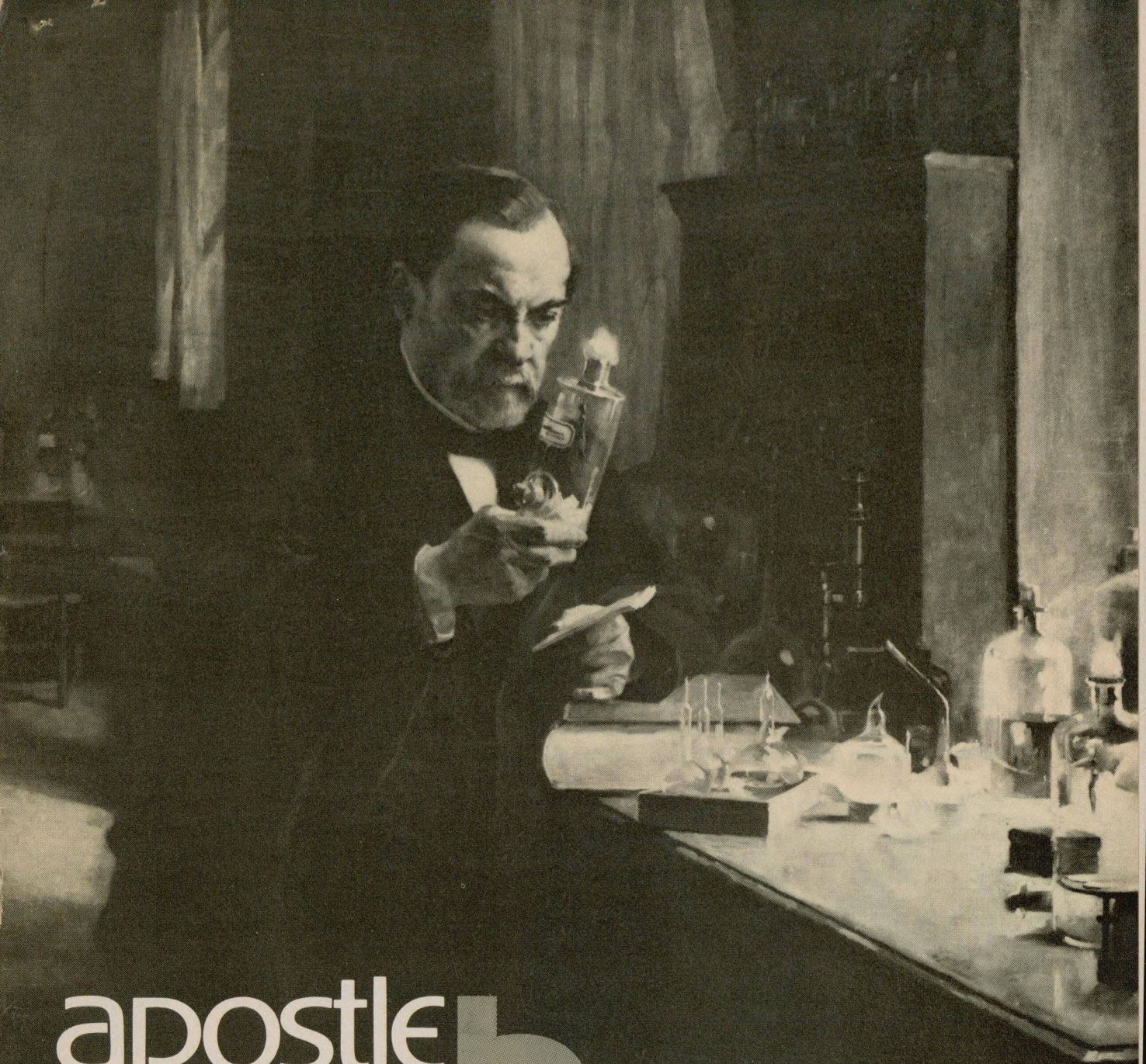




apostle of **h** SCIENCE

MD PERSONALITY

is schoolteacher wrote that he was the meekest, smallest and least promising pupil in his class, although he did have an insatiable curiosity. That curiosity led Louis Pasteur to bestow on mankind in numerous fields more benefits than any other man in the history of chemistry and medicine. His work on stereochemistry, the germ theory of fermentation and disease, and the development of vaccines had a colossal influence on the economics and health of nations. ■ **BEGINNINGS.** Near the fortified walls of an ancient castle in the Jura mountains is a statue of Pasteur that bears the inscription: "Here the ancestors of Pasteur tilled the soil." For three generations the Pasteur family had been serfs, but in 1763 Claude-Etienne Pasteur bought his freedom from the count of Udressier for

the price of four gold pieces. He found work as a tanner's assistant and acquired his own tannery and a large family.

His son Jean-Joseph, the father of Louis Pasteur, was trained in his father's trade and at 20 he was conscripted into the army of Napoleon. After the defeat of Napoleon he opened a small tannery and married Jeanne Etienne Roqui, the daughter of village gardeners. A somber, patient and hardworking man, he was a model of tenacity and dedication. His one passion was that his only son, Jean-Louis, should have an education.

Jean-Louis, born in Dôle on December 27, 1822, was raised in a pastoral setting of vineyards and meadows. At the age of five the family moved to Arbois, a village on the banks of the river Cuisance, in the shadow of the Jura mountains. In his teens he drew lithographs and portraits of townspeople, school friends and family. The portraits, particularly those of his mother and father, have been highly praised as revealing not only great technical ability but the analytic power and energy of a talented artist.

At 16, Louis' potentialities were recognized by the headmaster of the Arbois collège who urged his father to send him to Paris for his last year of rhetoric, as he was certain that Louis could pass the examina-

tions for the Ecole Normale, an élite school founded by Napoleon in 1808 to train people for teaching careers. He was sent to a preparatory school in the Latin Quarter but after only a month he became ill and homesick and wrote to his father: "Oh, if I could but smell the tannery again, I am sure I would get well." His father promptly returned him to the school in Arbois.

In 1839, he entered the collège in Besançon, about 30 miles from home. His preoccupation was to reach the top of his class in mathematics, physics and chemistry, and although he frequently suffered from headaches he wrote to his parents: "I hold a steady place among the best." He wrote to one of his sisters: "The three most important words in the dictionary are will, work, wait. These are the three cornerstones on which I shall build the pyramid of my success."

During this period of his life Pasteur read edifying books: the works of the romantic poet Alphonse de Lamartine, and the moralist Joseph Droz who taught moderation in all things and a religious doctrine based on love, peace and devotion to others.

PARIS. In 1842 Pasteur was admitted to the scientific section of the Ecole Normale Supérieure, but refused to enter the school because he was received 16th in his class. He returned to Paris to study at the Lycée Saint-Louis and the Sorbonne, and in 1843 he was again admitted to the Ecole Normale, but this time he was fifth in rank.

Determined to forge for himself a career as a professor of physics and chemistry Pasteur asked the famous chemist Jean-Baptiste Dumas to accept him as a teaching assistant. He wrote to Dumas saying



Jean-Joseph and Jeanne Etienne Pasteur were Louis' parents. These pastel portraits of them were done by Louis shortly before he first went to Paris.

In October, 1868 Pasteur suffered a cerebral accident that left him semiparalyzed. Although he was able to resume his work he often dictated letters and scientific papers to his wife Marie whom he married in May, 1849 when he was 27. Opposite, a page of his laboratory notes preserved in the Pasteur Institute.



that he wanted the job not "for the sake of money or for the purpose of forming a closer acquaintance with an important man, but because [he] had the ambition to become a distinguished professor."

Dumas accepted Pasteur as a student and a colleague but instead of guiding him into teaching introduced him to the world of scientific research. It was through Dumas that Pasteur met Antoine Jérôme Balard, a brilliant, eccentric professor of chemistry at the Ecole Normale and the discoverer of bromine at the age of 24. When Balard learned that Pasteur was to be sent on a teaching assignment to a small secondary school, he appealed to the ministry of education to permit Pasteur to spend an additional year doing research at the Ecole Normale.

Pasteur, who now spent most of his time working in Balard's laboratory, accepted his dictum that a research scientist should know how to "saw with a file and to file with a saw." At Balard's insistence Pasteur built his own equipment: a goniometer and polarimeter needed for his experiments on the formation and properties of crystals.

This type of research appealed to Pasteur's orderly and precise mind: obsessed by the problem posed by the crystals of tartaric acid and paratartaric acid, Pasteur patiently organized his experiments to prove that molecular dissymmetry is a fundamental characteristic of all substances. He broadened this notion when he later confirmed that lower organisms feeding on tartrates generally reject one of the two varieties of crystal, thus advancing the chemistry of isomers.

PROFESSOR. In 1847 Pasteur spent three months teaching elementary physics in Dijon, but he was dissatisfied with the post because it provided neither time nor facilities for research. With help from influential scientific patrons in Paris he was transferred to the University of Strasbourg, where he was named professor of chemistry at the age of 26. Here he met the daughter of the rector, Marie Laurent, a gentle girl of 22 who combined a sweet disposition with a gaiety of spirit.

Pasteur, in an impetuous manner characteristic of many of his later decisions, wrote to her father six weeks after meeting her to ask her hand in marriage. "My family is in easy circumstances, but with no fortune; I do not value what we possess at more than 50,000 francs, and I have long ago decided to hand over my share to my three sisters. My only means are my good health, good courage, and my position in the university. As to the future, unless my tastes should completely change, I shall devote myself entirely to chemical research."

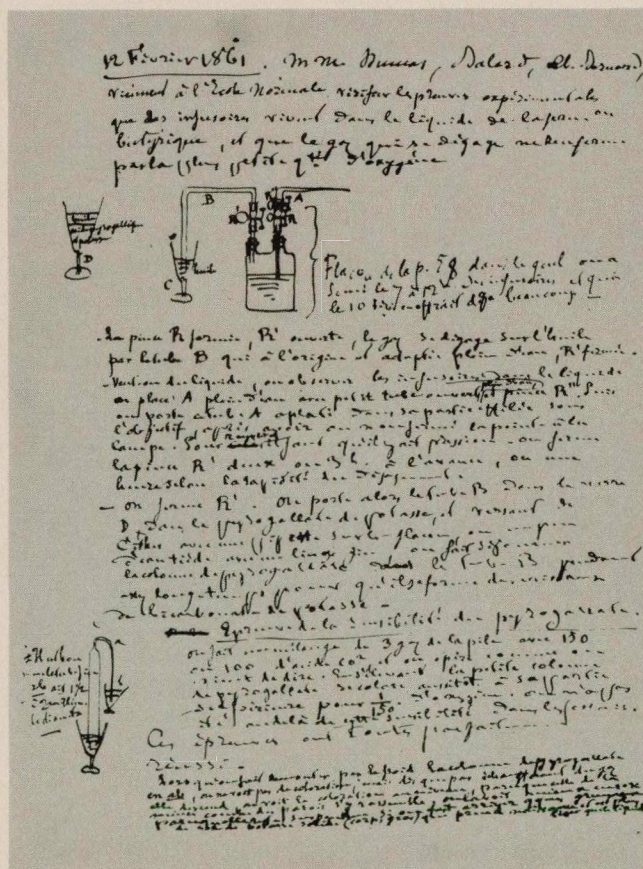
Pasteur married Marie on May 29, 1849, and it proved an idyllic union. She was utterly devoted to

his scientific career, accepting without complaint that even the most simple of family pleasures could only be enjoyed when Pasteur's mind was free, a time that came so infrequently that she wrote: "He is always absorbed in his thoughts, talks little, sleeps little."*

In a letter to a friend Pasteur wrote that in addition to preparing and giving his lectures he spent five days a week in his laboratory. He continued his researches into the natural origin and structure of paratartaric acid and in 1853 was awarded the prize of the Société de Pharmacie de Paris for his synthesis of racemic acid. Now widely known as one of the finest chemists in France, Pasteur was awarded the Legion of Honor, and in 1854 he was appointed professor of chemistry and dean of science in the newly created faculty of Lille.

The minister of public education had asked Pasteur to orient both his teaching and research to local industrial problems. Lille was in the heart of the sugar-beet industry and the problems of fermentation of beet sugar for the production of alcohol were uppermost in Pasteur's mind. Wrote the French scientist René Dubos: "Within two years after his arrival at Lille, the scientific philosopher had been converted into the servant of society; and

*She bore her husband five children, two died before their 10th year.





In the summer of 1885 Pasteur agreed to treat five Russian children who were bitten by rabid dogs. The children were vaccinated in a room of the Ecole Normale by Dr. Grancher, a medical colleague of Pasteur's.

from that time on, most of his efforts were to be oriented directly or indirectly, by the desire to solve the practical problems of his environment."

THE MAN. For the scientist, wrote Pasteur, there are "no applied sciences, only the application of science, and this is a very different matter." His own hypotheses were elaborated not only from detailed and meticulous observations but intuitive, imaginative speculation. It was the role of the experimental method to weed out fact from fancy, to confirm theories proved by experiment.

Pasteur was described by his associates as a dreamy, meditative man who after poring over his copious notes would sit silently for hours until his view of the entire problem could be brought into focus. Visitors to the laboratory were unwelcome.

Pasteur required that his assistants should work in silence; the noise of a busy laboratory, he said, "put his ideas to flight." They were not allowed to smoke, nor were physical comforts of any kind introduced into the laboratory. Pasteur was shocked to discover that one of his colleagues at a nearby laboratory had an armchair and even a rocking chair. Pasteur's assistants were usually left in complete ignorance of the strategy of his research; he revealed only what was necessary for them to accomplish their daily tasks. Noted one assistant: "He kept us remote from his thoughts, preferring an Olympian silence to surround him until the day when his work appeared to him ripe for publicity."

To be in complete control of all the details of his investigations Pasteur personally recorded all the experimental procedures and drawings necessary for his experiments.

His discipline and powers of concentration were awesome: he could sit motionless for hours watching the movements of an infected chicken or dogs inoculated with rabies vaccine. He often said that with his nearsighted eye he was capable of seeing what escaped others.

In the epidemiology of anthrax he was able to decipher the role played by earthworms by noticing their castings over the pits where animals had been buried, and although he had no knowledge of pathologic anatomy he was the first to detect brain tissue infected with the rabies virus. Pasteur attributed his success to his rapid passage from concept to experiment, and his tenacity in the laboratory; he was never discouraged by obstacles.

A polemicist of untiring energy with absolute faith in the design of his experiments, he wrote that there were only three steps in the establishment of evidence: "First to try to convince oneself, then to convince others, third, probably less useful, but very enjoyable, convincing one's adversaries."

Pasteur enjoyed overcoming his opponents and was infuriated by the trend in the scientific and medical world to accept inadequately proved theories, supported by florid and pretentious language instead of facts. In his famous battle over spon-



Laboratory at Pasteur's home in Arbois is maintained as a museum. Caricature of Pasteur satirizes his research methods and his strong Francophilia in that the contents of the test tube with which he injects himself is labeled "chauvinismus."

taneous generation with Félix-Archimède Pouchet, Pasteur used all his experimental and polemic talents. To Pouchet he wrote: "In experimental science it is always a mistake not to doubt when facts do not compel affirmation . . . In my opinion, the question is whole and untouched by decisive proofs."

His flair for the dramatic and his ability to acquaint the French people with scientific methodology were shown in his successful immunization of 25 sheep against anthrax and his dangerous gamble in treating two boys suffering from rabies. He had absolute confidence in his experimental method: if his vaccine worked in the laboratory it could work in a pasture or in a hospital.

Intensely devoted to his country Pasteur was outraged by the bombardment of Paris by the Prussians in 1870 and angrily returned the degree he had received from the University of Bonn. He pleaded with the government to support French scientific and cultural institutions, and himself turned to the encouragement of the French beer industry by showing it how to avoid letting beer become acid and putrid. Hoping that France would never again import German beer, he designed laboratory experiments that used pure cultures of selected yeast and gave suggestions on the production and improvement of plant equipment that were so useful he was granted patents on their production.

ACHIEVEMENTS. Pasteur lies buried in the chapel of the institute in Paris bearing his name. Inscribed

there on marble walls is a simple testament to both the scope and meaning of his life's work. What he did for man is caught in bright colored mosaics depicting wreaths of hops, vines and mulberry leaves, intertwined with figures of cattle, sheep, dogs and poultry. What he did for science is starkly summarized in a list of dates and discoveries: "1848 Crystalline Structures, 1857 Fermentation, 1862 refuted the theory of Spontaneous Generation, 1863 Diseases of the Wines, 1865 Diseases of the Silkworms, 1877 Causes of Contagious Diseases, 1880 Vaccines, 1885 Preventative for Hydrophobia."

All Pasteur's work was marked by a duality: as laboratory investigator he relentlessly pursued detailed facts while musing as a scientist on the broad meanings of what he had found. His first inquiry began with a student paper on tartaric acid that went on to describe crystalline structures and finally posed still larger questions. He asked himself: "Do such asymmetrical qualities, caused perhaps by cosmic influences, exist in light, electricity, heat and magnetism? Do these qualities relate to the movement of the earth, to electric currents by which physicists explain the existence of the magnetic poles?"

One discovery led him to another. He found the role of the microbe in fermentation after investigating asymmetric forms of amyl-alcohol. He turned next to the transmission of microorganisms, demolishing the then popular theory of spontaneous gen-

eration. He proved that sterile liquids remain so if properly protected and demonstrated the role that air plays in the movement of microbes. The demonstration was brilliantly simple: airborne contaminants can settle in openmouthed flasks but cannot enter narrow curvnecked ones.

He identified the difference between aerobic and anaerobic forms of microorganisms and demonstrated the role of spores, showing that each organism had a specific mode of life. His findings aroused a storm of controversy that went on for years.

At the request of Napoleon III he turned to a practical problem, to track down the microorganism that caused wine to become sour. He identified the bacterium as *Acetobacter aceti*, devised preventive measures and designed the necessary equipment. Wine growers were at first horrified by his advice to heat delicate wines (pasteurization) but he won them over with a dramatic demonstration.

In 1865 he was again summoned and was asked to investigate a silkworm disease that threatened to destroy one of France's most important industries.

Pasteur had never seen a silkworm before and he began by visiting the nurseries to examine the eggs, worms, pupae and moths. He discovered something that less observant viewers had overlooked: the infected insects were usually marked by tiny spots. He went on to identify the microspore involved, detected in passing another form of silkworm affliction and found remedies for both problems.

A decade later he came to the rescue of stock raisers, tracking down the cause and prevention of two deadly epizootics, chicken cholera and splenic fever; the second infection attacked man as well in the form of anthrax, malignant pustule and wool-sorters' disease. Pasteur isolated the bacteria involved, found that they lost some of their potency in storage; the result was vaccines prepared from what he called "mitigated viruses."

His last great contribution was the discovery of an immunization for rabies, based on an extension of his earlier techniques. Pasteur injected the hydrophobia virus from rabbit to rabbit, and found that an attenuated virus could be extracted from the dried spinal cord of a rabbit in the 25th generation of infectious transmission. On July 6, 1885, the still unproved inoculation was done after much soul searching into a rabies victim doomed to death. The success of the experiment brought Pasteur worldwide fame and led to the acceptance of the method almost at once.

Pasteur shrewdly publicized his discoveries because he knew well that public recognition meant financial support for research, but he was always careful to combine drama with a scientist's caution

in assessing results and advancing claims. At the height of his fame he advised his colleagues to preserve the enthusiasm inspired by bacteriology through its conquests, but "always accompany this enthusiasm with rigid restraint."

LAST YEARS. A fond *père de famille*, a devout Catholic, a political conservative and a warm partisan of the French empire, Pasteur was in most of his attitudes a typical representative of the French bourgeoisie. It was only in the world of science that he was called by his friends and enemies an unconventional adventurer of the mind.

Frequently embroiled in controversies, it was not until 1882 that he was elected to the Académie française, and even on this occasion he could not resist the temptation to take issue with the positivist philosophy of Auguste Comte. Pasteur resolutely refused to crown the new social sciences with the dignity of science. He saw in their attempt to analyze humanity or philosophy scientifically a travesty of the experimental method.

The summit of Pasteur's career was the creation in 1888 of the Pasteur Institute with funds from donations and the sale abroad of vaccines against anthrax, fowl cholera and erysipelas of pigs. Pasteur, appointed director for life, attracted scientists with a wide variety of training and specializations.*

On December 27, 1892 Pasteur's seventieth birthday was celebrated in the great amphitheatre of the Sorbonne, attended by the president of the republic and some of the world's foremost scientists. He was by this time too feeble to deliver his own oration and had his son read it for him. He declared: "Never permit the sadness of certain hours which pass over nations to discourage you. . . . Have faith that in the long run the nations will learn to unite not for destruction but for cooperation, and that the future will belong not to the conquerors but the saviors of mankind."

On November 1, 1894 Pasteur suffered a violent attack of uremia which left him exhausted. The following June he left Paris to rest at a branch of the Pasteur Institute at Villeneuve l'Etang, but his paralysis became worse and he died on September 28, 1895, one hand holding his wife's hand, the other holding a crucifix. His last words to his students were: "You have to work."

SUMMING UP. At the Sorbonne 70th birthday celebration of Pasteur, one orator said: "It was not merely a great scientist who was the hero of the day, but a man who had devoted all his strength, his heart and his genius in the service of mankind." 

*Still an outstanding center of research, since Pasteur's death six Pasteur Institute scientists have won the Nobel Prize.