increase of activity (amoeboid motion?). Later, when a greater amount of the substance has been taken in, the paralysing effect gets the upper hand. With alcohol the same experience is well known.

In following this point we are led to think of the remarkable influence of a sojourn in high mountain regions, on metabolism, on sleep, and on the state of the mind. The cause is entirely unknown. It has been proved that these phenomena are not due to the height as such, for in balloons they do not occur, nor are they found in high mountain regions, but when examining where they are observed, we find that it is in the neighbourhood of coniferous woods. So we are inclined to think that it is due to the stimulating effect of the odour of resin (turpentine, etc.) on the nerve-cells.

Prof. Sherrington and Miss Sowton, in their studies on the dosage of the mammalian heart by chloroform, found that, especially with greater amounts of the drug, it was usual for the first effect of the administration to be a distinct though slight increase in amplitude of the contractions. After cessation of the administration of the drug in moderate dose, it was not unusual before the recovery of the beat for the heart to pass over for a short time into a condition of super-activity. These phenomena suggest an irritative excitatory effect of small doses of the substance on muscle or nerve-fibres (or both) of the heart. These results agree with those previously obtained by Prof. A. D. Waller in his experiments with the isolated nerve.

There are experiments also with other organs which may be considered in the same light. Thus Prof. J. Loeb discovered that substances dissolving fat have the power of rendering possible the parthenogenetic development of eggs. Now we may imagine, with Loeb, that the substance dissolves in a lipid of the outer layer of the egg, thus giving rise to the formation of a fertilising membrane. We think we may safely go one step further and assume that it is owing to the weakening of the membrane that the movement of the protoplasm underlying every cell division manifests itself. This view is confirmed by the observation of Prof. R. S. Lillie, who saw also that by a short transitory raising of the temperature in the eggs of starfishes a typical fertilising membrane may be formed, which formation is followed by the development of part of the eggs into larvæ. J. Loeb was able to confirm this for *Medusa*.

After consideration of the foregoing facts and suggestions, we were inclined to think that the stimulating effect of traces of substances which dissolve fat on the activity of cells is a widespread phenomenon. Hence we have investigated whether this influence might also be seen in *plant-cells*. To do so, we chose the germination of seeds, a process in which a considerable division and growth of cells manifests itself. The seeds we chose were grains of wheat, and for the fat-solvent we took chloroform. With chloroform, 1 part to 100,000, an important acceleration in the germination was observed; chloroform 1 to 1000, on the contrary, impaired the germination, evidently because a second factor made itself felt, viz. paralysis of the protoplasm. Later I heard that in practice the growth of snowdrops is promoted by ether. In recent times Chiari succeeded in forcing blossoms to a considerable extent by ether-vapour, and Mansfield the germination of pumpkin-seeds by vapour of alcohol and ether.

Hence it is clear that the observations on phagocytosis deserve our attention on general grounds as well as special. We do not at all mean to say that all substances dissolving fat have the same effect on cells of all kinds; far from it. I would emphasise

that, in order to be brief and to avoid complexity of detail, I have here presented the matter somewhat simpler than it really is. Nor have all the suggestions here made towards explaining facts regarding other cells than phagocytes been actually proved. Without hypothesis, science cannot progress. Fortunately we need not stay in error for long, for we can always appeal to the supreme judge, experiment.

This account of results and views, the fruit of some years' work with several collaborators (Hekma, de Haan, etc.),² being of necessity incomplete, I have attempted to select what may specially interest the general scientific reader.

We are continuing our study of the biology of phagocytes, and each day we become more convinced of their excellence as a simple object, for the study of problems of a general biochemical nature, and for some of practical interest as well.

H. J. HAMBURGER.

IRELAND'S INDUSTRIAL OPPORTUNITIES.

A LECTURE delivered in April last before the Insurance Institute of Ireland by Mr. George Fletcher, the assistant secretary of technical instruction, and recently issued in pamphlet form, deserves the serious attention of all well-wishers of Ireland. We have in Ireland a population little more than half of what it was in 1841, and which is now annually depleted by emigration to such an extent that any increase in its population is well-nigh impossible.

It is obviously, therefore, of the highest possible importance to the well-being, not merely of Ireland, but also of the kingdom generally, that means should be taken to ensure the utmost development alike in agriculture as in manufactured products, since it is now clearly realised that it is only by a combination of both that the well-being of Ireland can be firmly established.

The Department of Agriculture and Technical Instruction established in 1899, mainly through the strenuous efforts of Sir Horace Plunket, the first vice-president, has done much for the promotion of agriculture and its products and of manufacturing industry. Improved methods have been introduced into farming, fishery, and industrial operations, especially in the latter case by the encouragement of cottage industries, with a view to find employment for the rural population in times and seasons not devoted to agricultural work, and with a view also to add to the interest of an otherwise monotonous life.

Large sums have been spent as a result of local and Governmental effort in the promotion of technical education, with the result that now practically all over Ireland facilities exist for the due training of the workers engaged in agricultural and industrial pursuits. At the same time, the Department has persistently urged the necessity, if technical training is to be of any real value, of a better and more pervading system of elementary and secondary education upon which to found it, and also for the reason that it is desirable to widen by means of a sound general education the mental horizon of the people.

Believing that no permanent good can be ensured except by the co-operation of the people themselves, it has been the aim of the Department to encourage the formation of associations of farmers and manufacturers, so as to secure a sense of solidarity and of common effort.

² A full account of the researches as far as the year 1912 can be found in my monograph "Physikalisch chemische Untersuchungen über Phagozyten. Ihre Bedeutung vom allgemein biologischen und pathologischen Gesichtspunkt." (Wiesbaden: J. F. Bergmann, 1912.)

The example of Denmark has proved a potent influence in the measures which have been taken to develop the agricultural resources and products of Ireland. The export value of eggs, butter, beef, mutton, pork, bacon, and hams from Ireland was in 1912 11,820,356l., but in 1913 we received from Denmark alone butter, eggs, and bacon to the value of nearly twenty-two millions sterling.

It cannot be said that this huge difference in value is attributable to a better soil or climate, and, as a matter of fact, it is entirely due to the better education of the people, to a more scientific treatment of the soil and of the animals concerned, and to a stronger sense of the advantages of co-operative effort. It is clear that given these conditions, Ireland, with its much larger acreage and more productive soil, could raise for export the greater part of this importation of food products; and as with agriculture, so with the smaller factory and cottage industries. It is made clear in Mr. Fletcher's address that there is abundant scope for their establishment and development, of which Belgium affords a striking and pregnant example, which the people of Ireland would do well to follow, and thus bring the small town and the countryside into close and harmonious relation.

J. H. REYNOLDS.

AEROPLANE STABILITY.

SOME phases of fore-and-aft or longitudinal equilibrium in flying are discussed by Dr. Orville Wright in a recent publication of the Smithsonian Institution, entitled "Stability of Aeroplanes." Although a beginner finds most difficulty in mastering the lateral control, it is his lack of knowledge of certain features of the fore-and-aft equilibrium which leads to most of the serious accidents.

In an ideal flying machine the centre of gravity would lie in the line of the centre of resistance to forward movement and also in the line of thrust, but in practice this is not always feasible, since the machine must be built to land safely as well as to fly. In flying, a low centre of gravity—that is, one below the centre of support, causes an oscillating movement about the lateral axis like that of a pendulum. On the other hand, a high centre of gravity tends to cause the machine to roll over in landing, and consequently a compromise is adopted.

The two principal methods used in preserving fore-and-aft equilibrium have been the shifting of weight so as to keep the centre of gravity in line with the changing centre of lift, and the utilisation of auxiliary surfaces, known as elevators, to keep the centre of pressure in line with a fixed centre of gravity. The first method has been found impracticable on account of the impossibility of shifting large weights quickly enough, but the second is used in most of the modern flying machines.

Flying machines of the latter type should have their auxiliary surfaces located in the front or rear as far as possible from the main bearing planes, because the greater the distance the greater is the leverage, and consequently the smaller the amount of surface required. No part of either the main surface or auxiliary surface should be exposed on their upper sides in a way to create a downward pressure for maintaining equilibrium.

The downward pressure of air is used to some extent, however, on account of its adaptability, in producing more or less inherent stable aeroplanes. Dr. Wright describes an aeroplane in which equilibrium is maintained by an arrangement of surfaces so placed that when a current of air strikes one part of the

machine, creating a pressure that would tend to disturb the equilibrium, the same current striking another part creates a balancing pressure in the opposite direction. This compensating or correcting pressure is secured without the mechanical movement of any part of the machine. While this system will control a machine to some extent, it depends so much on variation in course and speed as to render it inadequate to meet the demands of a practical flying machine.

In order to secure greater dynamic efficiency and greater manœuvring ability, auxiliary surfaces mechanically operative are used in present flying machines instead of the practically fixed surfaces of the inherently stable type, but they depend to a greater extent upon the skill of the operator in keeping equilibrium. If the operator were able to "feel" exactly the angle at which his aeroplane meets the air, at least 90 cent. of all aeroplane accidents would be eliminated. Instruments for this purpose have been produced, but they are not in general use. The average flier does not realise how dangerous it is to be ignorant of this angle, nor does he know when he is "stalling." By "stalling" Dr. Wright means coming to rest in the air, or nearly so.

The danger from "stalling" comes when the operator attempts to check the machine's downward plunge by turning the main bearing surfaces to still greater angles of incidence, instead of pointing the machine downward, at a smaller angle of incidence, so that the speed can be recovered more quickly. Most of the serious accidents in flying occur, after long glides from considerable heights with the power reduced, when an attempt is made to bring the machine to a more level course several hundred feet in the air. The machine quickly loses its speed and becomes "stalled." Those who have seen the novice make a "pancake" landing have seen the beginning of a case of "stalling" which might have been fatal had it taken place at a height of 100 or 200 ft. in the air.

The greatest danger of flying comes from misjudging the angle of incidence. If a uniform angle were maintained, there would be no difficulty in securing fore-and-aft equilibrium. Experiments made during the past year or two have brought about a considerable advance in the development of automatic stability. A device described by Dr. Wright comprises a small horizontal wind-vane so mounted on the machine as to ride edgewise to the wind when the machine is flying at the desired angle of incidence. In case the machine varies from the desired angle, the air will strike the vane on either its upper or lower side. The slightest movement of the vane in either direction brings into action a powerful mechanism for operating the controlling surfaces. If the wind strikes the vane from the underside the elevator is turned to cause the machine to point downward in front until the normal angle is restored, and if the air strikes the vane from above, an opposite action upon the elevator is produced. The author maintains that a machine so controlled is not liable to "stalling." Another method for maintaining fore-and-aft equilibrium utilises the force of gravity acting on a pendulum or tube of mercury, and a second employs the gyroscopic force of a rapidly revolving wheel. In both these systems, however, the angle of the machine is regulated with reference to the horizontal, or some other determined plane, instead of the angle of the impinging air. Other faults render the pendulum and mercury tube useless in regulating fore-and-aft equilibrium, although the pendulum is found to be useful in regulating the lateral stability.