LOUIS PASTEUR

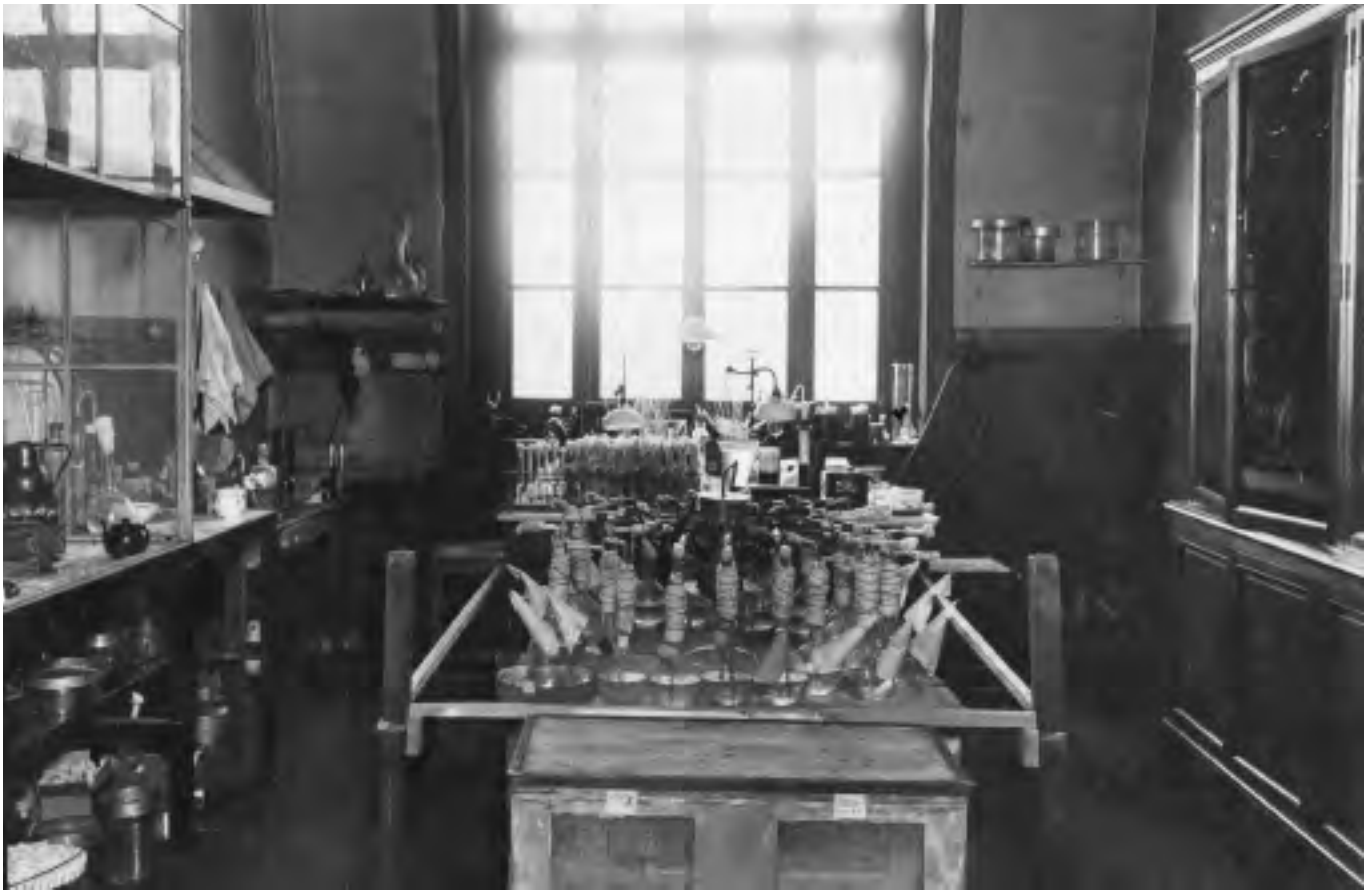
BY LESLIE LICHTENBERG

It takes hard work, tenacity and vision to accomplish what only a few scientists throughout history have been able to do: discover new science that not only advances our knowledge but also benefits the greater common good. Louis Pasteur, the French chemist and founder of microbiology, was among this elite group of men and women. His revelations in germ theory, pasteurization, fermentation and in the discovery of vaccinations created a ripple effect throughout the world more than a century ago that can still be felt today.

Born on December 27, 1822, in the small French village of Dole, Louis Pasteur was the son of Jean Joseph, a tanner, and Jeanne, a country woman. Louis lived with his parents and three sisters in the small town near Dijon. They were a hard-working, close-knit family.

The world into which Louis Pasteur was born was a dangerous one. Millions of people had died of diseases such as typhoid and cholera, while epidemics of flu, scarlet fever and diphtheria were wreaking havoc on large populations. Even a hospital visit in the early 19th century was considered a risky venture, due to the lack of knowledge about germs and their potential for harm to the human body. No one could have predicted then the impact Louis Pasteur's discoveries in microbiology and immunology would have on the future of medicine and human health care.

Though not a stellar student, Pasteur was an able fisherman and a talented artist. At age 15, things began to turn around in school, when the young Pasteur's academic progress garnered the attention of his teachers. At their urging, Pasteur left home for Paris in 1838, where he briefly attended the École Normale Superieure, the national school for training college professors. Unfortunately, a severe case of homesickness brought Pasteur back to Dole, where he once again took up his painting. A year later, Pasteur enrolled in the college at Besancon, where he thrived.



In 1842, Pasteur returned to Paris to attend the Lycee Saint-Louis. There, his hard work and diligence earned him not only the first prize for physics, but also a second chance at the École Normale. He completed his studies at the École Normale at the age of 26, with a Doctor of Science degree, and soon after he accepted a job as a chemistry assistant. By this time, Pasteur's desire for a career in science was firmly cemented.

Pasteur's doctoral thesis investigation of the form and structure of chemical crystals was the first of many scientific discoveries to earn him fame and respect among his colleagues. Picking up on earlier research by German chemist Eilhardt Mitscherlich, Pasteur's work further illuminated the behavioral properties of crystals. At 26, he became the young protégé of the science community.

At the death of his mother in 1848, Pasteur returned to Paris, where he took a position as a physics teacher at the high school in Dijon, and later as acting professor of chemistry at the Strasbourg Academy in eastern France. It was at Strasbourg that Pasteur met and later married Marie Laurent, the daughter of the school's religious leader. Marie shared Pasteur's traditional values and as such was his ideal mate. Despite her husband's constant preoccupation with work, she was a constant supporter and faithful assistant in the laboratory. The couple remained happily married well into their senior years and together raised five children: Jeanne, Jean-Baptiste, Cecile, Marie-Louise and Camille.

In the early 1850s, the Pasteurs left Strasbourg for Lille, where Louis began to investigate fermentation. Looking at the problems of fermentation in beetroot alcohol, Pasteur soon discovered ground-breaking laws regarding alcoholic and lactic fermentation; namely, that fermentation was caused by living organisms. It was considered a revolutionary concept and completely counter to the beliefs of the foremost chemists of the time, who maintained that the yeasts found in fermentation were dead, decomposing chemical substances.

As with his earlier research, Pasteur believed strongly in the importance of laboratory experimentation as the primary path to scientific discovery. Through diligence, perseverance and countless hours in the lab, he discovered and proved many theories that would forever alter the course of scientific investigation.

In 1857, Pasteur was named administrator and director of scientific studies at the École Normale. At his alma mater, Pasteur's research in microbes had already begun to dismantle the theory of spontaneous generation, until then thought to be the seminal theory of the origin of living things.

"Nothing is more agreeable to a man who has made science his career than to increase the number of discoveries, but his cup of joy is full when the result of his observation is put to immediate practical use," Pasteur said.

Using a few cramped rooms at the

École Normale to set up a makeshift laboratory, he once again set about the painstaking process of discovery that would mark the beginning of his work in germ theory. Pasteur used swan-necked flasks, into which he poured unsterilized, sugared yeast water, to prove that microbes were airborne, a stunning discovery that not only disproved spontaneous generation, but also laid the groundwork for renowned germ theory of disease.

In 1862, Pasteur was elected to the French Academy of Science. Not long after, the French Emperor Napoleon III invited the well-respected scientist to investigate the cause of a mysterious disease that was turning wine sour and thus threatening the viability of the country's wine industry. Pasteur was honored to have his counsel sought out by the ruler of France, and through his investigation, quickly learned that microbes were once again the root of the problem. Searching for a method that would kill the microbes without compromising the taste of the wine, Pasteur found that by heating, bottling and corking the wine, thus sealing it off from outside air, he could prevent new microbes from developing. This method, later named pasteurization, would eventually become a critically important method for preventing wine, beer, milk, cheese and other foods from turning sour.

When Pasteur lost his daughter, Jeanne, to typhoid fever in 1859, he found solace in his work. A workaholic who arrived at his laboratory before dawn every day, Pasteur vowed to continue his germ theory investigation in order to fight the disease that took his young daughter's life. Though his work brought him fame and renown, it also took its toll on his personal life. Pasteur was notoriously private, difficult to live with, and passionately dedicated to his science. Because of his knowledge and awareness of germs, Pasteur was care-

THE BIRTH OF PASTEURIZATION

In 1854, when he was named Dean of Sciences at the University of Lille, Louis Pasteur was asked to study the fermentation of beet sugar into alcohol. A local manufacturer was puzzled as to why the alcohol was often contaminated during the fermentation process. During the course of his investigation, Pasteur discovered that fermentation was caused by living organisms, and that in fact, the life processes of yeasts and other microbes were at the root of fermentation.

Pasteur soon extended this work, using other ferments, such as wine, vinegar, beer and milk. He claimed that "lactic yeast," comprising living organisms, was the reason behind the transformation of sugar into lactic acid, leading to such common by-products as sour milk and yogurt. These revelations, described in detail in Pasteur's 1857 paper, *Note on So-Called Lactic Fermentation*, marked the start of scientific microbiology and led to the process now known as pasteurization.

Pasteur's research was revolutionary because it shed light on ways to avoid spoilage of perishable products. By destroying the microbes already present in these products – mainly through heat — and by protecting the sterilized material against subsequent contamination, beverages and milk-containing food products could be preserved. Most disease-producing bacteria in milk could be killed by heating it to 145°F (62.8°C) and then keeping it at that temperature for 30 minutes.

Today, a more commonly used process known as "flash pasteurization" involves heating milk at a higher temperature of 161°F (71.6°C) and maintaining it for 15 seconds.

ful to a fault, examining the cutlery at the dinner table and avoiding handshakes at all costs.

The year 1865 marked a new chapter in Pasteur's career, when he was called upon by Jean-Baptiste Dumas, a chemist and politician, to investigate the cause of a disease that was threatening the French silk industry in Alais. Armed with his knowledge of microbes, Pasteur set about discovering the reason behind the plight of the silkworm farmers. Months into the investigation, however, Pasteur's work was cut short at the news of his father's death, followed shortly thereafter by the death of his own two-year-old daughter, Camille. When another daughter, Cecile, died from typhoid early the following year, Pasteur was nearly too distraught to continue, but he nevertheless continued his work.

"…I was only able to be with her (Cecile) for a few days, being kept here by my work, and full of deceiving hopes for a happy issue from that terrible disease," Pasteur wrote in a letter to a cabinet minister friend shortly after Cecile's death. "I am now wholly wrapped up in my studies, which alone take my thoughts from my deep sorrow."

Over the course of the next several years, Pasteur's silkworm investigation progressed. His discovery of bacteria in diseased silkworms and the conditions under which the bacteria thrived proved valuable for the farmers, who, under Pasteur's counsel, learned how to keep the silkworm nurseries clean, dry and bacteria-free. He also taught the farmers how to use microscopes to separate the diseased silkworms from the healthy ones. These revelations once again earned Pasteur great accolades, and in 1868, he returned to Paris, where Napoleon III ordered a new laboratory to be built especially for him.

Not long after his return to Paris, the 45-year-old Pasteur suffered a life-threatening stroke.

"Will I live to discover new mysteries and find these truths which God has created? Have I been able to provide a stone to this edifice of knowledge? I can only hope," wrote Pasteur.

These were the questions the ailing Pasteur pondered during his long road to recovery. Less than a year later, he returned to his laboratory, undeterred by the stroke that left him fatigued and slightly paralyzed.

In 1870, the start of the Franco-Prussian War punctuated the need for a deeper understanding of disease, as more than half of the French soldiers who underwent surgery during the war died of infection. French doctor Alphonse Guerin invited Pasteur to visit his hospital, enabling the chemist to gain a bird's-eye view of medical practice. His observations ultimately led to his development of a series of sterilization procedures for nurses and surgeons, including heating bandages, washing and sterilizing instruments.

"If it is a terrifying thought that life is at the mercy of the multiplication of these minute bodies, it is a consoling hope that science will not only remain powerless before such enemies," Pasteur stated in *The Germ Theory and its Application to Medicine and*

Surgery (1878).

In the late 1870s and early 1880s, Pasteur's continued investigations of germs – which he applied to such diseases as anthrax and cholera – led to a stunning discovery. After injecting a day-old culture of cholera microbes into several chickens, he learned that although the chickens remained slightly ill, they did not die. When the same chickens were injected with a fresh culture of cholera germs, they still lived, yet this same fresh culture injection killed a second group of chickens that had not received the old culture.

Pasteur's revolutionary experimentation with chicken cholera immunization revealed that a weaker strain of disease when injected into animals – and possibly humans – could aid in building immunity and fighting disease. Years later, when Pasteur applied the same principles of immunization to rabies, he would eventually have the opportunity to demonstrate them on his first human subject. In 1885, nine-year-old Joseph Meister, bitten by a rabid dog 14 times and near death, was brought to Pasteur by his distraught mother. Despite initial trepidation, Pasteur proceeded with the intensive and dangerous course of treatment, and not long after, the world rejoiced at the news that the young boy had survived. It wasn't long before victims of dog bites from around the world came to Pasteur's laboratory seeking his miracle cure.

In 1888, following the enthusiasm of Pasteur's discovery of the rabies vaccine, he was granted a new laboratory named in his honor, the Pasteur Institute. The world-renowned organization, still in existence today, became a hub of research into the cure of microbial diseases. In 1895, one year after discovering the diphtheria vaccine, Pasteur's failing health forced him into retirement. In September of that same year, he died peacefully in his sleep, surrounded by his family.

Louis Pasteur received a hero's funeral at Notre Dame Cathedral in Paris, and was buried in the chapel at the Pasteur Institute.