

HEALTH HEROES



LOUIS PASTEUR

METROPOLITAN LIFE INSURANCE COMPANY

HOME OFFICE: NEW YORK

Pacific Coast Head Office: San Francisco Canadian Head Office: Ottawa

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PASTEUR

By

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and

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LOUIS PASTEUR

IN a little house, on the Street of the Tanners in Dole, France, a baby was born on Friday, December 27, 1822. This baby was christened LOUIS, surname PASTEUR. Just 100 years later, on December 27, 1922, the bells of Dole rang for two minutes and all the bells from the plains of the Saone to the crests of the Jura replied in unison to celebrate the hundredth anniversary of this baby's birth. "Proud little town of Dole."

On the same day that the bells were ringing in Dole a great New York newspaper reminded people in an editorial that PASTEUR and his followers have probably by now added an average of twenty years or so to the lives of hundreds of millions of people, and that this vast gift of days went chiefly to the young and healthy.

Think how proud and happy you would be if you could give one extra year of life to someone you love! Yet the scientific discoveries of this man, whose life and work you are going to read about, will go on saving millions of lives year after year.

You would have loved LOUIS PASTEUR if you had known him. He was kindly and modest and warm-hearted, not proud and cold and haughty, as we sometimes imagine great men must be. He liked and respected boys and girls, and he reminded people that they would find in their own homes and in the schools of their

towns the great scientists and statesmen and heroes of the future. He never forgot that he used to be a humble peasant lad, even when he became one of the most famous men in the world.

Pasteur's Parents

LOUIS PASTEUR's parents were poor and lowly in position, but in the highest qualities of mind they were rich and noble. His father, JEAN JOSEPH PASTEUR, served



*The house in Dole where
LOUIS PASTEUR was born*

with bravery in the wars of NAPOLEON and was awarded the ribbon of the Legion of Honor. When he came marching home from the wars at the age of 25, he went to work as a tanner. This had been the trade of his father and grandfather.

His tannery was on the banks of the river Furieuse in Salins. In the early dawn as he stood on the steps leading to the river he

An expanded *Life of Louis PASTEUR* by the authors of this story has been published by D. C. Heath & Co., Boston, Mass.

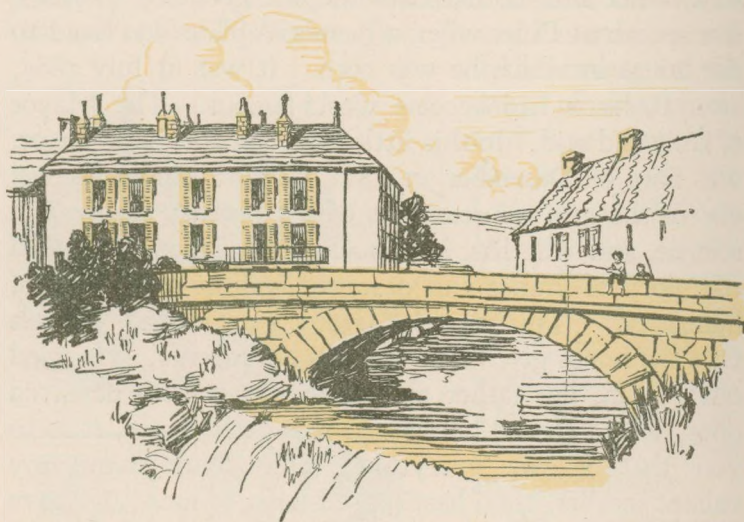
used to watch a young girl working in a garden on the other bank. Her name was JEANNE ROQUI and her parents were gardeners. She was modest, intelligent and kind. Finally JEAN JOSEPH PASTEUR asked for her hand in marriage.

The young couple moved to Dole and there LOUIS was born. No more beautiful tribute has ever been paid to a father and mother than the one given by PASTEUR in a speech at Dole, when a memorial plate was fixed to the house in which he was born. It was in July 1883, after PASTEUR had become world-famous. The Mayor of Dole had said, "In this little house in this little street, was born on December 27, 1822, he who was to become one of the greatest scientists of the century so great in science, and who has, by his admirable labors, increased the glory of France and deserved well of the whole of humanity." This moved PASTEUR very much. He felt that the honor given him was due his parents. He cried out: "Oh, my father and mother, my dear departed ones, who lived so humbly in this little house, it is to you that I owe everything. Thy enthusiasm, my valiant mother, thou hast passed it on to me. If I have always associated the greatness of science and the greatness of country, it is because I was filled with the feelings that thou hadst inspired. And thou, my dear father, whose life was hard as thy hard trade, thou hast shown me what patience and prolonged effort can do. It is to thee that I owe perseverance in daily work. Not only hadst thou the qualities which go to make a useful life, but also admiration for great men and great things. To look upward, learn to the utmost, to seek

to rise ever higher, such was thy teaching....Be ye blessed, my dear parents, for what ye have been and may the homage done today to your little house be yours!"

Pasteur's Boyhood

When LOUIS was 5 years old his father heard of a tannery to let on the outskirts of the town of Arbois



The PASTEUR house in Arbois

near the bridge which crosses the river Cuisance. The house was small, but it had a yard where pits had been dug for the preparation of skins. JOSEPH PASTEUR took the little house, and settled there with his family. Here LOUIS grew up with his two sisters and here his parents lived for the rest of their lives. LOUIS and his schoolmates used to play in the tannery yard with bits of bark

and stray scraps of iron. Sometimes the boys called for him and he went fishing with them on the river Cuisance.

LOUIS first went to the primary school attached to the college of Arbois. He was not a brilliant student. He was just average in his studies, but when he went to Arbois College, the headmaster, M. ROMANET, discovered a spark of vivid imagination in his slow, careful thinking. He used to talk to LOUIS about the great Ecole Normale (normal school) in Paris where young professors are trained. LOUIS listened with sparkling eyes.

JOSEPH PASTEUR, who was anxious to learn more himself, helped his son with his lessons. He used to think what a fine thing it would be if LOUIS could only be a professor in Arbois College where he was now a schoolboy. Little did he dream that in a few years his son would write a paper with a word in it that the headmaster couldn't find in the dictionary. He finally decided to send LOUIS to M. BARBET's school in Paris, so that the boy could prepare for the Ecole Normale.

On a cold rainy October morning in 1838, LOUIS PASTEUR and his friend, JULES VERCEL, took the coach for Paris. With heavy hearts they left their homes behind them in the gray distance.

Never was a lad more homesick than LOUIS, when he was finally settled in the Barbet School. He used to lie awake at night for hours thinking of his home. Although he already had a passionate love for study and a determined will to work hard, his homesickness, overwhelmed him. "If I could only get a whiff of the tannery yard," he said to JULES VERCEL, "I should be

cured." Finally M. BARBET, master of the school, became alarmed and sent for young PASTEUR's father.



LOUIS PASTEUR and JULES VERCEL on their way to school in Paris

One day a messenger told LOUIS he was wanted at a little cafe at the end of the street. He went there and found his father sitting at a table, his face in his hands. "I have come to fetch you," the father said.

In spite of his defeat by homesickness this boy of 15 knew that if he was to fulfill his dream of being useful to France he must equip himself by hard study under the great masters. He decided to prepare for the Ecole Normale at the college of Besançon which was near his home. He worked so hard there and was so modest and sincere that he won the love and respect of his masters and school fellows. It was at Besançon that PASTEUR made friends with CHARLES CHAPPUIS. CHAPPUIS was interested in philosophy and literature, PASTEUR in science and mathematics. In CHARLES, LOUIS found a sympathetic listener to whom he could tell all his great

ambitions. Thus in his youth PASTEUR had discovered the things that are most worth while to boys and girls—love of home, love of work, beautiful dreams of the future and a friend in whom he could confide. After PASTEUR had completed his course at Besançon he studied for another year at the Barbet School in Paris. This time he was not homesick. At the end of the year he passed the examinations for the Ecole Normale, fourth on the list. When the school opened he was in such a hurry to enter that he went to Paris some days ahead of the other students.*

Pasteur's Work with Crystals

At the Ecole Normale, PASTEUR quickly showed his leaning toward chemistry. He attended the lectures of J. B. DUMAS, a famous scientist, and came away filled with enthusiasm and a burning desire to devote himself to chemical research. He spent long hours in the laboratory practising the technique of making experiments, and was only dragged away under protest by CHAPPUIS, who had been instructed by PASTEUR's father to keep LOUIS from working too hard. PASTEUR was particularly fond of the study of crystals. He used to talk of them by the hour to CHAPPUIS. His explanations were so clear and enthusiastic that CHAPPUIS knew the youth had a great future before him. CHAPPUIS used to say, "You will see what PASTEUR will be."

After three years at the Ecole Normale, PASTEUR passed the examination that made him eligible for teaching. But another besides CHAPPUIS had noticed that the young student had an eager mind and could never

*Picture on the cover is a portrait of LOUIS PASTEUR at the time he entered the Ecole Normale.

let a fact alone until he knew why it was a fact. This was the celebrated chemist, BALARD, and he took PASTEUR into his laboratory. Here PASTEUR made important discoveries in the forms and nature of crystals. When he made his first discovery he was filled with excitement. He shouted, "I have it!" and dashed out of the laboratory.

It was just after making this discovery that PASTEUR's mother died. He could work no longer. He stayed at home for weeks. In the meantime the young man and his work were being talked about by some of the greatest scientists of Paris. One of them, BIOT, an old man of 74, could hardly believe that a boy fresh out of college had succeeded in explaining certain facts when experienced chemists had failed. When PASTEUR returned to Paris he went to see BIOT and convinced him of the truth of his experiments. Then BIOT took PASTEUR's arm and said, "My dear boy, I have loved science so much during my life that this touches my very heart." From that time on the love of BIOT for PASTEUR was like that of a father for his son.

Pasteur at Strasbourg

In January, 1849, when PASTEUR was 26 years old, we find him a professor of chemistry in the University of Strasbourg. Here he fell in love with MARIE, one of the daughters of M. LAURENT, the rector of the university and they were married in May. PASTEUR wrote to CHAPPUIS: "I believe that I shall be very happy. Every quality I could wish for in a wife, I find in her. You will say, 'He is in love!' Yes, but I

do not think I exaggerate at all!" Time proved that PASTEUR did not exaggerate. Mme. PASTEUR shared with her husband all his joys, his sorrows and his hopes, his whole life long. In September, 1854, he was made professor and dean of the faculty of science in Lille. Here he was to begin the work that was to carry his name to the four corners of the earth.

Studies in Fermentation

Lille was a great industrial and agricultural center, and it was this fact that started PASTEUR on his studies of fermentation. To appreciate the ideas on fermentation which were soon to flow out of his little laboratory to "inundate the world," it is necessary to know something of what people thought of the process.

Fermentation is as old as the world. People had made use of it from the time that they learned to make bread and wine and beer. But in the eighteenth century, all they knew about it was that sugar in a fermentable substance, like crushed grapes or crushed barley sprouts, was changed into alcohol and carbonic acid by some mysterious process.

Then in 1835 two scientists, SCHWANN in Germany, and CAGNIARD-LATOUR in France, started almost at the same time to examine, under the microscope, the yeast used in making beer.

Both men saw that the yeast is made up of little globules that can reproduce themselves. They do this by sending out buds, which finally break off from the parent globules to form new ones. These new yeast plants then go through the same process, and so on

through many generations. Only living things—that is, plants and animals—can reproduce themselves. Therefore, yeast is really a tiny plant.

SCHWANN found that fermentation takes place in sugar and water only when yeast is present, and stated that the cause of fermentation is the action of the yeast on the sugar. This explanation was the true one, but many scientists, notably one named LIEBIG, scorned the idea of yeast as the cause of fermentation.

But not for long. A new champion of the yeast plant arose in the person of LOUIS PASTEUR. So important did he feel the subject of fermentation to be that he wrote to CHAPPUIS: "I am pursuing as best I can these studies on fermentation which are of great interest connected as they are with the impenetrable mystery of life and death."

PASTEUR started his studies on fermentation to help a Lille manufacturer who had been having trouble in making beet-root alcohol. He worked for months and months, feeling himself on the brink of a great discovery and yet knowing that all his ideas might be mistaken. He widened his field of experimentation by studying the souring of milk. One reason for this was that LIEBIG and his followers had asked: "Why should we think yeast so important when we see so many fermentations, that of milk for example, taking place without it?"

PASTEUR found that, when milk sours, little gray patches are formed on the sides and bottom of the vessel. Under the microscope, he saw that this gray material was composed of tiny globules much smaller than those of yeast. He transferred a tiny bit of the gray material to another liquid in which it could live and found that

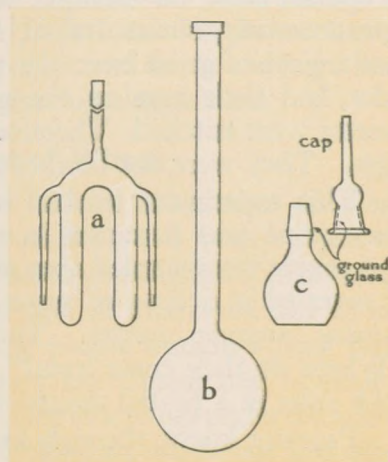
fermentation was set up there also. Thus this gray material might be called the ferment of milk.

You already know that yeast is a plant. Its nearest relatives are the mold plants like those you have seen on food. This ferment of milk is also a plant and belongs to the group of plants called bacteria. You may have studied about such plants already in your health class.

The next question was: "What part does the yeast play in the drama of fermentation?"

"The part of a living thing, just as you are," said PASTEUR. "The yeast eats the sugar, just as you eat your food, and throws out as waste the alcohol and carbonic acid just as your body throws off the waste from the food that it can not use." The problem was solved. Fermentation is caused by a specific ferment.

In 1857 PASTEUR left Lille to become a professor in the Ecole Normale, his old school. He had a great many duties, but he fitted up a laboratory in an old garret and went on with his studies in fermentation. In 1860 the Academy of Sciences gave PASTEUR the prize for experimental physiology because of these studies which proved so valuable to mankind.



Three pieces of apparatus used by PASTEUR at Lille, recently presented to Columbia University in New York. a—U-tube with side outlet. b—Flask. c—Special glass-capped flask.

Spontaneous Generation

His study of ferments drew him into the controversy on spontaneous generation. This had always been a favorite subject for debate. The question was: Do all living beings come from seeds or eggs in which the germ of life already exists, or can life be born of nothing, that is, spontaneously?

In past ages, poets, naturalists, philosophers, had all believed in spontaneous generation. The maggots found in spoiled meat, for example, were supposed to be born spontaneously, but an Italian, REDI, disproved this. He put a piece of gauze over the meat; flies, drawn by the odor, laid their eggs on the gauze, and from the eggs worms were hatched. Therefore, the maggots came from eggs. They were not born of nothing.

This experiment marked some progress. Then the microscope was invented in the seventeenth century, and people were puzzled over the tiny living beings that it revealed in a drop of water, or in any solution containing organic matter. The great question arose: "Where do they come from?" Distinguished scientists took sides in a heated controversy.

PASTEUR knew, through his long study of ferments, that each fermentation is caused by its own particular living ferment. Now, he set out to prove that every form of life, no matter how small, springs from a germ or seed peculiar to itself.

He began to study the air. First he drew air through a tube containing a plug of cotton wool. The wool often became black with dust and in this dust PASTEUR found tiny plants, or bacteria, which would multiply in a solution of organic matter. Then, he proved that

if a liquid capable of sustaining life was boiled to kill all the germs present in it, and was kept in a flask that allowed no dust from the air to enter, it remained pure indefinitely. But when a speck of dust was added, life began in the flask. In this way PASTEUR proved that many of the tiny forms of life which puzzled people when they saw them under the microscope, came from the air. Later, he found that living ferments abound also on many objects and in water.

PASTEUR's ideas were not accepted at once. He had to fight for them for years. He performed experiment after experiment to prove his points, and he was always finding out new things or correcting old mistakes.

Diseases of Wines

PASTEUR now turned back to his studies on wine. Wines in France had for many years been subject to diseases. Wines got sick, just as animals and human beings do. They became ropy or sour or bitter and had an unwholesome taste. Of course people wouldn't drink them then, and the manufacturers lost a great deal of money. When PASTEUR examined these sick wines under the microscope, he found not only little yeast plants but also other tiny microscopic bodies (bacteria). "These little rod-shaped bodies are the causes of the diseases in your wines," said PASTEUR to the manufacturer. "They enter it from the air, and when conditions are favorable for their growth, they start an unhealthy fermentation, just as the yeast starts a healthy fermentation." He then showed the manufacturers that by heating their wines to a certain temperature they could kill disease ferments without hurting the

flavor of the wine. Thus, the name PASTEURIZATION was given to the heating of liquids to a temperature sufficient to kill the harmful germs that might be in it.

New Ideas on Contagious Disease

"If tiny living organisms are responsible for diseases in wines why may they not be responsible for sicknesses that are catching in animals and human beings?" PASTEUR was asking himself this question just about the time of the Civil War in the United States. Do you see how very important this question was? On its answer depended the entire overturning of all previous ideas on disease. No one had ever heard of germs as the cause of sickness before. The light dawned clearly for PASTEUR when he found that living ferments cause the diseases of wines. He couldn't help believing that if some undesirable ferments cause diseases in wines, then it might well be true that others cause certain diseases of animals. Thus PASTEUR first advanced the germ, or ferment, theory of disease which was to revolutionize the practise of medicine and surgery.

Diseases of Silkworms

While PASTEUR was deep in his studies on the diseases of wines, a chance came for him to draw the attention of the whole world to the germ theory of disease. His old master, DUMAS, asked him to investigate a disease of silkworms that bid fair to destroy the silk industry.

The raising of silkworms for the cocoons from which silk is spun is one of the leading industries of France. The income from it amounts to millions of francs a year. The mulberry tree on which the silkworms feed is called the Tree of Gold.

In the nineteenth century the life of the population in certain departments in the south of France hung on the existence of the silkworm. People greeting each other instead of saying, "How are you?" asked "How are the silkworms?" The hurdles on which the worms crawled after hatching were often kept in the best rooms of the house.

Since 1849 a disease had ravaged the silkworm nurseries. The egg, the worm, the chrysalis, the moth, were all attacked. One of the signs of the disease was the appearance of little black or brown spots on the sick worms. Because these spots looked like pepper grains, the disease was called pebrine, after the word *pébré* (pepper). All sorts of foolish remedies were tried. The poor worms were dusted with ashes, soot, charcoal, sulphur, quinine, mustard or sugar. They were fumigated with chlorine gas and coal tar. The mulberry leaves were sprinkled with wine, rum or absinthe. Still the disease could not be stopped. It spread from France to Spain and Italy, to Greece, to Turkey, to Syria, to the provinces of the Caucasus, to China.

And then in 1865, M. DUMAS asked PASTEUR to study the disease. Finally he allowed himself to be persuaded, and in June, 1865, he started for Alais, one of the centers of the silkworm industry, where his work was to begin.



Stages in a silkworm's life—eggs, worm, chrysalis, moth

Other investigators of the silkworm disease had found in the bodies of the sick worms tiny oval bodies which they called corpuscles. PASTEUR had read of these corpuscles and the first thing that he did when he reached Alais, was to hunt for them with his microscope. He found them in the tissues of sick worms.

Now the great question arose: "Is this corpuscle the cause of the disease or a product of it?" For a long time PASTEUR didn't know. He did find, however, that the disease was both contagious and hereditary. Contagious, because worms could be infected by feeding or injecting them with material containing corpuscles; and hereditary, because the eggs laid by moths with pebrine also contained corpuscles. A knowledge of these facts pointed at once to a system of egg selection that would insure pure seed, as silkworm eggs were called. Only eggs from healthy moths were selected for hatching.

Although PASTEUR had found a way to combat the disease he was still puzzled as to its cause. Very often worms died without having any corpuscles at all. PASTEUR therefore thought that the corpuscles were a result of the disease which sometimes broke out before death and sometimes did not. He had spent two years on the problem (1865-1867) when, one day, he appeared before his assistants almost in tears, and, dropping into a chair said: "Nothing is accomplished; there are two diseases."

This second disease is called flacherie. It is caused by a microbe which attacks the digestive system of the worm. It was now possible to take measures for stamping out both diseases. After six years of hard work

and many discouragements, the diseases of silkworms were conquered and the south of France became once more a prosperous, fair and smiling country.

In the years that PASTEUR spent on silkworms many other things were happening in his life. It was a time of sorrow. In little over a year (1865-1866) he lost his father and two little daughters, CAMILLE and CÉCILE. His eldest daughter, JEANNE, had died in 1859. PASTEUR's only comfort during this time lay in hard work. In 1867 he left the Ecole Normale. The next year, through the friendship and interest of DURUY, France's great Minister of Education, and NAPOLEON III, Emperor of France, a laboratory was started for him where he could carry out further researches. He was then 46 years old. From the towering mountain-top of his imagination, he saw immense horizons reaching out before him.

Pasteur's Illness

But now dark shadows fell across these shining horizons. In 1869 he suffered a paralysis of the left side. For a time all hope of his recovery was abandoned. To one of his friends, he said, "I am sorry to die; I wanted to do so much for my country." This friend, the noted scientist, DAVILLE, replied: "Never fear; you will recover, you will make many more marvelous discoveries, you will live happy days." This was a true prophecy. Six months after the beginning of his illness, we find him once more in Alais earnestly and patiently working with his silkworms.

The Franco-Prussian War

Another great shadow was creeping up that soon darkened all France. In 1870 the Franco-Prussian war

began. France sprang to arms. All of PASTEUR's old students in the Ecole Normale enlisted. He himself tried to join the National Guard, but was rejected because of his half-paralyzed condition.

On September 5, he started for his old home in Arbois, his heart aching for the sorrows of his country. There, surrounded by his father's souvenirs of the glory that be-



The town crier of Arbois

longed to France in the days of NAPOLEON, he listened for the call of the town crier who proclaimed the news of the war. Always, always, it was news of defeat for France.

During the dark days of the war PASTEUR was unable to work, but in imagination he saw before him the promised land. To him this promised land meant the application of the germ theory of disease to the practise of medicine and surgery. When the war was over, we see him about to enter this field.

Election to the Academy of Medicine

In 1873 he was elected an Associate of the Academy of Medicine. In April he attended the first meeting. "As he walked toward the desk allotted to him, his paralyzed left leg dragging a little, none of his colleagues suspected this quiet and unassuming new member would become the greatest revolutionary ever known in medicine."*

PASTEUR took part in many famous debates with the physicians and surgeons of the Academy of Medicine, most of whom thought it a waste of time to listen to a "mere chemist." But a group of young men, undergraduates in medicine, eagerly followed PASTEUR's clear demonstrations of scientific methods. Once PASTEUR turning to these students said, "Young men, you who sit on these benches, and who are perhaps the hope of the medical future of the country, do not come here to seek the excitement of polemics, but come and learn method."

PASTEUR honored the scientific men of his day by spending valuable time in trying to convince them of the truth of his discoveries. But it was to the young men that he entrusted the carrying on of his burning torch. In PASTEUR's life we see beautifully blended the veneration of the student for his teachers and the love of the teacher for his students.

In 1874 PASTEUR was voted a grant of 12,000 francs a year for the rest of his life by the National Assembly, in recognition of his services to France and humanity.

Study of Anthrax

PASTEUR had long wanted to study infectious disease in animals. He now had a chance to do this. The disease

*Vallery-Radot, *The Life of Pasteur*, page 225.

of anthrax, or splenic fever, was ruining agriculture. In some flocks twenty sheep or more out of every hundred died. There were "cursed fields" and "dangerous mountains" where farm animals could not be pastured without catching anthrax. Animals that were stricken with this disease usually died within a few hours. Sheep sick with it lagged behind the flock with drooping heads, shaking limbs and gasping breath. Very often they died before the shepherd had time to notice that they were sick. Horses, cows, sheep, even men caught the fatal fever. PASTEUR was asked by the Minister of Agriculture to study the disease.

Important studies of the disease had already been made. DAVINE, a French scientist, had seen the little rod-like bacteria of anthrax under the microscope and had connected these tiny beings with the cause of the disease.

KOCH, a German scientist, had discovered that these bacteria are capable of forming spores. Spores are tiny rounded bodies with thick protecting walls that can lie dormant for many years like the seeds of plants and then revive and grow again in suitable surroundings. This discovery explained why anthrax epidemics broke out every summer and why sheep that grazed in one meadow took the disease while those in a neighboring field escaped. The spore was to blame.

When PASTEUR started his studies some people still refused to believe that the bacteria were the star villains in the tragedy of anthrax. However, he proved by a series of very remarkable experiments that the bacteria are the cause of the disease beyond the shadow of a doubt.

Discovery of Chicken-Cholera Vaccine

To understand PASTEUR's future work on anthrax, it is necessary for us to know of the great discovery he made at this time in his study of a disease called chicken cholera. This disease often killed ninety out of a hundred chickens in a flock. Its cause was found to be a tiny speck which was alive but could not move about. It multiplied very rapidly in a culture medium of chicken gristle broth. PASTEUR found that the smallest drop of a new culture on a few crumbs of bread would kill a chicken.

He was now to make, by chance, a discovery of the very greatest importance. One day he inoculated some hens with a culture that had been left standing for some time. Much to his surprise, he found that these hens became ill and then recovered. It then occurred to him to inoculate the same hens with the deadly virus of a fresh culture liquid. They remained perfectly well, although other hens inoculated with the fresh virus died.

The Principle of Vaccination

Eagerly PASTEUR followed up this discovery. He found that exposure to air weakened the chicken-cholera virus. If chickens were given this weakened virus they became forever protected from the deadly form of the disease. The principle of vaccination against a contagious disease had been discovered.

PASTEUR now saw far off in the dim future a day that would mark the complete stamping out of contagious diseases. But he didn't let his imagination run away with him. The path from the mountain-top of inspiration always led into the front door of his laboratory.

Vaccination had long been practised in the case of smallpox. In the latter part of the eighteenth century, an English physician, EDWARD JENNER, discovered that people who had had cowpox (smallpox in the cow) could not catch smallpox. In 1796 JENNER introduced into a scratch on the arm of a little boy some of the matter from a sore on the arm of a dairymaid who had caught cowpox from milking a cow sick with it. This was the first vaccination (*vacca*, cow). A sore developed on the boy's arm just like the one you had when you were vaccinated. Afterward it was found that the boy did not take smallpox, even when the germs were introduced into his body. In other words, he was protected from smallpox.

Vaccination has practically wiped out a loathsome disease which used to be even more common than measles and chickenpox are to-day. Yet no one understood its action until PASTEUR threw light on the mystery. He explained it by introducing a new idea into science. This idea was that germs can be weakened and that in overcoming these weakened germs, the body gains protection against the strong or virulent germs of the same disease. The process of weakening is simply the process of cultivating the germs under conditions unfavorable for their growth. In the same way we may make a plant unhealthy by growing it in infertile soil, and not giving it enough sunlight and water to nourish it properly.

PASTEUR now thought rightly that the smallpox virus is weakened by living in the body of the cow, a place which is unfavorable to its growth. By overcoming this weak virus, or vaccine, the body protects itself from the

strong virus of smallpox. The chicken-cholera microbes are weakened by being exposed to air from which they are protected in the body of the chicken. But after these weak germs are given to chickens, the fowls are safe from the deadly germs of the same disease.

Anthrax Vaccine

PASTEUR now set to work to weaken the bacteria of anthrax, hoping that he might be able to develop a protective vaccine against that disease. When he had succeeded and had proved by experimentation that his



Vaccinating sheep against anthrax—the famous experiment which resulted in conquering that disease (From bas-relief on monument at Chartres)

weakened bacteria culture did indeed protect animals inoculated with it against virulent anthrax bacteria, he announced his discovery to the Academy of Science.

Although PASTEUR had thus given to France the glory of a priceless discovery, he met with doubt and distrust from many Frenchmen. One of these was ROSSIGNOL, an editor of the *Veterinary Press*. He challenged PASTEUR to a public trial of his anthrax vaccine.

The Famous Pouilly-le-Fort Experiment

PASTEUR accepted the challenge. The conditions of the test were these: The Society of Agriculture of Melun was to furnish fifty sheep. Twenty-five of these were to be vaccinated and afterward inoculated with fresh anthrax virus. The twenty-five remaining sheep were to be inoculated with fresh virus only. PASTEUR prophesied that, after injecting the fresh virus, the twenty-five vaccinated sheep would all live and the twenty-five non-vaccinated sheep would all die.

This challenge, and PASTEUR's acceptance of it, caused great excitement. The first vaccination took place May 2, 1881, at Pouilly-le-Fort. A great crowd of agriculturists, physicians and veterinary surgeons was present. Most of them were full of doubt, and looked forward to PASTEUR's defeat. PASTEUR himself was very confident.

A second vaccination was made on May 17. CHAMBERLAND and ROUX, his assistants, went every day to visit the animals. On May 31 all the animals, both vaccinated and unvaccinated, were inoculated with the deadly anthrax virus, and on June 2 a great crowd assembled to see the result. It turned out just as PASTEUR had prophesied. Every vaccinated sheep was alive and well; every non-vaccinated sheep was dead. A few cows included in the test gave the same results as the sheep. This was a great triumph. After it millions of sheep were vaccinated and the spell of anthrax was broken.

PASTEUR's discoveries had saved France millions of francs. HUXLEY, the English biologist, said: "PASTEUR's discoveries alone would suffice to cover the war indemnity of five billions paid by France to Germany in 1870."

Pasteur Honored

He was hailed everywhere as a benefactor to humanity. His name became a household word. Because of his discovery of anthrax vaccination, the French Government offered him the Grand Cross of the Legion of Honor. He refused to accept it unless the Red Ribbon should be given to his two helpers. His reason was that he wished "the discovery to be consecrated by an exceptional distinction to two devoted young men full of merit and courage." His wish was granted.

In August of 1881, he went as a delegate to the International Medical Congress in London. When he arrived in the hall it was filled to overflowing. He was invited to the platform. As he walked down the aisle there was an outburst of applause. PASTEUR thought the Prince of Wales was arriving. "But it is you that they are cheering," said the President of the Congress, as PASTEUR took his place.

PASTEUR's pension of 12,000 francs was now raised to 25,000 francs as an expression of France's gratitude.

Study of Hydrophobia

While he was studying anthrax he had already started researches on hydrophobia. Hydrophobia is caused in human beings by the bite of a mad dog. It had a great hold on the imagination of the people because it always caused death with great suffering. The incubation period of hydrophobia is a very long one—that is, it often does not appear until thirty days or longer after a person has been bitten. This made PASTEUR think that hydrophobia attacks the nervous system. If this were true it would explain the slowness of certain incubations and the fortunate escapes from some bites from rabid dogs,

because the virus might stay in the body for a long time before reaching the nerve centers, or it might never reach them.

After many experiments with the saliva and blood of mad dogs, PASTEUR decided to inject nerve matter from a rabid animal directly into a dog's brain. Dr. Roux, an assistant, says that PASTEUR longed to try this experiment, but he dreaded to see it undertaken. PASTEUR could never bear to see an animal suffer. He always insisted that all operations should be performed under an anesthetic. One day when the master was out, Dr. Roux chloroformed a dog, and performed the experiment. When PASTEUR came in Dr. Roux told him the operation was over. PASTEUR was moved to pity for the dog: "Poor beast!" he cried, "His brain is without doubt wounded. He must be paralyzed." Dr. Roux called the dog. He was full of life, and started sniffing curiously about. PASTEUR lavished the fondest words on the animal. Dr. Roux says: "He felt an infinite liking for this dog which had so well endured trepanning, and thus had put to flight for the future all his scruples against it."

The dog became mad in fourteen days. This proved that the virus of hydrophobia does indeed attack the nervous system. PASTEUR was now able, by a series of injections from brain to brain in rabbits to reduce the period of incubation to seven days. The virus had then reached its greatest power and became what is called a fixed virus. The next step was to weaken the virus in order to obtain a protective vaccine.

The spinal cord of a rabbit which had had hydrophobia was removed and dried. After fourteen days a solution of this dried cord was injected into a dog and

was found to have lost its power to produce hydrophobia. The injection of a cord dried thirteen days was then made, followed by an injection from a cord twelve days old and so on until the injection from a cord of a rabbit that had died on the same day was reached. It was found that all animals that had received injections of this series of dried cords were immune to hydrophobia. Also, dogs that had already been bitten by mad dogs failed to develop rabies if they were given the series of injections shortly after they had been bitten.

It was a long time before PASTEUR dared to try this treatment on human beings. He said, "I believe my hand will tremble when it comes to deal with men." One reason for this fear was that some people failed to develop hydrophobia after a mad dog bite, and PASTEUR felt that he could never forgive himself if his treatment should cause the disease. However, the time came when he felt that he must make the important experiment.

The Case of Joseph Meister

One day a little Alsatian boy, JOSEPH MEISTER, entered PASTEUR's laboratory with his mother. He was only 9 years old and had been attacked by a mad dog on his way to school. He was so small that the dog had knocked him down,



Little MEISTER, the first human being inoculated against hydrophobia

and all he could do to defend himself was to put his hands over his face. A bricklayer rescued him, but not until he had received fourteen bites. The doctor who dressed the wounds advised Mme. MEISTER to go to Paris and see PASTEUR.

PASTEUR was greatly moved by the sufferings of this boy. He found a comfortable room for JOSEPH and his mother. Then he called in two doctors, in whom he had great confidence. After examining the boy, they both advised PASTEUR to give him the treatment. One doctor told him it was more than a right, it was a duty to do this.

Little MEISTER, who cried hard before the first inoculation, soon dried his tears when he found that a slight prick was all it meant. He was soon made happy with the animals in the laboratory. But PASTEUR's fears were not cured so easily. As the inoculations became more and more virulent, he was filled with anxiety. He walked the floor night after night, unable to sleep. JOSEPH merrily received the twelfth and last injection. This was rabid nerve matter only one day old, and bound to give hydrophobia to unprotected rabbits in seven days. The boy kissed his "dear Monsieur PASTEUR" and went to sleep peacefully. But PASTEUR spent a terrible night. In the long, slow, dark hours he imagined that the little boy would die. But time went on and JOSEPH remained perfectly well. PASTEUR was at last convinced of the success and safety of his preventive treatment.

Another case as urgent as JOSEPH MEISTER's was soon brought to PASTEUR. A shepherd boy, JUPILLE, 14 years old, had been bitten by a mad dog while bravely protect-

ing his little companions. Treatment was begun six days after the boy had been bitten. It was entirely successful.

People who had been bitten by mad dogs now flocked to PASTEUR's laboratory. Funds were collected for the building of a Pasteur Institute, where the master and his assistants might give the protective treatment for hydrophobia and carry on other important researches. PASTEUR was very

much touched in going over the contributions to find that one had been sent by little JOSEPH MEISTER. The Pasteur Institute was finished and became a great research institution. Up to 1912 it had treated more than 30,000 cases of hydrophobia, with a death rate of less than 1 per cent. This conquest of hydrophobia was the last great achievement of PASTEUR's career. He looked forward to new



JUPILLE protecting his companions against a mad dog. (Statue at Pasteur Institute, Paris)

fields to conquer, but his strength was failing.

Pasteur's Seventieth Birthday

PASTEUR died at the age of 73 in 1895. On his seventieth birthday, plans were made for a celebration. Delegations of scientists gathered from many nations to do

him honor. As PASTEUR entered the hall where the celebration was to take place, leaning upon the arm of the President of the Republic, the band of the Republican Guard played a triumphal march and the entire audience rose and greeted him with applause. In this hour it was given LOUIS PASTEUR to see how much human life owes him and will owe him in the years to come.

PASTEUR's speech was read by his son. In addressing the students, who were there in large numbers, he said: "Young men . . . live in the serene peace of laboratories and libraries. Say to yourselves, first of all, 'What have I done for my instructors?' and as you go on further, 'What have I done for my country?' until the time comes when you may have the happiness of thinking that you have contributed in some way to the progress and to the welfare of humanity."

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