PASTEUR
AND MODERN SCIENCE
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RENÉ DUBOS

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Almost forty years ago, in 1950, René Dubos published a superb full-scale biography of Pasteur under the title *Louis Pasteur: Free Lance of Science*. Ten years later, in 1960, Dubos distilled the essence of that larger book into *Pasteur and Modern Science*, which was originally published by the Anchor Books division of Doubleday and Company as part of its now-defunct Science Study Series. This series of textbooks and biographies, conceived in the wake of the launching of the Sputnik space satellite by the Soviet Union in 1957, was prepared under the direction of the Physical Science Study Committee of Educational Services Incorporated for an intended audience of students and their teachers.

Like other books in the series, *Pasteur and Modern Science* was out of print for several years. After Dubos's death, Doubleday and Company released the rights to his widow, who transferred them in turn to Science Tech Publishers. Their new edition differs somewhat from the original edition: more than 40 illustrations and tables have been added to Dubos's originally unillustrated book, as well as a new biographical sketch of Dubos, a glossary of technical terms, a chronological outline of Pasteur's career, and a brief list of suggestions for further reading. Finally, there is a new chapter, "Pasteur's Dilemma: The Road Not Taken" (Chapter 14), based on an article published in 1974 by Dubos, that briefly develops a theme originally introduced at the end of Chapter 13 in the 1960 edition. These changes enhance the book's accessibility, appeal, and pedagogic value, which had already won it a wide audience in its original edition.
The book’s enduring appeal is a tribute both to its subject and to its author. Few scientists indeed have so captured the public imagination as Louis Pasteur, and fewer still have had such a dramatic effect on everyday life. Pasteur began his career in the relatively abstruse field of crystallography, but his close study of what he once called “the arid details of crystal form” soon led him to a major achievement of broad significance: the discovery of optical isomers—left- and right-handed crystals of the same chemical composition—in the tartrates, a group of organic compounds associated with wine making. With this discovery in 1848, Pasteur penetrated more deeply than anyone before him into the relationship between crystal form and chemical structure; at the age of 25, his great scientific career was already launched.

During the next decade Pasteur pursued his study of the relationship between optical activity and crystal form. One aspect of that research appealed to the grandiose streak in his nature. Noting the correlation between optical activity, asymmetric crystals, and life, Pasteur briefly and privately sought to produce asymmetric, optically active, “living” substances from symmetric, optically inactive, “dead” starting materials—in short, he tried to create “the immediate principles of life” artificially in the laboratory. In undertaking these bold experiments, Pasteur hoped to become the Galileo or Newton of biology. And though the experiments failed, Pasteur never entirely abandoned his belief in a “cosmic asymmetric force.” Late in life, he wished he could return to those exciting days when he was trying to solve nothing less than the mystery of the relationship between asymmetry and life.

By then, however, Pasteur had long been occupied with more immediately practical matters, beginning with fermentation. The products of fermentation and putrefaction are often optically active, and Pasteur soon linked these processes with life in the form of “germs” or microscopic organisms. No one did more than he to establish the germ theory of fermentation. He especially sought to demonstrate that each decomposition process
results from the biological activity of a specific microbe, so that, for example, the lactic “ferment” that produces sour milk differs from the microorganism (yeast) responsible for alcoholic fermentation. At the same time, Pasteur devoted close attention to industrial fermentations, proposing new methods for the manufacture of wine, vinegar, and eventually beer, and new techniques for preserving the desired products from spoilage or the “diseases” to which they were susceptible. These preventive measures, consisting basically of sterilization by heat and cold, were labeled “pasteurization” almost immediately. By 1900, they had been applied to a wide range of substances, including notably milk.

Pasteur’s excursion into the study of fermentation brought him into two related arenas of debate: spontaneous generation and disease theory. Fermentation, putrefaction, and disease had long been seen as analogous processes, and any theory of one was likely to be extended to the others. When Pasteur arrived on the scene in 1857, the prevailing theory of fermentation was chemical, though some observers had noted the association between microorganisms and fermentation or disease. Even those who accepted this association, however, did not always agree about the nature of the relationship between microbes and these processes of decomposition. Some maintained that the microbes were actually products rather than causes of fermentation and disease—living products that had arisen not by biological reproduction from parents like themselves but by “spontaneous generation” from dead, decomposing materials. By thus raising doubts about the origin of microorganisms and trivializing their causative role, the doctrine of spontaneous generation posed a challenge to the germ theory of fermentation and disease. Despite the advice of friends and mentors to avoid the issue, which had political and religious overtones, Pasteur mounted a vigorous and largely successful campaign against the doctrine of spontaneous generation, ignoring all the while his own early efforts to create life experimentally from dead, optically inactive materials.
Pasteur was quick to note the implications for disease theory of his work on fermentation and spontaneous generation, but he was uncharacteristically cautious about moving directly into the medical domain. The first halting step, a study of silkworm diseases, came in 1865 at the urging of a French government concerned about the economic consequences of a devastating silkworm blight. Even after 1870, by which point he had solved the silkworm problem to his satisfaction, Pasteur hesitated to undertake his long-projected investigation of infectious diseases, citing the need for qualified research assistants and his own lack of medical training. Finally, in 1876, Pasteur did enter directly into veterinary and medical research, beginning with anthrax, another economically significant disease that primarily afflicted sheep.

Once Pasteur did take up the study of infectious diseases, he enjoyed swift and spectacular success. His contributions to our understanding of the etiology of anthrax were less important that those of his great German rival, Robert Koch, but Pasteur and his collaborators quickly developed vaccines against chicken cholera, anthrax itself, and swine erysipelas. In 1885, their efforts were crowned by a successful application of rabies vaccine to humans. Long a French national hero, Pasteur now became an international legend and a leading symbol of the humanitarian benefits of scientific research. The vaccine against rabies produced a flood of donations from around the world, and the resulting Institut Pasteur, inaugurated in November 1888, has loomed large ever since in the history of science and medicine.

Such a career has naturally attracted a host of biographers. Two of the earliest biographies remain two of the best. Within a year of the master’s death, his collaborator Émile Duclaux published Pasteur: Histoire d’un Esprit, a brilliant scientific biography which, though it ostensibly ignores personal matters, also provides a revealing glimpse into Pasteur’s personality and
scientific *modus operandi*, including his “Olympian silence” about the direction of his research. In 1900 Pasteur’s son-in-law, René Vallery-Radot, published a detailed two-volume study, *La vie de Pasteur*, which remains a standard source despite its often worshipful tone. A third crucial source from within the Pastorian circle is almost unknown: in the late 1930s, a half century after Pasteur’s death, his nephew and sometime research assistant Adrien Loir published a series of anecdotal but highly illuminating essays in an obscure journal under the collective title *À l’Ombre de Pasteur* (“In the Shadow of Pasteur”). There have been several fine full-length biographies since, but the best of them is René Dubos’s 1950 *Free Lance of Science*, which is in part an elegant synthesis of the works by Duclaux, Vallery-Radot, and Loir.

In Dubos, Pasteur found a modern biographer almost ideally suited to the task. A distinguished French-born microbiologist of broad culture and wide sympathies, Dubos had a deep appreciation for the power and enduring significance of Pasteur’s scientific work. He was also well equipped to recognize its nuances and weaknesses. To the more personal dimensions of the biographer’s task, Dubos brought his keen insight into the wellsprings of human action, behavior, and personality. He appreciated the full range of factors, motives, and fears that needed to be kept in mind, including his subject’s health, which was, like Dubos’s own, sometimes precarious. Dubos also displayed a lively interest in the philosophical, religious, and political dimensions of Pasteur’s life and times. He had the advantage that he had grown up in French culture, but had then spent most of his adult life in the United States, at a tempering distance from the more institutionalized aspects of the Pastorian cult in France. Finally, Dubos brought to the task his hard-won gift of graceful expression, which allowed him to convey the excitement and significance of even the most technical aspects of Pasteur’s work. All of these impressive qualifications did not go for naught. In very large part, Dubos succeeded admirably in the role of Pasteur’s biographer.
Inevitably, Dubos emphasized parts of Pasteur’s thought and work that were in keeping with his own intellectual predilections. In particular, he drew attention wherever possible to what may be called the environmental strain in Pasteur’s microbiological thought. Dubos’s own environmentalism can be traced to his training in agricultural economics in France and then in soil microbiology at Rutgers University in New Jersey. It found expression in his attitudes toward health and disease, and especially in his opposition to the tendency to equate disease simply with the presence of a pathogenic microorganism. Furthermore, despite his own major contributions to the development of antibiotics, Dubos predicted that drug-resistant microbial strains would evolve, and he recognized the role of individual constitution, nutrition, host resistance, and adaptation in health and disease. That position could only have been reinforced by his personal experience with tuberculosis, which took the life of his first wife in 1942 and also afflicted his second wife, Jean. Together he and Jean published in 1952 the prescient book *The White Plague: Tuberculosis, Man, and Society*, which presented some of the arguments and basic evidence for the now widely accepted view that nutrition and environmental conditions are leading determinants of health. Dubos developed this theme further in his influential *Mirage of Health* (1959) and *Man Adapting* (1965). Eventually, Dubos extended his environmentalism into a vision of the delicate interconnectedness of all living things that brought him fame as a sometimes unwitting guru of the ecology movement of the late 1960s.

Long before Dubos became famous for it, his environmentalism was evident in his treatment of Pasteur. In some elusive way, it informed his entire quest as biographer. Consider, for example, his attempt to articulate the sense in which Pasteur was both “Of His Time and Timeless” (pp. 150–151). There Dubos insists that “all scientists, like artists, naturally reflect the characteristics of the civilization and of the times in which they arise.” And if the great ones, like Pasteur, do sometimes seem to escape their cultural conditions, they should not be
seen as “aberrations in the natural sequence of cultural events.” Rather, they constitute “peculiar mentalities through which emerge and become manifest social undercurrents that remain hidden to less perceptive minds.” Some of them, including Pasteur and other popular scientific heroes, “succeed in converting their visions—which are really signs from the social and cultural subconscious—into messages and products meaningful and of immediate value to their fellow humans.” By pointing to this link between peculiar individual “mentalities” and “signs from the social and cultural subconscious,” Dubos extended his environmentalism into the realm of human intellect, its products, and their cultural reception.

More concretely, Dubos gave special attention to Pasteur’s relatively neglected work on the silkworm diseases, pébrine and flacherie. Dubos was especially impressed that, in the case of flacherie, Pasteur resisted the temptation to embrace a simple microbial explanation and emphasized instead the constitutional and nutritional susceptibility of diseased worms. In the full-scale biography of 1950, Dubos wrote of Pasteur’s study of silkworm diseases that he did not know a “more beautiful example of scientific investigation,” and he describes it in this book (page 94) as “one of the most dramatic and spectacular feats of [Pasteur’s] scientific life.”

Similarly, Dubos reveled in Pasteur’s experimental demonstration of how temperature could affect an organism’s susceptibility to microbial disease. Pasteur induced anthrax in a hen, ordinarily resistant to the disease because of its high body temperature, simply by chilling it in an ice-water bath. For Dubos, this experiment was a spectacular vindication of the environmental approach to disease, and he did what he could to enlist Pasteur in the cause. Ultimately, however, even Dubos had to concede that he could not quite transform Pasteur into a “Dubosian” ecologist of disease. Perhaps, theoretically, Pasteur could have followed this path, as Dubos suggests. Perhaps it was in keeping with the internal logic of his research. Yet in the end, as Dubos admits in the very subtitle of the new Chapter
14 printed here, this ecological road was, for Pasteur, "the road not taken."

Apart from his environmentalism, Dubos gently intruded himself into the Pasteur story in another way. In the personal realm, too, Dubos's Pasteur is more Dubosian than he was in real life. True, they were alike in many respects. Both were French-born microbiologists, "pure" scientists, who turned to practical issues partly out of a desire to contribute to human welfare. Both had a romantic, almost poetic side to their nature. But Dubos and Pasteur were by no means identical in personality and character. In particular, the biographer was more idealistic, optimistic, and generous of spirit than his subject. Dubos managed to extend his generosity of spirit to Pasteur, even when he seemed puzzled by the latter's behavior. Dubos did not ignore, but he did tend to minimize the less appealing aspects of Pasteur's character and conduct, including his preoccupation with fame and money and his self-serving treatment of his rivals and sometimes even his collaborators. If Dubos was too shrewd to miss the clear evidence of such behavior, he was also too generous or perhaps too wise to make much of it.

There was, in fact, only one real defect in Dubos as Pasteur's biographer: his scholarship was occasionally careless, and his decision to omit footnotes makes it hard to identify the sources of his information and insights. However, much the same could be said of all the existing books on Pasteur. Today there is still no proper scholarly biography of him, but such a book will one day appear. When it does, it will benefit from the rich collection of surviving Pasteur manuscripts, the bulk of which are now available to scholars at the Bibliothèque Nationale in Paris. Research into those manuscripts, which include Pasteur's laboratory notebooks, has been underway for some time now, and some of the results are beginning to appear (see Further Reading). Yet even when all the results of this future scholarship reach the light of day, readers will still turn with profit to Dubos's biographical efforts. They will still want to read the concise
and accessible introduction to Pasteur found in *Pasteur and Modern Science*. Indeed, one can say of this book somewhat the same thing that Dubos says at the book’s end about the work of Pasteur: it retains its value despite inevitable defects in details and changes of perspective. In this centennial year of the Institut Pasteur in Paris, the reprinted edition is especially welcome. It should find a new and larger audience still.

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About the Author

René J. Dubos, the noted scientist and author, died in 1982 at the age of 81. Throughout his long and productive career, he wrote 33 books and over 300 laboratory research articles. Among his books are important technical works for the physician and scientist as well as numerous books for the general public. He was one of those rare individuals able to write not only for the scientist but for the student and layperson as well. He was awarded the Pulitzer Prize in 1969 for his book *So Human an Animal*.

Dr. Dubos was born in France and received his early education there. He earned his Ph.D. in 1927 from Rutgers University (New Jersey). Except for a two-year period as a professor at Harvard University, he spent all of his long and productive career at the Rockefeller Institute for Medical Research in New York City. Although his early training was in agriculture and soil microbiology, he made major contributions to antibiotics research and to the understanding of tuberculosis and other infectious diseases. He was also a pioneer in the important and burgeoning field of environmental medicine. His prominent role in studying social and environmental effects on health
brought him very early into the mainstream of the environmental movement in the late 1960s. His highly publicized views that everything in life plays an interconnected part made him a dominant spokesperson for those disturbed about the effects of rapidly expanding technological civilization on human life. His eloquent skills in speaking and writing, coupled with his stature as a scientist, enabled him to bring the issues to the attention of an extensive public audience. His well-deserved fame in his final years was a result of his passionate involvement in serving as the "conscience of the environment." His human-centered views, considerate of both liberals and conservatives in the environmental movement, continue to influence public policy.

His French upbringing and his background as an agricultural and medical scholar make René Dubos an ideal person to explain Louis Pasteur and his work to a broad audience, and his skills are evident in Pasteur and Modern Science. In addition to this book, his other popular books include The White Plague: Tuberculosis, Man, and Society (with Jean Dubos), Mirage of Health: Utopias, Progress, and Biological Change, The Dreams of Reason: Science and Utopias, Man Adapting, So Human an Animal, A God Within, The Wooing of Earth, and Celebrations of Life.

René Dubos achieved worldwide fame as a microbiologist, experimental pathologist, author, lecturer, and environmentalist. Any one of these careers would have sufficed for most people, but he managed to combine them all. He was endowed with many intellectual talents, great sensitivity, originality, and rigorous self-discipline. His contagious enthusiasm for new ventures and his endless curiosity and wonder about life are especially well revealed in Pasteur and Modern Science, a book he originally wrote for students but which can now have a much wider audience.
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