

1865 his attention was directed by a colleague to the work which had been done on fermentation and putrefaction by Pasteur from 1857 onwards. This work came upon him as a revelation, and almost at once he grasped the full significance of the Frenchman's discoveries for surgery. Ten years later he tells us specifically that the work of Pasteur "long since made me a convert to the germ theory, and it was on the basis of that theory that I founded the antiseptic treatment of wounds in surgery."

Although he frequently reiterated his indebtedness to Pasteur, it is, I think, a vulgar error to regard Lister as a mere imitator of his great French contemporary. As early as 1861, and before his acquaintance with Pasteur's papers, he was getting near the truth about suppuration, and afterwards he advanced beyond the point where Pasteur had led him. From now on he became ardent in the pursuit of bacteriology. This was about 1870, when the study of microbes had scarcely emerged as a distinct science. At the time there were two conflicting views. The one, supported particularly by the eminent botanist Ferdinand Cohn, held that bacteria exhibited a constancy in form which might be used as a basis of their classification into genera and species.

According to the other view, there is no such morphological stability, but rather a pleomorphism whereby one and the same microbe could assume different forms according to the environment. In his earliest bacteriological work in 1873 Lister ranged himself among the pleomorphists, and it has to be admitted that he suffered shipwreck when he stated that Ehrenberg's and Cohn's classification was "entirely untrustworthy." Lister's mistake was one made by a great many others at that time, and serves but to show how unwary the earlier bacteriologists were of the pitfalls lying in their path. There exists an exceedingly interesting correspondence which passed between Lister and Pasteur on the subject. Pasteur clearly saw where Lister had erred and advised him to repeat his experiments with added precautions. This, Lister did, and, profiting by his now experience, became one of the foremost bacteriological technicians and pioneers of his time. So imbued was he with lofty ideals that, instead of covering up his tracks, he handsomely admitted his error. "Next to the promulgation of truth," he said, "the best thing I can conceive that a man can do is the recantation of a published error." This sentiment was almost exactly that which was given to us sixteen hundred years ago by Celsus, who, however,

added that "such a confession is suited only to a great genius whose splendour is such as to survive the sacrifice, especially in the performance of a task which is to be handed down for the benefit of posterity as a beacon of truth to warn them against similar errors." From the theory of Cohn and Pasteur it was to be presumed that in some way—at that time unknown—bacteria might be separated from each other and cultivated in a pure state. The great mycologist Brefeld early pointed out the necessity of raising pure strains or cultures from one single germ. Lister attempted this, and by unsurpassed technique, involving a remarkable understanding of the whole problem, he succeeded in obtaining a pure growth of a microbe which he called *Bacterium lactis*, and which was a cause of the so-called lactic fermentation. He grew the microbe in sterile milk and raised a pure strain, constant morphologically and physiologically, from a single bacterial cell. This was possible by the aid of an ingeniously constructed syringe of his own invention.

He also introduced several of the methods of sterilization which are in constant use to-day. His work on lactic fermentation is a classic, and stands as a model of what a scientific research should be.

Like Pasteur, Lister had the supreme faculty of seeing as if by instinct the exact experiment required to eliminate an element of doubt or to advance ahead. He was a master of the experimental method—a rare and precious gift which the Abbate Spallanzani truly said "has always been confined and always will be confined to the few."

And now I am at the end. No one could come into contact with Lister without being impressed by his noble personality, his magnanimity, his liberality, and his modesty. His aims were of the loftiest kind, and probably no medical man ever kept more steadfastly before his gaze the covenants of the Hippocratic Oath. He venerated his teachers, he taught his art to his pupils, he kept nothing secret from his profession, and followed that system which, according to his ability and judgement, he deemed best in the interest of his patients. With purity and holiness he passed his life and practised his art.

When one looks down the long vista of time and contemplates the art of medicine, three names stand prominent, and we should all feel pride in our English stock which gave birth to Harvey, to Jenner, and to the great Lister—a name to resound for ages.

LISTER AS A SURGEON.

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SELDOM is a great discovery the product of one man's mind. In the work of other men it has ancestors; fore-runners possessing one or more attributes whose final and felicitous association within new work constitutes new truth. When that new truth is fully disclosed its relation to many other truths familiar to all for perhaps many years and in many associations becomes clear. The claim may then arise that those who have revealed isolated and antecedent truths have priority in the final discovery. Such truths are, however, only progenitors with no claim to be regarded as their own descendant, the new truth itself.

SURGERY A CENTURY AGO.

The immortality of Lister, whose centenary we commemorate to-day, is due to discoveries which did for the craft of surgery what John Hunter had done for its science. The oldest human remains bear evidence of surgery. Before Lister came operations had been relatively few because of their heavy mortality and their almost insupportable burden of terror and of suffering. Every operation risked the life of the patient from one single cause—putrefaction in the wound. So frequent was this that it was always expected; and whenever it appeared

no man might foresee or measure its consequences. Evidence of this we find on almost every page of the old textbooks and in the biographies of the great surgeons. It is startling to read that when, in the year 1821, Astley Cooper operated upon George IV for a small sebaceous cyst on the head, so tortured was he by anxiety lest erysipelas or pyaemia might develop that he sought to put upon others the responsibility of the operation—on Cline, on Everard Hume, on anybody but himself. He speaks of the operation in terms which to us now appear absurd, fearing that "it might by possibility be followed by fatal consequences." He says, "I saw that the operation, if it were followed by erysipelas, would destroy all my happiness and blast my reputation"; and "I felt giddy at the idea of my fate hanging upon such an event"; and again, "I am certain that if anything happened to the King that at any rate I should leave London and live in retirement." It is hard to believe that a surgeon eminent enough to be chosen for service to the King should be so deeply moved at the prospect of what was to him, as to us, technically the simplest of operations. The exercise of the art of surgery brought terror then where it now brings joy, to surgeon no less than to patient.

THE FIRST STEPS.

Lister's discovery was very gradual. His earliest interests in surgical inquiry were concerned with inflammation, its cause, its nature, and possible methods of controlling it. In this, as in many of his earlier investigations, Hunter was both inspiration and guide. His paper "On the flow of the lacteal fluid in the mesentery of the mouse," published in 1857, but based on researches begun in 1853, is an extension of Hunter's experiments on absorption. His studies on coagulation of the blood began with an investigation on the blood in the veins of sheep's "trotters" obtained from the slaughterhouse. By devising neat and critical experiment he was able to carry knowledge of coagulation of the blood far beyond the point which Hunter and Hewson had attained a century before. Yet the methods he employed were clearly modifications of those used by his great forerunner. By such investigations as these Lister was training himself, but his chief interest lay always in the problem of the healing of wounds. When, therefore, he learnt of Pasteur's researches his mind was open to the new truths and expectant of them. Before the British Medical Association in Dublin in 1867 he said:

"In the course of an extended investigation into the nature of inflammation, and the healthy and morbid conditions of the blood in relation to it, I arrived several years ago at the conclusion that the essential cause of suppuration in wounds is decomposition brought about by the atmosphere upon blood or serum retained within them; and, in the case of contused wounds, upon portions of tissue destroyed by the violence of the injury. To prevent the occurrence of suppuration, with all its attendant risks, was an object manifestly desirable, but, till lately apparently unattainable, since it seemed hopeless to exclude the oxygen which was universally regarded as the agent by which the putrefaction was effected. But when it had been shown by the researches of Pasteur that the septic properties of the atmosphere depended not on oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air by applying as a dressing some material capable of destroying the life of the floating particles."

Lister's first step was therefore a realization of the truth that decomposition in wounds depends upon the activity of living micro-organisms; his second, which followed immediately, was based upon the belief that such organisms might be destroyed in the wound, or as they were about to enter the wound; his third and last, which came more slowly, was founded upon the hope that the organisms within the field of operation might be destroyed before they entered the wound.

Around every step of his advance fierce controversy raged. The scepticism and hostility of early contemporaries was stupid, unimaginative, and petty. The history of science is not only the story of new truths and their slow emergence from error, it is a recital of bitter and vexatious opposition from those who should have been the first to acclaim and to welcome the new vision. Only a few weeks ago we learnt once again of the diffidence of Isaac Newton in the publication of discoveries made years before; his reluctance was due in part perhaps to a native modesty and indifference to the applause of others; in part also to shrinking of a sensitive nature from the acrimony and coarseness of controversy.

The rank hostility of Riolan to Harvey, the disdainful incredulity of Liebig at the discoveries of Pasteur, are in direct intellectual relation to the revolt of Calvin at the discoveries of Servetus, the animosities of the Church which martyred Giordano Bruno, the threat of torture which subdued the aged Galileo, and all that long record of sinister events which proclaims the inveterate hostility of impervious minds to novelty. For such minds novelty is always error, truth is bent through an angle of refraction as it enters them. Lister's answer to indifference, opposition, and denial was unflinching continuance in inquiry and experiment, and in the demonstration day by day and case by case of changed results.

THE PAST RENEWED IN THE WAR.

Few if any now living remember the full horror of the old days. But an experience not dissimilar awaited us in the earliest days of the great war. A pestilence of infection to which we were wholly unaccustomed turned our faces towards the early struggles of Lister. On all sides we heard that our inability to check a raging suppuration in a heavily infected wound proclaimed the failure of Lister's methods. So to Lister we turned again, only to realize much more acutely how the problems which faced us had been his problems; how our experience, horrible in its new revelation, had in the first years of his practice been his daily experience. Reading Lister's works with clearer perception and new understanding of the difficulties by which he was confronted, our admiration of his patience, insight, and courage glowed into greater reverence than ever before. Lip-service we had long given to the founder of the new era; we were now compelled to realize that Lister is indeed the man who has saved more lives than all the wars of all the ages have thrown away; the man who has changed the face of surgery, the one man who has in truth created, if not a new art, at least new and safe, and illimitable opportunities for the practice of the old art.

The first conception in Lister's mind in respect of treatment was that the organisms within the wound, and those entering the wound, might be destroyed by some chemical agent the nature of which was to be determined by a series of experiments. From time to time changes were made as search brought to light some new chemical substance more active in destroying bacteria and less harmful to the living tissues of man. The search is not ended yet. Up to this moment it has engaged the interest of such men as Dakin, Browning, and J. B. Cohen, and no doubt it will long continue. The problem, however, is not merely that of accomplishing highest bacterial destruction with lowest cellular injury: it is rather one of augmenting the natural powers of cells and of serum to subdue and destroy bacteria and their poisons. Lister, I feel confident, realized all this to a greater degree than many of his successors. Godlee in his *Life of Lister* makes this quite clear. Though the earliest efforts were concerned with the abatement of existing decomposition of wound discharges, it was not long before the problem of the prevention of infection became paramount. It is beyond dispute that Lister clearly realized the distinction between the "prophylactic" and the "therapeutic" uses of chemical agents in surgery. We know now that the old quarrel as to the relative merits of the "antiseptic" and the "aseptic" methods was senseless and jejune: for Lister was indubitably the parent of both—if, indeed, there are really two methods. No surgeon ever practised with success a method in which agents for the destruction of organisms were omitted. Aseptic surgery is the wise practice of antiseptic surgery. There is a difference in detail, not in ideal or in fundamental truth.

We have no need to discuss the relative merits and claims of Pasteur and Lister. It is true that without Pasteur there would have been no Lister at the time when Lister was. Pasteur set out to discover the truth as to spontaneous generation, and by crucial and magisterial experiment settled that problem once for all. While at Lille, in the centre of a district of many distilleries, the problem of fermentation engaged his mind, and the assertion of Liebig, foremost among chemists of his day, that it was "a change in organic fluids and tissues set in motion by the access of oxygen" was shown to be incomplete. The genius of Lister lay in immediate realization of the fact that the biological truths established by Pasteur might be applied to other circumstances. His mind was prepared for the new vision by his physiological training. I make no attempt to exalt Pasteur by saying that Lister's work was corollary to his; nor to belittle Pasteur by speaking of his ignorance of the full effect of his work. Let the world be thankful for both. We who are within the profession of medicine have once again to learn that progress depends, not only upon our own efforts in the discharge of our daily task of healing, but upon an association as intimate as can possibly be with every aspect of biology.

THE ANTISEPTIC THEORY AND ITS CONSEQUENCES TO
SURGERY.

The consequences of Lister's work are many and far reaching. The immediate result was, of course, the complete abolition of many of the dangers attaching to the most certain and most dreaded peril of all—infection in the wound extending to other parts, causing severe and protracted suffering, even grave risk to life itself. But when the few operations then practised became safe, it was obvious that other operations might be attempted. The result was that procedures condemned as "murderous," the practice of which should, in the opinion of high authority, lay a man open to a charge of manslaughter, were greatly increased in number as soon as it could truthfully be claimed that the risk of operation was definitely less than the risk of inaction. The most exemplary instances were found in the practice of abdominal surgery. Ovariectomy, condemned by highest authority as homicidal (the governors of King's College Hospital in 1877 had forbidden the staff to undertake it), became so safe in expert hands that neither patients nor surgeon hesitated in the choice of operation.

In all new advances in surgery it is only the patient whose disease has reached a high development threatening disability, suffering, or death who is submitted to operation; the cases with the greatest risk already attached to them are the first to undergo adventurous treatment. As the safety of surgery is shown in these, similar cases are treated, but in an earlier stage—a stage in which the surgical risks are less, the convalescence quicker, the mortality lower. Ultimately a fatality occurs only in the exceptional case, from causes connected rather with the original disease than with the operation practised. In my days as a resident in hospital ovariectomy was regarded as an operation of utmost gravity, and was performed with much ceremony in private wards and with special nurses. McGill, who led me by the hand along the path of surgery, always had a Turkish bath in the afternoon of the preceding day, and operated at an unusually early hour in the morning. Some mammoth tumours were removed—tumours which at times greatly outweighed what was left of the patient; indeed, we removed patient from tumour rather than tumour from patient. From ovariectomy an advance was made to the treatment of other pelvic conditions. Fibroid tumours of the uterus were everted and a constricting band of metal applied to the cervical stump, which was brought up into the wound. When for the first time I returned the pedicle to the abdomen after the operation of hysterectomy, our obstetric physician, Dr. Braithwaite, quailed with horror at such temerity. The conquest of other disease of the abdomen was soon inaugurated; the campaign owed almost everything to those who had practised what we now call gynaecology. Spencer Wells removed the enlarged spleen from a patient whose tumour he had believed to be uterine; and a condition of tuberculous ascites, misnamed "ovarian cyst," improved so much after the release of the fluid that similar cases were quickly claimed for surgical treatment.

The whole abdomen soon became the province of the surgeon, whose activities also rapidly extended to the cranial and thoracic cavities, so that at the present day neither technical difficulty nor any danger in the trauma inflicted prevents the surgeon from dealing with almost any lesion, wherever it may lie, or whatever its nature. There is scarcely any organ which cannot be attacked; there is no inherent and inescapable risk in any technical procedures.

An extension of safe operative measures within the cavities, especially within the abdomen, has resulted in a complete revision of our knowledge of the earlier structural changes in many organs attacked by disease, and of the clinical manifestations which those changes produce. Surgery has proved an implement of research; it is indeed the most powerful of all, though this fact is not yet fully realized, nor is adequate use yet made of it. In the mortuary period of pathological knowledge only the most advanced stages of disease, those stages which at last proved fatal, could as a rule be examined. The final symptoms of the terminal changes in structure were, not perhaps the only, but they were certainly the chief interest of the

clinician; little was known of the dependence of earlier symptoms upon tissue changes. Pathologists and physicians alike were incredulous as to the truth or significance of much of the new knowledge which the surgeon was daily accumulating as the result of his widening observations. Even to-day the physiologist and physician do not appreciate how much is to be learnt at the bedside or in the operation theatre.

As an implement of research, surgery has been generously used by the physiologist in his experiments upon animals. Perhaps the most entrancing exploit of all was that inaugurated in this country by Ferrier and pursued by Macewen, Horsley, Sherrington, and others, by which the functions of the various parts of the nervous system have been elucidated. There is something of enthralling interest in the story of the localization of function in the cerebral cortex, in the realization that in the convolutions of the brain exist allotments each with its own highly specialized and exclusive function. The work of the surgeon upon the abdominal viscera, his discoveries concerning, not only changes of structure in various diseases, but also disorders of visceral reflexes, and symptoms associated with these, have been not less arduous, nor less interesting, and even more fruitful in the clinical study of diseases, and in the relief of human suffering.

The capacity of the surgeon to enlarge the area of his operations has been used with gratifying success in the treatment of accessible cancer. The lines of extension of this disease have been the subject of inquiry by pathological anatomists, who have studied afresh, not only the lymphatic systems of the various organs affected, but also the exact lines along which the cancer cells may drift or grow. The work of Sampson Handley on the breast, and of Ernest Miles on the rectum, are worthy of special commendation. Since we know beyond dispute that cancer is primarily a local disease, we know also that every accessible cancer is curable if operation is practised in the early stages of disease. That is not the least of the debts we owe to Lister. It is his work that has permitted us so to plan our operations that not the growth alone but also all those parts, such as lymphatic glands into which the growth makes haste to extend, can all be removed in one mass, and that infection is now the least of our anxieties.

THE FUTURE.

We may almost claim that the full effect of Lister's work is now accomplished. We know that for all time operations of every kind may be practised without the grave risks that formerly were prohibitive. The art of surgery is far in advance of all the sciences upon which its future progress depends. Until they stand abreast, or even advance ahead, the progress of surgery will be slow. The great search for us all must now be for the methods of applying new discoveries in other sciences, physiology, biochemistry, pathology, physics, and the like, to the study of disease.

Many lines close in the dial's centre. From all the vast periphery of our surgical world messages of gratitude and of homage converge upon Lister to-day. Lister made possible the new surgery, beyond all question the most beneficent art mankind has ever practised. So long as there are men to live and suffer, so long will Lister be there to heal them, to hold the gates of life ajar.

To the honoured dead we raise our monuments, some cast in bronze, some graven in stone; some, like that of immortal Hunter, begun in a man's lifetime, the work of his own hands, are enlarged and lovingly enriched through generation after generation by those who labour in the master's cause. On the roll of honour which in letters of gold bears the names of the saviours of mankind, no man is more worthy of remembrance than Lister. His living and enduring memorial is a great, and ever greater multitude of men, women, children, of every nation, of every race, of every creed, through his mercy and by the skill of his most gentle hand relieved from infirmity and suffering and sorrow, and made for a time triumphant over death itself.

It is immortal Lister we salute to-day, the supreme benefactor of mankind.