periment which has of late attracted the most attention has been the substitution of electricity for steam on the New York elevated railways. That this experiment has not succeeded as well as could be wished is not due to any inapplicability of electricity to the purposes of locomotion. All that has been attempted in New York has been successfully carried out in Germany, and a more careful copying of the details and methods of Messrs. Siemens & Halske would have produced success. The enormous traffic on these roads taxes to the utmost the carrying-capacity of the steam-plant, which is the result of half a century of study and modification of machinery of locomotives and cars. The substitution of electric motors for steam-locomotives will be a gradual process, and will progress just in proportion to the engineering skill brought to bear upon the problem. W. D. MARKS.

CARTWRIGHT LECTURES ON PHYSIOLOGY.

WHILE physiological science has made rapid advances in recent years, there are still many problems which it has as yet failed to solve, notwithstanding the fact that many patient and skilled investigators have devoted their entire time and energy to their solution. Among these problems, none is of greater interest and importance than the life-history of the blood, and to its elucidation the best minds in Europe and in this country have been directed. Prof. William Osler, M.D., of the University of Pennsylvania, was invited to deliver the fifth course of the Cartwright lectures of the Alumni association of the College of physicians and surgeons of New York, and selected as his subject, 'Certain problems in the physiology of the blood.' The course of these lectures began the evening of March 23, at the hall of the Young men's Christian association.

The first lecture dealt with the blood-plaque, which is also known as the elementary corpuscle of Zimmerman, the haematoblast of Hayem, the third corpuscle and blood-plate of Bizzozero. In blood withdrawn from the vessels, in addition to the red and white corpuscles, are seen grayish granular masses, being from ten to fifteen times the size of a red corpuscle. These are known as Schultze's granule masses. They are made up of small bodies, which are of uniform size, and, seen in face, have a disk shape, and in profile appear as rods. These bodies are the blood-plaques. Their diameter is from 1.5 micro-millimetres to 3.5 micro-millimetres. They are always found in mammalian blood, though their number is subject to considerable variation, in health averaging one to twenty red corpuscles. The estimates of their number, made with the haemacytometer, give about two hundred and fifty thousand of them to each cubic millimetre of adult blood. In the new-born this may be doubled, as also in consumption. In fact, in all wasting diseases their number is much increased, as not only in consumption, but also in cancer and in anaemia; and they appear sometimes to occupy nearly the whole field of the microscope. During acute fevers they are much diminished in number, and again increase during convalescence.

When the blood is withdrawn from the blood-vessels, these plaques have a tendency to conglutinate, forming the granule masses of Schultze; and so rapidly does this occur, that it would appear to be the condition in which they exist while within the vessels. This is, however, not the case, but is a property which they possess analogous to the nummulation of the red corpuscles. That this state of conglutination is not the natural one may be shown by examining the blood while circulating in a living animal, as in the omentum of a guinea-pig or rabbit, or in the subcutaneous tissues of a new-born rat, which is admirably adapted to the purpose. Or, if a drop of a solution of osmic acid (one per cent) or Pacim's fluid be placed upon the tip of the finger, and then the finger pricked, so that a drop of blood will flow directly into this solution, and then the whole transferred to a microscope-slide and examined, it will be found that the plaques are isolated, and the tendency to coherence has been overcome.

There are some investigators who hold to the opinion that these blood-plaques are disintegrated white corpuscles, but the objections to this explanation are numerous and incontrovertible. It may therefore be considered as established that the blood-plaque is a separate entity, and distinct from the mature red and white corpuscle.

The history of these corpuscles may be divided into three periods. In the first, prior to 1877–78, a number of investigators were at work upon it, among them Donné, Zimmerman, and Erb. In 1874 Osler pointed out that the granule masses of Schultze only formed after the blood was withdrawn from the blood-vessels. In the second period, 1877–78, Hayem demonstrated the existence of this third corpuscle, and called it haematoblast. In 1882 additional researches were made by Bizzozero, who described it as a blood-plate. In the third period, from 1882 to the present time, a number of investigators have been at work, and there have appeared some twenty different articles upon the subject. Kemp has been investigating the question at the Johns Hopkins university, and his paper will contain a full bibliography.

The second lecture in the course was delivered March 27, and treated of the degeneration and the regeneration of the corpuscles.

In our study of the blood, we find that there are factors constantly at work to maintain its histological uniformity, but as to these processes our knowledge is still very imperfect. In some conditions, as during fever, anaemia, and after hemorrhages, the number of the red corpuscles is very much diminished. In profound anaemia there will be found in the blood the normal red corpuscle, certain small corpuscles to which the name microcytes has been given, and larger ones, known as megalocytes. In addition to these, are very irregular forms known as poikilocytes. In atrophy of the stomach the condition of microcytosis, in which the microcytes abound, is very marked. The interesting question concerning these forms is, Are they young cells on their way to the formation of the red corpuscle, or are they degenerated red corpuscles on their way to disintegration? Hayem considers that first in order come the blood-plaques, and then the microcytes: Osler, on the other hand, believes them to be degenerated corpuscles, fragments of the old ones. In anaemia, where the irregular shape of the corpuscles is marked, or the condition of poikilocytosis, as it is termed, this may go on to such a degree as to lead to the separation of small particles; and this suggests a possible origin of the microcytes. They may also be formed from the red corpuscles by fission and budding, as may be seen in the red marrow of the bone.

The megalocyte may be studied in anaemia induced by hemorrhage. It has a diameter twice that of the red corpuscle, fourteen millimetres: it is not usually circular nor biconcave, but flattened and irregular. In these cases of induced anaemia by hemorrhage, the white corpuscles are increased in number, both relatively and absolutely; and, as we have already learned, the blood-plaques are increased. In severe anaemia or leukaemia we may find nucleated red blood corpuscles, which are normally formed during foetal life, in the new-born, and up to the age of four or five years. One of these may be seen in every three or four fields. These corpuscles in various stages of development may be studied in the red marrow of the bone, as the vertebrae and the ribs of the child and embryo. Here we find a small solid cell or nucleus; next, this with a layer of translucent protoplasm; next the protoplasm becomes colored, and we have a nucleated red corpuscle. The nucleus gradually disappears and disintegrates, giving us the non-nucleated red corpuscle. Rindfleisch thinks the nucleus emigrates from the corpuscle, but Osler thinks this is a post-mortem change when it occurs. Some authorities regard these extended nuclei as the blood-plaques. Bizzozero describes a process of fission in the red corpuscle by which it becomes two cells, and thus explains the formation of new corpuscles, those that undergo fission being direct descendants from the embryonic red corpuscles. Hayem regards the blood-plaques as becoming the red corpuscles. In cells which are to be seen in lymph-glands, in the spleen and the bone-marrow, are oftentimes to be found red corpuscles, which some regard as on their way to degeneration: others look upon them as being new cells. In this intracellular production of the red corpuscles, Osler is a believer.

The third and last lecture of Professor Osler, in the Cartwright course before the Alumni association of the College of physicians and surgeons, was delivered on March 30, and dealt with 'The relation of the corpuscles to the process of coagulation.'

The views of Buchanan, published soon after 1830, that the coagulation of the blood was dependent upon the white corpuscles, which acted like a ferment somewhat as rennet does in the coagulation of caseine, had for many years been forgotten and ignored. Schmidt of Dorpat, and his pupils, later elaborated these views of Buchanan. They considered that the white corpuscles furnish fibrinoplastine or paraglobuline, and a ferment, while fibrinogen exists normally in the plasma of the blood; that the white corpuscles, in furnishing these two elements, undergo disintegration and destruction.

Woolridge has, within the past few years, maintained that the white corpuscles play an important part in the formation of fibrine. He has been able to procure leucocytes, or colorless corpuscles, from the lymph-glands; and when these corpuscles, to which has been added an equal volume of a ten-per-cent solution of salt, are placed in peptone-plasma obtained from the blood of an animal into whose vessels peptone has been injected, coagulation at once takes place. The quantity of fibrine which is thus produced depends upon the number of leucocytes added. These corpuscles seem to form the fibrine, and the weight of the fibrine is the same as that of the leucocytes added. The albumen undergoes no change, while examination shows that the leucocytes have undergone disintegration.

The formation of fibrine in the blood may be studied in the moist chamber. The time at which the process commences varies from fifteen seconds to two minutes. Before coagulation commences, all the corpuscles can be easily distinguished; and Osler has never seen any appearance indicating

that the fibrine filaments were formed by a disintegration of the white corpuscles. On the other hand, these corpuscles seem to be stable elements. As a matter of fact, no observer has claimed ever to have seen the actual change of a corpuscle into fibrine.

The process of coagulation can also be studied in a fine capillary tube. The clot forms in the centre, and the serum outside. The white corpuscles seem to be squeezed out of the clot, or to migrate from it.

Landois, whose observations were made some ten years ago, thinks that the red corpuscles are connected with the formation of fibrine.

But the most interesting of all the problems is the relation of the blood-plaques to this process of coagulation. In blood drawn from the vessels we see fine filaments shooting out radially from the granule masses of Schultze, — those masses which we have already learned are collections of the blood-plaques. Ranvier, in 1873, regarded these as the centres of fibrine formation. The fibrine certainly does stand in a thick, dense network about these masses. In healthy blood, fibrine also appears entirely independent of the plaques. The filaments are fine, and appear much like margarine crystals. These filaments may be especially dense near the plaques; but any one can satisfy himself, by examining the blood in the moist chamber, that the fibrine forms independently of them as well. If we pass a ligature through the femoral vein of a dog, and allow it to remain for five minutes, particularly if we have separated the threads of the ligature, and then examine it, we shall find it coated with blood-plaques. If the blood of a dog is received into a cup, and this is whipped with a brush of threads for five minutes, we have the same aggregation of the plaques upon the threads: some white corpuscles will also be found, but the plaques are the striking feature. If these threads are dipped into a solution containing a coagulable substance, clotting will at once take place. The greater the number of blood-plaques, the denser and firmer will be the clot.

Still more instructive and interesting is the study of thrombosis, or clotting in the blood-vessels. If a dog is bled to death through a cut in the femoral artery, and the vessel excised and placed in osmic acid, and subsequently examined, we shall find on the cut edges and in the lumen of the vessel a finely granular material, and outside of this a darker mass composed of red corpuscles. The inner portion, the finely granular material, however, which is in contact with the elastic lamina, is composed of blood-plaques, and not white corpuscles. These plaques are the first elements or factors in the formation of a thrombus. Eberth, in Virchow's 'Archives,' has just shown that the first elements to settle and to lodge on lacerated vessels are blood-plaques. In all white thrombi these plaques seem to make up their bulk. If a needle is passed through a blood-vessel in the omentum of a living animal, the first elements which collect at the point of injury are the blood-plaques, and a distinct white thrombus is formed. These observations on the relation of the plaques to coagulation have been made by Bizzozero, Hayem, and Eberth.

In the circulating blood the plaques keep with the red corpuscles. If we examine a vessel of the omentum of the rabbit or guinea-pig, we shall see only a red streak, which occupies the central part of the vessel. In the space between this and the wall of the vessel, in the still layer as it is called, we may occasionally see a few colorless corpuscles. If the circulation now becomes slower, we shall see the plaques in the still layer with these colorless corpuscles. If atheromatous ulcers of the aorta are examined, it will be found that the material which has collected upon them is made up of blood-plaques: the same is true of the vegetations found upon the valves. While the distinct plaque form is apparent in the superficial parts of these structures, and the same is true of white thrombi, the deeper parts are also plaques, but in a granular state of disintegration.

Eberth has shown, that while, in the rapidly circulating blood, the corpuscles and plaques are together, yet, if acid is placed on the edge of a vessel or laceration, the plaques collect, and form a definite aggregation or white thrombus. We frequently find in autopsies atheromatous ulcers or calcareous plates which have no thrombi: in these cases, the circulation during life having been rapid, the plaques remained central; but, as the current becomes slower, these plaques become peripheral, and adhere to surfaces denuded of endothelium, and thrombi result.

LONDON LETTER.

IMPORTANT changes are in progress at Oxford which will give the university a real faculty of medicine. It has hitherto conducted medical examinations for graduates in arts who have obtained their professional education elsewhere, generally at one of the great London hospitals. But in future Oxford men will be able to enter the university as medical students, as has long been the case at Cambridge. It will still be necessary for them, however, to graduate in arts, which will practically mean in the school of natural science, before they can proceed to a medical degree; and,