of the local attractions, but because a meeting in the colonies has generally been followed by a large meeting at home. Few places have industries the operations of which afford such interest to visitors. To see an armour-plate rolled or the forging of some huge mass of red-hot metal is a sight for a lifetime, whilst the variety of the industries engaged in some form of steel-making or silver-plating is very great. Arrangements are being made whereby a large number of the more important works will be open for inspection by members.

It is generally supposed that Sheffield is a sort of city of dreadful night, and that it and smoke are convertible terms. This is, however, a complete delusion. Few cities of its size have more delightful suburbs or such picturesque scenery in the neighbourhood. The city stands at the confluence of five valleys, with contributory streams to the Don. The ridges between rise sharply to 900 feet above it, and then run up to the grouse moors, the valleys being each distinctive and well wooded. The near neighbourhood is full of historic and archæological interest. Sherwood Forest is on one side and Little John's grave on the other. The Peak caverns, the beautiful Derwent valley, with Chatsworth and Haddon and the gorge of Matlock, are close at hand, and the whole district is a pedestrian's paradise. It is hoped no member of the association will be deterred from coming by what he has seen from the railways, which in many cases actually pass through some of the large works.

PROF. ROBERT KOCH, For.Mem.R.S.

BY the death of Prof. Robert Koch there goes from amongst us one of the most remarkable men of his time, a man of tremendous determination, great capacity, and indefatigable energy, who has left an impress on the science and practice of medicine such as is made by a few exceptional men only. It would be affectation to say that all his work is of equal value, for although under his hand and mind no subject could remain unaltered, his pioneer work on the isolation and cultivation of bacteria in solid media, his studies in anthrax, and his work on tuberculosis and cholera, must always stand out above any other that he did. The controversial methods of his earlier years, as exemplified by his controversy with Pasteur in 1883, were succeeded by methods of a less pungent, but equally vigorous, character, but his arguments were always respected, even by those who did not agree with him, as those of a man thoroughly in earnest, whilst his utterances could always be accepted as those of a man who had every right, by reason both of experiment and experience, to give full and free expression to his opinions, opinions that must be carefully weighed and considered, especially by those who differ most widely from him.

Born in Klausthal, Hanover, on December 11, 1843, Robert Koch was a member of a large family. His father held some official position in the Department of Mines and Forests. At nineteen Koch commenced his medical studies in the University of Göttingen, at which he worked for five years. After passing his State examination and taking his degree, he became assistant medical officer in the General Hospital in Hamburg. He then engaged in private practice, first at Langenhagen, near Hanover, moving thence to Rackwitz, where he remained until he went as a volunteer surgeon with the army in the Franco-Prussian war. In 1872 he again started private practice, this time in Wollstein, in Posen, where he commenced his investigations and studies on the isolation of pure cultures of bacilli, studies which led to the method of cultivation of bacteria on solidifying media, a method to the use of which we owe many of the most important advances made in the bacteriology of disease.

Up to Koch's time, Salomonsen's and Cohn's methods of isolating single bacteria were the only methods available. Salomonsen mixed a very small number of organisms with a large quantity of blood, and drew the mixture into a series of long, fine glass tubes; then as the organisms grew and used up the oxygen in the blood, little black points made their appearance along the course of the tube. Blood taken from the tube broken at one of these black points was often found to contain a pure culture of a single organism only. This method, of course, could not receive very general application, but as the blood might coagulate in the tube, the organisms could not move about at all readily until the clot was broken down or decomposed by the organisms themselves Cohn's method consisted in diluting the culture containing the organisms with very large quantities of broth, and then taking a single drop and transferring it to a flask or tube containing broth; in this case the observer trusted to the dilution being so great that a single drop would contain only a single organism. These methods, imperfect as they were, were used by Pasteur and Lister in their investigations, and were brought by them to considerable efficiency.

Koch's method of isolation was exceedingly ingenious but very simple. Taking a nutrient medium containing meat juice or sugar along with certain saline constituents to which had been added from 5 per cent. to 10 per cent. of gelatin, he boiled or heated the mixture several times to 70° C. or 80° C. in order to destroy any germs that might already be present. The material to be investigated was then added to this sterilised nutrient medium whilst still in a fluid condition. The mixture was then well shaken, so as to distribute any organisms that might be present, and poured over a glass plate sterilised by heat contained within glass vessels similarly sterilised. When this nutrient medium cooled down it became a solid jelly and the organisms were fixed in position, each organism giving rise to a colony, so that each organism with its progeny was isolated and could be studied separately. At this date we are apt to lose sight of how much bacteriologists owe to Robert Koch for this simple method, which was devised by him in order that he might study more thoroughly than had yet been done the anthrax bacillus, the bacillus that gives rise to splenic apoplexy in cattle, and to one form of malignant pustule in the human being. By means of this method, too, he was able to isolate and study various organisms found in wound infection and in septicæmias of certain animals, the results of which are given in a paper translated and published in 1880 in the Transactions of the New Sydenham Society. His studies on the production of immunity against anthrax in cattle and sheep were, however, anticipated by Pasteur, who, in 1881, gave his marvellous and striking demonstration at Chartres.

In 1880 Koch was appointed Government adviser to the Imperial Board of Health, and in the laboratories in the Louisenstrasse carried out that series of investigations which ended in the demonstration of the presence of the tubercle bacillus in the diseased tissues of tuberculous animals and in the sputum and tissues of human beings suffering from tuberculosis. Here again his ingenuity and mastery of methods enabled him to do what so many others had failed to accomplish—to stain the tubercle bacillus in the tissues and to isolate and study this organism on artificial media outside the body. As the tubercle

bacillus would grow luxuriantly only at the body temperature, Koch found it necessary to obtain some solid medium that would not melt at that temperature, and, going on the principle that the fluids of the body would probably afford the best nutrient medium for an organism that grows so readily in the tissues, he took the blood serum of sheep, calves, &c., which not only contained the necessary nutrient elements for the bacillus, but was consolidated by heat, and he found that if the consolidation were effected at a sufficiently low temperature, the medium retained most of its nutrient properties. Here again was a tremendous advance, and his paper, read on March 24, 1882, before the Berlin Physiological Society, and published in the report of the Imperial Board of Health, was received with acclamation on every hand, and although criticism of all kinds was directed against his findings, Koch maintained his thesis against all comers. After this work on tuberculosis, Koch was naturally looked to, not only by his own countrymen, but by scientific men of all countries, as the man most likely to solve the questions bound up in the causation of cholera. In 1883 he went out to Egypt on a quest for the *causa causans* of cholera, and in 1884 acted as chairman of the German Cholera Commission, which carried out much of its work in India. His works on cholera, one volume published in 1884 and a second in 1894, must be looked upon as classical monographs, and from 1884 onwards the cholera vibrio, or comma bacillus, became indissolubly associated with cholera as its prime etiological factor.

In 1885 Koch was appointed professor of hygiene in the faculty of medicine in Berlin University, and his classroom and laboratory became the resort of students from all parts of the world, as they had already been at the Gesundheitsamte, though on a smaller scale. His pupils there trained took up many of the problems for the consideration of which he had neither time nor energy. In 1890, at the tenth International Medical Congress, he announced the discovery of tuberculin, and, in a series of admirable experiments, demonstrated the action of tuberculin as an immunising agent, an aid to diagnosis, and even as a curative when injected into animals already suffering from tuberculosis. The announcement of this treatment seemed to give hope of prolonged life to thousands of tuberculous patients, many of whom clamoured to be treated. The method, however, had not been sufficiently fully developed, and there can be little doubt that it fell into disrepute, not because it failed to accomplish what had been claimed for it by Koch, but because it failed to give such results as had taken form in the imagination, alike of patients and of medical men, who could not understand the limitations of such a method of treatment—a method still in its infancy. Those, however, who really studied the tuberculin treatment never lost heart, and in 1897 Koch reported a new tuberculin, with which much more satisfactory curative results have since been obtained. There can be little doubt that some modification of this method must form the basis of any specific curative treatment.

In 1891 Koch was appointed director of the magnificent new Institute for the Study and Treatment of Infective Diseases, and here, with his band of workers, in which were men whose reputation is now world-wide, continued to work out some of the problems in which he was now interested. In 1896 he was called to South Africa to study rinderpest, a disease which, with the assistance of Kolle and Turner, he traced to its cause and for which he devised a method of immunisation. As the result of these observations, on which were built up investigations by later workers, rinderpest has become a manageable disease. At this time Koch first took up the question of sleeping sickness, but, like most other observers, he failed at the outset to find any organism that he could associate causally with the disease. From this he turned his attention to the bubonic plague, studying it in India and German East Africa. Following up the observations of Yersin and Lowson, and tracking down the bacillus of plague, he found that it was really conveyed by rats, and that, however, it was endemic in Mesopotamia, in Hunan in China, in Tibet and Mecca, and in Kissiba, Victoria Nyanza. As a result of his observations, he expressed the hope and assurance that in time these plague centres might be cleansed, and when the reservoirs and carriers of the disease could be localised, plague might gradually be exterminated. How far these prognostications may be realised it is still early to state, but the continuation of this line of research and the tracking down of the flea as a further carrier have undoubtedly brought this period nearer.

In 1907 Koch exploded his great bombshell at the International Congress on Tuberculosis in London when he said, "I feel justified in maintaining that human tuberculosis differs from bovine and cannot be transmitted to cattle." That he wished further evidence, however, is evident from the fact that to this statement succeeds the following:—"It seems to me very desirable, however, that these experiments should be repeated elsewhere in order that all doubts as to the correctness of my assertions may be removed." As regards infection of the human subject by the material from tuberculous cattle, he said:—"I should estimate the extent of infection by the milk and flesh of tuberculous cattle and the butter made of their milk as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it." It was this last statement to which special objection was made, as it involved such a complete alteration in our method of procedure in connection with milk and milk products from tuberculous cattle. It is not necessary here to repeat what has been now before the public for so long in the Interim Reports of the Royal Commission on Tuberculosis and of the German Commission on Tuberculosis, the Transactions of the International Congress on Tuberculosis at Washington, and many papers by individual workers. Moreover, there seems some reason to believe that latterly Koch had modified his views somewhat, in so far that in his interview with the *Times* correspondent in Berlin during the early part of last year he stated that the "Differences still unsolved between my critics in the Royal Commission and myself have been greatly reduced by further examination, and are now very slight." As shortly before his death Koch was making a very thorough search for the bacillus of bovine origin in cases of pulmonary tuberculosis, it is to be hoped that his colleagues and literary executors will give the world the results of his investigations.

In 1903, still in search of fresh fields to conquer, he returned to South Africa to study on the spot coast fever (allied to Texas fever), a condition due, apparently, to the presence of protozoal parasites in the blood. At this period his investigations were occupying so much of his time that in order to devote himself to them more thoroughly he retired from his position as director of the Institute for the Study and Treatment of Infectious Diseases. In 1905 he was awarded the Nobel prize in recognition of his great services to medicine, an award approved by all.

In 1906, returning to East Africa, he continued his studies on sleeping sickness, especially in relation to its treatment by atoxyl. At one time it appeared as though he had obtained a drug specific for this

disease. It was found, however, that although there was amelioration in the condition of the patient in the early stages of the treatment, the drug soon lost its effect, whilst certain sequelæ, *e.g.* blindness, the results of the action of the drug, led men to be exceedingly chary of using it. In connection with sleeping sickness, Koch, following up Bruce's theory of a living reservoir in which certain parasites might exist without giving rise to any definite and appreciable disease, instancing the wild buffalo, where the parasite is kept alive in its host without apparently doing any damage, but ready to attack non-immunised animals when carried to them by the tsetse fly (*Glossina morsitans*), Koch suggested that the crocodile might be the reservoir host of the trypanosome that gives rise, when carried to the human being by another tsetse fly (*Glossina palpalis*), to sleeping sickness, and he then made the suggestion, afterwards carried out, that the infective zone around certain waters should be cleared of its underwood, and the crocodiles lurking there and in the neighbouring waters killed. Koch also worked at malaria in Java and in the Malay Peninsula. He studied blackwater fever and tried to determine its relation to malaria, or, alternatively, to quinine poisoning contracted during the treatment of malaria.

Koch's last great public appearance was at the Washington Congress on Tuberculosis in 1908, when he announced that he intended to devote the remaining years of his life to the settling of the question that he had raised in London eight years earlier, and everyone hoped that he had some years of useful work before him. These years have been all too few, and we cannot expect that the work he then undertook is finished.

The record of a man's work is his best obituary notice—and in such a case as that now under consideration the writer is relieved of an enormous responsibility—but this notice would be very incomplete did it not contain some record of the honours accorded to him by his fellows, especially those who followed and appreciated his work. Robert Koch was an honorary member of a very large number of learned associations, amongst them of the Prussian Academy and of the Royal Society of London. He had been invested with the Prussian and French Orders of Merit, and with orders of various kinds awarded by the rulers of almost every State in Europe. In some cases these distinctions might mean but little to those who come after us, but, associated with Koch's name, they must ever retain their significance as associated with one of the names on the imperishable roll of the great in science. The death of Robert Koch involves a loss not to Germany only —all mankind is the poorer.

MAJOR PHILIP CARDEW, R.E.

MAJOR PHILIP CARDEW, whose death we record with deep regret, combined a fine mathematical mind with careful scientific training, and a remarkable natural ability in grasping the principles involved in any practical question. He passed through Woolwich Academy with every honour, and started a brilliant career in the Royal Engineers in 1871. He was appointed, in 1883, instructor in electricity at the Military School of Engineering at Chatham, and threw himself with great energy into those innumerable electrical problems which were being so rapidly developed in telegraphy, telephony, electric lighting and power. In 1888 he was selected as the first electrical adviser to the Board of Trade, and he inaugurated the rules and regulations for the use of electricity for public supply and for electric tramways and railways. These rules have formed a model for all countries, and there is very little doubt that the freedom of water and gas pipes in England from electrolysis due to stray tramway currents is the result of the wise restrictions which Major Cardew initiated. The standardisation of electrical units was part of his work.

When Major Cardew retired from the Board of Trade his energies were diverted into the execution of various lighting, power, and traction schemes. Under his personal guidance, every Government dockyard in the British Empire has been equipped with electric power, and numerous electric railways, tramways, and lighting systems originated. He was a prolific inventor, and his vibrator is largely in use in connection with military telegraphs, while the hot-wire voltmeter which bears his name was for years one of the few trustworthy electrical instruments. The Cardew safety earthing device has also been of great value in connection with the public supply of electricity.

Major Cardew contributed a number of papers on electrical subjects to the Royal Society and the Institution of Electrical Engineers.

His death, at the early age of fifty-eight, is greatly to be regretted. He was intimately associated with all the modern developments of electricity, and his experience and advice were much in demand.

NOTES.

IN consequence of the death of King Edward VII., the usual ladies' conversazione of the Royal Society will not be held this year.

AT a meeting of the council of the Royal Society, held on Thursday, May 26, at Burlington House, an address of condolence and homage to His Majesty King George V. was adopted, and the society's seal affixed. At the ordinary meeting of the society, which followed, the address was communicated to the fellows present by the president, Sir Archibald Geikie, who spoke as follows:—"Since the last meeting of the society a great calamity has unexpectedly befallen the country, and under the shadow of that mournful event we now resume our duties. The death of King Edward is a national loss, the full effect and meaning of which cannot yet be appreciated. We, fellows of the Royal Society, share in the universal sorrow that a life so revered, so full of achievement, and with the promise of still many fruitful years, should have been cut short in its prime. But we have also a more personal ground for regret. The late King had been for nearly half a century one of our fellows, and on his accession to the throne had become our patron. Among the many claims which His Majesty had to our regard, not the least was the interest which he always took in the furtherance of that natural knowledge which the Royal Society was founded by Charles II. to promote. In our annals the name of King Edward VII. will always hold an honoured place. The council has approved and sealed an address to His Majesty King George V. in which, while expressing our condolence in the deep grief of the Royal Family, we offer our respectful congratulations on his accession to the throne of his ancestors, and our confident hope that his reign may be long and prosperous." The address was then read from the chair, and was adopted in silence, the fellows present all standing.

As we go to press, the *Terra Nova* is starting on her journey with the British Antarctic Expedition, and, after calling at a number of places, is expected to arrive at Lyttelton, New Zealand, about October 13. Hitherto Antarctic expeditions have sailed to the south in the latter