LIFE AND LABORS

OF

LOUIS PASTEUR

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BY

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"*In the present state of science, spontaneous disease has no more existence than spontaneous generation.*"—Life of Pasteur.

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LOUIS PASTEUR.

Louis Pasteur is a Frenchman. His father was at first a soldier, and after having served his country with valor, attested by decorations on the battle-field, he settled down to the trade of a tanner. As to Louis, his humble parents resolved and were accustomed to say: "We will make of him an educated man." The education of a boy is a good thing, but it does not necessarily lead to, nor away from his father's vocation. They sent Louis to school, first as a half pay scholar, and when the poor boy was somewhat advanced in his studies, he practiced relf-reliance by earning something in a somewhat menial way at his school. Little did these humble parents imagine that the time would come when their little house would be decorated with a plate having these letters on it in gold:

HERE WAS BORN LOUIS PASTEUR,
Dec. 27, 1822.

Little did they dream that that son, in the midst of a triumphal procession, and crowned with honors as a benefactor of his age, would pause before that cottage, thus decorated, and busrt into tears as he remembered their affection, devotion, and sacrifice in his behalf.

Pasteur is now in his sixty-fourth year; and for seventeen years he has suffered from paralysis. A newspaper correspondent thus describes Mr. Pasteur, in a letter dated Paris, Dec. 7, 1885:

"The young man at once took my card to M. Pasteur, and in a few moments returned in company with the famous chemist. M. Pasteur is a short, thick-set man, active and quick in his movements, with a large head and very determined expression, both in the eyes and mouth. His eyebrows turn up into sharp points, giving him something of the appearance of the alchemist as described in Sir Walter Scott's novels. He wore a small black silk smoking cap on one side of the head and a sort of dark blue reefing jacket, in the button hole of which was the Legion d'Honneur."

It looks very much as if we should have to take *cum grano salis*—with a grain of salt—the statement that he is "active and quick in his movements." He conducts his work through assistants, whom he directs and supervises. His paralysis was caused by personal exposure in prosecuting his scientific labors in rescuing the silk worm from its deadly parasites, and restoring to France, not to speak of other countries, the silk industry, with an annual revenue of thirty million dollars. He brought it to a more healthy and profitable condition than it had ever before enjoyed, after having fallen into utter and seemingly hopeless ruin. Notwithstanding this personal affliction, such is still his indomitable perseverance, and such his intellectual vigor and skill in directing the labors of assistants in his laboratory, that man and beast might fitly join in devout orisons for the prolongation of a life so precious, and the continuance of those useful labors, that have now been extended over a period of forty years. The hydrophobia sensation looks upon him as having acquired a wonderful and superficial notoriety by a chance shot, whereas it is but an incident in his long life of wonderful discovery.

Let me hasten to say that, at this time, I propose to notice very briefly and cursorily, and from a practical point of view, only a few of his labors. Of course, the student and scientist will go to the original memoirs of the Academy of Sciences and to his published works; and his recently published Life, which is virtually an autobiography, will not be neglected.

Prof. Tyndall, in his introduction to this book, says: "It is the record of extraordinary scientific ardor and success." And, also, that Pasteur's "labors have rendered him one of the most conspicuous scientific figures of this age." Indeed, it may be fairly questioned whether, when tested by the criteria of positive science and of usefulness, his solid and subtle discoveries and contributions to science do not have a homely value, surpassing those of any man of this century. Greatness is legitimately won only by service rendered, and thus judged, Pasteur's admirers may be excused for thus adjudging him first honors. M. Pasteur is a chemist. He is a member of the French

Academy of Sciences. He has held many important positions, has won many prizes and medals, and in recognition of his discoveries the French Government, 1874, granted him a pension of 20,000 francs a year.

His maiden exploit as a discoverer was made when a youth about twenty-four years of age. It was in the domain of molecular physics. The occasion of this exploit was the famous note commucated to the Academy of Sciences in these words:

"The paratartrate and the tartrate of soda and ammonia have the same chemical composition, the same crystalline form, the same angles, the same specific weight, the same double refraction, and consequently the same inclination of the optic axes. Dissolved in water, their refraction is the same. But while dissolved tartrate causes the plane of polarized light to rotate, the paratartrate exerts no such action. M. Biot has found this to be the case with the whole series of these two kinds of salts. Here the nature and the number of the atoms, their arrangement, and their distances apart, are the same in the two bodies."

This note calls attention to two well known bodies as "rigorously identical" in every empirical and describable particular, except that one acted on light in a manner different from the other. Scientists could find no explanation of this difference in the constitution of the two bodies; and the unsolved problem was formally and gravely laid before the French Academy by the distinguished Mitscherlich, a German chemist. Pasteur at once attacked this problem, and effected its perfect solution by showing that there is a tartrate with left-hand and another with right-hand rotation, the optically neutral salt arising from the union of the two. M. Biot rigidly confirmed this brilliant discovery of Pasteur, and when his report of this confirmation was made to the French Academy of Sciences, M. Arago, sharing the enthusiasm of the members, moved that the report "be inserted in the collected *memoirs* of the Academy"—an exceptional honor.

The details are too minute and too technical for our present use, but the importance and difficulty of the problem are sufficiently evident from the interest it excited and from the consequences of its solution.

When, afterwards, M. Biot presented Pasteur to Mitscherlich, with the remark, "My young friend, you may boast having done something great in having discovered what had escaped such a man as this," Mitscherlich replied with gravity and somewhat ungraciously, it seems to me, "I had studied with so much care and perseverance in their smallest details, the two salts which formed the subject of my note to the Academy, that if you have established what I was unable to discover, you must have been guided to your result by a pre-conceived idea." This seems rather stiff and indicative of wounded pride. How different the behavior of these two veterans of science towards this youth! When Biot had perfectly verified the discovery, taking Pasteur by the arm, the illustrious old man said to him: "My dear child, I have loved science so well throughout my life that this makes my heart beat." Surely it was pardonable in this "dear child" that on making this startling discovery he was seized with a fit of enthusiasm, rushed from his laboratory, and, on meeting a colleague, threw his arms around him, exclaiming: "My dear Monsieur Bertrand, I have just made a great discovery, and I am so happy that a nervous tremulousness has taken possession of me, which prevents me from looking again through the polariscope. Let us go to the Luxembourg, and I will explain all to you." How human!

Is it strange that Cupid appeared upon the scene at about this juncture, and shot an arrow to the triumphant Parteur's very heart, that prostrated him at the feet of a fair maiden, who would réceive it with a smile, when, in after life, reminded how he forgot his wedding day, so that it was necessary for a friend to go to his laboratory and remind him of it. The idea of a foung fellow being so absorbed in his laboratory as to forget his wedding day! Here is scientific enthusiasm.

Strangely enough, this first exploit of Pusteur in the seemingly remote and sterile domain of inorganized matter of molecular physics led by an easy transition to the two greatest discoveries of his life, and of this century, whose full unfolding, in the beneficial interest of man and animal, may require another century of luck and of ingenious and industrious labor. These two discoveries were: first, *the nature of fermentation;* and, second, *the transforming of the malignant virus* of zymodic diseases into benignant vaccine virus.

As to fermentation, Pasteur has overthrown the still popular and current doctrine of Justus V. Liebig, that it is a spontaneous chemical or semi-mechanical process. Let Liebig speak for himself. He says:

"By the terms *fermentation*, *putrefaction* and *eremacausis* are meant those changes in form and properties, which compound organic substances undergo, when separated from the organism, and exposed to the influence of water, and a certain temperature Fermentation and putrefaction are examples of that kind of decomposition, which we have named transformations; the elements of the bodies capable of undergoing these changes arrange themselves into new combinations, in which the constituents of water generally take a part.

"Eremacausis, or decay, differs from fermentation and putrefaction, inasmuch as it cannot take place without the access of air, the oxygen of which is absorbed by the decaying bodies. Hence, it is a process of slow combustion, in which heat is uniformly evolved, and occasionally even light. In the processês of decomposition, termed fermentation and putrefaction, gaseous products are very frequently formed, which are either inodorous, or possess a very offensive smell.

"The transformations of those matters which evolve gaseous products, *without odor*, are now, by pretty general consent, designated by the term *fermentation*; whilst the spontaneous decomposition of bodies which emit gases of a disagreeable smell, the term putrefaction is applied. But the smell is, of course, no distinctive character of the nature of the decomposition, for both fermentation and putrefaction are processes of decomposition of a similar kind, the one of substances destitute of nitrogen, the other of substances which contain it.

"It has also been customary to distinguish from fermentation and putrefaction a particular class of transformations, viz.: those in which conversions and transpositions are effected without the evolution of gaseous products. But the conditions under which the products of the decomposition present themselves are purely accidental; there is, therefore, no reason for the distinction just mentioned."

Here we have, in Liebig's own words, his doctrine of fermentation as a chemical or semi-mechanical process. This extract is from "Liebig's Complete Works on Chemistry, the Part on Agriculture and Physiology," edited from the manuscript of the author, by Lyon Playfair, Ph. D., p. 90.

Liebig in another place says that fermentation "is the very reverse of the vital process," and all who had accepted and maintained this doctrine, misled by the mimicry of chemical processes, totally repudiated all vital action in fermentation as well as in contagious and infectious diseases.

On the other hand, Pasteur has firmly established the opposing doctrine, that fermentation or putrefication is probably in all cases due to the action of minute living organisms; and that the substances usually regarded as ferments are the food for these organisms; that fermentation is a process of nutrition.

The general name which it is proposed to give these minute beings is that of *microbes*, compounded of two Greek words *mikros*, little, and *bios*, living—little living things. They are indeed little. The name is good, as it implies no theory as to whether these little creatures are vegetable or animal, or neither, in their nature. "The problem, whether in a given case, an organism is an animal or plant, may be insoluble." Certain accomplished investigators and authors, in the domain of biology are quoted by Mr. Huxley, to the effect 'that they cannot express the excessive minuteness of the living granules in question; they estimate their diameter at less than 1-200,000 of an inch; *i. e.*, it would take more than 200,000 placed side by side to make an inch. Under the highest powers of the microscope, at present applicable, such specks are hardly discernible. Nevertheless, particles of this size are massive, when compared to physical molecules, each molecule being an aggregation of atoms, whence there is no reason to doubt that each microbe, small as it is, may have a molecular structure sufficiently complex to give rise to the phenomena of life. And, as a matter of fact, by patient watching of the place at which these infinitesimal living particles were discharged, our observers assured themselves of their growth and development into new monads. These, the progeny, in about four hours from their being set free, had attained a sixth of the length of the parent, with the characteristic cilia, though at first they were quite motionless, and in four hours more they had attained the dimensions and exhibited all the activity of the adult. These inconceivable minute particles are, therefore, the germs of the monad, and from the dimensions of these germs it is easily shown that the body formed by conjugation, may at a low estimate, have given exit (existence) to thirty thousand of them; a result,' as Mr. Huxley remarks, 'of a matrimonial process whereby the contracting parties, without a metaphor, 'becoming one flesh.' enough to make a Malthusian despair of the future of the universe.'

These processes, according to the new doctrine, simply consist in the destruction or transformation of these compounds, and the formation of others by the action of these minute microscopic living organisms called microbes, whose multitudinous proliferations and voracious appetites beggar computation and description, because they defy conception. In these respects they are all alike, but they are quite diverse as to their modes of life and habits. The microbe that effects the production of lactic acid in soured milk differs from that of butyric acid in rancid butter, and both from that of yeast in bread, and so on.

Pasteur pressed his inquiry to the point of ascertaining that the free oxygen of the air is nescessary to some of these microbes, which are named for that reason, ærobies, and that it kills others, named anærobies; whereas that of yeast is amphibious, as it can live either with or without free air, but, strangely enough, when the air supplies oxygen to this yeast microbe, it is not a ferment, whilst it is one, when reduced to the necessity of appropriating or wresting its oxygen from a fixed state in some chemical compound.

A German manufacturer of pure chemicals was perplexed in his business by a mysterious and damaging fermentation of the commercial tartrate of lime, on being dissolved in water and exposed to summer heat. This case was brought to the attention of Pasteur, who demonstrated that the fermentation was due to a living organism that fed on the right-handed tartrate, and not on the left-handed tartrate, the very acids which he had discriminated in his primary discovery in response to the Mitscherlich note to the Academy. It required the searching analysis of light to detect the difference between these tartrates, and yet the appetite of the living germ of the common mould, *penicillium* *glaucum*, was found to be equally discriminating. This has been pronounced a "most remarkable experiment," but its critical importance to Pasteur and the world consisted in the notable circumstance, that his discovery in the domain of molecular physics was the occasion of his now being brought face to face with the phenomena of fermentation as vital phenomena.

The new doctrine that fermentation is due to microbes, in short, is "simply a phenomenon of nutrition," served to explain the whole process of the manufacture of vinegar, which is an extensive industry in France. Vinegar, as the name indicates, is wine turned sour; but vinegar or acetic acid, has in it no alcohol. In the formation of vinegar the alcohol disappears and is replaced by acetic acid. The true and only ferment of vinegar is a little plant, a microscopic and microbic fungus or mould, and of all plants it is one of the simplest and most minute, and has been known from time immemorial under the name of mother of vinegar. This plant is a cryptogam and like larger vegetables feeds on its appropriate aliments.

When Pasteur's views were questioned, he boldly gave the challenge that, in the presence of the Academy he would undertake, in the space of twenty-four hours, to cover with this fungus, *mycoderma aceti*, a surface of vinous liquid as large as the hall in which they were assembled. Said he, "I would only have to sow in it the day before almost invisible particles of newly formed *mycoderma aceti*.

By his scientific aid, this industry of vinegar manufacture was relieved of its troubles and placed on an intelligent, secure, and profitable basis.

In like manner he pointed out the diseases of wine, due to microscopic vegetations, and provided the simple remedy. On the same theory, he in like manner attacked and remedied "the diseases of beer." On this theory, he manufactured sweet wine, and pointed out the conditions for making and keeping it sweet and free from fermentation.

After Claud Bernard's death, a series of experiments was found among his papers, aiming at a new method of vindicating the spontaneous generation of the musk or ferment of the grape. Certainly here was a formidable foeman, but Pasteur soon silenced this newly unmasked battery. Said he:

"I will start for the Jura. In the midst of my vineyard, which," he proudly added, "is ten metres (thirty-three feet) square, I will cover some stocks with an improvised frame. These stalks will go on living and bearing grapes, which will ripen. It is now July. At this time of year the germs of the cellules which form the ferment of the grape in the vats do not yet exist, either on the green grapes, on the bunches, or on the vine leaves. I will envelop the bunches of the stalks that are underneath the frame with a layer of cotton-wool that has been raised to a temperature of 150 degrees C, so as to free it of all germs. This done, I will come back to Paris, with the keys of the frame in my pocket, not returning to the Jura until the vintage season, at the beginning of October. I predict to the Academy that the grapes wrapped in cotton wool under the frame, and which will have grown ripe, may be crushed in the open air, and that the juice coming from them will not undergo fermentation."

He did as he proposed and returned in October to the Jura, plucked several stalks, brought them to Paris with care, placed them on the table in the presence of the Academy, and M. Berthelot, the editor of Bernard's posthumous pamphlet, and his colleagues were invited to cut as many bunches as they pleased. "Only crush them in contact with pure air," said Pasteur, "and I defy you to produce fermentation." His prediction was fulfilled, and his triumph, as usual, was complete.

Pasteur is represented as being as reserved and timid as a child till his laboratory work has put him in possession of nature's truth, then he is as bold and fearless and may be as fierce as a lion in its defence. He has contended valiantly at home and abroad with men of great distinction, and with singular success for what he has conceived to be the truth. It is said of him that "no scientific man now living has fought so many battles as he." His views have won their way against skepticism and opposition. In one of these fierce scientific contests at the Academy of Medicine, a gentleman at the age of eighty, challenged him to mortal combat as a scientic ultimatum. His last antagonist is a noted political demagogue.

Prof. Huxley says: "I know not where we can hope to find any absolute distinction between animals and plants, except their mode of nutrition. * * * Thus we have a very wide basis of fact for the generalization that plants are essentially characterized by their manufacturing capacity—by their power of working up mere mineral matter into complex organic compounds."

Just as the lives of green plants and animals are distinguished by their different modes of feeding, so their diseases are, also, seemingly due, largely, to the difference in the modes of feeding by microbes or microscopic living organisms. There is, for example, a fungus, which is an obscure and microscopic mould, in structure as much a mould as mildew. This fungus is the cause of the potato disease, and brought about the Irish famine.

"Just as the common mould multiplies by the breaking up of its hyphæ, or filaments, into separte, rounded little bodies, the spores—so, certain of the filaments of this fungus grow out into the air, through the interstices of the superficial cells of the potato plant, and develop spores. Each of these filaments usually gives off several branches, the ends of the branches dilate and become closed sacs, which eventually drop off as spores, *i. e.*, as minute, separate, rounded bodies. The spores falling on some part of the same potato plant, or carried by the wind to another, may at once germinate, throwing out tubular prolongations, which become filaments and burrow into the substance of the plant attacked. But more commonly, the contents of the spores divide into six or eight separate portions. The coat of the spore gives way and each portion then emerges as an independent organism, which has the shape of a bean, rather narrower at one end than the other, convex on one side, and depressed, or concave, on the opposite. From the depression, two long and delicate cilia proceed, one shorter than the other, and directed forwards. Close to the origin of these cilia, in the substance of the body, is a regularly pulsating, contractile vacuole. The shorter cilium vibrates actively and effects the locomotion of the organism, while the other trails behind; the whole body rolling on its axis with its pointed end forwards. The eminent botanist, DeBary, who was not thinking of our problem, tells us, in describing the movements of these zoospores, that, as they swim about, foreign bodies are carefully avoided and the whole movement has a deceptive likeness to the voluntary changes of place which are observed in microscopic animals.

"After swimming about in this way in the moisture on the surface of a leaf or stem (which, film though it may be, is an ocean to such a fish) for half an hour, more or less, the movement of the zoospore becomes slower and is limited to a slow turning upon its axis, without change of place. It then becomes quite quiet, the cilia disappear, it assumes a spherical form, and surrounds itself with a distinct though delicate membranous coat. A protuberance then grows out from one side of the sphere, and rapidly increasing in length, assumes the character of a hypha or filament. The latter penetrates into the substance of the potato plant, either by entering a stomata or by boring through the wall of an epidermic cell, and ramifies, as a mycelium, in the substance of the plant, destroying the tissues with which it comes in contact. As these processes of multiplication take place very rapidly, millions of spores are soon set free from a single infested plant; and from their minuteness, they are readily transported by the gentlest breeze.

"Since, again, the zoospores set free from each spore, in virtue of their powers of locomotion, swiftly disperse themselves over the surface, it is no wonder that the infection once started soon spreads from field to field and extends its ravages over a whole country."—Science and Culture, and Other Essays, by Huxley, pp. 175, 177.

From the plant world let us pass over to the animal world, and the interest of our search will be heightened. We shall there find increased and confirmatory evidence that the unity of nature, in her normal workings, is emulated by her unity in what, perhaps, our ignorance designates abnormal workings; that her unity in the normal physiology of plants and animals is rivaled by a discovered unity in her abnormal pathology. It may be stated that the diseases of animals appear to be largely, if not wholly, as really due to the normal life of parasites, as are the diseases of plants. In the present state of science, as illuminated by the genius of this age, it would seem that spontaneous disease may have no more existence in plant or animal than spontaneous generation.

Leaving now the potato patch, the vinegar, the beer and the wine vats, let us go to the chicken coop, to the fowl yard, to the sheep, to the hogs and to the cattle of the barn-yard, and then to the sick chamber of man, and we will find everywhere that what is the normal life of the microscopic parasite is the death of the gross animal organism. Just as the normal nutrition of the microbe destroys the life of the animal, which has for man food value, so the normal life of the mould (*peronospora infestans*), the microscopic potato parasite, is the death of the gross vegetable, which also has food value for man. Plants have eminently the power of feeding on inorganic elements as well as on organized food; a bean in water containing certain mineral salts in due proportion with air, sunlight and heat, will grow and produce a crop as if planted in the ground. But animals feed on organized food; and hence they either feed on plants or on other animals that feed on plants. Plants build up, animals tear down.

Recent discoveries are in the direction of establishing the fact that many of the most deadly diseases of animals are caused by the feeding of carnivorous microscopic parasites, vegetable or animal, upon their vital organs. Investigation tells us, as already remarked, that these minute organisms almost elude the highest powers of the microscope, being sometimes but specks almost infinitesimally small, even less than one two hundred thousandth of an inch in diameter. "Nevertheless," says Huxley, "particles of this size are massive when compared to physical molecules, whence there is no reason to doubt that each, small as it is, may have a molecular structure sufficiently complex to give rise to the phenomena of life. And, as a matter of fact, these infinitesimal living particles have been observed to grow and to develop into new monads or microbes."

In Europe and America, chickens are subject to "an exceedingly fatal contagious disease" that causes enormous losses. This disease is popularly known as "chicken cholera." This statement is substantially from the Report of United States Department of Agriculture, for 1881, on Contagious Diseases of Domestic Animals, page 27. This disease of chicken cholera is thus described:

"The bird, which is attacked by this disease, is without strength, staggering, its wings drooping, the ruffled feathers of the body give it the shape of a ball. An overpowering somnolence takes possession of it. If forced to open its eyes, it appears as if awakened out of a deep sleep. Very soon the eyelids close again, and generally death comes without the animal changing its place, or without any struggle, except at times a slight movement of the wings for a few seconds. The examination after death reveals considerable internal disorders."

This description will suggest to every physician cerebral affection.

Various professional parties had supposed that this disease was due to a microscopic organism or microbe, but it remained only a puzzling and unverified conjecture or suspicion till Pasteur took up the subject and unveiled its secret. So completely did he master the case, that he prescribed a simple and perfect remedy, that puts it in the power of every farmer to banish this pest from his barnyard. Here is the remedy:

"This very serious disease depopulates sometimes all the poultry yards in the country. The only means of arresting the contagion is to isolate for a few days only, the fowls and the chickens, to remove the dung heaps, to wash the yard thoroughly, especially with water acidulated with a little sulphuric acid, or carbolized water with two grammes of acid to the litre. These liquids readily destroy the microbe, or, at least, suspend its development. Thus all causes of contagion disappear, because, during their isolation, the animals already smitten die. The action of the disease, in fact, is very rapid."

But there were two things connected with the conquest of this case that claim our special attention, on account of their radical importance; one was the method of identifying and individualizing the chicken cholera microbe, and the other was the conversion of the malignant into a benignant microbe, taming, or domesticating it. Pasteur took what was supposed to be the deadly microbe from the fowl, and devised a way of cultivating it in an artificial medium. An infusion of the muscle of the chicken was found most favorable. By sterilising this infusion with potash and heat, and then putting into it this microbe, thus freed from mixture or confusion with other organisms, in a few hours the clear infusion began to grow turbid from the new birth of microbes, and a fowl inoculated with the thousandth part of a drop of it was seized by the disease and died.

By passing from one prepared infusion to another, and simply transferring the least possible quantity, only so much of the last fluid as the point of a needle would carry, the new proliferation would in like manner be shown by turbidness, and after a thousand successive cultivations its malignity would not be lessened or altered. The fact that the last in these successive steps of reproduction produced by inoculation of the same minute quantity, the same disease and death as the first parental organisms in the series, certainly identified the microbe as the true and sole author of the disease. But it was, curiously enough, noticed that between no two of these successive cultivations must more than twenty-four hours intervene, or the virulence would be modified. This fact was full of meaning. This modification or attenuation of the contagium, or virus, generally corresponded with the duration of the interval. If any number of birds were inoculated from any given culture or crop of microbes, within twenty-four hours after its production, a hundred per cent. of them would die; whereas, if the culture were allowed to remain three months hermetically sealed, or only exposed to pure air, then its inoculation would cause some illness in the fowls operated on, but not a death would occur, and in a few days all would recover their appetites and spirits. And now, to complete the proof, it was found that, if, after this recovery, the fowls were inoculated with the fresh, deadly virus, it would occasion some illness, but no death.

Here, then, is a poisonous microbe, a virulent microscopic parasite, a living organism, *cultivated in the laboratory, outside of the body of any animal*, and, by a very simple mode of handling, converted into its own antidote. The malignant virus, in a word, is rendered benignant. Moreover, this benignant or attenuated virus may be cultivated without reverson to its malignity, or it may be made to revert. Its mitigated and mild nature may be caused to remain unchanged, however, and then it retains its beneficent power of protecting against the assaults and ravages of its own kind in their original and savage state. Their deadly fangs are extracted.

The intimate process in nature's laboratory by which this modification in any given microbe is effected, may not be fully understood, but the fact is brought to light and placed under the control of man's will and intelligence; and this is the new and important vantage ground from which the battle of life in the future will be waged, at least against all virulent and non-recurrent diseases caused by discovered microscopic organisms. Already the keen discrimination of many observers has individualized the microbes of different animal diseases, as well as of various vegetable diseases. It had already been shown, before this discovery of the attenuation of the chicken cholera microbes was accomplished, that the microbes of splenic fever and septicæmia were specifically distinct from each other, and, also, that each differs from that of fowl cholera; other microbes have been individualized in other diseases, and the list is increasing; great diligence is aroused in this field of inquiry. Is it unreasonable to anticipate the time when glanders, diptheria, the plague of the east, yellow fever, scarlatina, measles, camp typhus, leprosy, and other infectious and specific diseases will be as subject to human control as small-pox, to which chicken cholera, hog cholera, splenic fever, tuberculosis, hydrophobia, and a few others are already being added? Dr. W. A. Hardaway, of St. Louis, in his excellent little work on vaccination, remarks that "the researches of Pasteur on the attenuation of viruses lends the strongest scientific support to the results of clinical experience. The time may even arrive," says he, "when the inoculation of attenuated variola virus will supercede altogether the use of vaccine lymph." That is to say, vaccination for small-pox, as practiced by Jenner, and ever since, in all its variations by its transference from animal to animal, is not scientific, but merely empirical, its microbe never having been indi vidualized and cultivated outside of the animal body, and the conjecture is here indulged that Pasteur's method of scientific vaccination for small-pox may yet supercede our present empirical practice. It is due to this empiricism that the present unfortunate and insuperable difficulties and uncertainties are attendant upon the procurement of virus perfectly pure, and of standard vigor. It is manifest that this discovery of Pasteur transcends that of Jenner, and will probably serve to perfect what was, with Jenner, a chance observation, which has hitherto received no true scientific development.

Said M. Bouley, on the day when Pasteur announced his discovery of cultivating and modifying a virus in the laboratory, to the Academy of Sciences:

> "A new doctrine opens itself in medicine, and this doctrine appears to me powerful and luminous. A great future is preparing: I wait for it with the confidence of a believer, and with the zeal of an enthusiast."

Pasteur is not a physician, but a chemist and scientist, and the medical world has already shown some appreciation of his work. A brilliant spectacle was witnessed in London five years ago, August, 1881, illustrative of this remark, when three thousand Doctors of Medicine, from all parts of the civilized world, convened in an International Congress, received Pasteur with marks of honor and enthusiasm. He used in response to their complimentary address the following significant language:

> "I have lent to the expression 'vaccination' an extension that I hope science will consecrate as a homage to the merit and immense services rendered to humanity by one of the greatest men of England—Jenner."

He thus modestly points out how his great discovery in attenuating a virus has raised vaccination from the dull round of empiricism to the luminous sphere of a science—from an individual case, treated by rule of thumb, to an intelligent principle and a method applicable to all like cases—but this anticipates.

The virus of chicken cholera had been controlled, but was it possible to control the virus of other deadly diseases? The answer is at hand. This was vital. In 1879, the Minister of Agriculture in France appointed M. Pasteur to test the value of a mode of treatment recommended by a veterinary surgeon for cows affected with splenic fever.

Pasteur soon demonstrated its inefficiency by noting on trial, that as large a percentage recovered without the treatment as with it. It was some merit, perhaps, that the treament made the cases no worse. But in making this test he also noted that some cows, once sick of this fever and near death, when after recovery, freely inoculated with the malignant virus, were entirely proof against the disease. His next step was to render, also, this virus benign, as he had done that of chicken cholera. But the two parasites are of different forms, and are unlike in their modes of propagation, the proliferation of one being by fission and of the other by spores; could these unlike germs be alike controlled or mitigated? When engrossed with this new problem, Pasteur was heard to exclaim, in soliloquy: "Ah! what a grand thing it would be if one could arrive at that—if the fact that the attenuation of the microbe of fowl cholera proved not to be an isolated one!" For a time he was much absorbed and very reticent. At last, one day, he came to his house with a radiant face and tears in his eyes; having, Frenchman like, embraced the members of his family, he said: "I should never have consoled myself if a discovery, such as my assistants and I have just made, were not a French discovery." His patriotism inspired him, and he had come to realize that his labors as a scientist involved the glory of his beloved France.

February 28, 1881, in his fifty-ninth year, thirteen years after his stroke of paralysis, and the second year after entering on the investigation by government appointment, he communicated to the Academy of Sciences, in his own name, and in the names of his assistants, his great discovery that the deadly splenic fever virus could be cultivated in the laboratory, outside of the animal body, and mitigated into a prophylactic vaccine virus. To his honor be it said, Pasteur has never ignored his coadjutors, young or old. Soon after this report was published, the president of the Agricultural Society in Melun, Le Baron de la Rochette, visited Paris and invited him to test before the society, and on a grand scale, his "splenic fever vaccination." The society agreed to place at his disposal sixty sheep and ten cows; ten sheep were to receive no treatment; twenty-five were to be vaccinated with attenuated virus, and, after a certain interval, to be inoculated with malignant virus; and, also, at the same time, and with the same malignant virus, were to be inoculated twenty-five sheep that had not been vaccinated with the benignant virus. Six cows were to be vaccinated and four were not to be vaccinated; and the ten cows were then, after an interval, to be alike inoculated with the same malignant virus, and on the same day as the sheep. Pasteur predicted—and this is one of the truest and severest tests of a discovery in nature—that, when the animals were inoculated with the malignant virus, the unvaccinated sheep would die, and that the vaccinated ones would resist this malignant virus; also, that the six vaccinated cows would resist, and that the unvaccinated ones, if they did not die, would be extremely ill—the natural system of cattle being more resistant to this fever than that of sheep. When it was published in scientific and agricultural circles that M. Pasteur had engaged to carry out this programme, it caused a commotion. Several of his colleagues in the Academy of Sciences, we are told, remonstrated with him, lest they should be compromised by his rashness and failure. But his faith in the soundness of his laboratory work inspired him with the courage to say: "I have full confidence." And one of his colleagues, M. Bouley, responded to his anxious associates: "Fear nothing; he will come back triumphant."

Well, May 5, 1881, on a farm belonging to a veterinary doctor, who was secretary general of the agricultural society, the experiment was entered upon by vaccinating twenty-four sheep and a goat (by consent substituted for a sheep), and six cows, each with five drops of attenuated virus. Twelve days later, the thirty-one animals were re-vaccinated with virus somewhat less benignant. May 31, or after an interval of fourteen days following the second vaccination, the thirty-one vaccinated animals stood side by side with the unvaccinated, and all were then inoculated with the same malignant virus. The vaccinated and unvaccinated were inoculated alternately. The crowd then adjourned to meet June 2, the second day afterwards, and more than two hundred persons of all classes were then assembled to witness the result; among them were farmers, senators, journalists, veterinarians, doctors and counsellors. Those who believed, and doubters, came.

On their arrival at the farm of Pouilly-le-Fort, they could not repress a shout of admiration. Out of the *twenty-five sheep* which had *not* been *vaccinated*, twenty-one were dead; the goat was also dead; two other sheep were dying, and the last, already smitten, was certain to die that very evening. The *non-vaccinated cows* had all voluminous swellings at the point of inoculation, behind the shoulder. The fever was intense, and they had no longer strength to eat. The vaccinated sheep were in full health and gaiety. The vaccinated cows showed no tumor; they had not even suffered an elevation of temperature, and they continued to eat quietly.

There was a burst of enthusiasm at these truly marvelous results. The veterinary surgeons especially, who received with entire incredulity the anticipations recorded in the programme of the experiments, and who, in their conversations and in their journals, had declared very loudly that it was difficult to believe in the *possibility* of preparing vaccine capable of triumphing over such deadly diseases as fowl cholera and splenic fever, could not recover from their surprise. They examined the dead, they felt the living.

"Well," said M. Bouley to one of them, "are you convinced? There remains nothing for you to do but to bow to the master," he added, pointing to Pasteur, "and to exclaim—

I see, I know, I believe. I am undeceived."

Having suddenly become fervent apostles of the new doctrine, the veterinary surgeons went about proclaiming everywhere what they had seen. One of those who had been the most sceptical carried his proselytising zeal to such a point that he wished to inoculate himself. He did so with the two first vaccines, without other accident than a slight fever. It required all the efforts of his family to prevent him from inoculating himself with the most virulent virus.

An extraordinary movement was everywhere produced in favor of vaccination. A great number of agricultural societies wished to repeat the celebrated experiment of Pouilly-le-Fort. The breeders of cattle overwhelmed Pasteur with applications for vaccine. Pasteur was obliged to start a small manufactory for the preparation of these vaccines in the Rue Vauquelin, a few paces from his laboratory. At the end of the year 1881, he had already vaccinated 33,946 animals. This number was composed of 32,550 sheep, 1,254 oxen, 142 horses. In 1882 the number of animals vaccinated amounted to 399,102, which included 47,000 oxen and 2,000 horses. In 1883, 100,000 animals were added to the total of 1882, making 500,000.

It is reported that to the extent that this new system has been practiced among flocks and herds, the mortality from splenic fever has been reduced from ten to fourteen times less. But this disease is "common both to men and animals," it being known in the former as "malignant pustule," and is usually found in those whose business in some way brings them into contact with domestic animals, and who are in any way exposed, from a slight abrasion or scratch of the skin, or the sting of a fly, to an invasion by the deadly splenic microbe.

There is, then, a human side to this story, and in that, after all, our chief interest centers, but it cannot be estimated in dollars and cents. As far back as 1862, in his memoir on spontaneous generation, Pasteur had applied his new doctrine of fermentation to ammoniacal urine and found that its alteration was due to the presence and action of a little microscopic fungus, not to pus, nor to some morbific force inherent in the excess of mucous secreted from distension which chemically attacks the urea. A representative of the profession, Dr. Traube, put this microbe view to the test, and concluded on his facts that "notwithstanding the long retention of the urine, its alkaline fermentation begins only when the germs of vibrios find access to the bladder from without." Dr. Guyon, clinical professor of urinary diseases in the Faculty of Paris, in one of his lectures, credited Pasteur with the honor of this discovery and satisfactorily applied microbicide remedies. These cases are mentioned here as items in a record. Dr. Lister, whose name is honorably associated with antiseptic surgery the world over, began his special labors in Edinburgh in 1865, and in 1874 wrote to Pasteur as follows, to wit:

"It gives me pleasure to think that you will read with some interest what I have written about an organism which you were the first to study in your memoir on lactic fermentation. I do not know whether you read the *British 'Medical Journal;'* if so, you will, from time to time, have seen accounts of the antiseptic system, which, for the last nine years, I have been trying to bring to perfection. Allow me this opportunity of sending you my most cordial thanks *for having, by your brilliant researches, demonstrated to me the truth of the germ theory of putrefaction, thus giving me the only principle which could lead to a happy end, the antiseptic system.*"

Prof. Tyndall acquired not a little distinction by his inquiries respecting spontaneous generation and microscopic germs. Our natural curiosity to know whence came his inspiration, is gratified by the following acknowledgment and tribute. In 1876, Prof. Tyndall wrote to to Pastuer, thus:

"In taking up your researches relating to infusorial organisms, I have had occasion to refresh my memory of your labors; they have revived in me all the admiration which I felt on first reading them. *It is my intention to follow up these researches until I shall have dissipated every doubt that has been raised as to the unassailable exactitude of your conclusions.*

Prof. Tyndall, describing his own experiments, says, " the experiments have already extended to 105 instances, not one of which shows the least countenance to the doctrine of spontaneous generation." Nature, Vol. XV., p. 303. Dec. 21, 1876.

" For the first time in the history of science we are enabled to entertain the sure and certain hope that, in relation to epidemic diseases, medicine will soon be delivered from empiricism, and placed upon a real scientific basis. When this great day shall come, humanity will recognize that it is to you the greatest part of its gratitude is due."

These special labors of Tyndall, the physicist, and of Lister, the surgeon, were, therefore, confessedly based on the labors of Pasteur, the chemist.

At the International Medical Congress in London, 1881, to which reference has been made, a member who practices in one of the principal hospitals of that city, conceded that there were parasitic diseases, but expressed it as his opinion that "the microbes are the effect and not the cause of these diseases." Pastuer, who was present, at once took up the gauntlet, expressed his amazement that "such a scientific heresy" should be held at that day, and then challenged this member to a test of the opposing views, in these words: "Take the limb of an animal and crush it in a mortar, let there be diffused in this limb, around these crushed bones, as much blood or any other normal or abnormal liquor as you please. Take care only that the skin of the limb is neither torn nor laid open, and I defy you to exhibit on the following day or during all the time the malady lasts, the least microscopic organism in the humors of this limb." The challenge thus promptly, openly, and defiantly made, was declined. However, this member's advocacy of spontaneous generation had previously suffered a terrible overthrow by England's most distinguished biologist.

It is now six years since M. Pasteur began to wrestle with hydrophobia, another of the diseases common to man and animal. Soon after a microbe virus was discovered in the saliva of a rabic victim, which was easily cultivable, but it failed to establish its exclusive claim as the specific cause of the disease. Instead of saliva being used, it was at last found most effective to inoculate into the circulation by a vein, the nervous matter of a rabic animal. Usually, the brain pulp is used, and the mitigation is affected by its passage through certain living organisms as was discovered to be practicable with the hog cholera microbe. The rabies' microbe is as yet conjectural, as it has not been isolated so as to certainly secure its cultivation outside of the animal organism. Hence, this particular case has not yet been brought fully up to the scientific standard. Yet, public impatience has forced a practice which has lost only about one per cent. out of over six hundred cases, and, certainly, with such a practical record, the theoretic aspect is about as hopeful as that of small-pox. It will require much time to mature and perfect the methods so auspiciously and brilliantly inaugurated.

The publication of the French Acadamy, Jan. 24, 1887, gives the number of cases of hydrophobia, including those from wolf-bites, up to Dec. 31, 1886, treated at the Institute of Pasteur in Paris, 2,682, of whom 31 died, *i. e.*, about one per cent. It is stated that previous to Pasteur's treatment, the most favorable statistics show about 16 per cent. of deaths. However, the treatment of hydrophobia, like that of small-pox, is still empirical, and involved in controversy.

In 1872, Dr. Lionel S. Beale published his work on Disease Germs, and his exposition and defense of the germ theory of disease had an important influence on the medical profession, and on current views as to the nature of disease. It enrolled some of the sturdiest of the profession. In that work, Dr. Beale uses this language: "That the several kinds of contagious matter of small-pox, scarlet fever, and other eminently contagious maladies, are distinct, each being imbued with its own specific and peculiar power, is demonstrated by observation, but that this difference in power or property should be associated with any recognizable difference in appearance, form, chemical composition, or any physical characters, is exactly what a careful examination of the facts, and a judicial weighing of the evidence, would not lead us to anticipate." By Pasteur's method, as we have seen, is accomplished, already, and to a considerable extent, exactly what, according to this high authority, was not to be anticipated.

Some germs are sensibly distinguishable. In speaking of the protective action of attenuated virus or vaccine microbes, Prof. Tyndall unfolds Pasteur's idea of it under the garb of farming, thus: "When a tree or a bundle of wheat or barley straw is burnt, a certain amount of mineral matter remains in the ashes—extremely small in comparison with the bulk of the tree or of the straw, but absolutely essential to its growth. In a soil lacking or exhausted of the necessary mineral constituents, the tree cannot live, the crop cannot grow. Now contagia are living things, which demand certain elements of life just as inexorably as trees, or wheat, or barley; and it is not difficult to see that a crop of a given parasite may so far use up a constituent existing in small quantities in the body, but essential to the growth of a parasite, as to render the body unfit for the production of a second crop. The soil is exhausted, and, until the lost constituent is restored, the body is protected from any further attack of the same disorder. Such an explanation of non-recurrent diseases naturally presents itself to a thorough believer in the germ theory.

"To exhaust a soil, however, a parasite less vigorous and destructive than the really virulent one may suffice; and if, after having by means of a feebler organism exhausted the soil, without fatal result, the most highly virulent parasite be introduced into the system, it will prove powerless. This, in the language of the germ theory, is the whole secret of vaccination. This problem," he continues, "of which Jenner's discovery was a particular case, has been grasped by Pasteur, in a manner and with results which, five short years ago, were simply unimaginable."

In a word, Pasteur has individualized the causes of disease, and generalized vaccination by disclosing a new method of dealing with the discovered microbes of the viruses of deadly maladies of plants or animals, by mitigating a malignant into a benignant virus. The name vaccination is no longer to be confined to the inoculation of the mitigated virus of small-pox, but of any mitigated virus, whether that of chicken cholera, hog cholera, anthrax, tuberculosis, or any other of many varieties. Adam Smith's theory of the origin of general terms is, that they were all, at first, particular names. The word river, for example, meant, in its first use, a particular stream of water; and he mentions a case, within his knowledge, of an untutored man who attached no other meaning to the word river than that of a particular stream flowing by his cabin.

In reference to the bearing of such labors as these of Pasteur, Prof. Tyndall uses the following strong language in his "Introduction to the Life of Pasteur:" "Never before, during the long period of its history, did a day like the present dawn upon the science and art of medicine. Indeed, previous to the discoveries of recent times, medicine was not a science, but a collection of empirical rules, dependent for their interpretation and application upon the sagacity of the physician. How does England stand in relation to the work going on around her? She is, and must be, behind hand. Scientific chauvinism is not beautiful in my eyes. Still, one can hardly see, without deprecation and protest, the English investigator handicapped in so great a race by short-sighted, mischievous legislation.

"A great scientific theory has never been accepted without opposition. The theory of gravitation, the theory of undulation, the theory of evolution, the dynamical theory of heat—all had to push their way through conflict to victory. And so it has been with the germ theory of communicable diseases. Some outlying members of the medical profession dispute it still. I am told they even dispute the communicability of cholera. Such must always be the course of things as long as men are endowed with different degrees of insight. Where the mind of genius discerns the distant truth, which it pursues, the mind not so gifted often discerns nothing but the extravagance, which it avoids. Names, not yet forgotten, could be given, to illustrate these two classes of minds."

The labors of Pasteur have given the finishing stroke to spontaneous generation. This dream of ignorance is older than Horace, Virgil, and Lucretius, who dress its gross form in poetic language, as does Aristotle, in the prose of philosophy. This heathen conceit wended its its way down the ages, till in the seventeenth century a celebrated alchemist gave as a recipe for producing scorpions: "Scoop out a hole in a brick; put into it some sweet basil, crushed. Lay a second brick upon the first, so that the hole may be perfectly covered. Expose the two bricks to the sun, and at the end of a few days the smell of the sweet basil, acting as a ferment, will change the herb into real scorpions." And the same philosopher gave as a prescription for the production of mice, to stuff a dirty shirt into a vessel containing a little corn, when the ferment proceeding from the dirty shirt, and the odor of the corn, will, in about three weeks, transmute the grain into mice, full grown, and of both sexes. In the same century, Francesco Redi, 1668, published the first attack on spontaneous generation, maintaining the doctrine, *omne vivum ex vivo*—no life without antecedent life. This doctrine of biogenesis, as distinguished from spontaneous generation of life or of abiogenesis, is in all quarters triumphant. Prof. Huxley, sixteen years ago, in an address before the British Association for the Advancement of Science, sums up the case in these words: "So much for the history of the progress of Redi's great doctrine of Biogenesis, which appears to me, with the limitations I have expressed, to be victorious along the whole line at the present day." Says Pasteur, in a lecture at the Sorbonne, 1864: "There is not one circumstance known at the present day which justifies the assertion that microscopic organisms come into the world without germs, or without parents, like themselves. Those who maintain the contrary have been the dupes of illusions and of ill-conducted experiments, tainted with errors which they know not how either to perceive or avoid. Spontaneous generation is a chimera."

M. Flourens, permanent secretary of the Academy of Sciences, pronounced these words before that body, to wit: "As long as my opinion was not formed I had nothing to say; now it is formed and I can speak. The experiments are decisive." The controversy on the subject of spontaneous generation was at its height about ten years ago, and in December, 1876, in a communication to the Royal Society of London, Prof. Tyndall, describing his own experiments, says: "The experiments have already extended to one hundred and five (105) instances, not one of which shows the least countenance to the doctrine of spontaneous generation." It is obvious to remark that even distinguished scientists are not at liberty to entertain or to express it as their opinion that spontaneous generation has in fact occurred, for it is conceded that the overwhelming evidence of science is against it. It is a matter of no little surprise that both Prof. Tyndall and Prof. Huxley fall under this censure. Moreover, it should not escape attention that thorough going evolution, such as that of Spencer and Haeckel, proceeds on the false and fallacious assumption of the truth of spontaneous generation, not accepted by Darwin himself.

The vitalising idea of this paper is that practice depends on etiology, that the views on etiology, in the mind of the profession, are determined by the reigning science of the hour; that Pasteur, the scientist, has shed such light on the pathology and the cause of many diseases as to give a new key note for the practice of the future in certain important respects. It is most unwise to exaggerate or underestimate, and it is not pretended that everything practicable or desirable has been accomplished, but doubtless a noteworthy step has been taken towards a more rational practice of medicine. By the aid of sound science, superstition is being dispelled from the dark realm of disease, and rational treatment is still gaining ground by ascertaining and dealing with the true causes, rather than with the symptoms of disease. Abracadabra is a cabalistic word, utterly devoid of meaning, which repeated in a certain way a certain number of times, was formerly supposed to cure fevers and to prevent many diseases; and for its supposed curative and prophylactic virtues, it was figured in triangular form on amulets which were suspended around the neck. I am not aware that the sacred boon of wearing them was ever accorded to the afflicted lower animals. Such discoveries as those just imperfectly sketched, show that these cabalistic amulets are no longer in order.

Another manifest drift of M. Pasteur's labors is that of putting animal medicine, in theory and in practice, on a footing hitherto unrecognized. After making due allowance for the modifying influence of moral qualities and emotions as distinguishing man from lower animals, he holds that "the cause of every contagious malady is physiologically the same in the two groups, and that our bodies, notwithstanding our superior moral qualities, are exposed to the same dangers, to the same disorders as the bodies of animals." There is no good reason for objecting to this view as substantially correct. There are two weighty considerations which give decided emphasis to the importance attached to animal medicine; one relates to the financial interest at stake, and the other to its reflex influence on human medicine. The estimate is official that our national animal losses from one single disease, hog cholera, amount to forty millions a year. Yet its microbe has been discovered and the vaccinations at numerous stations in Europe give promise of its control. And if the figures given be reliable, then over thirty millions of this amount would be saved to us, if the new discovery were completely utilized. In France M. Pasteur's scientific labors have so greatly added to the material wealth of the country, and especially to agriculture, that Prof. Huxley is quoted as saying that Pasteur's "discoveries suffice of themselves to cover the war indemnity of a thousand millions of dollars paid by France to Germany."

There is here a tangible and brilliant illustration of the value of State aid to scientific labors. It may be of sufficient general interest to state that at the Missouri Agricultural College a laboratory has been established for the cultivation and distribution of vaccine viruses for the use of the profession and of the citizens of the State. Our State veterinarian, a man thoroughly educated for his profession, a member of the faculty of the State University of Missouri, and under whose care this laboratory is placed, is now in France pursuing this subject in the interest of our people, having ample leave of absence for that purpose, and being furnished with suitable credentials by the authorities of the institution and endorsed by the Governor of the State, which will secure for him during his residence abroad, access to the best advantages of the age.

Under the inspirations of these scientific labors abroad, the State veterinarian, Dr. Paul Paquin, was granted leave of absence from February to September, 1886. He was furnished an official letter issued under the seal and signature of the Board of Curators, which was also signed by the President of the University and the Dean of the State Agricultural College and endorsed by the signature of Governor Marmaduke. This document secured him access to the very best advantages whilst resident in France.

The following statement shows the various institutions in which the veterinarian studied, viz: The Histological and Pathalogical laboratory at Charity Hospital, of Paris, director, Dr. Latteux; Cornill's Bacteriological Laboratory at the Paris Medical School, director, Dr. Chantemesse, one of Pasteur's assistants; the laboratories and the surgical clinics; the celebrated Alfort Veterinary School, professors, Teasbot and Nocard, the latter a co-laborer of Pasteur; and finally the laboratory of Mr. Pasteur, witnessing and noting this renowned man's methods of producing hydrophobia-vaccine through the rabbit, and also vaccination against that disease.

In this laboratory the veterinarian was one of the few who had the privilege of attending the conferences of Dr. Perdrix on Prof. Pasteur's methods of cultivation of bacteria and attenuation of virus. Dr. Perdrix, it may be well to state, is one of the assistants of Pasteur, who studied under the great pathologist and bacteriologist—Koch of Germany. So that the veterinarian had the very best advantages for his studies.

The legislature in the Thirty-fourth General Assembly of Missouri having appropriated $5,000 for the experiment of a pathological and vaccinal laboratory in connection with the Agricultural College and State University, we are in hope that the State veterinarian will find time to devote to the study of obscure diseases of animal if not also some of the human family.

We have already started to produce tested and perfectly reliable vaccine against small-pox in man, and arrangements are made for the erection of the veterinarian's laboratory, and for the purchase of all necessary instruments and apparatus for its outfit.

It may also be stated, as likewise indicative of our appreciation of this new advance in the interest of man and lower animals, that the degree of M. C. D.—Medicinæ Comparativæ Doctor, has been provided for in the Missouri University Medical School. Comparative anatomy, comparative physiology and comparative pathology are familiar and need only the addition of comparative therapeutics and practice. The following extract is from the London *Lancet* of 1881, giving an account of a conference in that city: "The discussions which took place at meetings of the conference afforded another proof of the necessity of instituting a chair of comparative pathology at each of our medical schools. Surely a knowledge of animal diseases, in their relation to those in our own species, is of far more moment to the surgeon or physician in the practice of his profession than an acquaintance with zoology or comparative anatomy. Such chairs are established in nearly all, if not all, continental medical schools in which their value has long been recognized. Why is it, then, that we are so slow or so unwilling to adopt what it so manifestly and so urgently required in order to complete the student's education and to render him a more useful and enlightened member of society?"

There seems to be no intelligent ground left for questioning the propriety and duty of medical practice upon the lower animals. The literature of the subject is already ponderous, and many of the distinctive workers are men of first rank with distinction. It is a legitimate question, and one in the line of present progress: Should these two departments of practice be kept sharply distinct and allotted to separate professions, or should they come under the care of one and the same practioner? This is not a topic for dogmatism. There will be difference of opinion, and there will probably be as great a change in the not distant future as in the not distant past. It is now six years since, as chairman of the committee on medical education of the Mis- State Medical Association, the present writer used the following language in the report published in the proceedings of 1880:

"There is another aspect of medical education—it relates to our indebtedness, not merely to humanity, but to the lower animals, for much of our most valuable knowledge—their ills are so like ours and are so amenable to intelligent treatment. And yet, is it not deemed beneath the dignity of the medical profession to doctor these kindred creatures? Such attention to the lower animals has its reward in the enrichment and culture and scientific information of the observer and experimenter. Their mute and unaffected manifestations give a field of rare observation, and their morbid anatomy is doubtless as strikingly analogous to ours as their normal anatomy; and thus the foundations of the rational treatment of disease must be by such proceedure deepened and broadened. Whatever the objection to vivisection, there is here no obstruction to post mortems."

There seems to be ground for concluding that the injunction of Chomel, not so much to treat disease as patients affected with disease, is losing its axiomatic force. Therapeutics is becoming realistic rather than personal. The history of diseases, according to Dr. B. W. Richardson, shows a gloomy catalogue of fully two hundred and fifty of them, as to which "throughout the whole period of human existence on earth, not one new disease has been added, not one withdrawn." The practice has been honorably pursued through the centuries from Æsculapius to Austin Flint; and yet, within a present lifetime, by one of the most able and distinguished professors of the oldest medical school on the American continent, this startling, but not unparalleled, language was deliberately used in an address to a graduating class: "Let the declaration go forth with all the authority which can be given to it by the combined influence of the whole medical profession—that there is no cure for any disease; no single remedy, no happy combination of remedies for any disease which has ever affected humanity." This grave utterance was put forth April 6, 1850; could it be repeated in 1886; "More light—*Mehr Litch!*" were the last words of the immortal Goethe uttered a little more than fifty years ago as he ordered a servant to open the blinds of his chamber window. In the brief inval that elapsed before his peaceful death, seated quietly in his arm chair, he mutely made signs with his forefinger in the air and traced figures on the shawl that covered his lap. The discoveries of this wonderful age are solving and voicing the riddles of the past.