Vapour pressure measurements indicate that the rise in osmotic pressure when a muscle is fatigued to exhaustion in nitrogen is considerably larger than can be accounted for by all the known breakdown reactions added together: only about 75 per cent of the observed change is accounted for by lactic acid production and phosphagen breakdown (assuming the latter to be in combination with some colloidal constituent and therefore to exert a negligible osmotic pressure, since it is non-diffusible). As mentioned above, the resting muscle in nitrogen produces heat at the expense of the breakdown of phosphoric esters; the heat production, moreover, remains constant although the rate of phosphate formation decreases. Both these facts suggest the existence of other reactions in muscle which still await discovery.

In invertebrate muscle, arginine phosphate plays the same part as creatine phosphate in vertebrates. *In vitro*, the breakdown of creatine phosphate is accelerated by the presence of molybdate, whilst that of arginine phosphate is retarded to an equal degree.

In conclusion, it may be pointed out that the phosphagen mechanism appears to be peculiar to muscle; it is both quicker and more efficient than the lactic acid mechanism, which appears to be a property common to all animal cells and perhaps represents the fundamental source of energy in animal organisms.

In a recent article in our columns[2] Prof. O. Meyerhof has reviewed our present knowledge of the lactic acid mechanism of muscle. Glycericaldehydephosphoric acid and dioxyacetonephosphoric acid are formed from the phosphoric esters originally present, an equilibrium mixture of aldose- and ketose-monophosphoric acid, probably with fructosediphosphoric acid as an intermediate step, and then converted to α-glycerophosphoric acid and glyceric-acid-monophosphoric acid ('phosphoglyceric acid'), from the latter of which pyruvic acid and phosphoric acid are formed. The pyruvic acid reacts with the α-glycerophosphoric acid to form lactic acid and a triosephosphoric acid which then undergoes rearrangement with the formation of glyceric-acid-monophosphoric acid and glycerophosphoric acid. The inhibition of the mechanism by monoiodoacetic acid is due to inhibition of the reaction of pyruvic acid with glycerophosphoric acid. Sodium fluoride inhibits lactic acid formation by preventing the splitting off of phosphoric acid from the phosphoglyceric acid.

[1] *Biol. Rev.*, vol. 8, pp. 46 and 74; 1933.
[2] NATURE, 132, 337 and 373; 1933.

Psycho-physiological Research in Industry

A DISCUSSION arranged by the Department of Industrial Co-operation of Section F (Economic Science and Statistics) of the British Association on September 11 was devoted to the psycho-physiological requirements of modern factory equipment. Sir Henry Fowler presided, and two papers were presented. The first, by Dr. G. P. Crowden, of the London School of Hygiene and Tropical Medicine, dealt with the practical value of physiology to industry. Dr. Crowden referred to the gap which frequently exists between discoveries and knowledge acquired by experimental work in research laboratories and their application for the general comfort, efficiency and health of mankind. Physiology can, to a large extent, define the needs of man which are essential for the maintenance of normal healthy life, and the nature and mode of execution of industrial operations in relation to the capacity for and the efficient performance of muscular work by the human body is a physiological problem. The strain placed on the body when working under extreme conditions of temperature and humidity, the relation of hours of work and the rate of working to the production of normal or excessive fatigue, the intensity and arrangement of lighting which permits the eye to see with maximum efficiency and minimum strain, the effects of noise and vibration on the human body, are all matters falling within the scope of physiology. Equally, the applications of physiology in industry are concerned with the products of industry.

Discussing the physiological factors which must be considered in any industrial problem, Dr. Crowden said that these fall into four groups: the work factor, comprising the study of the muscular effort involved, the environmental factor, the time factor and the personal factor. The latter is largely outside the control of the management and only education, understanding and goodwill between employees and employers can ensure that this factor does not discount the good results achieved by attention to the other factors.

Dr. Crowden described the results of a number of recent investigations on these various factors, including studies of muscular work in industry, the effect of noise and vibration, particularly in connexion with the use of pneumatic tools, and emphasised the necessity of supplementing laboratory work by field work. Close co-operation between physiologists and industrialists is essential. Important investigations are also being carried out on lighting, ventilation and heating, as well as on the efficiency of manufactured products such as the insulation from heat of sun helmets, etc., which has already led to the design of new helmets. A great deal can still be done in this way to improve the conditions of habitation in the tropics and elsewhere with advantage to health and efficiency.

The second paper was contributed by Dr. G. H. Miles and dealt with the human factor in relation to the design of factory equipment and machinery. The interest of modern management, not only in the mechanical results but also in the efficiency with which they can be repeated throughout each working-day, is leading designers of factory equipment and machinery to take into account the limitations of those who use the machinery and equipment. Limitations may be imposed by fatigue caused by badly arranged controls or working positions, unnecessarily heavy muscular effort, harmful posture, etc.; by the rhythm of machinery operations not synchronising with the worker's rhythm; by badly placed working or observation points; by distraction of attention by moving parts or in other ways; or by waste of effort due to bad design in setting up, stripping or cleaning machines.

Defects of this kind are frequently overcome by human effort but at the expense of the quality of work, and the whole unnecessary strain is detrimental to human welfare. The machine should be designed to fit the human being, and when mechanical or process limitations make this difficult, the adjustment should be facilitated by careful selection of the most suitable workers for the machine or process.