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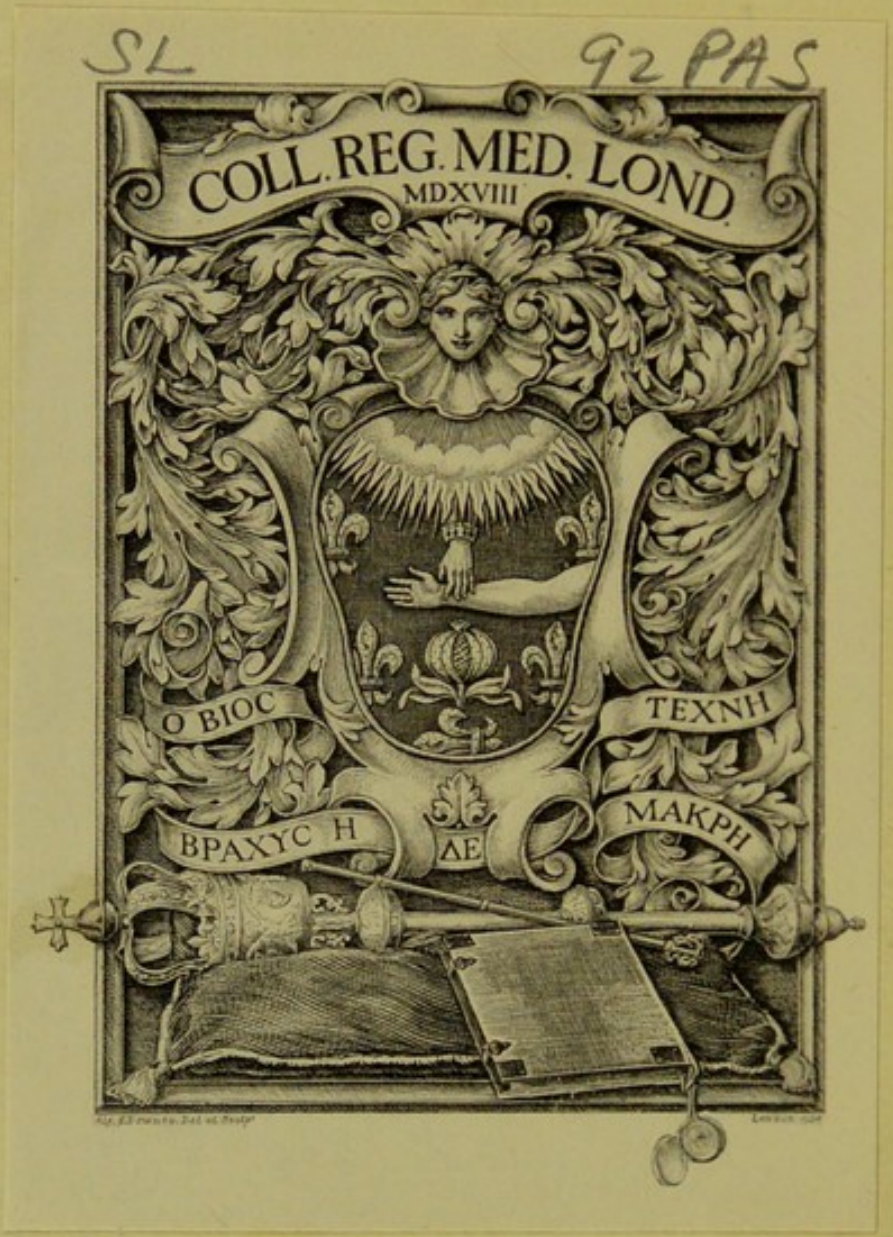
PASTEUR



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FOREWORD

TO

LIFE OF PASTEUR

L'œuvre de Pasteur est admirable ; elle montre son génie, mais il faut avoir vécu dans son intimité pour connaître toute la bonté de son cœur.—Dr. Roux.

PASTEUR

AN INTRODUCTION TO A NEW EDITION OF RENÉ VALLERY-RADOT'S LIFE

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FOREWORD

L'homme en ce siècle a pris une connaissance toute nouvelle des ressources de la nature et, par l'application de son intelligence il a commencé à les faire fructifier. Il a refait, par la géologie et la paléontologie, l'histoire de la terre, entraînée elle-même par la grande loi de l'évolution. Il connaît mieux, grâce à Pasteur surtout, les conditions d'existence de son propre organisme et peut entreprendre d'y combattre les causes de destruction.—Monod *L'Europe Contemporaine.*

WHETHER to admire more the man or his method, the life or the work, I leave for the readers of this well-told story to decide. At the request of my friend, Mr. Henry Phipps, a munificent supporter of science, and a man with a keen appreciation of its value in the progress of humanity, I write an introduction to this edition of Mrs. Devonshire's translation of Radot's *Life*. Among the researches that have made the name of Pasteur a household word in the civilised world, three are of the first importance—a knowledge of the true nature of the processes in fermentation—a knowledge of the chief maladies which have scourged man and animals—a knowledge of the measures by which either the body may be protected against these diseases, or the poison neutralised when once within the body.

I.

Our knowledge of disease has advanced in a curiously uniform way. The objective features, the symptoms, naturally first attracted attention. The Greek physicians, Hippocrates, Galen, and Aretaeus, gave excellent accounts of many diseases; for example, the forms of malaria. They knew, too, very well, their modes of termination, and the art of prognosis was studied carefully. But of the actual causes of disease they knew little or nothing, and any glimmerings of truth were

obscured in a cloud of theory. The treatment was haphazard, partly the outcome of experience, partly based upon false theories of the cause of the disease. This may be said to have been the sort of knowledge possessed by the profession until men began to study the "seats and causes" of disease, and to search out the changes *inside* the body, corresponding to the outward symptoms and the external appearances. Morbid anatomy began to be studied, and in the hundred years from 1750 to 1850 such colossal strides were made that we knew well the post-mortem appearances of the more common diseases; the recognition of which was greatly helped by a study of the relation of the pathological appearances with the signs and symptoms. The 19th century may be said to have given us an extraordinarily full knowledge of the changes which disease produces in the solids and fluids of the body. Great advances, too, were made in the treatment of disease. We learned to trust Nature more and drugs less; we got rid (in part) of treatment by theory, and we ceased to have a drug for every symptom. But much treatment was, and still is, irrational, not based on a knowledge of the cause of the disease. In a blundering way many important advances were made, and even specifics were discovered—cinchona, for example, had cured malaria for a hundred and fifty years before Laveran found the cause. At the middle of the last century we did not know much more of the actual causes of the great scourges of the race, the plagues, the fevers and the pestilences, than did the Greeks. Here comes in Pasteur's great work. Before him Egyptian darkness; with his advent a light that brightens more and more as the years give us ever fuller knowledge. The facts that fevers were catching, that epidemics spread, that infection could remain attached to particles of clothing, etc., all gave support to the view that the actual cause was something alive, a *contagium vivum*. It was really a very old view, the germs of which may be found in the Fathers, but which was first clearly expressed—so far as I know—by Frascastorius, a Veronese physician in the 16th century, who spoke of the seeds of contagion passing from

one person to another; and he first drew a parallel between the processes of contagion and the fermentation of wine. This was more than one hundred years before Kircher, Leeuwenhoek, and others, began to use the microscope and to see animalculæ, etc., in water, and so gave a basis for the "infinitely little" view of the nature of disease germs. And it was a study of the processes of fermentation that led Pasteur to the sure ground on which we now stand. Starting as a pure chemist, and becoming interested in the science of crystallography, it was not until his life at Lille, a town with important brewing industries, that Pasteur became interested in the biological side of chemical problems. Many years before it had been noted by Cagniard-Latour that yeast was composed of cells capable of reproducing themselves by a sort of budding, and he made the keen suggestion that it was possibly through some effect of their vegetation that the sugar was transformed. But Liebig's view everywhere prevailed that the ferment was an alterable, organic substance which exercised a catalytic force, transforming the sugar. It was in August, 1857, that Pasteur sent his famous paper on *Lactic Acid Fermentation* to the Lille Scientific Society; and in December of the same year he presented to the Academy of Sciences a paper on *Alcoholic Fermentation*, in which he concluded that the deduplication of sugar into alcohol and carbonic acid is correlevant to a phenomena of life. These studies had the signal effect of diverting the man from the course of his previous more strictly chemical studies. It is interesting to note how slowly these views dislocated the dominant theories of Liebig. More than ten years after their announcement I remember that we had in our chemical lectures the catalytic theory very fully presented.

Out of these researches arose a famous battle which kept Pasteur hard at work for four or five years—the struggle over spontaneous generation. It was an old warfare, but the microscope had revealed a new world, and the experiments on fermentation had lent great weight to the *omne vivum ex ovo* doctrine. The famous Italians, Redi and Spallanzani, had led

the way in their experiments, and the latter had reached the conclusion that there is no vegetable and no animal that has not its own germ. But heterogenesis became the burning question, and Pouchet in France, and Bastian in England, led the opposition to Pasteur. The many famous experiments carried conviction to the minds of scientific men, and destroyed for ever the old belief in spontaneous generation. All along the analogy between disease and fermentation must have been in Pasteur's mind; and then came the suggestion: "What would be most desirable would be to push those studies far enough to prepare the road for a serious research into the origin of various diseases." If the changes in lactic, alcohol and butyric fermentations are due to minute living organisms, why should not the same tiny creatures make the changes which occur in the body in the putrid and suppurative diseases. With an accurate training as a chemist, having been diverted in his studies upon fermentation into the realm of biology, and nourishing a strong conviction of the identity between putrefactive changes of the body and fermentation, Pasteur was well prepared to undertake investigations, which had hitherto been confined to physicians alone.

The first outcome of the researches of Pasteur upon fermentation and spontaneous generation represents a transformation in the practice of surgery, which, it is not too much to say, has been one of the greatest boons ever conferred upon humanity. It had long been recognised that now and again a wound healed without the formation of pus, that is without suppuration, but both spontaneous and operative wounds were almost invariably associated with that change; and, moreover, they frequently became putrid, as it was then called—infected, as we should say; the general system became involved, and the patient died of blood poisoning. So common was this, particularly in old, ill-equipped hospitals, that many surgeons feared to operate, and the general mortality in all surgical cases was very high. Believing that from outside the germs came which caused the decomposition of wounds, just as from the atmosphere the sugar solution got the germs which caused

the fermentation, a young surgeon at Glasgow, Joseph Lister, applied the principles of Pasteur's experiments to their treatment. It may be well here to quote from Lister's original paper in the *Lancet*, 1867 :—"Turning now to the question how the atmosphere produces decomposition of organic substances, we find that a flood of light has been thrown upon this most important subject by the philosophic researches of M. Pasteur, who has demonstrated by thoroughly convincing evidence that it is not to its oxygen or to any of its gaseous constituents that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life, long since revealed by the microscope, and regarded as merely accidental concomitants of putrescence, but now shown by Pasteur to be its essential cause, resolving the complex organic compounds into substances of simpler chemical constitution, just as the yeast plant converts sugar into alcohol and carbonic acid." From these beginnings modern surgery took its rise, and the whole subject of wound infection, not only in relation to surgical diseases, but to child-bed fever, forms now one of the most brilliant chapters in the history of Preventive Medicine.

II.

Pasteur was early impressed with the analogies between fermentation and putrefaction and the infectious diseases, and in 1863 he assured the French Emperor that his ambition was "to arrive at the knowledge of the causes of putrid and contagious diseases." After a study upon the diseases of wines, which has had most important practical bearings, an opportunity came of the very first importance, which not only changed the whole course of his career, but had great influence in the development of medical science. A disease of the silkworm had, for some years, ruined one of the most important industries of France, and in 1865 the Government asked Pasteur to give up the laboratory work and teaching, and to devote his whole energies to the task of investigating it. The story of the brilliant success which followed years of application

to the problem will be read with deep interest by every student of science. It was the first of his victories in the application of the experimental methods of a trained chemist to the problems of biology, and it placed his name high in the group of the most illustrious benefactors of practical industries.

The national tragedy of 1870–2 nearly killed Pasteur. He had a terrible pilgrimage to make in search of his son, a sergeant in Bourbaki's force. "The retreat from Moscow cannot have been worse than this," said the *savant*. In October, 1868, he had had a stroke of paralysis, from which he recovered in a most exceptional way, as it seemed to have diminished neither his enthusiasm nor his energy. In a series of studies on the diseases of beer, and on the mode of production of vinegar, he became more and more convinced that these studies on fermentation had given him the key to the nature of the infectious diseases. It is a remarkable fact that the distinguished English philosopher of the seventeenth century, the man who more than anyone else of his century appreciated the importance of the experimental method, Robert Boyle, had said that he who could discover the nature of ferments and fermentation, would be more capable than anyone else of explaining the nature of certain diseases. The studies on spontaneous generation, and Lister's application of the germ theory to the treatment of wounds, had aroused the greatest interest in the medical world, and Villemin, in a series of most brilliant experiments, had demonstrated the infectivity of tuberculosis. An extraordinary opportunity now offered for the study of a widespread epidemic disease, known as anthrax, which in many parts of France killed from 25 to 30 per cent. of the sheep and cattle, and which in parts of Europe had been pandemic, attacking both man and beast. As far back as 1838 minute rods had been noted in the blood of animals which had died from the disease; and in 1863 Devaine thought that these little bodies, which he called bacteridia, were the cause of the disease. In 1876 a young German district physician, Robert Koch, began a career, which in interest and importance rivals that of the subject of this memoir. Koch confirmed in every

point the old researches of Devaine; but he did much more, and for the first time isolated the organism in pure culture outside the body, grew successive generations, showed the remarkable spore formation, and produced the disease artificially in animals by inoculating with the cultures. Pasteur confirmed these results, and in the face of extraordinary opposition succeeded in convincing his opponents. Out of this study came a still more important discovery, namely, that it was possible so to attenuate or weaken the virus or poison that the animal could be inoculated, and have a slight attack, recover, and be protected against the disease. More than eighty years had passed since, on May 14th, 1796, Jenner, with a small bit of virus taken from a cow-pox on the hand of the milkmaid, Sarah Newlme, had vaccinated a child, and thus proved that a slight attack of one disease would protect the body from disease of a similar character. It was an occasion famous in the history of medicine, when, in the spring of 1881, at Melun, at the farmyard of Pouilly le Fort, the final test case was determined, and the flock of vaccinated sheep remained well, while every one of the unvaccinated, inoculated from the same material, had died. It was indeed a great triumph.

The studies on chicken cholera, yellow fever, and on swine plague helped to further the general acceptance of the germ theory. I well remember at the great meeting of the International Congress in 1881, the splendid reception accorded to the distinguished Frenchman, who divided with Virchow the honours of the meeting. Finally came the work upon one of the most dreaded of all diseases—hydrophobia, an infection of a most remarkable character, the germ of which remains undiscovered. The practical results of Pasteur's researches have given us a prophylactic treatment of great efficacy. Before its introduction the only means of preventing the development of the disease was a thorough cauterisation of the disease wound within half an hour after its infliction. Pasteur showed that animals could be made immune to the poison, and devised a method by which the infection conveyed by the bite could be neutralised. Pasteur Institutes for the treatment of hydro-

phobia have been established in different countries, and where the disease is widely prevalent have been of the greatest benefit. Except at the London Congress, the only occasion on which I saw the great master was in 1891 or 1892, when he demonstrated at the Institute to a group of us the technique of the procedure, and then superintended the inoculations of the day. A large number of persons are treated in the course of the year; a good many, of course, have not been bitten by mad dogs; but a very careful classification is made :—

(*a*) Includes persons bitten by dogs proved experimentally to have been mad.

(*b*) Persons bitten by dogs declared to be mad by competent veterinary surgeons.

(*c*) All other cases.

The mortality even in Class A is very slight, though many patients are not brought until late. Incidentally it may be remarked the lesson of this country in its treatment of hydrophobia is one of the most important ever presented in connection with an infectious disease. There are no Pasteur Institutes; there are no cases. Why? The simple muzzling order has prevented the transmission of the disease from dog to dog, and once exterminated in the dog, the possibility of the infection in man had gone. In 1888 the crowning work of Pasteur's life was the establishment of an Institute to serve as a centre of study on contagious disease, and a dispensary for the treatment of hydrophobia, which is to-day the most important single centre of research in the world. The closing years of his life were full of interest in the work of his colleagues and assistants, and he had the great satisfaction of participating, with his assistant Roux, in another great victory over the dread scourge, diphtheria. Before his death in 1895 he had seen his work prosper in a way never before granted to any great discoverer. To no one man has it ever been given to accomplish work of such great importance for the well-being of humanity. As Paul Bert expressed it in the report to the French Government, Pasteur's work constitutes three great discoveries, which may be thus formulated. 1. Each

fermentation is produced by the development of a special microbe.

2. Each infectious disease is produced by the development within the organism of a special microbe.

3. The microbe of an infectious disease culture, under certain detrimental conditions is attenuated in its pathogenic activity; from a virus it has become a vaccine.

In an address delivered in Edinburgh by Sir James Simpson in 1853, in which he extolled the recent advancement of physic, occur these words:—"I do not believe, that, at the present moment, any individual in the profession, who, in surgery or in midwifery, could point out some means of curing —or some prophylactic means of averting by antecedent treatment—the liability to these analogous or identical diseases—viz., surgical or puerperal fever—such a fortunate individual would, I say, make, in relation to surgery and midwifery, a greater and more important discovery than could possibly be attained by any other subject of investigation. Nor does such a result seem hopelessly unattainable." Little did he think that the fulfilment of these words was in the possession of a young Englishman who had just gone to Edinburgh as an assistant to his colleague, Professor Syme. Lister's recognition of the importance of Pasteur's studies led to the fulfilment within this generation of the pious hope expressed by Simpson. In Institutions and Hospitals surgical infection and puerperal fever are things of the past, and for this achievement if for nothing else, the names of Louis Pasteur and Joseph Lister will go down to posterity among those of the greatest benefactors of humanity.

III.

In his growth the man kept pace with the scientist—heart and head held even sway in his life. To many whose estimate of French character is gained from "yellow" literature this story will reveal the true side of a great people, in whom filial piety, brotherly solicitude, generosity, and self-sacrifice are

combined with a rare devotion to country. Was there ever a more charming picture than that of the family at Dôle! Napoleon's old sergeant, Joseph Pasteur, is almost as interesting a character as his illustrious son; and we follow the joys and sorrows of the home with unflagging attention. Rarely has a great man been able to pay such a tribute to his father as that paid by Pasteur:—"For thirty years I have been his constant care, I owe everything to him."

This is a biography for young men of science, and for others who wish to learn what science has done, and may do, for humanity. From it may be gleaned three lessons.

The value of method, of technique, in the hands of a great master has never been better illustrated. Just as Harvey, searching out Nature by way of experiment, opened the way for a study of the functions of the body in health, so did Pasteur, bringing to the problems of biology the same great *organon*, shed a light upon processes the nature of which had defied the analysis of the keenest minds. From Dumas's letter to Pasteur, quoted in Chapter VI., a paragraph may be given in illustration:—"The art of observation and that of experiment are very distinct. In the first case, the fact may either proceed from logical reasons or be mere good fortune; it is sufficient to have some penetration and the sense of truth in order to profit by it. But the art of experimentation leads from the first to the last link of the chain, without hesitation and without a blank, making successive use of Reason, which suggests an alternative, and of Experience, which decides on it, until, starting from a faint glimmer, the full blaze of light is reached." Pasteur had the good fortune to begin with chemistry, and with the science of crystallography, which demanded extraordinary accuracy, and developed that patient persistence so characteristic of all his researches.

In the life of a young man the most essential thing for happiness is the gift of friendship. And here is the second great lesson. As a Frenchman, Pasteur had the devotion that marks the students of that nation to their masters, living and dead. Not the least interesting parts of this work are the

glimpses we get of the great teachers with whom he came in contact. What a model of a scientific man is shown in the character of Biot, so keenly alive to the interests of his young friend, whose brilliant career he followed with the devotion of a second father. One of the most touching incidents recorded in the book relates to Pasteur's election to the Academy of Sciences :—"The next morning when the gates of the Montparnasse cemetery were opened, a woman walked towards Biot's grave with her hands full of flowers. It was Mme. Pasteur who was bringing them to him . . . who had loved Pasteur with so deep an affection." Pasteur looked upon the cult of great men as a great principle in national education. As he said to the students of the University of Edinburgh :—"Worship great men";* and this reverence for the illustrious dead was a dominant element in his character, though the doctrines of Positivism seemed never to have had any attraction for him. A dark shadow in the scientific life is often thrown by a spirit of jealousy, and the habit of suspicious, carping criticism. The hall-mark of a small mind, this spirit should never be allowed to influence our judgment of a man's work, and to young men a splendid example is here offered of a man devoted to his friends, just and generous to his rivals, and patient under many trying contradictions and vexatious oppositions.

And the last great lesson is humility before the unsolved problems of the Universe. Any convictions that might be a comfort in the sufferings of human life had his respectful sympathy. His own creed was beautifully expressed in his eulogy upon *Littré* :—"He who proclaims the existence of the Infinite, and none can avoid it—accumulates in that affirmation more of the supernatural than is to be found in all the miracles of all the religions; for the notion of the Infinite presents that double character that it forces itself upon us and yet is incomprehensible. When this notion seizes upon our understanding, we can but kneel. . . . I see everywhere the inevitable expression of the Infinite in the world; through it,

* A great nation, said Disraeli, is a nation which produces great men.

the supernatural is at the bottom of every heart. The idea of God is a form of the idea of the Infinite. As long as the mystery of the Infinite weighs on human thought, temples will be erected for the worship of the Infinite, whether God is called Brahma, Allah, Jehovah, or Jesus; and on the pavement of those temples, men will be seen kneeling, prostrated, annihilated in the thought of the Infinite." And modern Pantheism has never had a greater disciple, whose life and work set forth the devotion to an ideal—that service to humanity is service to God :—"Blessed is he who carries within himself a God, an ideal, and who obeys it : ideal of art, ideal of science, ideal of the gospel virtues, therein lie the springs of great thoughts and great actions; they all reflect light from the Infinite."

The future belongs to Science. More and more she will control the destinies of the nations. Already she has them in her crucible and on her balances. In her new mission to humanity she preaches a new gospel. In the nineteenth century renaissance she has had great apostles, Darwin, for example, whose gifts of heart and head were in equal measure, but after re-reading for the third or fourth time the *Life of Louis Pasteur*, I am of the opinion, expressed recently by the anonymous writer of a beautiful tribute in the *Spectator*, "that he was the most perfect man who has ever entered the Kingdom of Science."

WILLIAM OSLER.