

## Surface Chemistry

THE immense progress that has been made in unravelling the details of surface phenomena, since the fifty years old generalisation of J. J. Thomson and Willard Gibbs that the energy conditions at surfaces may profoundly modify not only the concentrations, but also the chemical equilibria at surfaces, were well surveyed on September 6 in a vigorous and crowded discussion held by Section B (Chemistry) at the Norwich meeting of the British Association. The principal speakers were Profs. H. Freundlich, E. Waldschmidt-Leitz, E. C. C. Baly and E. K. Rideal, and Drs. N. K. Adam, A. H. Hughes and J. H. Schulman. Many of the outstanding points in the behaviour of molecules at the principal types of surfaces which occur in systems of actual or potential biological importance were touched upon in more or less detail.

With the simplest kinds of surface film, the unimolecular films at water-air surfaces, the structure is now so fully known that the size, shape, mechanical properties, orientation and motion of the molecules can be discerned in much detail. The links, also, with structural organic chemistry have been made secure by establishing the truth of Langmuir's generalisations that the surface films behave just as would be expected of a layer of floating objects having all the properties of the molecular models of the organic chemist, and that the field of force of the surface is simply the aggregate of the chemical forces round the surfaces of the individual molecules. Fatty compounds and sterols may have any of a large number of different types of film; the molecules may stand upright, or lie flat, or oscillate through various positions, always, however, keeping the water-attracting end to the water. Proteins and the higher carbohydrates lie flat if there is sufficient space on the surface; they may tilt a little if compressed, but never stand upright. With these simple films every stage of compactness is found, from the dilute gaseous films which have the molecules lying flat and swimming about individually in the surface, to the solid condensed films where they are upright, close packed, and interlocked so as to form a two-dimensional polycrystalline structure.

Unimolecular films may, or may not, be actually present as membranes in living cells; but that their properties are of fundamental importance for cell behaviour is already clear. It is possible to imitate, quite closely, on synthetic unimolecular films of substances present in red blood corpuscles,

the phenomenon of hæmolysis. Hæmolytic agents introduced into the underlying water cause a great increase in surface pressure, penetrating into the natural film so as to force the molecules apart and cause it to expand, destroying its natural cohesion. Some such penetration and expansion of the membrane round a corpuscle must occur during hæmolysis. Probably agglutination is essentially due to the penetration of substances into the film, the molecules of which orientate themselves so as to render the outer surface more hydrophobic; the attraction of the cell surface for water is thus diminished and the cells tend to clump together.

There is, as yet, no proof that the intrinsic reactivity of molecules is altered merely by adsorption at a *liquid* surface, but nevertheless the surface may greatly affect the chemical equilibrium and the velocity of chemical reaction, through two factors. First, the actual concentration of the molecular species is usually very much altered through adsorption; secondly, the accessibility of the reacting portions of the molecules may be affected by the particular orientation in the surface. For example, the oxidation of unimolecular films of unsaturated fatty acids which have a double bond in the middle of the hydrocarbon chains is much accelerated if sufficient space is allowed on the surface for the chains to lie nearly flat, so that the double bonds can easily come into contact with the oxidising agent in the underlying water; the oxidation is retarded if the film is squeezed so as to push the chains more upright and the double bonds away from the water. Electrolytic dissociation, also, is often affected by adsorption at the simplest kind of surfaces, a phenomenon which may cause indicators to play unpleasant tricks in solutions of colloidal substances. All such phenomena are, however, only effects of the changes in the environment of the reacting groups in the adsorbed molecules, caused by their crowding and special orientation at the surfaces. A *liquid* surface seems incompetent to impose on adsorbed molecules the strains necessary to activate them, and catalyse the variety of reactions which are caused by enzymes and many solid surfaces. But certain colloidal supports can certainly do this.

Enzymes consist essentially of colloidal protein particles, on a part of the surface of which there is a grouping of atoms which has specific adsorptive and activating properties. Substances in the surrounding liquid must both be adsorbed on this

active patch and be activated when there; there must be a highly specific relation between the structure of the active patch and the substrate adsorbed from solution for both these processes to occur. These surface patches do not appear to constitute any great part of the mass of the colloidal particle, for many pure enzymes activating very different reactions are so similar in general composition that ordinary chemical analysis cannot distinguish between them. The enzyme may thus be regarded as a colloidal carrier having a specific local surface structure. The nature of the carrier is of importance, though it is secondary to the nature of the surface grouping; if the

carrier is changed the catalytic efficiency of the enzyme may, or may not, be changed. The complex phenomena of activation of enzymes are often due to the combination of two types of particle; and among the most important activators are the sulphhydryl grouping and the iron-containing part of hæmoglobin.

The discussion gave a good idea of the progress made by the new science of the molecular anatomy of surfaces; it is well started and cannot fail to develop rapidly and increase in interest and in usefulness to the biologist, and perhaps ultimately also to the practising physician.

N. K. ADAM.

## Migrations of Animals

A COMPREHENSIVE discussion which covered the movements of most of the migratory groups of animals occupied the morning of September 10 at Section D (Zoology) of the British Association at Norwich and brought together much recent information about migration and theories concerning it.

The discussion was opened by Prof. James Ritchie, of the University of Aberdeen, who dealt with the migrations of mammals and directed attention to two problems—the cause or causes of migration and the way in which migratory routes were determined. He described briefly the well-known large-scale movements of such as the lemmings in Scandinavia, the brown rats which invaded Europe from the Caspian region in 1727, the grey squirrels and martens in North America before 1866. These, due to lack of food following undue multiplication, were casual, rather sporadic, one-way movements—overflow movements and not migration proper, and they aimed at no definite goal. True migrations, regular seasonal goings and comings or two-way movements, are of two types, differing in degree rather than essence. The local migration, shown by the red deer of Scottish hills or the Wapiti deer of the Yellowstone Park in the United States, was a movement from summer feeding grounds at high altitudes to a winter range in the shelter of the valleys. Its primary urge was food.

The great seasonal migrations, impressive in extent as well as in the mass of animals taking part in them, were formerly represented by the movements of the wild horses of the steppes of Asia, of the countless antelopes of Africa, the bison, reindeer and musk-oxen of America. They were determined mainly by scarcity of food, though other 'hungers' for water or for salt, also induced

regular migrations; and their route often followed regular tracks or roads surveyed and made by far distant ancestors after trial and error towards a definite goal. Road-making is characteristic of the daily activities of mammals, and migratory tracks formed a heritable property handed down from generation to generation. Such an explanation of migration avoids the need of invoking any special migratory instinct or special sense of direction.

Dr. N. A. Mackintosh described the migrations of whales from the antarctic region where they are most abundant during the summer, gorging upon the crustacean *Euphausia superba*. In winter they move northwards to temperate waters for the breeding season, and although actual migrations have not been often traced, the circumstantial evidence is strong. For example, in the antarctic, whales fatten enormously as the summer advances, and then off South Africa whales very fat in body and yet with empty stomachs are found, clearly immigrants from the antarctic feeding grounds. Again in winter off the African coast whales bearing fresh scars were found, but when whales were caught in the antarctic the scars were healed—they had been contracted in warmer waters during the northern migration. How the migrating whales are guided on their movements is not clear: except in coastal waters landmarks seem to be out of the question, but perhaps the temperature of the water controls the movements, since the regular presence of whales seen from the *Discovery* in the antarctic shows that they frequent tongues of warm water and are obviously sensitive to temperature.

Recent discoveries regarding the migrations of birds were described by Dr. A. Landsborough Thomson, who pointed out that the old idea of narrow migration routes along coast-lines and river-valleys had been abandoned in favour of the