Physiology at the British Association.

THE outstanding features of this most successful meeting at Edinburgh were the large number of discussions and the giving of an official semi-popular lecture. Before the beginning of the latter a very pleasant interlude was furnished by Prof. Halliburton announcing a presentation to Sir Edward Sharpey Schafer on his seventieth birthday by his former students and co-workers.

The address of the president of the section was followed by a debate. Sir E. Sharpey Schafer discussed three points in connection with physiology, namely, the position of histology, physiology as a pure science, and physiology in relation to clinical medicine. He stated that anatomy is not a dead subject without histology, as it can be developed along the lines of morphology and embryology, but that histology is essential for the proper understanding of physiology. He further pointed out that, although it can be called microscopic anatomy, histology has developed as a branch of physiology. The study of physiology as a pure science is necessary, because it is in the pursuit of knowledge that discoveries are made. It is not always known what practical applications may arise for new knowledge, but by confining one's attention to purely practical applications the reserve of knowledge to be applied will become exhausted. The application of physiology to clinical medicine should come by the clinical teacher having held a position in the physiological laboratory. The physiologist has sufficient work to accomplish in his laboratory without attempting to become a clinician. By the proper training of clinical teachers in physiology it is hoped that invaluable applications will arise in medical practice.

A number of other speakers took part, all of whom enforced the views of Sir Walter Fletcher that physiology must be studied as a pure science in a university; that the physiologist should study the organism as a whole, so that histology, chemistry, and physics all may be applied to explain the behaviour of living organisms; and that it is only by a combination of all these that one can appreciate to what extent the chemical and physical processes may be regulated in the living cells.

Prof. A. R. Cushny opened a discussion on the relation of tests for studying the efficiency of the kidney to the views as to the function of the kidney. Various tests have been used to test the functional activity of the kidneys without a proper consideration of the conditions of its activity. The excretable substances must be distinguished from the non-excretable. The threshold substances are those which are excreted when their concentration rises above a certain threshold, and the no-threshold substances are those which are completely excreted, *i.e.* they are of no further use to the organism. Of the various substances used, water, chlorides, and urea are not satisfactory, as they are not completely excreted. By comparing the amount of urea and sulphate in blood and urine it has been found that sulphate is concentrated twice as much as urea, so that the functional activity as judged by the sulphate excretion would be twice as great as when judged by the urea excretion. Sulphate, phosphate, and creatinine were concentrated to equal degrees; therefore, the concentration of any of these in plasma and in urine might be measured as a test for functional activity.

Prof. J. Meakins commenced by agreeing that urea is not a toxic substance. He quoted cases where chronic incomplete obstruction of the ureter gave rise to a large volume of dilute urine. If temporary removal of the obstruction causes the kidney function to become normal, this is an indication for surgical interference; but if the excretion does not become normal, surgical interference is contra-indicated. Sometimes one finds that a no-threshold substance (*e.g.* creatinine) is being retained. Retention of urea by itself is not important, because along with this retention one may find such conditions as an excessive excretion of phosphates or a retention of chlorides, which are more responsible for the symptoms. The kidney does not function as a whole under abnormal conditions, and if one adheres too rigidly to one criterion of functional efficiency abnormalities may be overlooked.

Dr. J. S. Haldane expressed the view that under normal conditions the kidney regulates the diffusion pressure of water, but that under some abnormal conditions the level set by the kidney is not that required by the tissues.

Prof. P. T. Herring showed some slides of the skate's kidney, which demonstrated the direct excretion of substances into the kidney tubule. He stated that normally the kidney has a constant function, but in disease the function is variable, being influenced by other organs. A study of the comparative structure of the kidney in various animals may help to show how various parts of the kidney tubule function; part may be absorptive and part excretive.

Prof. A. Krogh (Copenhagen) pointed out that the concentration of urea is the same throughout the tissues, but that it may be present in different concentrations in the various secretions.

Prof. T. H. Milroy re-emphasised the uniformity in concentration of urea in blood and muscle. He added that an increase in concentration of urea in the blood is followed by a latent period before the extra urea is eliminated. The concentration in blood and muscle falls slowly to the former level.

Dr. C. L. Evans thought that local circulatory changes in different parts of the kidney might affect the excretion of different substances by different parts of the tubule. The circulatory changes in arteriosclerosis is a case in point.

Dr. E. P. Poulton stated that in the arterio-sclerotic kidney there is a marked difference between the two parts of the kidney and slight urea retention. In azotoic nephritis urea excretion is damaged, but the chlorides are not retained.

Sir James Mackenzie desired that more attention should be paid to the interrelation of kidneys and other excretory organs, such as the skin and bowels.

Prof. E. P. Cathcart opened a discussion on "Heavy Muscular Work." Heavy muscular work requires a co-ordination of the muscular, circulatory, respiratory, and nervous systems. In carrying out heavy work rest periods are important, but the data concerning the number and duration of them are not yet satisfactory. Overwork is prevented by two factors of safety, namely, fatigue, which is slow in onset and may be produced by any degree of work, and collapse, which is sudden in onset, probably due to heart failure, and not to lack of oxygen-supply to muscles. The former is hastened by monotony, such as in marching, and the latter occurs sooner if the work involves a static or maintained element. The effects of training and of diet are important in determining the power to carry on work. All movements are mixed, but some recent experiments may be quoted as indicating a division into three varieties of work, namely, positive, such as lifting a weight; negative, such as lowering a weight; and static, such as maintaining a weight. The first two correspond to isotonic conditions of contraction, and the last to isometric contraction. As a measurement of the expenditure of energy in these forms of work a subject was given the task of lifting a weight on his hand, lowering the same weight and holding it steady both in the prone and supine positions, the rate of movement being controlled by a metronome:—

Form of work	Calories per sq. m. per hour
Positive	150·9
Negative	124·5
Positive and negative	180·5
Movements without weight	60·1
Static	94·6

In spite of the apparent severity of static work in producing fatigue the metabolism is not excessive, and the fatigue may be due to interference with the circulation.

Prof. A. V. Hill showed curves founded on the heat production of isolated frog's muscles, indicating that maintenance of a contraction is expensive, requiring ten times as much energy expenditure. He also gave results obtained by moving a flywheel at different rates of speed. The rapid rates of movement waste energy because the change of form of muscle requires work to be done in overcoming the viscosity of muscle, whilst slower rate of movement allows a larger proportion of energy to appear as external work. It is important to find out the most efficient relation between the work to be done and the rate at which it should be carried out.

Prof. H. Briggs described the physical endurance tests used during the war. He showed curves relating the variation of energy expended with the work done. A normal load is one which can be continued indefinitely. It was found that well-trained men get assistance from breathing oxygen only when doing excessive work, whilst a man in poor condition is helped by breathing oxygen with smaller loads. Stamina is the ability to maintain work. It appears that habitual hard work may maintain a man's stamina to greater ages than is found in sedentary individuals.

Dr. J. S. Haldane quoted experiments on the circulatory side of work. These experiments were made on man, the lungs being used as an aerotonometer. With increasing severity of work the blood-flow increases exponentially, whilst the percentage of oxygen desaturation of the blood rises logarithmically, and the output per heart-beat remains almost uniform. Therefore, the pulse-rate varies with the blood-flow. In a few individuals in whom the percentage of oxygen utilisation is already high the output of the heart increases as well as the rate of beat. Acapnia decreases circulation-rate, and is thus unfavourable to work.

Prof. A. V. Hill reported some results on pulse conduction in relation to blood-pressure, using the hot-wire sphygmograph. The pulse conduction can be expressed by

$$3{\cdot}57/\sqrt{\text{per cent. increase of arterial volume per mm. Hg increase in pressure.}}$$

By measuring systolic and diastolic pressures and the rate of pulse conduction it is possible to estimate the increase in volume of the arterial reservoir at each heart-beat.

Prof. A. D. Waller described the simplified method for the estimation of physiological cost of work done under various industrial conditions. He suggested that, instead of the various arbitrary terms such as sedentary, light, medium, and heavy work, one should use the energy expenditures of 100, 200, 300, and 400 kilogram metres respectively.

Prof. A. Krogh laid emphasis on the effect of diet on the respiratory quotient and on efficiency. For short experiments a diet containing plenty of carbohydrate is better for maintained exertion. He criticised Prof. Waller's technique, but said that it was probably satisfactory for the investigation of energy expenditure under working conditions in industry. Prof. Waller's methods were criticised by several others. Some criticisms were on technical points, such as the accuracy of dry meters, temperature and pressure measurements or the size of bag used in collecting the expired air, and some were on the results, namely, the low carbon dioxide output in his published work. As Prof. Briggs pointed out, there may be greater sources of error neglected by both sets of workers than those due to the errors of analysis.

The discussion terminated by a paper on "The Economy of Human Effort in Industry" by Mr. E. Farmer. The aim of his study was to find more rapid methods of carrying out industrial processes. One must see the effect on output without the stimulus of special pay. The principles to be used in devising new methods are to encourage smooth movements without marked change in direction and to avoid the intervention of discrimination. He gave examples of increased output in packing chocolates and in metal polishing. Further points requiring study are: What is monotony, what is the influence of noise, and what is the influence of vibration on the workers?

A few individual papers were given.

Prof. A. Krogh described a simple apparatus, consisting of a volume recorder containing soda lime, for measuring oxygen consumption. The soda lime absorbs all carbon dioxide and the volume decrease as recorded on a kymograph gives a measure of the oxygen absorption.

Dr. J. C. Drummond gave an interesting account of some recent work in connection with vitamins and their relation to public health. Green plants and fruits are the main source of vitamins. Dairy products are good in furnishing the vitamins provided that the cows have been fed on green food containing them. The plankton in the sea by the presence of green plants is a source of vitamins which we obtain in fish and fish-oils. It is important that industrial populations should obtain a proper supply of vitamins, because a relative deficiency in them may cause ill-health without the appearance of such diseases as scurvy or beri-beri.

Dr. F. W. Edridge-Green reported experiments on mixing white light with spectral colours. He was followed by Dr. Shaxby, who described a useful instrument consisting of a grating spectroscope with two collimators by which the spectra are formed in reversed order. By a shutter in the eye-piece it is possible to compare monochromatic patches in reversed order.

Dr. R. J. S. McDowall read a paper on "The Independence of the Pulmonary Circulation as shown by the Action of Pituitary Extract." Tracings were shown in which the pulmonary pressure was seen to vary independently of the systemic circulation.

Dr. E. P. Poulton and Dr. W. W. Payne read a paper on "Epigastric Pain." They consider that epigastric pain is not necessarily referred pain, but that it may be due to spasmodic contractions of the œsophagus, stomach, or duodenum.

A number of demonstrations were given, and one afternoon was spent seeing some of these at the Clinical Laboratory, Royal Infirmary. Amongst these demonstrations were Dr. R. K. S. Lim, demonstration of the mucoid cells of the stomach; Dr. E. P. Poulton and Dr. W. W. Payne, peristalsis of the human œsophagus; Mr. McClure, psychogalvanic reflex; and Prof. J. Meakins, respiration with decreased volume per respiration, with and without oxygen, and effect of resistance to breathing on respiration at rest and whilst working.

The Week in West Africa

AT a meeting of the Royal Anthropological Institute held on December 13 Mr. Northcote W. Thomas read a paper on "The Week in West Africa." He said there were in West Africa a number of sub-divisions of the lunar month, such as 16-day periods, 10-day periods, and the like, the origin of which was either in the market or in some religious belief. There were, in addition, a number of shorter units, comparable to our week, of more uncertain origin; they ranged in length from two to eight days. They were very rarely sub-divisions of the month, and there was reason, where the week is synchronised with the month, to suspect foreign influence. Generally speaking, the month in West Africa was of small importance and played no part in economic or religious life; it was reckoned from the day on which the new moon was first seen, but the native can only very rarely say of how many days it consists. There was no less uncertainty as to the length of the year; few, if any, tribes had any exact knowledge of its length. The calendar was sometimes adjusted by the recognition of two years of different length, as in Benin, where the female year seems to have been about 340 days in length.

The week has been traced to a religious origin. Webster has regarded the "rest day" as its germ, but the rest day is an institution of agricultural people, and there are many such peoples in Africa who have no week. On the other hand, the distribution of the market is practically conterminous with that of the week, and it is probable that the calendar first came into existence as a means of indicating the market day. We have, however, little or no evidence to show why the different units were chosen. A certain number of day-names are derived from names of deities, notably on the Gold Coast, but, generally speaking, the kind of work done on a given day or the market attended is the decisive factor, and consequently they are used only in a small area. To this there is one striking exception; the Ibo day-names, used also in a different order in Benin City, are found everywhere from the Niger to the Cross River, but we are ignorant of their meaning.

The four-day week of the Lower Niger, which appears to be independent of the week of the Congo, seems to occupy the largest area; but we know too little of the distribution of the five- and six-day weeks, especially in French territory, to make any very definite assertion. There is good reason to suppose that a non-Mohammedan seven-day week was known; some of these weeks are clearly expanded from an earlier four-day week, but they have native, not Arabic, names.

Scientific Research and Industrial Development.

IN a lecture on "The Benefits of Research to Corporations" (No. 18, R. and C. Series of Nat. Res. Council, U.S.A., 1921) Dr. Charles L. Reese, chemical director of the de Pont de Nemours Explosives Co., U.S.A., gives examples of the advantages which accrue when a large industrial concern is equipped with a staff capable of applying scientific knowledge to the improvement of materials and processes.

Before the war this important company had already systematised its procedure by developing a system of records and costing, and had completed a number of investigations which had been the means of saving money, resulting, for example, in methods for shortening the time of separation of nitroglycerine from its acids, increasing its yield, preventing its freezing in dynamites, and for nitrating cellulose by the use of the mechanical dipper. Studies from the company's laboratories on the nitration of toluene and of the characteristics of nitrocellulose propellants became of great importance when war broke out, as did also a process for the recovery of a considerable proportion of the alcohol used in gelatinising the propellant, this leading to a direct saving in corn—estimated at ten million bushels—which thus escaped being fermented.

During the war enormous extensions were made by the company for the production of nitrocellulose powder, trinitrotoluene, picric acid, amatol, and tetryl, and in this connection it is stated that the staff of the chemical and mechanical research departments of the firm was increased in number from 212 to 987, with an expenditure on experiment and research of 3,360,000 dollars for four years of the war, the output of military explosives being seven million tons.

Since the war the company has transferred its research organisation with success to the production of dyes, and is spending, and is prepared to spend, many millions of dollars on research to meet German competition, but protection is considered to be essential at present to the existence of the industry.

The address is interesting as giving an idea of the scope and the methods of a large chemical concern in utilising the services of scientific men for the investigation of new processes and the conservation of materials. A custom obtains with the company of recompensing inventors by means of a bonus in the form of the company's stock, in some cases sufficient to make them independent.

Little mention is made, however, of research on the theory of explosives, on which doubtless much work has been done by the staff. A few remarks may be made as to some subject-matter of the claims. Thus, while the mechanical dipper was undoubtedly an advance for obtaining output on the old pot-process of making nitrocellulose, the Thomson displacement process as used in this country and in France also greatly reduces handling of the material and eliminates fuming off, which appears still to occur occasionally with the mechanical dipper. Much is made of the "work found necessary to develop satisfactory methods for loading that very successful high explosive developed in England known as amatol, a mixture of trinitrotoluene and ammonium nitrate," but it is understood that an enormous