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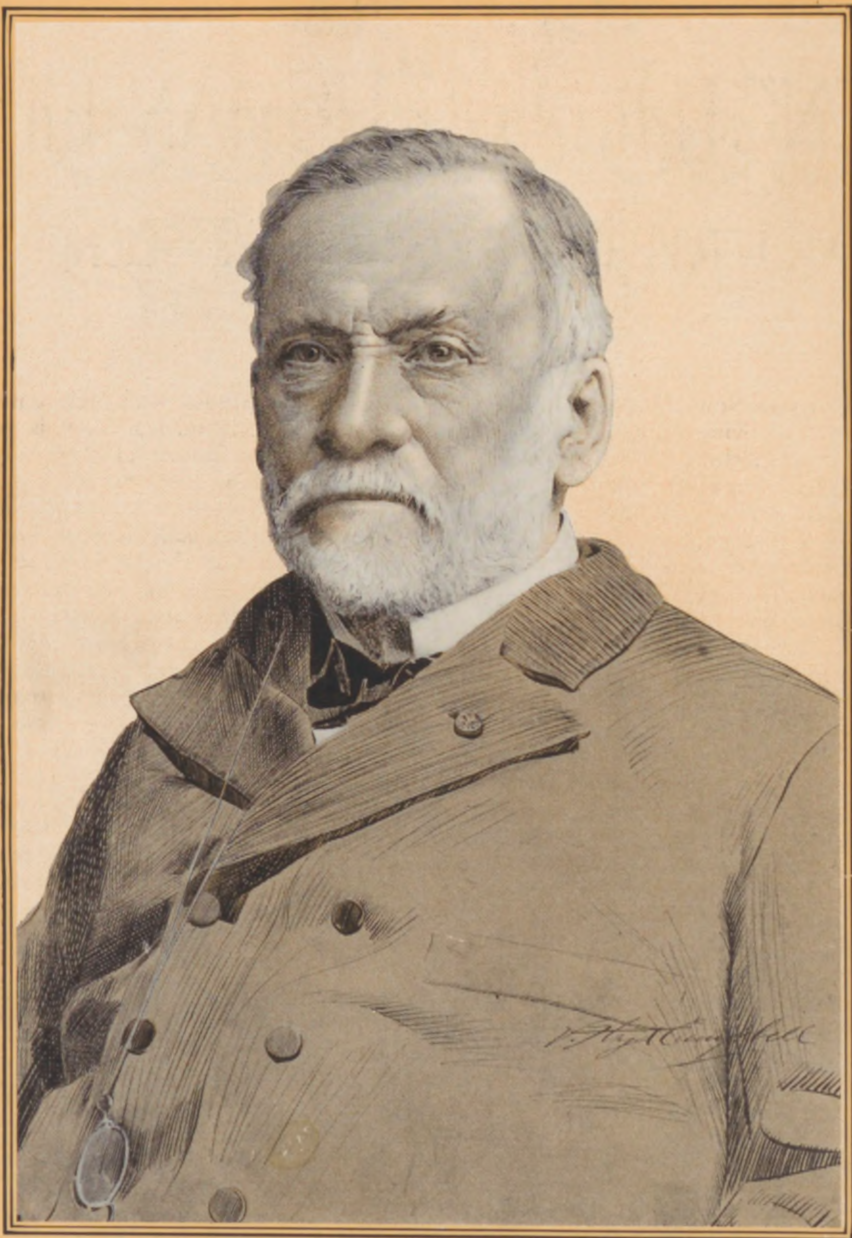


From photograph by Pierre Petit

LOUIS PASTEUR

FATHER OF MODERN SCIENTIFIC MEDICINE

LENGTHENING HUMAN LIFE

VICTORIES OF MODERN MEDICAL SCIENCE

In the city of New York alone there are 150,000 people living today who would be dead if the mortality of fifty years ago still prevailed. Popular opinion has scarcely yet come to realize what medical science has been doing in late years. People sicken and die, think the laity, and the efforts of the physician are just as futile as before the recent discoveries about which so much is said. This idea is, however, erroneous. I will venture to say there is scarcely an adult living today who has not experienced or will not experience an actual prolongation of life due to discoveries of the last fifty years.

Regard for a moment two of the diseases which have been practically eradicated from civilization by recent discoveries in medicine, and realize the number of lives thus saved. Cholera was wont to visit the cities of the Atlantic coast in the past about every ten years, and it was a standing menace to the world every summer. It was not uncommon for this disease to decimate whole towns and cities. Since the discovery of its cause, however, it has been robbed of its terrors, and the children of today will probably never know of it except by name. Yellow fever was even a more frequent and fatal visitor. Now an ever contracting circle is gradually drawing about it, which limits it just at present to a narrow zone in the tropics and promises its entire extinction.

Diseases thus eradicated are forgotten by the laity, the decrease in mortality from diseases still extant is made clear only by statistics which are not open to the public, and popular prejudice finds little or nothing that the scientific medical man is accomplishing. As a matter of fact, however, the latter half of the nineteenth century saw medical discoveries that have already proven of incalculable benefit, and are pregnant with marvels for the future.

The most interesting and far-reaching of these discoveries were in the realm of the infinitely little, the study of which was inaugurated by Pasteur.

Pasteur's work in infectious diseases followed the lines of a forecast made three hundred years ago by Sir Robert Boyle, who is known from his kinsman's description as the "Father of chemistry and the brother of the Earl of Cork." Boyle said, "He who succeeds in explaining fermentation will be in a position to throw great light on the causes of the contagious diseases." Pasteur's first work was on fermentation, which he demonstrated to be due to minute living organisms, vegetable in nature, and he went directly from this to the infectious diseases. The first infectious disease to be run to the ground was a disease of wine. The wine industry of Southern France was threatened with annihilation on account of the failure of the wine to ferment properly. Pasteur's studies in fermentation procured him the invitation to discover its cause. He found a second micro-organism contaminating the wine, interfering with the desired fermentation, and demonstrated a ready means for preventing its entrance.

The next step in the study of infectious diseases was likewise along industrial lines.

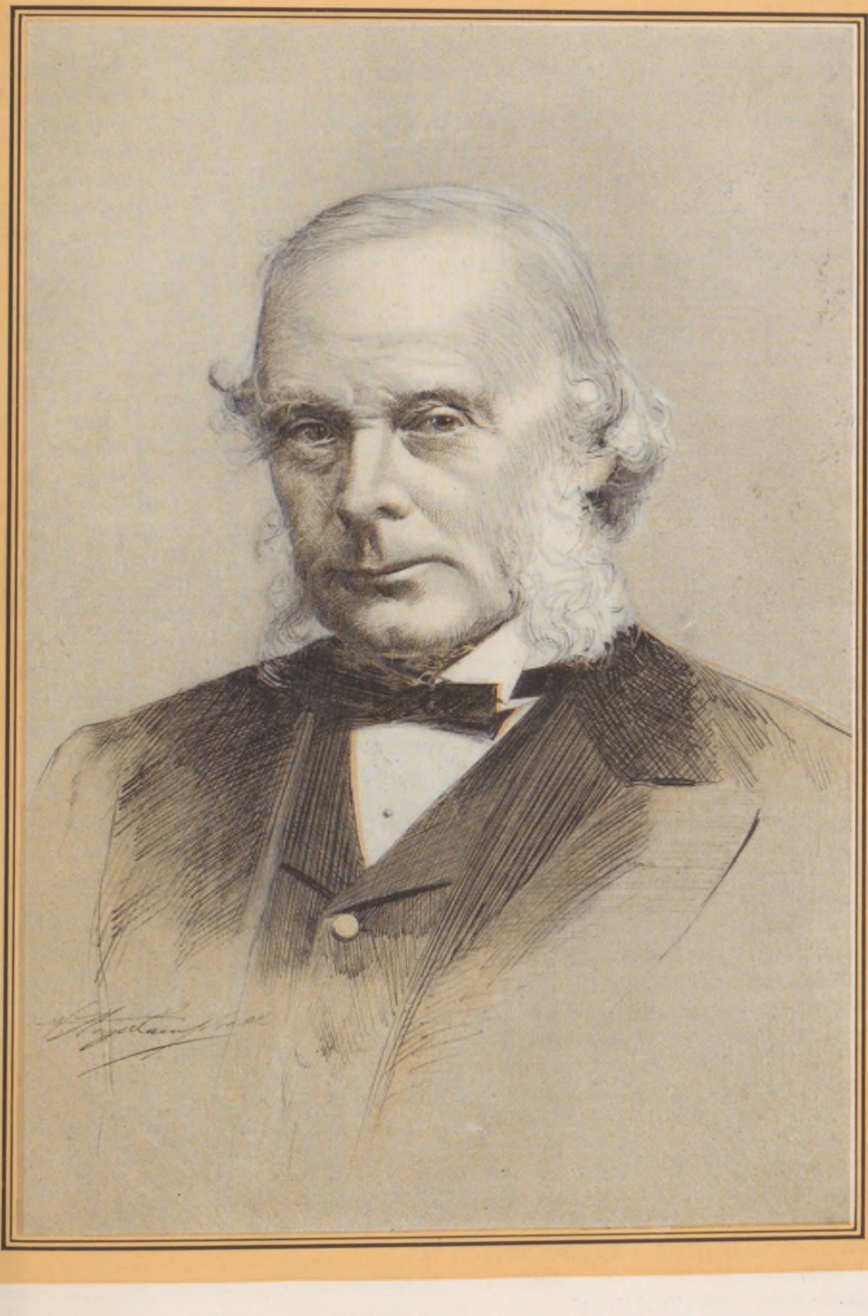
There was a blight of silk-worms, so severe that the silk industry dwindled from fifty millions to three or four millions in two years. The silk-worms were dying by the thousands and the country was in despair, when this brilliant young chemist was again called on. He undertook the task and discovered the cause of the first positively known infectious disease. By the simple method of isolation of the sick from the well he saved the industry.

These two industrial triumphs made Pasteur one of the most notable men in his own country, and called the attention of the scientific world to infectious diseases generally. Even before Pasteur's time certain small rods, since then named bacilli, had been found in immense numbers in the blood of sheep dead with anthrax, but their significance had been overlooked. Now, with new ideas in mind, those bacilli were studied and found to be the cause. Anthrax is a severe, frequently fatal disease, reasonably common among the lower animals, especially sheep, but communicable to man. Pasteur presently found that although most animals were very susceptible to the disease, certain ones, like fowl, proved resistant. His ready mind, ever alert for reasons, jumped to the conclusion that the higher normal temperature of birds might have something to do with it. The temperature of man and ordinary animals is about $98\frac{1}{2}^{\circ}$; the temperature of birds about 103°. To test his conclusions Pasteur stood pigeons in ice-water, and inoculated them with the organism. He found to his gratification they developed the disease, but recovered when placed in an incubator and restored to normal temperature. Further experimentation showed that the organisms which the fowl had resisted were not capable of inducing the disease even in susceptible animals, and that the animals so injected with the attenuated organism became insusceptible to virulent cultures. This, in short, was the discovery of how vaccination acts. At the time it meant another industrial revolution, because Pasteur's discovery was at once applied praccally and found to be effective. Anthrax now, as a scourge, does not exist.

Jenner's discovery of vaccination in 1796 practically eradicated small-pox. Pasteur's discovery demonstrated the modus operandi, so that a line was given along which similar experiments might be made on other diseases. He himself later applied this principle to hydrophobia, depriving it of its terrors in countries where hydrophobia is common.

In the actual prolongation of life Pasteur's personal work is demonstrated only in the lives saved by the eradication of the disease anthrax and the curing of hydrophobia; but all his discoveries were fundamental in character and it is the results accomplished since through the knowledge of them that must be considered. For instance, without Pasteur's discoveries Dr. Joseph Lister's work would have been practically impossible, though to this is attributable the success of more than half the serious operations undertaken in recent years. In the domain of surgery the discovery of anaesthesia (which, by the way, was made by Morton, of South Carolina) holds the most important place because by it operations became possible that otherwise would not have been dreamed of; but second only to anaesthesia, stands Lister's discovery of antisepsis. Before Lister, operations on the abdominal cavity were attended by a mortality of fifty per cent.; since then this has been reduced to about five per cent. Before Lister, Senn's brilliant work in abdominal surgery could not have been done, and his invention of the earliest successful method of intestinal anastomosis would have been useless. Before Lister, operations involving the opening of the skull were almost invariably fatal; since then operations on and around the brain have a mortality quite comparable to that of abdominal surgery. Thirty years ago the removal of a tumor from the stomach or intestine, or the opening of an abscess in the brain, would not have been thought of; the disease was simply allowed to run its course till death. Today these are common surgical operations, and they have preserved thousands of useful lives.

The discovery, however, that has proven most beneficial as a result of Pasteur's original work was the discovery of the bacillus of tuberculosis (consumption). A long time before the actual finding of the organism it was known that tuberculosis was an infectious disease, communicable from person to person, but the actual cause was unknown. So thousands



LORD LISTER

PIONEER OF ANTISEPSIS IN SURGERY

Photograph by J. C. Schaarwächter

ROBERT KOCH

DISCOVERER OF THE BACILLI OF TUBERCULOSIS AND CHOLERA of consumptives were walking about, ignorant of their condition, spreading the contagion broadcast. The germ of tuberculosis is one of the most difficult to find at the outset. Yet it was captured and made subject to distinctive tests among the earliest of the micro-organisms, and is now the one most easily and positively recognised. On account of the difficulties to be overcome, Koch's study of the tubercle bacillus will always rank as one of the most brilliant pieces of scientific work ever done. Moreover the investigation was so thorough that though twenty years have elapsed since it was finished, nothing of importance has been added to it.

As Pasteur's work on infectious diseases inaugurated the studies which have proved so fruitful, Koch's work on tuberculosis started the chase which will eventually hound this disease to earth. This sounds sanguine, but even at present, though scarcely imagined by the laity, tuberculosis has a mortality of less than twenty-five per cent., that is, seventy-five per cent. of the people affected with it recover. And the mortality is constantly decreasing. In the mind of the medical man of today there is no doubt that our present century will see its positive eradication. Today one of every seven deaths is attributable to it; a century hence it will be as rare as small-pox on the death certificates of the health office.

Though a specific for the cure of tuberculosis was once exploited—and exploited by Koch, the brilliant discoverer of the germ—it was found to be a delusion, and as far as specific curative properties were concerned it was practically dropped within a year or two. Koch's work, however, which was by no means an entire failure, stimulated research along this line, and in 1894 Behring (and a little later Roux) announced his specific cure of diphtheria. The antitoxin for diphtheria has been known less than ten years, yet the mortality of that dread disease has been reduced from between ten and fifteen per cent. to less than seven per cent.

Quite as important a feature as the actual saving of life in diphtheria is the fact that it has given us another scientific method for the specific cure of disease, the first being virus attenuation as demonstrated by Pasteur. The cure of tuberculosis, apart from the prevention of the disease, might have been accomplished to the extent it is today without the discovery of the bacterial cause; the cure of diphtheria by antitoxin necessitated the discovery of the diphtheria bacillus, since the antitoxin is manufactured through its agency. To understand the nature of the antitoxin it is necessary to understand the nature of the disease. Diphtheria is described technically as a "general disease with a local manifestation"—that is, it affects the whole body, as is shown by the prostration, fever, and increased heart-beat, though the only place where actual destruction of tissue occurs is where the micro-organism locates, and this is usually in the throat. Any one who has ever had an ordinary ulcer in the mouth will readily appreciate that the diphtheritic ulcer *per se*, which is usually about the size of a dime, is totally inadequate to produce the severe symptoms seen in diphtheria.

The cause must then be looked for elsewhere. It is found in the poison (or toxin) thrown out by the diphtheria bacillus in its work of destruction. This poison is taken up by the blood and acts on the nerve centres. The poison is produced even when the organisms are grown outside the body, and can readily be separated. The introduction of the poison, thus separated, into an animal, produces the same general symptoms as are seen in diphtheria. If, however, the dose at first injected is very small and then is gradually increased, the animal may be made completely insusceptible to any quantity. This insusceptibility to the poison is apparently brought about by the production in the animal's blood of an antidote. The blood serum of such an animal acts as our diphtheria antitoxin. It is usually procured from the horse.

Just how diphtheria antitoxin or antitoxins in general (since we have antitoxins to tetanus and the bubonic plague) act is not known, because we do not know how the toxin acts, and, therefore, cannot describe the ways it may be combatted. Yet recent experimentation in this line has developed what promises to be almost a whole new science—namely, the science of immunity. Though yet in its infancy, being only five years old, it has added more than half a hundred new words to medical terminology, and has for the moment attracted the attention of scientific observers from everything else. The first scientific study of immunity—in other words, of toxins and antitoxins—was given to the world several years ago by Ehrlich, of Berlin. We already knew that certain toxins had a predilection for certain tissue cells, as for instance, tetanus toxin for nerve cells, but why was a mystery. Ehrlich demonstrated that these and no other cells possessed certain bodies capable of combining with this particular toxin. Further, the cells containing these bodies are capable of producing them in practically unlimited quantity, and when stimulated by repeated small doses of the toxin are even capable of throwing them off into the blood. These bodies, named receptors, retain the faculty of combining with the toxin even when free in the circulation. Therefore when they are present in sufficiently large numbers in the blood, the blood will act as an antitoxin by rendering harmless the poison.

The formation of antitoxin, however, to combat the toxin is not the only method adopted by nature for the cure of infectious diseases. Metschnikoff, the modest pupil of Pasteur, practically an exile from his country, Russia, has been demonstrating for the last two decades how the micro-organisms are dealt with directly. As is well known, the blood is composed of two principal elements, red and white blood cells. The function of the red, namely, to carry oxygen to the tissues, has long been known, but the interesting function of the white, which is to act as an actual police-patrol within the body, was first

Photograph by Pierre Petit

ÉLIE METSCHNIKOFF

DISCOVERER OF THE FUNCTION OF THE WHITE BLOOD CELLS brought out by Metschnikoff. The red cells are carried in the blood stream passively; the white wander through the tissues independently. In addition the white cells possess a power of selecting and digesting most foreign elements. When, as in the case of a wound, micro-organisms are introduced into the tissues, the white blood cells emigrate from the blood vessels to the wound in immense numbers. They proceed at once to take up, digest, and so kill the micro-organisms. When the micro-organisms are not very virulent this completes the process; when they are virulent, instead of being digested by the white cell, they may kill it. Still, no matter how many are killed, thousands more flood to the scene. In other words, the entrance of micro-organisms into the tissues always means a pitched battle between the invaders and the police-patrol, and on which is victorious depends the health or death of the individual.

A sketch of medical progress would be incomplete if it excluded Ramon y Cayal, of Madrid, the patient student who has revolutionized the theories on brain anatomy and the mechanism of nerve function. The anatomy of the nervous system, and consequently its physiology, was regarded in the past as very simple. Cayal showed that the specific brain cell is an independent unit provided with multiple processes, by means of which it is capable of acting not through one nerve alone but several. This independent brain unit or cell is called a neuron, and Cayal's theory the neuron theory. A simple illustration of how the

Drawn by V. Floyd Campbell

RAMON Y CAYAL

SPECIALIST IN PHYSIOLOGY OF THE BRAIN

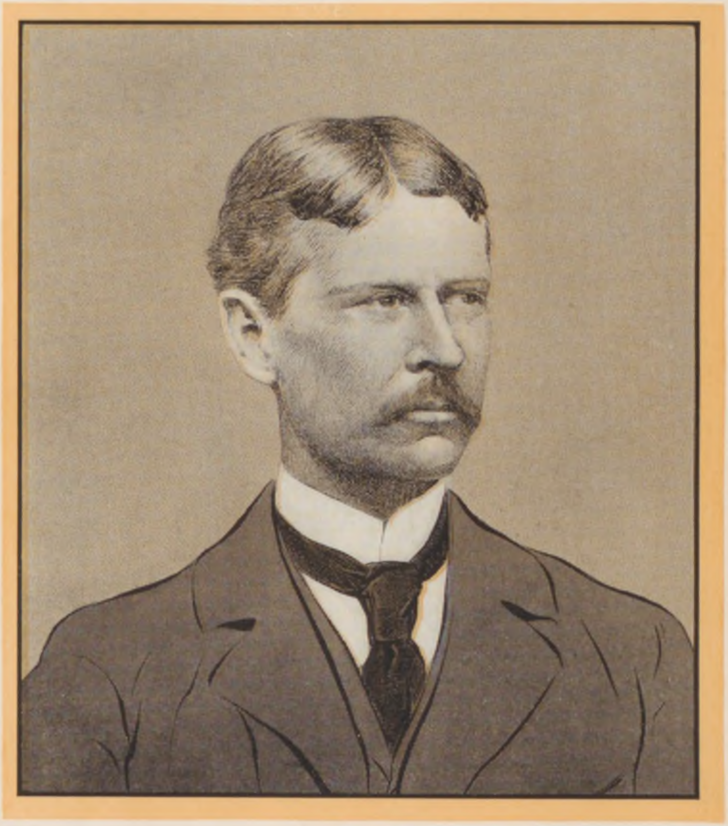
EMIL BEHRING

DISCOVERER OF DIPHTHERIA ANTITOXIN

PAUL EHRLICH

ORIGINATOR OF THE SCIENTIFIC STUDY OF TOXINS AND ANTITOXINS neuron acts is furnished by our not infrequent hunt for a name or idea which we know we possess. We feel that the name is there, but we cannot recall it. We get various names near it, beginning even with the same letter or the same vowel sound, yet only after minutes or even hours does it actually occur to us. What is supposed to happen is that the particular cell of intellection which we are using throws out its process among the cells of memory for names, and though this process is brought in connection with cells containing similar names, it is only after a more or less prolonged search that it hits on the right one. It is as if the telephone operator in the central office felt around blindly for the connection wanted, and only after putting the plug into various holes eventually struck the proper one.

The discoveries of the last ten years have changed completely the story of life in the tropics. The two diseases making the tropics dread regions are so manacled that they are no longer to be feared, and it is likely that most of us will be in at their death. I speak of malaria and yellow fever.



WALTER REED

YELLOW FEVER EXPERT

The micro-organismal cause of malaria was discovered as far back as 1881, but how to avoid this cause has only been demonstrated in the last few years. The record of this running to earth reads more like a romance than an actual problem in scientific medicine. The malarial organism was supposed to breed in swamps and be wafted by the winds to places near at hand.

The swamps supposed to breed malaria were long recognised to be hot-beds of certain varieties of mosquitoes. The idea of a connection between the two was first publicly suggested by Manson, though at the time Donald Ross, a military surgeon in India, was endeavoring to demonstrate it by finding the organism in the body of the mosquito. With indefatigable zeal, Ross pushed his investigations till he found the disease, and transmits it in a changed form to the larvae. These larvae are deposited in a certain kind of swamp and develop nowhere else. These swamps, or rather stagnant pools, are comparatively easily redeemed, and when this is impossible, the larvae can be readily killed by other means. During this advance others were demonstrating that malaria could be contracted in no other way than by the

Drawn by V. Floyd Campbell
From copyright photograph by Elliott and Fry

DONALD ROSS

DISCOVERED THAT MOSQUITOES CONVEY MALARIA

the organism in the stomach of the mosquito, traced it through the larvae and then into the salivary glands in connection with the proboscis. Others at once took up the subject, demonstrating each step before the next was taken. They showed that only a definite variety of mosquito carries the organism. The mosquito obtains it by sucking the blood of a patient ill with bite of a mosquito, that this practically always occurred at night, and that the simple precaution of sleeping under a net gave almost absolute protection. Malaria, therefore, with its thousands of victims yearly, has practically passed into medical history and will scarcely be heard of again.

The results of the study of malaria gave the cue for the study of yellow fever. The

From steel engraving by Henry Taylor, Jr.

NICHOLAS SENN

THE MOST FAMOUS AMERICAN SURGEON

idea gradually gained ground that yellow fever was associated with the *culex fasciatus*, a particular variety of mosquito common in Cuba. Dr. Walter Reed, surgeon in the army of occupation, started an investigation four years ago, and, following the line laid down in the conclusive experiments on malaria, he demonstrated again and again, so that it is impossible to doubt it, that yellow fever is not directly contagious, but is transferred from individual to individual only through the bite of this particular mosquito, and then only after it has fed on a yellow fever patient. When the history of Amercian medicine is written Walter Reed's name will occupy one of the most prominent places, if it does not actually head the list. Yellow fever, already sheared of its strength by sanitation, he tracked to its lair, and would not even have stopped here, but he was called away by death through appendicitis.

Reading history with a medical eye it is remarkable to note, as we come down the ages, the number of prominent personages who died of appendicitis. Yet the exact definition of the disease was left to our own day and to an American, Reginald Fitz, of Boston. It is curious, yet sufficiently frequent to have passed almost into an axiom, that it is not the man who sees the greatest number of a particular kind of cases, but usually the one who sees only a few, who makes the discovery. At his death Rokitansky of Vienna, was said to have done fifty-seven thousand autopsies; Osler while in Montreal gave us a record of only twenty hundred, yet for statistics Osler's twenty hundred are quoted more frequently than Rokitansky's fifty-seven thousand. Rokitansky must have seen hundreds, if not thousands, of cases of appendicitis, yet the post-mortem reports continued to speak of inflammation of the bowels and general peritonitis, while the actual cause was overlooked. The definition of appendicitis made by the Boston physician on the basis of comparatively few cases has been the cause of saving thousands of precious lives in every quarter of the globe.

Another example of the man working with a few cases is Dr. S. Weir Mitchell, of Philadelphia. In the continental cities the nervous specialist sees ten cases of every kind of nervous disease to our one, yet it was here that the system of cure was elaborated. I speak of Mitchell's rest-cure.

Scientific medicine is only in its infancy. Its progress will prolong more and more markedly the average age of life by removing the diseases that play havoc during childhood and adolescence. For example, cholera-infantum, the terror of mothers during the second summer, has within the year delivered up its cause to a medical student (Duval) of the University of Pennsylvania, working under the direction of Professor Flexner. With the examples of Vienna and Munich before us we realize the fate of typhoid fever, which proves the pitfall of so many an ambitious adult. With typhoid will disappear its most notable sequela, gall-stones. Thumbs were turned down twenty years ago on the animal parasitic diseases such as trichinosis and tapeworms, when the late Dr. Joseph Leidy, of Philadelphia, entered the lists and demonstrated how easily they might be conquered.

When the organisms themselves cannot be directly handled, the source of contagion will be learned, and the diseases thus avoided. Our now constant enemies, tonsillitis, influenza, and tuberculosis, will find it impossible to progress when people realize the uncleanliness of handkerchiefs and come to the use of paper napkins. Diphtheria and whooping-cough (and probably other diseases) will have one source of contagion removed when pet dogs and cats are kept away from children or carefully held within doors. Inventions outside the province of medicine will be by no means without influence. We have every reason to believe from analogy that flies are a frequent medium of transferring contagious diseases. Flies breed, practically, only in stables, and the replacing the horse by the automobile means their extermination.

In thus depicting the advance of medical science and predicting its ultimate triumph over disease are we imagining a millennial condition? No! decidedly not. It is only a picture of the end of our present century when man will accomplish his fourscore and ten in comparative freedom from the disease hobgoblins of today.

Joseph Walsh M. D.

(Philadelphia)

From a photograph by Nadar

GUY DE MAUPASSANT