Cellulose, Starch and Glycogen

A VALUABLE article on recent work on cellulose, starch and glycogen, by Prof. H. Staudinger, has appeared in a recent issue of *Die Naturwissenschaften* (**25**, 673; 1937). The fact that cellulose, starch and glycogen can be converted into esters without altering the degree of polymerization, and can be reconverted into the original substances, as shown by molecular weight determinations, optical rotation and other properties, shows that the glucose residues in the colloidal particles of these substances are linked by principal valencies. The colloidal particles are therefore macro-molecules. The determination of the molecular weights of these substances is discussed. The ebullioscopic and cryoscopic methods are difficult to apply owing to the smallness of the effect, and other anomalies; but molecular weights can be satisfactorily determined from osmotic pressure data using the equation of Schulz, or by Svedberg's method using the ultra-centrifuge. It is also possible to determine them from viscosity data by an equation due to Staudinger. All these methods agree in giving a value about 200,000 for the molecular weight.

X-ray analysis shows the molecule of solid cellulose to be extended, and there is reason for believing that this is also the case in solution. Viscosity determinations show, however, that in starch there is a bending back of the molecules. Starch molecules are only about one eighth as long as they should be if extended. With glycogen, solutions of the same concentration have the same viscosity, no matter what the degree of polymerization. This points to the existence of spherical macro-molecules in this case. The linking of the glucose residues in these three compounds is discussed, and the connexion between physical properties and the shape of the molecule is emphasized.

Colloidal particles can be classified into two groups, linear and spherical colloids, according to the shape of the particles. The latter are powders in the solid state, and dissolve in water without swelling to give solutions of low viscosity. Linear colloids, on the other hand, are tough, fibrous substances, which dissolve with considerable swelling, and form viscous solutions. Glycogen is a typical spherical colloid, and its physical properties are not greatly altered by change in the size of the molecule. Cellulose is a typical linear colloid, and the physical properties depend a good deal on the size of the molecule. Starch occupies a position intermediate between cellulose and glycogen. A similar difference in structure of the macro-molecules is found in the case of the albumens.

The form of the macro-molecule of polysaccharides and albumens decides the different functions of these substances in the living organism. Cellulose forms the solid portions, whereas substances which have to be transported through the organism are spherical colloids.

Twenty-one Years of Glass Technology

THE subject of the presidential address delivered to the Society of Glass Technology at its twenty-first anniversary meeting at Sheffield by Prof. W. E. S. Turner was "Twenty-one Years. A Professor Looks Out on the Glass Industry". This address has now been published (Society of Glass Technology, Sheffield. Pp. 70+46 tables. 10*s.*; postage 3*d.*). Whilst its introductory and short concluding chapters are concerned mainly with the growth and development of the Society of Glass Technology and its international relationships, the major portion is occupied with an account of the great advances, mechanical, chemical and physical, which have revolutionized the ancient craft of glass-making throughout the world. The volume is one for the student of social history and of commerce as well as for those interested in the advances of applied science.

That the development of the completely automatic machine has been the dominant factor in influencing conditions in the industry during the period under review is brought out clearly by means of a carefully collected mass of evidence. The tendency to mechanization was already evident before 1916, as, for example, in the Owens' bottle machine which was brought to a commercial stage in the early years of the century, and by 1914 was in operation in ten European countries as well as in the United States. But its use was limited to a small number of licensees, and similar conditions prevailed with the few machines available in other sections of the industry.

During the intervening years, mechanical progress has been very rapid, and there are now in wide use seven or eight different types of bottle machine, as well as automatic machines for the manufacture of tumblers and other domestic ware, plate and sheet glass, electric lamp bulbs and tubing. The change has led to an enormous increase of productive power, as is evidenced, for example, by a growth of the annual output of containers in Great Britain between the years 1924 and 1935 by sixty-two per cent, or to take a still more striking example, of an increase of machine-made electric lamp-bulbs in Europe from 2½ millions in 1919 to 127 millions in 1932.

Concurrently with the advance of the machine has been the steady disappearance of the skilled glass-blower, for a single bottle machine may equal the output of more than fifty men, and, to take an extreme case, the most modern lamp-bulb machine, the Corning 399, has produced more than 500,000 bulbs daily, equivalent to the production of 500 glass-blowers. The same tendency has not been at work in other branches of labour, for there is evidence even of a slight improvement in total employment in the industry, due to the great increase of sales of glassware, largely induced by the cheapening of production, for which the machine has been primarily responsible.

Two other consequences have issued from the increased use of machinery. The first is the ousting of the small works and the concentration of production to an increasing degree in fewer but larger factories (the number of window glass works, for example, in the United States fell from 79 in 1919 to 18 in 1933). A second result has been a rapid world-wide spread of the industry, for the recent growth in many additional countries, of which Japan is an outstanding example, would not have been possible if it had depended on a supply of skilled glass-blowers.

With the development of machine production, and indeed rendered necessary by it, there has been a corresponding improvement in furnaces and refractory materials, in feeding devices for molten glass, and in lehrs for annealing the finished product.

In the striking advance here so admirably illustrated, the chemist and physicist, in addition to the engineer, have played a decisive part. To them has fallen such tasks as providing purer and more varied supplies of raw materials in ever-increasing quantities, and exploring the relationships between the chemical composition and chemical and physical properties of glasses so that a material most suitable for each type of production might be obtained. But the attention of the technologist has been by no means confined to the field of mass production, and a number of fresh developments in various fields during recent years testify to his industry. Among them may be cited 'Vita' glass, Safety glasses, Pyrex glass, Vitrolite, glass building bricks and modern glass wool or silk.

These and other advances in the art and science of glass-making have been reflected in the marked growth of technical training and research institutions and in the copious output of valuable literature, of which the *Journal of the Society of Glass Technology* is a striking example.

Science News a Century Ago

Debate on Civil List Pensions

IN the House of Commons on December 19, 1837, Mr. Rice, the Chancellor of the Exchequer, moved that the Civil List Bill be read a third time. To this, Mr. Grote, the historian, then M.P. for the City of London, replied by moving an amendment that the clause empowering Her Majesty to grant a certain sum [£1,200] annually should be struck out. He maintained that pensions ought no longer to be assigned at the mere arbitrary and irresponsible will of the Sovereign. The proper distribution of these involved a great public duty, and the House should take them under its control.

Sir Robert Peel, speaking against the amendment, said that the sum of £1,200 as a provision for the United Kingdom was too limited. The honorable gentleman [Mr. Grote] would do away with pensions altogether, but cases would arise—cases where it would be proved that men of science had devoted the energies of their minds and fortunes for the benefit of society, and then the country would revolt against the niggardly conduct of Parliament. A pension and an honorary dignity were on the same principle awarded by the Crown. Literary and scientific men should, in his opinion, receive pensions if they stood in need of them; if not, they should receive those conventional distinctions, which the Crown alone should have the power of conferring. Mr. Buller, the member for Liskeard, who agreed in the main with Sir Robert Peel, said it was almost impossible to point out one instance of a person who had benefited his posterity either by his writings or his advancement of science, from the time of Chaucer to the present day, who had not been supported by either the bounty of the Crown or the charity of some individual.

In the course of the debate, references were made to Locke, Johnson, Southey, Wordsworth, Coleridge, Dalton, Wollaston, Airy and Mrs. Somerville. Mr. Buller also referred to the case of "Mr. Wallace, who had been for many years Professor of mathematics at Edinburgh, and who was second only to Ivory in his talents or attainments, and yet when he applied for a pension he was refused: he considered this a cruel case." Mr. Grote's amendment was lost by 23 votes to 125.

Faraday's Experimental Researches

AT a meeting of the Royal Society on December 21, 1837, Faraday continued the reading of his "Experimental Researches in Electricity", Eleventh Series. The reading of the paper had been begun on December 14 and its concluding portion was read on January 11, 1838. The official abstract said: "The object of this paper is to establish two general principles relating to the theory of electricity, which appear to be of great importance: first, that induction is in all cases the result of the actions of contiguous particles; and secondly, that different insulators have different inductive capacities. . . . In conclusion, the author remarks, that induction appears to be essentially an action of contiguous particles, through the intermediation of which the electric force originating or appearing at a certain place, is propagated to or sustained at a distance, appearing there as a force of the same kind and exactly equal in amount, but opposite in its direction and tendencies. Induction requires no sensible thickness in the conductors which may be used to limit its extent. . . . But with regard to dielectric or insulating media, the results are very different; for their thickness has an immediate and important influence in the degree of induction. As to their quality, though all gases and vapours are alike, whatever be their state, amongst solid bodies, and between them and gases, there are differences which prove the existence of specific inductive capacity."

Naturalists in Abyssinia

"FRENCH and German naturalists," said the *Athenæum* of December 23, 1837, "are overrunning Abyssinia in all directions. Letters have just been received from Schimper, who was sent by the Würtemberg Naturalists' Society, to Africa. After sending home a collection of plants from the Hedjas and Mount Sinai, he arrived at Massawa in January, where great obstacles were raised to his prosecuting his journey, by the recent circumstance of two French travellers having been killed in Abyssinia. However, he succeeded in reaching Arkíko and Haley, and thence sent on to the Abyssinian King Wabeah, who was encamped at Hazabo, between Adowa and Axum, for permission and safe conduct. This was granted, and he was soon welcomed at Adowa, the king's capital, by the German missionaries, sent from England; Blumhardt and Isenberg. From thence he intends to prosecute his scientific tour to the Abyssinian Alps." Wilhelm Schimper was born in Mannheim in 1804 and died at Adowa in 1878.